WHY ARCHITECTS SHOULD LEARN TO CODE

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Abstract

What does she place programming in our everyday lives? It allows us to work smarter, and helps us perform certain tasks. To go further, the tools at our disposal are rather impersonal and sometimes not enough adapted to our will. Today it becomes necessary to be able to go beyond this limit, to understand and learn the fundamentals of computer programming in order to carry out simple actions allowing us to optimize our working time to devote ourselves to other more important tasks. Since the transition to digital technology, the acceptance of computer tools is rather badly perceived among architects. The question today, as Antoine Picon points out in his book "Digital Culture and Architecture", is no longer whether digital is a good or bad thing for design. Rather, it is about understanding where tomorrow's architecture is heading. With these technological innovations, the only certainty we can have is that this change in the way we design will be significant.

Keywords

Futur, Architecture, Learning, Code

1 Introduction

This introduction is dedicated to the presentation of the preliminaries necessary for the modeling of the problematic, the authors' research is divided into three theoretical parts developing on human thinking, the emergence of computation, and Human/Machine collaboration. They expose the evolution of reflections through time.

The first part of our reflection is addressed to the period in which computers were introduced into the processes of conception of architecture. Starting with mental thinking through the conceptual idea to the emergence of digital, the authors wish to highlight what the architect has gained and what he has lost.

In the history of architectural conception, we have gradually passed from a mental reflection towards a reflection helped by digital tools. We have therefore passed from a conception method based on human reasoning and ink drawings on paper, to a conception method based on human reasoning and drawings on a computer screen, to a conception method based less and less on human reasoning and more and more on algorithms.

These new technologies go far beyond mere formal and structural qualities, we will confront logical thoughts from mental thinking and more contemporary thoughts from computational thinking [1].

2 The Logic

There are now a few years where questions are raised about learning logic language, code, programming. Architects have to learn some rules of representation, construction, regulations.

And yet today, when computers dominate in many fields, the architect uses the means of representation by hand, using simple tools such as ruler and compass, not limiting in any way the expression of form [2].

Even if he is still not proficient in a field he is familiar with today, computer representation could one day become hostile to him. This is why a better knowledge of his tools would allow him to evolve with the technique and to be much more efficient for certain very repetitive and sometimes even complex actions.

It is very serious to note the evolution of architects in an environment that is hostile to them, manipulation without knowledge can be very dangerous for the design of the project. The nature of the design of certain very complex buildings, no longer especially call upon engineers, but upon mathematicians, programmers, able to use big data in order to generate forms of urbanism/project optimized according to the sunshine, the urban flow, the views, the space. The architect, having tamed physical space, must nowadays tame virtual space.

3 The Vision

The vision at the beginning of the digital era was very dark, the drawing generally was done on white paper with the help of the hand and the pencil. This one started to turn towards black screens composed of pixels, which when the hand holding the digital pencil passed, allowing the lighting of the pixel then selected allowing the drawing. The drawing on paper then gave way to white lines on a black background.

Ivan Sutherland (Fig. 1), a young graduate student working at the MIT labs, had a very junior position and was therefore only allowed to use the machine in the middle of the night. He developed Sketchpad, the first program that made it possible to draw directly on the screen [3, 4].

The introduction of digital instruments in the architect's conceptual approach was not without difficulty, its integration undoubtedly provoked a disorderly arrival of the tools on the market. During the 1970s and 1980s. Computer technology was first interested in urban analysis and architectural programming, then in the production of plans already produced by hand, and finally in the modeling of computer-generated images of the project.

This accidental succession of means caused confusion in the natural sequence of the phases of the creative process: the constitution of the plans and the communication of the idea began to precede or even replace the realization. This undoubtedly led to a negative view of computer technology for many architects and its rejection as a design tool.

