Generic Images (index, generate, learn): A Heteromatic Environment?

Gaëtan Robillard
Inrev-AIAC University of Paris 8
LDI ENSAD TALM-Tours
e-mail: gaetanrobillard.studio@gmail.com

Prof. Alain Lioret
Inrev-AIAC Université Paris 8
e-mail: alainlioret@gmail.com

Abstract

In the 1960s and 1970s, scientific and technological progress heralded a new industrial era and a new cultural model. Fordism gave way to information society; and post-war modernism to dematerialized post-modern art [1]. The New Tendencies movement which emerged in Zagreb seized upon this rapid development by conducting Computer and Visual Research, offering the possibility of making concealed processes visible in the hope of giving everyone the opportunity to negotiate this future world.

In a society that is now composed with algorithms, dubbed by the promise of a computational intelligence, it is worth asking which place we reserve for the construction of the subject (in the words of the epistemologist Jean Piaget). Art, which is conceived with algorithms and in particular the digital image, is investigated in the context of education. The fact that algorithmic art must be verbalized and formalized would foster an increased reflection on the artistic practice itself. We find these thoughts in the practice of pioneering computer artist Frieder Nake [2]. Following theoretical investigations in generative aesthetics, we will then present a creative implementation.

Generic Images is a creative software project based on an open workshop for algorithmic practice in the context of art education. The procedural drawing software that is presented here serves as an experiment for creating graphical and generative content from a participatory process. Through an experience such as the one proposed how do individuals, algorithms and artistic language interact? Can we talk about a “heteromatic” environment [3]? Can we transpose artistic practice to an algorithm or a software? In retrospect, is a generative image an image that has learned art?

Generic Images website
https://tabouret-studio.github.io/Images-Generiques

Introduction

In a society that is now composed with algorithms, coupled with the promise of a computational intelligence, it is worth asking which place we reserve for the construction of the subject (in the words of the epistemologist Jean Piaget). Art, which is conceived with algorithms and in particular the digital image, is investigated in the context of education. The fact that algorithmic art must be verbalized and formalized would foster an increased reflection on the artistic practice itself.

Generic Images is a creative software project based on an open workshop for art education in the context of algorithmic practice. The procedural drawing software that is presented here serves as an experiment for creating a graphical and generative content from a participatory process. Through an experience such as the one proposed how do individuals, algorithms and artistic language interact? How to structure a cognitive space, which weaves these relations? Can we transpose artistic practice to an algorithm or a software? In retrospect, is a generative image an image that has learned art?

One of the working hypotheses proposed here is that in order to produce an environment specific to artistic development and teaching of generative aesthetics; it is necessary to think of an environment that is both human, software and hardware, and to structure it in three parts: 1° an index of visual elements drawn by hand or generated by algorithmic procedures, 2° "generation" of new arrangements and the transformation of these arrangements from a given repertoire, 3 ° learning through verbalization and the determination of a syntax of visual operations, in between natural and formal language. Strongly inspired on one hand by the sources that have been produced by the New Tendencies movement, and on the other hand by the approach of Software Studies, Generic Images software, which centralizes the efforts of intellectual and collective development is then offered both as a collective work and an interface to foster an increased interaction between individuals, algorithms and artistic language. In this context, we intend to question the critical framework of the relation between art and program by the means of a survey conducted with the pupils from a high school. Through this paper, we will defend that it is the experience of different groups with a software - from its conception to its use, and the visual and generative production chain understood in its globality, that engender a model for thinking about an artistic and heteromatic environment. Not only does this environment function as a system of interaction between human agents and automated agents, but moreover, it is a critical step towards questioning human activity in the era of automation of cognitive work. We will then argue about the possibility of formulating artistic environments that could be both generative, critical and heteromatic (#1).

1. New Tendencies: Computers and Visual Research

In the 1960s and 1970s, scientific and technological progress heralded a new industrial era and a new cultural model. Fordism gave way to information society; and post-war modernism to dematerialized post-modern art [1]. If a large majority of the

intellectual and artistic community rejected the technological efforts of the time, the “New Tendencies” movement, which emerged in Zagreb seized the burgeoning computer science to project a future free from alienation and oppression. The Zagreb movement is singular for a variety of reasons. Geographically, Yugoslavia is one of the non-aligned states, which entered modernity late, but with the strength of cultural renewal. Many European research groups met on this artistic platform: GRAV (France), Zero Group (Germany), Group N and T (Italy), Equipo 57 (Spain). It is a truly international movement. Other aspects further underline the exceptional character of NT: reformation of the notion of artistic genius, reformation of art through research, public viewed as user or co-producer, art-science articulation, social-cybernetic synthesis...

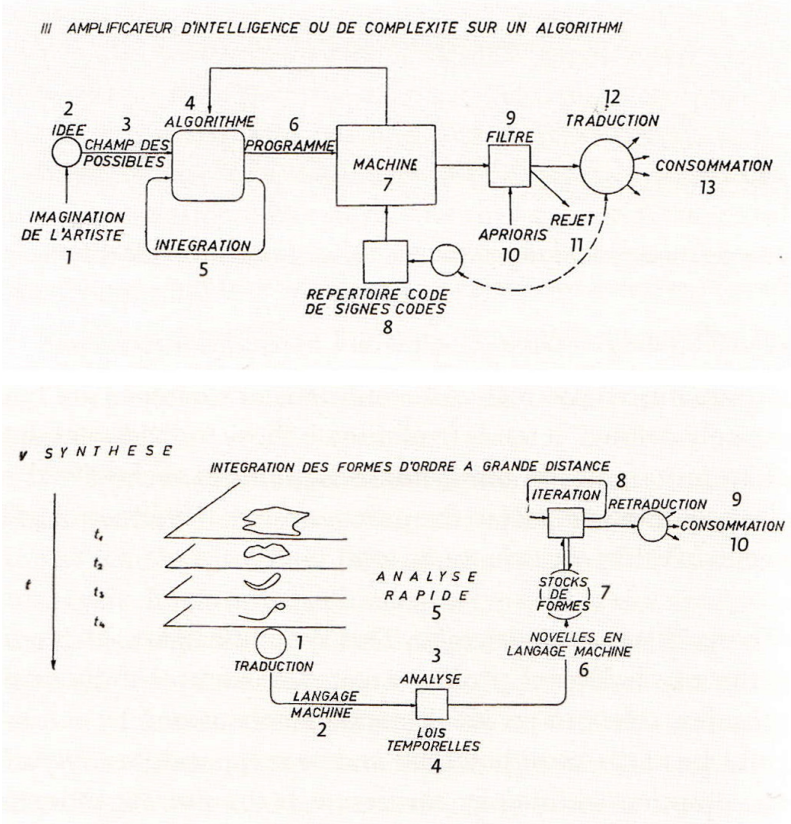
Computers and Visual Research symposium, Zagreb, 1698.

