## An artistic exploration of new and uncanny properties of white light through a "quantum" light source

Color and light have long fascinated both artists and scientists. However, these two "disciplines" were fundamentally separated in the modern era, each one confined to its own methods, goals, and temporalities, and there are few examples of an approach to these phenomena that comprise both the artistic and the scientific.

The project carried out by Adrien Lucca may well represent a means of reconciliation. After spending ten years investigating the properties of color from an analytical and esthetic perspective, the artist's interests shifted to the characteristics of white light. His research focused on developing a device that could produce such a light, apparently "neutral" and visually stable, whose spectrum he could then modulate to generate variations in the perception of colors of certain materials. Lucca in fact insists that the color of light and its effect on the color of objects are two independent parameters. By programming a light source's wavelengths (in this case, using LEDs), he has been able to obtain pigment shifts from grey to pink, lemon yellow to white, red to green, etc.

He accomplished this through in-depth research and the use of colorimetry, computer programming, and lighting; his work also benefited from the support from a number of experts, including the chemist Thomas Pons, the designer Mathieu Zurstrassen, and the computer scientist Nathan Boulet. In the fall of 2020, varying configurations of his "programmable white light synthesizer" were presented at LMNO Gallery in Brussels, the Liège Public Art Triennale, and Villa Empain, also in Brussels. He is currently preparing a report for publication describing his research process, with all its trials, tribulations, and successes.

This initial research phase concluded with a two-day conference held on November 18-19, 2020, organized by Adrien Lucca and Marjolijn Debulpaep as part of a collaboration between their affiliated institutions (La Cambre and IRPA), which Villa Empain then also joined. These two days focused on light and color, with particular attention on the fields of preventive conservation and art restoration. This event helped Lucca situate his discoveries within a broader cultural context, in which the manipulation of light also involves ethical and institutional questions of considerable, contemporary relevance. Ultimately, it is a call to restore the ties between the sciences and the arts that came unraveled in the modern era.

The following interview was conducted in Brussels on September 9, 2020.

(A/R) How did you come to study the phenomena of light and color?

(A.L.) I started making art already as an adolescent. I wanted to be a composer. I made electronic music for three or four years in and around Paris. I began to develop a very mathematical approach. There is a very direct relationship in sound between perception and mathematics: when you multiply a frequency by two, you go up one octave. When I turned twenty, I gave up everything and came to Belgium. I didn't really know what I wanted to do. I couldn't decide between studying science or art. Someone told me about the ERG. I found out that it was a school where they didn't teach anything; it's a school for autodidacts. (Laughter) So, I went and spent five years there studying just about every discipline. I have always looked for a medium in which I could think like a musician, but in a visual manner. Video seemed like a good fit, with its relationship to time, composition, editing, but I finally settled on drawing. I began making geometric drawings that mixed notions of perspective and color.

(A/R) Which were your main artistic reference points?

(A.L.) I was always quite fascinated by postimpressionism and its relationship to science. Seurat was the most scientific painter of his time, but unfortunately, he died at age thirty-one. If he had lived to see 1907, I think that Braque and Picasso would have found themselves a bit late to the game. (Laughter) Paul Klee also made a huge impression on me, especially his book The Thinking Eye, which talks about his classes at Bauhaus. Kokoschka and Kandinsky as well to some extent, for their relationship to music. In fact, I tended somewhat to ignore contemporary art. I felt that there was so much unexplored potential in older artists from the 19th and 20th centuries. I did always like contemporary music, though: Iannis Xenakis and especially Giacinto Scelsi, the composer who influenced the Spectral Movement, which

treated sound like a material, even in almost entirely monotone works where your attention focuses on the complexity of the sound. That really inspired me. I realized fairly quickly that sound and color don't really work in the same way, and that I ultimately didn't know anything about the latter. So, I began a long period of study, reading everything I could find about color, from Goethe and Wittgenstein to the sciences. One day, Narcisso Silvestrini, professor of color at the Milan Polytechnic, told me about a school near Avignon called Ôkhra, where scientists were all too willing to talk about color with artists, and I went there often to ask all my questions. After graduating, I entered the Jan van Eyck Academy in Maastricht. This was when I bought a lot of pigments and machines, and also when I started to learn computer programming. I concluded this period of study in 2014 with large-scale drawings in which I explored notions of optical averaging, simultaneous variations, and color constancy.

(A/R) At what point did this more specific interest of yours in light emerge?