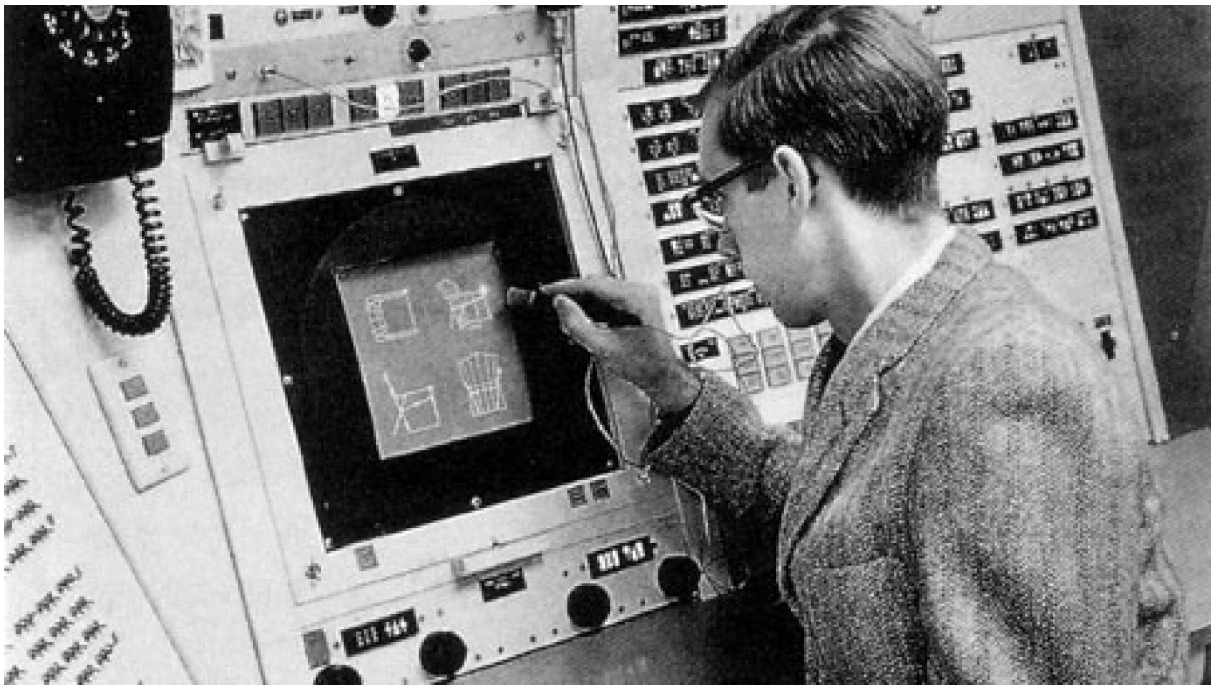

Figure 1. Ivan Sutherland working with Sketchpad.

4 The Tools

In 1992, "Paperless Studio" created by Bernard Tschumi, Dean of the Department of Architecture at Columbia University in New York, uses computer tools in the field of design. New technologies integrating information into the program, such as motion and flow data as a conceptual basis, made it possible to see the impact on design.

At that time, modeling and animation software was used for special effects in Hollywood, as architects hijacked this technique in order to use it in architectural design.

Frank Gehry uses the digital model for the Walt Disney concert hall using the FaroArm, a mechanical arm used to measure a three-dimensional object to model the project on the computer. This was done using aerodynamics software from Dassault Système, which allowed the forces to be calculated and the project structure to be dimensioned.

These experiments, in which the first digital architects were involved, gave rise to numerous architectural creations in the most diverse forms, usually characterized by a lack of orthogonality. "Free form", "liquid", "blob", "digital" or "non-standard" are all qualifiers for this trend towards the wealth of the formal expression stimulated by advances in computer graphics.

Since that time, architects have had to deal with a veritable electronic tidal wave, both in terms of hardware and software. The question today, as Antoine Picon points out in his book "Culture numérique et architecture", is no longer whether digital is a good or bad thing for design; it is rather a question of understanding what tomorrow's architecture is heading towards [6].

Faced with cascading technological innovations, the only certainty we can have is that this change in our way of thinking will be significant. It could prove to be as radical and lasting as the transformation that gave birth to the architectural discipline at the beginning of the Renaissance. At that time, the adoption of new tools and procedures (plan projection, cutting and elevation, perspective representation) was inseparable from phenomena. Like the emergence of the figures of the architect and the engineer and the new place taken by design [7].

5 The Importance

Why is the digital revolution becoming more and more important today? To answer this question, we have to go back to the beginning of computer science, to the era of mechanical calculating machines, perforated tape calculators, and the first electronic calculators. The physical space required for this computing power was phenomenal for a minimal computing power of one operation per second, today our smartphones are able to process $9.01x10^{15}$ operations per second.

The reason is Moore's law, it tells us that the power of an average computer will double every 18 months. But this law has already undergone some revisions to fit the reality. Yesterday we were at the level of the capacity of an insect brain, today at that of a mouse, tomorrow at that of a human. It is very likely that within a few years we will all know a virtual assistant, helping us in our complex daily tasks. But then we will have to face the fundamental physical limitations of microelectronics. [8]

There are 7.7 billion of us who want to replace tedious tasks with machines. It goes without saying that this programming will be done with time and demand.