During the summer of 1968, the NT movement organized the colloquium and exhibition “Computer and Visual Research”, which together with the Cybernetic Serendipity exhibition in London, would become the first international manifestation of computer art. Artists such as Marc Adrian, Charles Csuri, Frieder Nake, Herman de Vries, Hiroshi Kawano, and Zdeněk Sýkora - presented in the exhibition, have in common the intuition or the desire to recast visual and artistic language through the creation of algorithms. Logical instructions are then used by the artists to produce a new image regime. Umberto Eco who participates in the movement develops the concept of "open work". The images are then thought by these artists as instances, which from a given repertoire of signs and a finite number of instructions, generate an infinitely variable space.

The symposium of 3rd and 4th of August 1968, which brings together researchers, artists, architects, mathematicians and engineers, presents a mathematical, ethical, technological and social approach to research in art. The theory of information aesthetics is defended by Abraham A. Moles who will open the first conference of symposium [4]. In producing algorithmic art and visual research by and with the

computer the NT movement aims to make visible hidden processes. In doing so they attempt to give everyone the opportunity to negotiate a future society in which the computer would play a central role. As Armin Medosch points out in a book dedicated to the historical analysis of the movement: "The growing availability of software in general and software for artists in particular introduced a substantial problem into the discourse of art." We cannot avoid evoking the decentring of the author. Indeed, what becomes of the artist's work, if a program produces an aesthetic form in its place? How to perceive the work if it is embodied in a software?

2. The machine of Moles: Cybernetic and social art



Two diagrams by Abraham A. Moles from Cybernetics and the Work of Art (1965): "III. Amplifier of intelligence or complexity of an algorithm: 1° Artist's imagination, 2° Idea, 3° Field of possibilities, 4° Algorithm, 5° Integration, 6° Program, 7° Machine, 8° Repertoire of encoded signs, 9° Filter, 10° A priori, 11° Reject, 12° Translation, 13°Consumption " and "V. Synthesis : 1° Translation, 2° Machine language, 3° Analysis, 4° Temporal laws, 5° Rapid analysis, 6°Messages in machine language, 7° Stores of forms, 8° Iteration, 9° Retranslation, 10° Consumption".

New Tendencies movement focused on Abraham A. Moles and his theories mostly between 1965 and 1968. His cybernetic posture and his interest in objectifying aesthetic judgment appealed to the Yugoslav movement. His idea of automating art production rebounds to the connections already established by the movement with

industrial processes and materials. As Medosch reports via the minutes of a symposium held during the 3rd Zagreb exhibition, by 1965 NT already wanted to extend the notion of art to visual research. The computer's arrival was to provide the means to formalize this search. On the occasion of the 1968 colloquium, Abraham A. Moles announces a revolution of "automation, artificial thinking, and symbiosis with machines". He then asserts that "information is the third fundamental element alongside matter and energy" [25]. Unreservedly, Moles relies on the unification of sciences through cybernetics, in order to deploy his vision of society and culture. Moles direction in thinking directly echoes the theories of Norbert Weiner on communication between man, machine and animal. Medosch points out that according to Moles, "Automation (...) should allow each person at home to enjoy unique artworks designed by the cybernetic creative machinery of human and machine components."

Convinced in his ability to describe mathematically the measure of originality [5], Moles then seeks to statistically reconstruct human perception and aesthetics in his cybernetic model. It is clear that his proposal to orient art towards a cyborg practice raises many problems, particularly that of a computer fetishization. Moreover, even if his theories conclusively lead to a statistic of the image and to a logic of quantification or categorization of its constituents (as signs and supersigns), it is legitimate to ask how and in which way an automatically generated image, could inherit the human, social, material and environmental factors from which it is derived from. Finally, the idea of Moles's cyborg artwork separates the work from its critical reception, which would represent a major contradiction with the positioning of art throughout the twentieth century [6].

3. The drawing in Generative Aesthetics

3.1 Max Bense, for a generative aesthetic

Max Bense is also a theorist who inspired the second phase of the NT movement. Bense is a key player in the emergence of information aesthetics in the 1960s. Like Moles, Bense assumes that it is possible to objectify the aesthetic measure of a certain object. To arrive at this measure, quantities of order and complexity are put in relation to one another, all based on the measurement of information as proposed in the theories of Claude E. Shannon. Even if "Moles was one of the first who predicted machines would soon generate aesthetic objects based on automatic decision making" [2], it was Bense who first proposed the term "generative aesthetics". He conceives with the mathematician Georg Nees - then his PhD student, the world's first computer art exhibition. The exhibition took place in the study gallery of the University of Stuttgart in February 1965.

In a text titled Projects of generative aesthetics [7], edited for the occasion, Bense introduces his concept as follows:

> Generative aesthetics therefore implies a combination of all operations, rules and theorems which can be used deliberately to produce aesthetic states (both distributions and configurations) when applied to a set of material elements. (...)

> It helps to formulate the principles of a grammatical schema–realizations of an aesthetic structure.

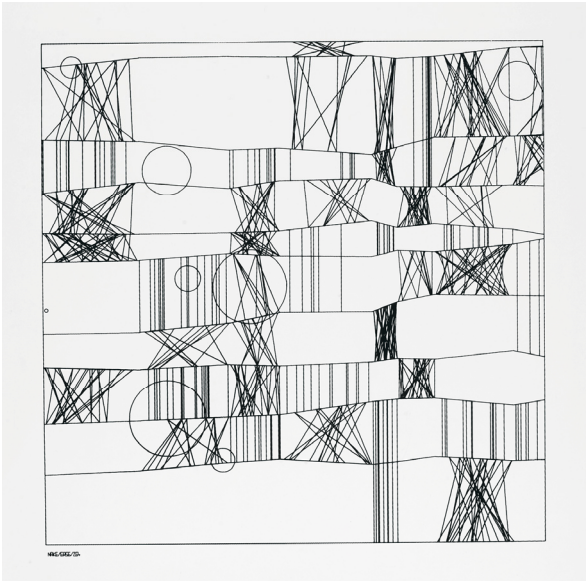
As Frieder Nake points out in a text titled "Information Aesthetics: A heroic experiment":

> The interpretation that we traditionally expect from an aesthetics gets changed into construction. The effort to rigorously define measures in order to evaluate certain characteristics of the work (of art), in the case of the model of Information Aesthetics is shifted to the opposite effort of algorithmically generating such works. Scientific and engineering methods break into the realm of the humanities – a provocation!