(A.L.) From the start, I was very aware that the issue of light was intrinsically linked to color. The fact that theories of color generally did not talk about light appeared nonsensical to me. But I didn't have the means to carry out a project on the light spectrum. And I was very busy with my pigments. It was only in 2015, while I was working on a kind of synthesis of my work, that I devoted myself to drawing up a manifesto on colorimetry. The cool thing about colorimetry is that you can reduce light and color to a set of parameters to which you can then apply mathematical functions. This was in fact what I had been looking for since the very beginning, when I thought that sound and color functioned in the same way. I then won a public art competition for a project in Montreal, in which I had proposed fourteen glass mosaics composed on the basis of algorithms. That's how I met people who work in stained glass, and others who work with LEDs. This all continued to percolate in my brain, right up to the commission for a public artwork in Uccle. At that time I was fascinated by some of Olafur Eliasson's work, and I began working with the same light sources as him: sodium vapor lamps. For Room for One Colour (1997), he placed several of these lamps in the same space. When you first walk in, everything is yellow, but then your eye adapts, and you end up seeing everything in black and white. This is a wellknown phenomenon, but he was the first

Art/Recherche	(A/R)
Adrien Lucca	(A.L.)

one to transpose it to the art world, that I know. I liked this piece, where the light determined how the colors manifested themselves. It was pretty radical. For my piece in Uccle, I wanted to use sodium vapor lamps together with LEDs to whiten the light, but I didn't find the right LEDs to complement the sodium vapor lamps. One day I realized that I could use only LEDs and that I could make white light using just two colors. Someone told me that it was impossible, that you have to have red, green, and blue. (Laughter) I asked a Canadian lighting company to send me the digital data on all their LEDs. I worked on this and finally showed a prototype to the art space Été 78: a white light that combined just cyan and red. This white totally changed the color of certain materials, especially yellow objects. It's pretty spectacular. I began a series I titled the Yellow-free Series, in which the lights made the yellows vanish. Unlike Eliasson, who uses a yellow light to transform everything into black and white, I use a white light under which yellow no longer appears.

- (A/R) A piece that is its own manifesto, in a way.
- (A.L.) Yes, that was definitely the intention,
- even if he is surely unaware of it! (Laughter)
- (A/R) How did you come up with the project that you presented to FRArt?

(A.L.) I'm getting there. The system was reaching its limits. The Canadian company couldn't do everything with the LEDs that I wanted. So, just as for the colorimetry or the computer programming, I learned how to make lights myself. And I realized pretty quickly that I was going to need some money to do anything that demanded a certain precision in relation to the light spectrum. That's when I found FRArt. Everything was already quite clear in my head, so the application was pretty easy to put together. This is how I presented it: I was going to make lights using programmable LEDs that produce a white light, and I would have this light vary imperceptibly, but the colors of the materials would change. I called this light source a "quantum light synthesizer."

(A/R) Why "quantum?"

(A.L.) LEDs don't exist in all the wavelengths that you need. There is a gap between the green and the yellow-orange; there's nothing there. But that's where you find several wavelengths that are necessary to create these effects. So, I contacted Thomas Pons, a chemist at the Advanced Institute of Physics and Industrial Chemistry (ESPCI) in Paris, who produces "quantum dots." These are fluorescent crystals that can absorb the blue energy or UV of a LED and convert it into another wavelength. Thomas Pons was very interested in my project, and agreed to help me. We ran into all kinds of problems, and for that matter, we're not even all the way there yet, but that notwithstanding, I have obtained some extraordinary results. The light coming out of my synthesizers contains wavelengths that do not exist anywhere on the market,

except at LMNO Gallery, the Public Art Triennale in Liège, and soon at the Villa Empain<sup>1</sup>!

(A/R) This is what you call "programming light," meaning going to the source of the light spectrum and manipulating it as you see fit.

(A.L.) That's it, a bit as if I were playing a keyboard.

(A/R) We're coming back around to music. (A.L.) Yes, except in a musical chord, you hear all the notes. When you make a light chord, only one color appears. And above all, there are a number of different chords made out of light that produce the same color. It's what we call metamerism. This is the phenomenon that lets me make white lights that have an identical appearance by using different wavelengths. Since I work with pigments, this gave me the opportunity to reexplore my entire collection. I knew them very well in daylight, but with these new chords, I found things that were just incredible. I developed new colors, designated by the composite names that correspond to the variations according to which they appear. I have a red-black, a rose-grey, a green-red, a blue-pink, a lemonred, and a lemon-white. You can see some of them in the Single-many series at the LMNO Gallery. In these drawings all the graphic elements painted by hand become visually uniform at a certain moment, and then they differentiate. For example, Red-many is a large drawing that appears entirely red, a very intense red, before its elements differentiate into nine colors: brown, black, yellow, orange, green, and so on. I have also exhibited several Turquoise-many, Blue-many, and one Grass-many, because at one point the piece looks like grass under the sun, a bit like in a Seurat, actually.

(A/R) You mentioned problems in designing the lamps. What kind of problems did you have?