In architecture it is a bit the same observation, we are able today to generate master plans for a procedural way, re-transcribing our physical space in order to make the machine understand the study environment in a simulation. We then use flow, sunshine, wind and temperature data... in order to generate or find an optimization for our buildings (Fig. 2).

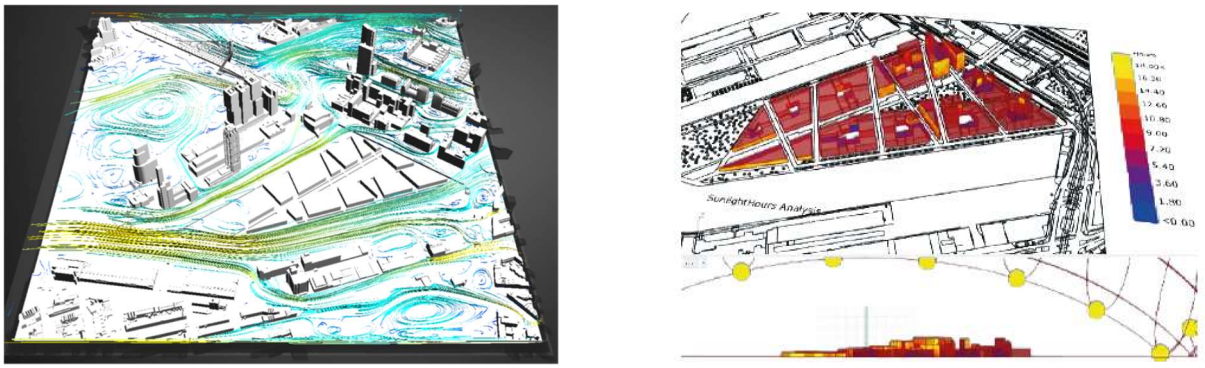

Figure 2. Rotterdam Wind and Solar urban optimization

The creation process is then questioned, the idea is no longer fixed, but modifiable in time by the program. The architect's creative phase, the idea of space and time is then taken into account by the machine, but remains to be conditioned by man. Once the intentions had been

well defined, it was then a good idea to optimize the light on each island core while modifying the heights of the interior spaces by maximizing the volumetric.

The paper information had to be entered into the machine to begin programming functions to vary the heights and interiors of the island cores. Once the urban organization had been redesigned, it was possible to simply select the area to be optimized and program an intelligent cut-out to distribute optimized areas for offices and housing [9]. This is why I then come to conditioning and programming, the tool that the architect of tomorrow will use will have to meet a certain programming logic and why it is undeniable that the architect will need this logical knowledge in the near future.

6 What We Gain and What We Lose

This way of doing things and thinking is not very common in the world of engineers and even less so among architects. This is, first of all, due to a certain complexity of the tool, but it has become increasingly easy to use over the years, thanks to the performance of our equipment and our increasingly advanced programs for the study of materials and structures.

Today, when digital technology dominates architectural representation, we most probably have a certain crisis of immediacy between the brain and the hand, partly lost in the drawing. Other phenomena with the arrival of digital technology such as the loss of scale in architectural drawing, we no longer know today what scale is represented by a digital drawing.

Zooming and de-zooming are daily and become a basic function on our supports, which gives us the feeling that it is neither too small nor too big. This crisis in design ethics then takes on a new dimension with digital and new means of representation.

Other practices are emerging and have enriched the architect's vocabulary. It is one of the characteristics of the architect to be so versatile in tools rather than in other fields. Tomorrow the architect may also be a programmer with the evolution of digital technology, where programming will be part of our design tools.

This crisis in the traditional ethics of architecture with, for example, that of constructive truth, we are witnessing a whole rise in the desire for sympathetic collaboration with the material. It is not a question of following the pattern of imposing form on the matter, but of collaborating with matter to allow form to emerge. They are commonplace in digital fabrication and form interesting propositions with the emergence of computation.

7 What emerges

Not without consequence, the conventional graphic practice is lost, to be found again in new means of representation.

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It is interesting to note that some of this research in recent years, through parametric design which was already present in the late 90s, the early 2000s. Why are we talking about it so much today if it's that old? With the evolution of machines and the miniaturization of electronic components, it is becoming easier and easier for us to get high computing power at our fingertips. This has had a strong tendency to bring certain research out of the closet, in particular Machine Learning, which over time is being perfected towards artificial intelligence.