In complicity with Georg Nees, Frieder Nake will also continue Max Bense's project. He is foremost a mathematician and will have access to one of the first computers of the University of Stuttgart. He then takes advantage of this situation by programming algorithms to explore aesthetic propositions, hence becoming a pioneering artist of algorithmic art. Thus, Bense's ideas quickly take shape in the production of works (of drawings), which attract the attention of the art realm in Germany and internationally.

Through what will be called the Stuttgart School [8], computer art would eventually surpass the vision of computer as a tool. Thinkers and artists could focus on the computer so as to incorporate the rules and formulas of art [9]. Bense proposed the term "art as a model for art" [10].

3.2 Frieder Nake, from hand to head

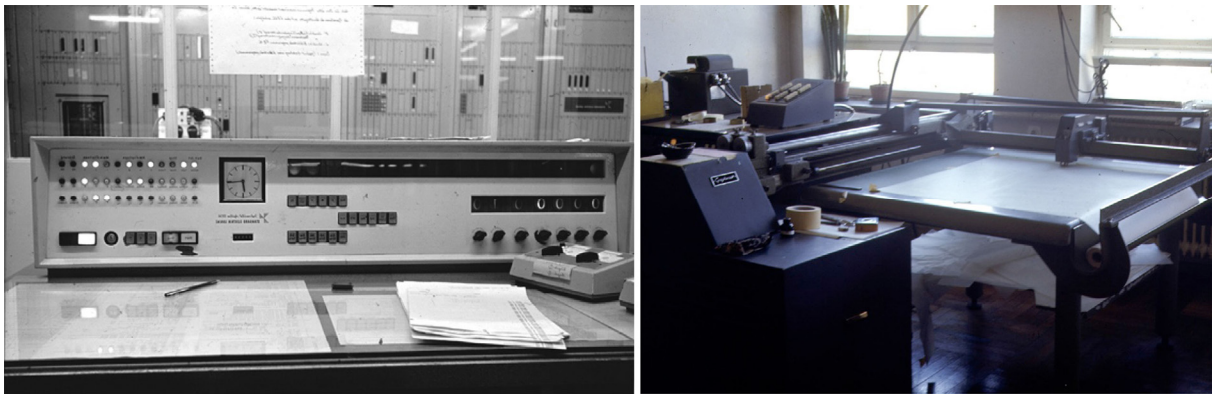


Frieder Nake, Hommage à Paul Klee, software: COMPART ER56, hardware: ZUSE-Graphomat Z64, 40x40 cm, 1965.

Through generative aesthetics, and more particularly with respect to drawing, the work of the artist shifts. According to Nake, moving from the immediacy of the gesture of the hand to the conception of an algorithm transforms the artist into “the mediating specifier of conditions a machine has to obey when it generates a physical line” [11]. As he put it, his part has become “drawing by brain” instead of “drawing by hand”. Furthermore, Nake argues that this shift from material to semiotics implies that the artist has removed himself from the immediacy of the material and gained a “higher level of semioticity”. In reality, it is not so much a matter of thinking and drawing a line, a single line. It is rather the intellectual gesture of anticipating the drawing of any line. In this way, Nake envisions that creativity then has much more to do with “semiotic situations and processes than material situations and processes”.

However, this statement should be nuanced. Indeed, the assertion does not really take into account the material situation with which computer art could develop especially around 1965. The nascent computer equipment that comes to furnish the laboratories of the time is an essential technological environment that should be detailed. We thus plan to problematize the apparent antagonism between a fundamentally semiotic art and the material and industrial reality in which it was constituted.

3.3 The Stuttgart school, technical environment



A computer and a drawing machine in Stuttgart in 1965.

On the occasion of a 2013 CAPC conference in Bordeaux [12], Frieder Nake accompanied his personal account with two photographs of the machines with which he developed his first artistic works in 1963. He is a student in mathematics at the University of Stuttgart and works part-time in the computer center. The first image shows a control console that allows operating standard computer Elektrik Lorenz ER56 at the center. The second presents the plotter with which Nake debuted, a Zuse Graphomat Z64 machine. Before receiving the plotter, the professor in charge of the department asks the young mathematician if he would program the software - which did not exist then, and which would allow the machine to draw. Frieder Nake

tells us that it had not yet occurred to him that a computer could draw. “How to draw when your instrument is not made to draw? " he asks us. It is a constitutive moment in his thinking; Nake takes up the challenge and gets to work [13]. He then develops at the extremely low level of the ER56 machine language an overall program to develop simple geometric shapes that could be realized automatically.

Through his writings on the "Computers and Visual Research" period of the New Tendencies movement, Armin Medosch continues the description of this material environment: “The Graphomat could be filled with four different colors made of Indian ink of varying consistencies, some drying up too quickly, others forming drops.” Added to this was that “although the drawing table was described as fully automated by the manufacturer, it actually had to be watched all the time" [14].

What Medosch suggests in his analysis is that, beyond a concept, one should actually look at this emerging artistic form as the result of an entire assembly of human and machine. In addition to embodying a new figure of mathematician-artist who confronts abstract concepts with the production of relevant images, “she or he struggles with the physicality of complex machines that produce unexpected results precisely due to their properties as machines, as real things producing heat, making noises, breaking paper tape, spilling Indian ink [1]. The competence was not only to be able to conceive an algorithm, but also to build an assembly of hardware, software and people to produce something that could be shown as art. One could ask then if it would be possible to give a different perspective to algorithmic thinking when considering the importance of such heteromatic embodiements. Can the technical and material conditions we have described here inspire a particular physical environment conducive to the reflection of generative aesthetics?

3.4 The algorithmic image as a transmissible form

In the field of drawing, approaching the image by the algorithm leads us to verbalize and formalize what is visible. This transposition of the visible into the language and into the universe of calculated procedures enhances the possibility to discuss gestures and a practice. Retrieving an algorithm from a generative artwork demands a precise analysis of the visual work in question [15]. From the point of view of the analysis of early computer art, the 2012 ReCode project by the American Matthew Epler retains our attention. The project embodies an effort in translating images back into programming language. Here is what he writes on his own website:

> The ReCode Project is a community-driven effort to preserve computer art by translating it into a modern programming language (Processing). … The focus of the ReCode Project is three-fold:
>
> 1. Bring historic works of computer art back into the public eye.
> 2. Make it accessible and useable.
> 3. Save the code. (Epler, 2013)

However we can see today that the work on the platform is discontinued. On the German side, Frieder Nake, adds a remarkable critical analysis of the relationship

between code and aesthetic form. He also proposes a "re-coding" approach. But unlike Epler, his discourse on the re-coding of existing works focuses more on the effort of interpreting than of translating them. At the center of his teaching of algorithmic art, Nake offers the experience of algorithmic thinking, a concept that should be elsewhere examined.

If the activity of coding or recoding a work constitutes a rich perspective in the field of aesthetic production or that of artistic education, how to approach a work with an inexperienced public in the realm of computer programming? Can algorithmic language operate intuitively in the field of drawing? Moreover, how to incorporate in this type of artistic education that, which goes beyond the computational framework: the relationships which cross a group of individuals in the process of learning, or the verbalization of their experience in a relationship with the machine? The project Generic Images is an attempt to provide some answers to these questions.

4. Generic Images

4.1 From "generic" to generative

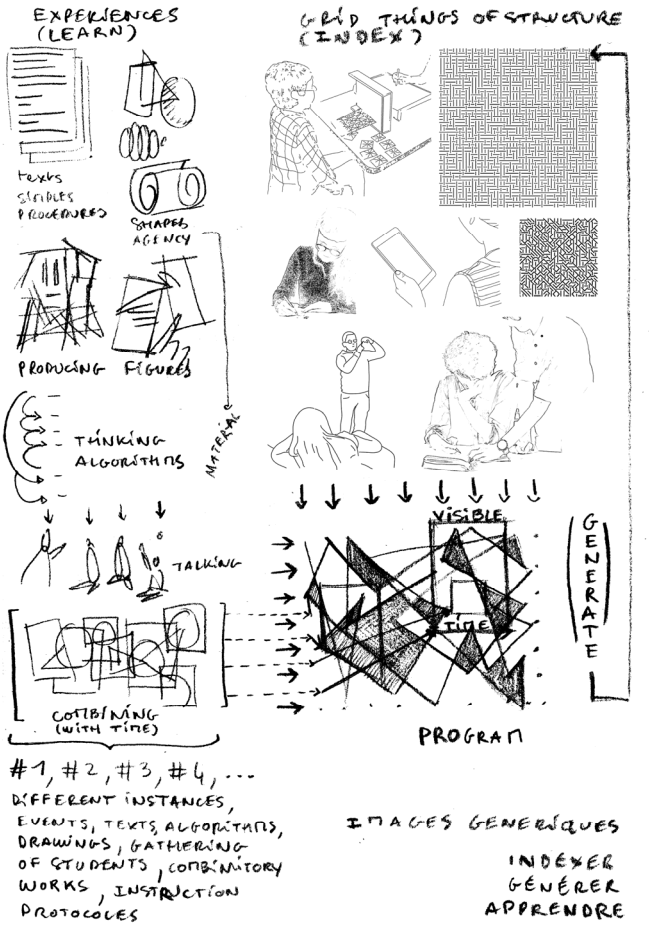
> The work is a software. It is a software that learns. It also has a cogito. It has no voice, but it thinks by drawing. It is a graphic machine. From the visual memory that founds it, it presents graphics of individuals engaged with algorithms and who live in a world that is transformed with technology. The software returns us an image. Sufficiently different from our world so that we can look at it differently and close enough so that we can live in it. Without fatigue, the drawings evolve, they multiply, they vary, they transform and they generate new figures according to learning procedures. The drawings offer generic representations, but these representations become singular at each step while the program progresses over time.
>
> Extract from a presentation note of the Generic Images project, 2017.

Generic Images is a creative software project based on an open workshop for algorithmic practice in the context of art education. The procedural drawing software that is presented here serves as an experiment for creating graphical and generative content from a participatory process. The software and the drawing process are both created during different stages of the workshop.

In this work, we want to reflect generative aesthetics and the vision of computer as "universal image generator" [16]. A notion of the generic in art is also developed. A notion that the poet and artist Franck Leibovici describes as follows: "the characteristic of a generic is to serve as a template for receiving other questions. it is therefore left to future users to adapt this generic to their particular problem "[17]. Thus the generic term in our case has a double meaning, that of a structure capable of being modified according to situations of use on one hand and on the other that of a generative dynamic which delimits a visual repertoire and explores at the same time a space of possibilities.

This project was set in different phases. The first phase involved the design and development of the Generic Images software (**./i**), which responds to a scenario of generative images capable of representing relationships between individuals and digital interfaces. The second phase involved a high school class, offering them a workshop with sessions on hand drawing, algorithms, manipulation of generative procedures, and materialization of these new drawings by a pen plotter. The third phase is the maintenance and documentation of the software. The project resulted in an exhibition, with the results from the workshop as well as an installation that includes elements from different phases of the project.

4.2 Diagram



Gaëtan Robillard, Generic Images, diagram, 2017.

Schema, diagram, sketch, piece of penciled tablecloth… Are they not the place of a common language in which thought is spatialised and displayed ? Isn't it happening like the instantaneous mediation of a stroke, whether it is about giving a visual form to a theoretical system or thinking about an artistic device [18]?

If the diagram is the matrix drawing of a situation of experience (David Zerbib, 2018), the figure presented above, which is elaborated prior to the project enabled the organization of thought. The following three parts are connected:

1. Index: graphic shapes, hand drawings, or transformations of these drawings. The index can be related to the notion of repertoire found in generative aesthetics.

2. Generate: new visual propositions from the distribution of elements from the index. Most of these spatial operations use random calculation. The generativity of the software is similar to the distribution of probabilities in the field of generative aesthetics.

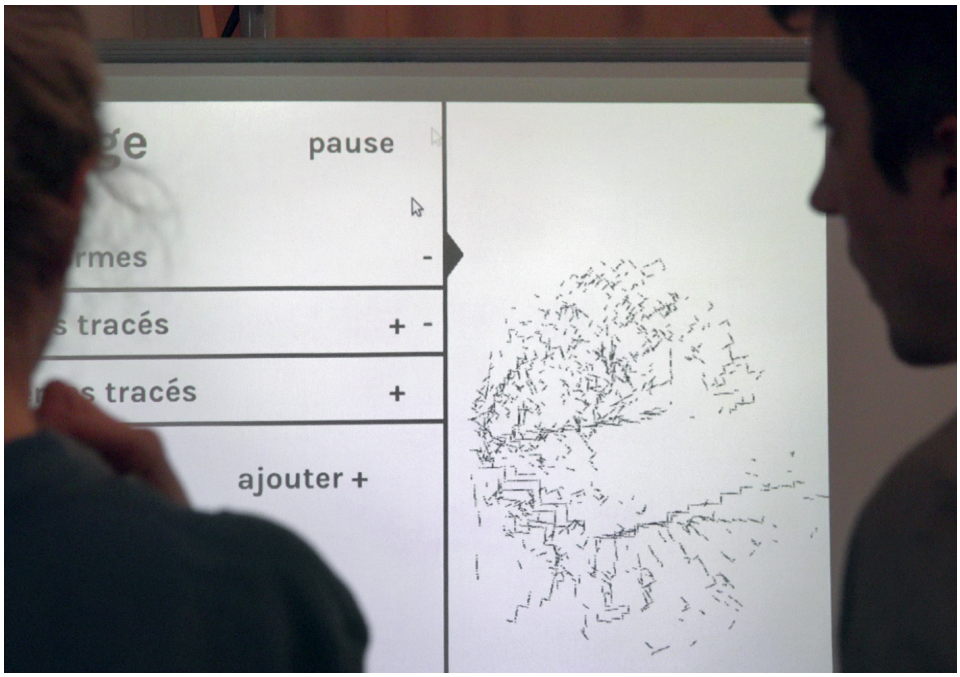
3. To learn: a language allowing to describe algorithmic operations (instruction, assembly, loop ...), but also - saving visual results.