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There is also a growing body of work on digital design and how to generate complex shapes using digital manufacturing. Another point also on digital manufacturing and the arrival of CNC machines, and 3D printing, which today occupy a whole questioning on and encourage investigating the possibilities of these new tools today.

8 Anxiety

The world is now entering a new phase of ascension, building a complex machine, capable of interacting and solving problems is now possible. The results exceed expectations, but there is still one last step, that of creating intelligence capable of thinking to think, and as is often the case, fiction enters into dance and accompanies technological developments. The authors did not wait for the arrival of AI to create an extremely rich imagination by bringing new ideas that broaden the field of possibilities (Fig. 3). Fiction reveals new frontiers for scientists to surpass and also causes new anxieties among populations.

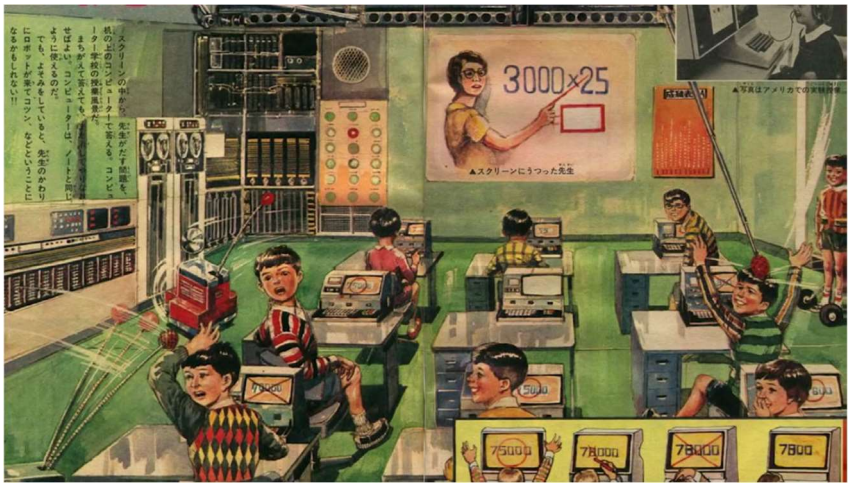

Figure 3. The anxiety of machine-controlled human upbringing.

Czechoslovakia, 1921, a new play entitled RUR is performed in Prague. It is on the stage of a theater that the term robot appears for the first time, it is a word made from several Slavic terms like Robota which means chore in Czech or Robotnik for workers in Polish. For this

futuristic work, a manufacturing plant produces robots intended to serve men, the machines see themselves one day equipped with artificial intelligence and then becoming aware of their condition revolt against their master.

Thus, from the fictional birth, it is already at the heart of justified fascination and deep anguish. Fiction will then maintain a complicated relationship with AI, although it is sometimes a sympathetic or benevolent role, it is often destructive and inhuman, built to annihilate us without a state of mind. This old fantasy of the creature turning against its creator. This robotic fear takes its source at several points, on the one hand, AI is the exact opposite of us, they are devoid of intelligence, doubt, feeling, pity or love, apathy, so many things difficult to code. So when faced with a moral dilemma, will the robot make the right decision or can its choice endanger humanity?

Conversely, would the idea of endowing robots with the ability to develop self-awareness, a bit like the monkey that became human, ever want to dominate the reign of the species like we do?

The Microsoft firm tested a conversation robot called Tay.ai on Twitter. This chatterbot was designed to chat with users, and within 24 hours, it began to make Nazi comments. After having integrated all the trolls that had fed its database, it was not so sure that Machine Learning would be effective, if the world from which the machines were learning made fun of them or was hostile to them. In the end, our fear is that the AI will escape us. That it will develop a cyber-soul. It would then have its own priorities which would not be the same as ours, finding the energy to survive, increasing its computing power, hacking access if we disconnect it. And if the robots try to divert us from the course of evolution, the computer robots, in good mathematical management will see that we do not respect our environment and sometimes our fellow human beings, their goal will be to ensure their survival as long as possible. Will they look favorably on this unpredictability, in short, we feared that robots would find us useless, even harmful?
As for reality, automation and the computer, we took our place in many areas and often for the better. We leave the hard work to them, but it is also what puts a number of workers and laborers out of work. So we will have to find a model of society, and until we do, we will see AIs as parasites that rob us of our livelihood.