The notion of learning intersects here at least two things. Integrated as a function in the software - even symbolically, it problematizes the translation of an artistic gesture into a formal language - an algorithmic one or a program. The question that arises then is: what does formal and natural language have in common ? On another note, the notion of learning confronts machine learning methods often present in our contemporary technological world (genetic algorithms, deep learning, artificial intelligence, ...). As the epistemologist Giuseppe Longo points out, if in mathematics some researchers are worried about the way in which artificial intelligence technology comes to hide the most fundamental aspects of scientific theories [19], we in this project, initiated a critique on the relation of art to this same technology. We will now look at how artistic intuition and algorithmic writing work together.

4.3 Software

Principle

The software **./i** was designed and developed with the help of a team of engineering students from the IMAC(3#) program at University of Paris-Est Marne-la-Vallée. It is embedded in a pedagogical program of tutored projects within the curriculum. The Generic Images project was therefore a teamwork with several steps such as open workshops during which other students, teachers, artists and outsiders - were invited. This open work process emphasizes a participative principle involving users whose feedback validates the outcome of the algorithms. From the research point of view, succession of human choices dictates the design of the software, which makes the software a machine to produce knowledge [20]. As Eglantine Schmitt points out in a 2016 article, "if the functioning of a program enjoys a certain autonomy, its conception and its implementation consist of a succession of moments of choice in a space of possibilities that leaves the capacity of human action at the heart of the process ". It is precisely this space of possibilities that we have striven to produce.



*Collective experiments with **./i** in the situation of a class, Paris, 2018.*

Elements of language and visual elements

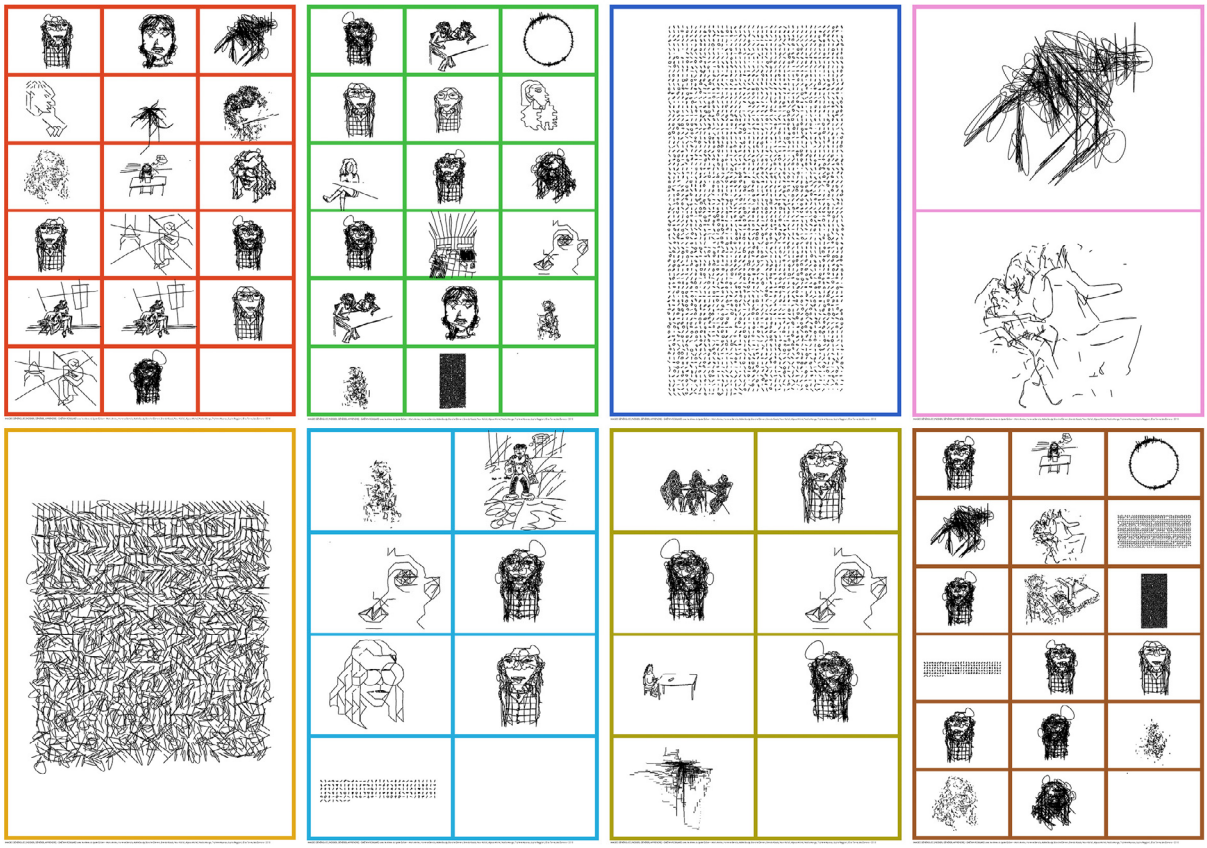
In order to establish an interaction between a large audience and the creation of algorithmic or generative visual procedures, we wanted to allow everyone to develop elementary semantic assemblies. Regarding the functions, the terms used are extracted from a lexical field of transformations or spatial distributions: translate, rotate, chain, scatter, ladder... For each of these terms, we have developed an algorithm that acts on a set of visual elements from a chosen vector drawing. In some cases and particularly effectively, algorithms such as "rotating" and "translating" use a random calculation that quantifies the transformation or distribution of elements from the drawing. On the other hand, we have chosen to categorize two distinct visual elements: shapes and paths. The shapes are given by a sequence of Béziers points connected to each other, and capable of forming any figure. The shape can be open or closed and the number of points is unlimited. The paths are the smallest visual element included in a vector drawing: a pair of dots delimiting a single segment that can be curved or not. Thus one determines two sets, that of the transformations / distributions, and that of the visual elements which can be targeted by these transformations (shapes or paths). The user is then offered to combine two elements so as to link the two sets, for example: "reordering the forms". By convention we chose to name this combination an instruction. The user can then compose several instructions and thus define an assembly.

Two indexing functions make it possible to produce two different tables from "shapes" and "paths" contained in one drawing. Thanks to these analysis functions, we can visually list the components from any drawing in vector format. These components are understood as elements in a repertory.

We are aware of a digital infrastructure that is global. Therefore we aimed for connectivity: an export function is integrated in the software. It allows the user to save a vector image from the assembly operations at any point in the loop. This export saves a file in SVG format which can be reintegrated into the general file index of the software.

We do not confuse **./i** with a programming environment. We preferred to propose a method of continuity from hand drawings to generative transformation and to distribution of signs that constitute them. The interface is light and offers a list of moderate number of possible actions.

4.4 "What drawings & what future for the code?" (#2)



Series of posters, part of the final presentation of the workshop with a high school class, Lycée Colbert Paris, 2018.

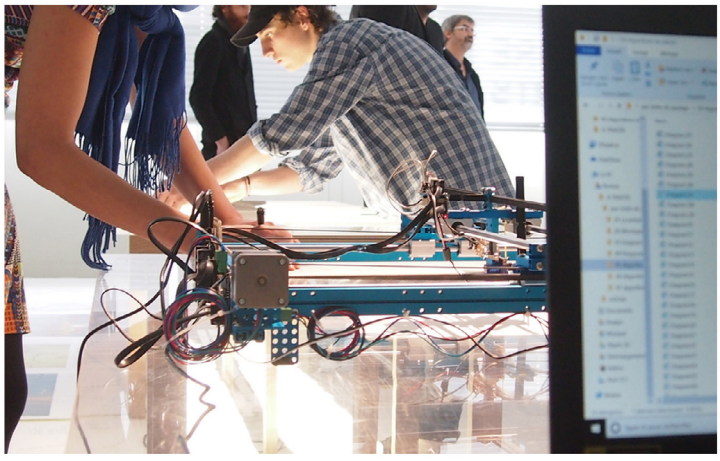
How to transmit algorithmic art? Is a generative image an image to which a gesture has been transmitted? The project aimed to move drawing gestures in a software environment in order to question the role of the algorithms in artistic creation. During our experiments, we addressed high school students. At first, we offered them a drawing session. Students would draw their neighbors at the table; then they would

move in space and draw again by observing each other. We then listed together a specific vocabulary that could describe the drawings they had produced. We focused on developing an ability to name specific plastic components. To put a drawing into words - and to voice an artistic gesture with these words, necessarily induces a passage between an instruction and the interpretation of this instruction. But comparing an instruction, which passes from one individual to another with one which passes to a machine is indeed necessary for discovering the field of algorithmic art. Inspired by Charles Sanders Pierce's theory of signs, Frieder Nake stresses that human beings interpret in the greatest diversity all that is presented to them, while the machine can interpret (calculate) a sign in only one and unique way. Therefore natural language and its implication became a large part of our work in class. After verbalizing various drawings and visual characters, we vectorized the hand drawings, and we created instructions and assemblies with the software **./i**. We would then modify the directory of drawings and the indexes of lines (shapes or paths).

Visual materials produced through various workshops were collected. Thus the image directory, which constitutes the memory of the program increases in size. The first images represent human figures, learning situations, human-machine relationships. Gradually the images evolve into a registry of structures (grids, point clouds, chains, ...). The pedagogical project, which is made of several stages (draw, index, code, generate, draw, show) allows everyone to see the entirety of a creative process, with its know-how, its fortune and its accidents. This process was ongoing until the final presentation of the completed work.

4.5 A plotter in the work environment

In order to echo the technical and material specifics of the genesis of algorithmic art, we have integrated into our work environment and software deployment a light pen plotter of the type Makeblock XY-Plotter Robot Kit V2.0. Once the form and path elements were indexed and redistributed generatively by the users, we suggested that they choose the results that pleased them the most, so that we could have the images drawn with black pen on paper. We argue that it is the experience of moving from the hand gesture to an algorithmic expression that promotes an intuitive understanding of the computer as a "Universal Image Generator". The experience is completed when drawing materializes anew. We defend that when compared to the computer screen, the plotter enriches the construction of artistic sense. The triangulation between intuitive gesture, generative algorithm and mechanical realization then supposes such an environment of creation and transmission as a global chain. In our case, these three parts are indissociable from each other. We come forward with this model because it enhances awareness in the field of generative aesthetics.



Generic Images, workshop views, 2018.

4.6 Questions to students

In such an educational environment, how is the relationship between art and program perceived? What happens to artistic creation and the image if a program deals with the random distribution of visual elements? These questions are embedded in the discussion around the generative aesthetics of the 60s and 70s. The reception of computer generated aesthetics is still often accompanied by a debate on the place of the artist. We also wished to introduce this debate to the students of the class. We asked twelve of them the three following questions:

1. Do you think a program can do art for you?

2. What would be the conditions for this?

3. What would you ask it to do?

In the absence of a complete analysis of the given answers, we can still note three types of recurrent responses. The first type refers to the notion of freedom. The reasoning is then: the program follows instructions, it is not free and so it cannot do art. The condition for a program to be able to create would then be that it has a free will. The second type of response summons the intention as a priori to the creation of an artistic form. Finally, the third type of response is between nature and tools: the technological tool is an intermediary that separates us from a type of artistic production called "natural". It is interesting to note that some answers bring out the term artificial intelligence. Other answers could also be mentioned here. But above all, we want to retain their great diversity. Overall, the questions allowed the students to become aware of the place of the human and his relation to the machine through a process of artistic creation.