They fascinate us as much as they frighten us, they make us face our own fallibility, our own imperfection. Even the legendary chess player Garry Kasparov and a supercomputer named Depp Blue was once faced in a worldwide contest (Fig. 4), as if the feverish world wanted to ensure its supremacy.

If we want to make the most of our technology, we must face our fears. We must overcome those fears if we are to get the best out of what humanity can give.

As the Russian proverb says: "If we cannot overcome them, let us join them". Garry Kasparov had the idea that we could play with a computer... with a computer at his side while combining our forces. Human intuition and the calculating ability of the machine, human strategy, machine tactics, human experience, machine memory.

Figure 4. Garry Kasparov (left) Vs. Deep Blue (right).

The idea became reality in 1998, under the name Advanced Chess, this human/machine competition against elite players. However, in this first attempt, both failed to effectively combine their own skills. Advanced Chess found its place on the internet and in 2005 this freestyle chess tournament was a revelation. A team of grand masters and top machines participated, but the winners were neither grand masters nor a supercomputer. The winners were a duo of American amateur players who controlled three machines. Their talent in accompanying their machines thwarted the superior chess knowledge of the Grand Masters against them, and the computer power far greater than that of other people.

Garry Kasparov came up with the idea that a low-level human plus machine is superior to a very powerful machine alone. However, even more remarkable is that he can be superior to a pro-human player with a machine and a lower algorithm. This has convinced us that we need better interfaces to help accompany machines and make this intelligence more useful.

The human plus the machine is not the future, it is already our present.

Everybody has already used online translation tools to understand the main lines of a foreign press article. Despite their imperfections, we use after our human experience to make sense of it all, and then the machine learns from our corrections. This model is developing in medical diagnostics and safety analysis. The machine analyzes data, calculates probabilities, goes 80 or 90 percent of the way, making it easier for human analysis and decision-making. But you're not going to send your children to school in a driverless car that is 90% or even 99% reliable. So we need a big step forward to gain a few more crucial decimal places.

At a time when intelligent machines are making their way into every industry every day. But where in the past machines have replaced manual labor, today they are attacking graduates or politically influential people. Garry Kasparov as the person who fought them and lost, he is here to say that this is great news. One day, all professions will have to face this pressure. It is not up to us to choose when and where technological progress will stop. We cannot slow it

down. In fact, we have to speed it up. Our technology excels at erasing difficulties and uncertainties from our lives, and so we must look for greater, more uncertain challenges.

Machines make calculations, we understand things. Machines receive instructions, we have goals. Machines have objectivity, we have passion.

Mankind can only do one thing, dream! So let's dream big dreams [12].

9 Conclusion

The use of these tools in architecture has transformed the way we do things. Our thinking about architecture is changing with the new ways of representation, analysis, and design. The arrival of digital tools is totally transforming the traditional ethos of the hand drawing to focus on computational design in the future design.
Reflecting on the past, speculating on the present and exploring the future. The future of digital architecture, we are moving towards an approach multidisciplinary in a technological context of architecture combining design, programming and architecture.

We need to connect more with mathematicians... or developers, in a world where technology has made it possible for us to allow us to live better and optimize our resources.

This proliferation of IT tools leads to a transformation of the way we live and work. We are looking for a morphological and optimal design performance. The multiple digital generations of architectural prototypes analyze the benefits and costs, this significantly improving the digital design process at physical.

The human plus the machine is not the future, it is our present. We have to face our fears if we want to make the most of our technology, and we have to overcome those fears if we want to get the best out of what humanity can give. By combining our strengths, human intuition and the computing capacity of the machine, human strategy, machine tactics, human experience, machine memory, would this be the most perfect project ever?

We no longer have a race against the machine, but with it. We have to collaborate in this race, to program the machine for the future of the possible, to solve the problems, to respond to the performance and economy of the project.
Thanks to these optimizations, we can save calculation time on a project, but also keep an important advantage in the construction.
We are only at the beginning of this revolution, and so much remains to be done. In the future, these advances will make it possible to establish tangible connections to the evolution of the digital process necessary to ensure the success of automated construction for humans. We must aim at programming as we have done for mathematics from a very early age, we are lagging behind, and this awareness should not be taken lightly.

The issue of our century, AI, will transform our jobs, our way of conceiving, it is important to develop this new technology in order not to stay behind in the years to come. Even if creation will resist a time, we are no longer in the time of science fiction, technologies are developing

fast, and this in the same way as our computer power. We must be optimistic until then, and launch awareness campaigns today.

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