4.7 Conclusion on the experiment

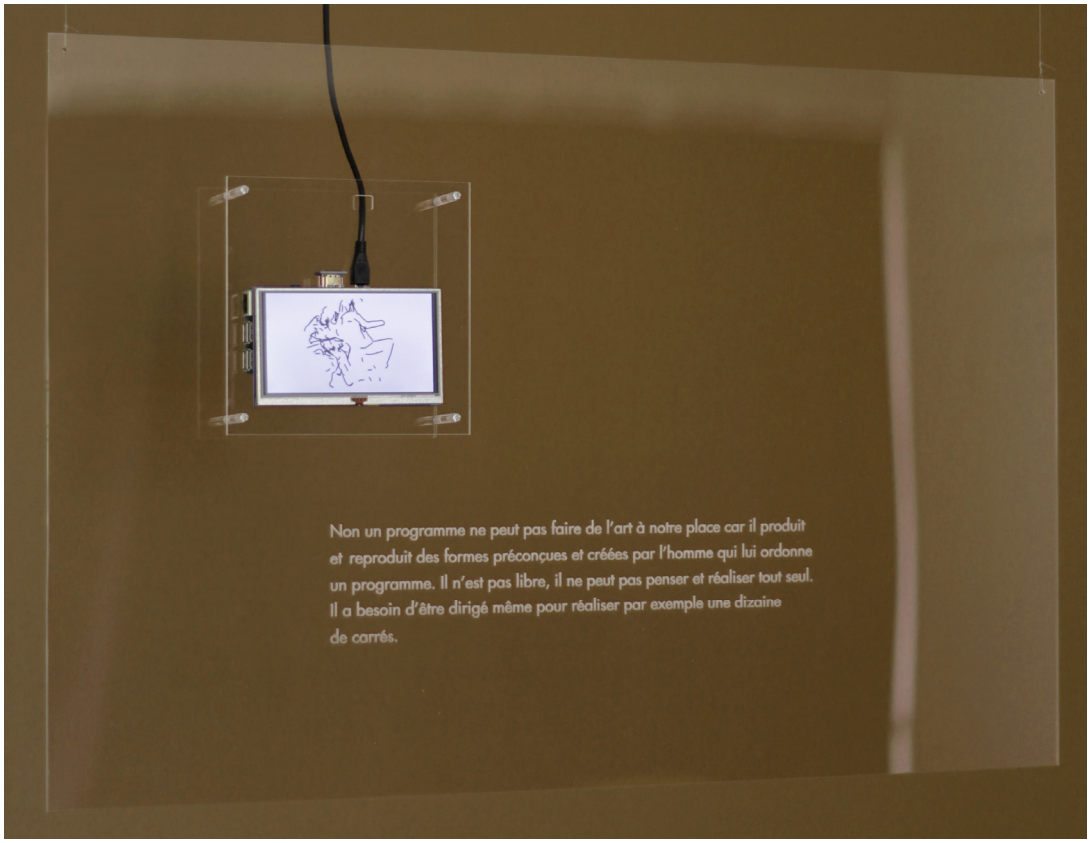
The Generic Images project has evolved in various stages of the work and in a variety of organizational modes. It is a project that has been supported by educational institutes such as University of Paris-Est Marne-la-Vallée and Colbert Lycée in Paris. Its first outcomes were presented at the “36hours of research in art, in Paris” [23]. Ultimately the core of the project is based on the development of the software **./i** that we have thought as a succession of moments of human choice concerted in a space of possibilities. Generic Images takes the form of a C ++ / OpenGL application that must be compiled for use. Currently, the installation only works on UNIX systems (MacOS, Linux, etc.), which is an important restriction when considering experimenting in new contexts. We retain that the interface we propose allows a relatively intuitive handling and no specific programming knowledge is required for interacting with this computer environment. The counterpart is that the algorithm is only perceived in a symbolic way. Moreover, we defend a global approach that certainly considers software as an artistic agent in an algorithmic environment. But this global approach must also consider spatial, material and human environment in which the software takes place. The graphic and semantic chain from hand to algorithmic thinking is at the center of our project. The posture is

also to consider the software as an open structure that is as much a potential place for artistic production as of visual research.

We have seen that the proposed system leads to questions on the relationship between manual and intellectual gesture, but also between thought and algorithmic calculation. We believe that today the wakening to the importance of such questions is necessary and that it goes beyond the framework of artistic education. The heteromation analyzed by Hamid Ekbia and Bonnie Nardi in 2017, which divides the work between humans and machines by means of algorithms, poses an economic, social and political problem. Just as artificial intelligence can be perceived as an "epistemological revolution" [24], the importance of illuminating relationships between human cognition and machine calculation must be considered. Focusing on the artistic creation to reflect the social activity of an era also allows a critical experience in a complex maze of individuals and algorithms.

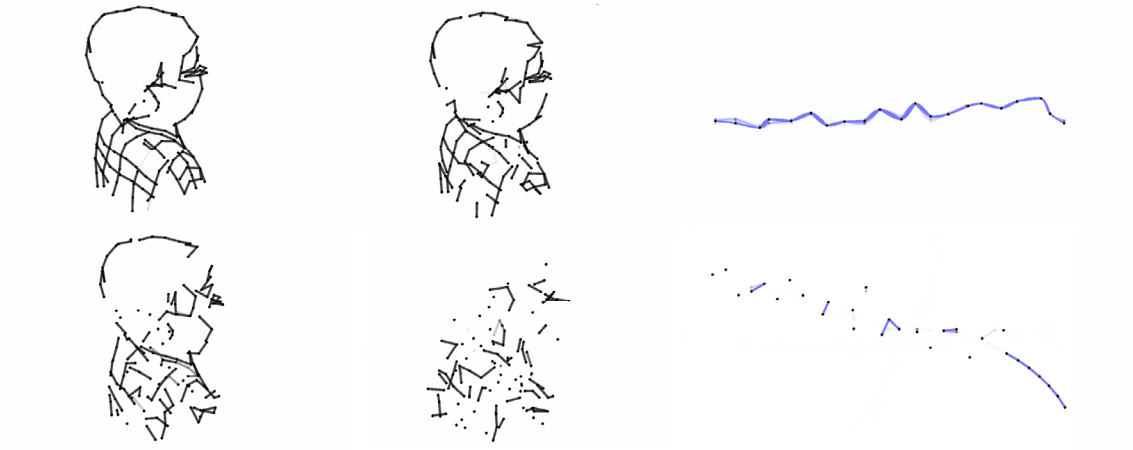
From the point of view of visual creation, many new sets of drawings were produced. Succeeding, the Generic Images project has been transposed into a new program and installation project titled Logical Drawings.

5. Logical Drawings



Gaëtan Robillard, Logical Drawings (detail), plexiglass with laser engraving, 5" LCD screens, raspberry computers with program, coloured paper, 2018.

Among the questions we raised, we wondered about the possibility of teaching a drawing to a program. If it is obvious to digitize an image, what is it to conceive a generative program that would explore a given element of representation? What about gesture and writing? Moreover the artistic challenge in a program of generative images does not rest only on the software domain. To apprehend forms and produce meaning, it is necessary to conceive the material space in which the program takes place. That's why we'll talk about the installation. How can one perceive the variation of the drawing? How to perceive the generativity and calculation of the program? How to propose a critical articulation between cognition and machine learning?



Logical Drawings, various visual outputs, 2018.

The work Logical Drawings conceived by Gaëtan Robillard attempts to pursue these questions both in terms of writing a new generative program and by designing a space that integrates and displays the program. Responses the high school students gave to the questionnaire mentioned above offer a discursive counterpoint to the presentation of the dynamic images. The installation is variable in size. Plexiglass holders that carry screen and microcomputer systems can be shown suspended in the middle of an exhibition space, or hung on the wall. Colorful backgrounds are used to differentiate each of the programs, which adapt according to a repertoire of predetermined drawings. The colors are consciously chosen referring to edutainment aesthetic. The programs are differentiated according to a nomenclature M1, M2, M3, M4, ... For each of them, a series of parameters are varied such as the definition of the subdivision of a line into segments, or the minimum distance between two points so that a line is actually drawn on the screen.

The program adopts a logic inspired by genetic algorithms: from an initial situation and through a process of crossing and mutating values, we explore a space of possibilities. A set of vector drawing files make up the base directory. The program selects a file and draws a line by following coordinate points (X, Y) extracted from the lines recorded in this file. With each new iteration, a crossing function randomly

exchanges coordinates between the set of points established, either between X1 and X2, or Y1 and Y2, or between X and Y. A second function - of mutation, modifies the value X or Y by adding a positive or negative value fixed at the beginning. After a certain time, the drawing is saved and the original file is replaced. Finally, a next file is called and the program draws and then executes again the two functions described above. So on and so forth. The number of source files is finite. After having drawn and modified the elements of the last file of the list, the program returns to the first file. Thus all the files are progressively modified by the program. According to a preset time cycle, the program randomly chooses a file that has been successively modified over time and replaces it with the original source file.

As a whole, the installation presents us with a multitude of drawings that change over time. The initial drawings describe situations of transmission. As an environment, it proposes a transaction of meaning between program, image and language. The verbal responses of the students in formation counterpoint the programmed image. The divergent opinions represented by these texts sometime oppose to the logic of the program. We hope that this juxtaposition forms the critical character of the installation which enhances public awareness on learning and creating in the "heteromatic" society.

Conclusion

Through this article, we sought to question the creation of generative and critical environments in relation to the educational context.

To this end we proposed an incursion into the genesis of algorithmic art not only to derive a theory of generative image but also to understand the social and reformist vision present in the New Tendencies movement. Abraham A. Moles and Max Bense contemporaries of each other, and both involved in information theory have in common the discussion of an objective aesthetic measure which relates order and complexity. But their proposals also differ. Max Bense, who is interested in poetry and exhibits works in the university, offers a constructive approach. The generative aesthetics that emerges in Stuttgart is thought to produce aesthetic statements from rules and theorems calculated in a program. Through Bense's manifesto the scientific method possibly breaks into the humanities. Mathematicians and artists like Frieder Nake develop an algorithmic and visual production that responds to this vision of “art as a model for art.” According to him, thinking a form drawn by the algorithm moves the artist's attention from the manual gesture to a conceptual gesture. In doing so the artist is extricated from the material immediacy of the work and gains a higher level of semioticity. However, this shift towards semiotics does not reflect the material reality in which this thought emerges. Mainframe computers were not designed to produce aesthetic forms. In 1963, the University of Stuttgart receives one of the first plotters. Frieder Nake, as a young mathematician who is asked to program a pilot, then considers the computer as a drawing machine. It is in this scientific and technical environment that he begins his artistic career. One should not be mistaken about the seemingly automatic character of such an environment. We learn in Medosch's analysis that far from working alone, the plotter then requires constant monitoring. Its

physicality must be understood as the assembly of hardware, software and people in which the practice of algorithmic art is forged. Besides characterization of this historic environment, we studied a current tendency in the analysis of the pioneering works created using a program, called the “re-coding”. We then asked ourselves the question of whether the mastery of a programming language was essential for transmitting these artistic forms. In order to answer this question we looked at the practical implementation of transmission of algorithmic art: the project Generic Images.

The Generic Images project is a software creation project that explores different dimensions of generative aesthetics. We presented and defended the way the software has been designed, placing human capacity for action at the heart of the process. We also wanted to stand back from an existing model for the transmission of art and algorithmic thought. We believe that it is necessary to form a triangular relation between intuitive gesture, generative algorithm and material realization. This model then requires a certain creation and transmission environment. It is seen as a global chain where each part must be linked to the other two through an experience. To try to characterize this experience, we must focus on the notions of gesture, verbalization, instruction, assemblage and looping. As we have seen, the attempt to create art with algorithms generates a debate. This debate which is also related to the developments in artificial intelligence is not new. It has therefore been necessary to open a critical space within this project. On the other hand, the concept of "heteromation", which we have discussed, gives a new perspective on the labor society that now consists of algorithms. We then proposed that the project Generic Images becomes part of an expanded reflection on the relationships between image, human cognition and computability.

Finally, we presented Gaëtan Robillard's installation Dessins Logiques, which stems from the thoughts initiated by the Generic Images project. The installation is a generative environment and carries an edutainmental tone. It distributes signs repertories ranging from speech, generative image to space. It is not only about offering a programming experience with the help of a partially genetic algorithm - which explores a space by mutation and crossover without being selective, but also about producing discursiveness on this same space. Thus we want to introduce a disruption between creation and automated learning.

If we come back to the constructivism of Jean Piaget and his contemporary reading by the philosopher Patrice Maniglier, we can assert that learning is a true construction of oneself (the very structures of functioning of the mind). Maniglier informs us that such integration of change in a structure reflects on the connectionist models of neural networks[22].

In his text "Calculating Cultures" dated 2007, the philosopher confronts the symbolic approach of generativism with connectionism while seeking a filiation in structuralism. Beyond comparing which model would be most capable of variation, the philosopher proposes an archeology of artificial intelligence and returns to semiology: "a science which studies the life of the signs within social life "(Saussure, 1972). One can wonder how in a future stage of research we could echo such an archeological approach by addressing it from the point of view of art and transmission.

Notes

(#1) The term "Heteromatic" is derived from "Heteromation", a concept defined by Ekbia and Nadi as a shift from technologies of automation that disallow human intervention to technologies that call for heterogeneous actors (humans and algorithms). Ekbia and Nadi point out that in the context of artificial intelligence and the asymetric relation between firms and workers, heteromated systems alter social relations by fashioning humans as computational components. This raises remarkable social, economic and ethical questions. Heteromated systems include video games, social media, certain crowdsourced applications, system of microwork such as Mechanical Turk, personal health records, devices that require intermediation for some users (such as cell phones)...

(#2) Translated from the French title that was given to the workshop with high school students of Lycée Colbert - Paris : "Quel dess(e)ins pour le code?".

(#3) Image Multimedia Audiovisuel Communication – Engineer training dedicated to art and science field. IMAC is a part of ESIPE in University Paris-Est Marne-la-Vallée

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