(A.L.) I spent most of my time working on the lamps. I made tons of prototypes, and I bought LEDs from the world over. Wavelengths are really complicated. For example, if I need a blue turquoise LED, it might be too green from one manufacturer and too blue from another. And you have to buy them to find out. LEDs are almost one-off pieces. To select a precise shade, you have to buy them in packages of a thousand. For one reference for red LEDs, there are fifteen shades. It's a nightmare! And then, we ran into a lot of problems trying to build an LED with a wavelength of 570 nanometers, a yellow that just doesn't exist on the market. The Paris lab considered the number of atoms to assemble to do this. They thought it was possible, and they had an intern work on it for one month. They sent me the crystals, which I put into my resins. I turned on the power and measured

the output: 590 nanometers. I didn't understand. I went so far as to recalibrate my machines to be sure that I wasn't making any mistakes, and I asked them to do the same. In fact, this was the result of a phenomenon of auto-stimulation, which means that part of the light converted by the crystals was reconverted by the adjacent crystals, shifting the light towards red. So, we had to start all over again, this time striving for 560 nanometers, which is tough, because the crystals are smaller and more fragile. The lab sent them to me, and I re-performed the test. This time, it worked, but only for three minutes. The heat made the crystals burst. It was unusable. So, I looked for other solutions. I found a way to make a 550, a very interesting yellow-green that creates a white when combined with a purple. We still don't have a 570. But I need one! (A/R) You're used to consulting experts. Was

your collaboration different this time? (A.L.) No, not really. Except that the FNRS<sup>2</sup> label helps a lot. Scientists usually take me seriously pretty quickly when they see that I know what I'm talking about, but when I mention FNRS, things move along even faster... (A/R) Who are your other collaborators

involved in the project?

(A.L.) I worked at length with another artist, Mathieu Zurstrassen. He was trained as an architect and he is really good at solving "scientific" design problems. He was the one who designed the lamp based on the content and constraints that I gave him. There's also Nathan Boulet, a computer scientist who has worked on cards that control an LED's intensity. For all the versions I am currently exhibiting, I used cards that are available on the market, but we are on the verge of launching our very own production of cards, which are stronger and easier to control. I also proposed to an art restoration and conservation workshop that specializes in contemporary art, studio Nicolas Lemmens, to do a project on preserving these lamps, also to reassure the collectors. I prefer to be prudent and to avoid some big company buying a piece and then ransacking the conservation protocol to turn it into toys.

(A/R) In the application you submitted to FRArt, you in fact insisted on publicizing not just the results of your research, but the method as well.

(A.L.) I've always done that. For my piece in Montreal, I published a catalogue with a rather technical text about my method. It's not a scientific article; you couldn't directly reproduce what I did. But I think this is really important. I wish more artists would think this way, because this would allow us to discuss things. As I do with my assistant, Pedro Ruxa, a painter who knows pigments really well. But this issue of public restitution has become very sensitive for me. In late 2019, two designers contacted me through a scientist who knows my work well. They had been commissioned by a museum. They had seen *Yellow zone/yellow-free zone* (2019), my piece with two balls that change color. They asked me to help them create a piece with changes in shades of yellow, because, while they knew that something of the sort was possible, they didn't understand anything about it. I agreed to collaborate, and I told them about my programmable light project. A few days later they told me that they didn't want to work with me any longer. In March, on Instagram, I saw what they designed for the exhibition; in my opinion, and according to many other people who saw it, it was plagiarism! I contacted the museum and the two designers through my attorney, and they acted as if they hadn't done anything wrong. They said that they didn't know I was an artist, and that when they had contacted me, their project wasn't clear to them at all. In the end, I took them to court for plagiarism. So, it's a complicated issue. I think it's essential that we share, but at the same time, there are people who think that contemporary art is a supermarket where you can pick up things for free and put your logo on them without citing your sources.

(A/R) Have you thought about filing a patent, not for the sake of commercializing your work, but to the contrary, to protect it from this kind of commercialization?

(A.L.) Filing a patent can be really expensive. You need to conduct research, and assistance from an engineer. I didn't have either the time or the money. But there are subventions for patents. I'm going to look into this issue next year.

(A/R) A publication was originally foreseen. Is this still a possibility?

(A.L.) Yes, I just can't help it. I have a personal need to write, from an intellectual standpoint, so as not to forget. It opens up new perspectives every time. But I'm going to be a little more cautious. That said, the project was a little delayed because of Covid. Some interns are working on it. Pierre Huyghebaert, the head of the typography workshop at the La Cambre Art School, helped me find them. My text isn't ready yet. The book will be published by JAP<sup>3</sup>, with whom I have already worked. It will be a limited edition. After that we will look for additional funds to print a larger edition.

(A/R) Did the healthcare crisis involve any other setbacks or critical situations? How did you adapt?

(A.L.) I have a workspace here in my apartment, and another one in Forest, my own private fablab with digital wood saws, machines, and more. Since I work mostly on my own, I don't really rely on companies that might have closed down, temporarily or for good. But it did take me some time to get certain materials, like the inks for the book printing. I didn't really suffer during this crisis because I build everything myself. None of my invitations were cancelled, but everything has been postponed.

(A/R) In addition to the exhibition at the LMNO Gallery, your research is also

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currently being made public at the

Liège Triennale. What is this work about? (A.L.) The piece is titled 5, 4, 3, 2... sans jaune/sans rouge. It's a two-person piece together with Adrien Tirtiaux. We found a concrete parking garage built in the 1950s or 60s, the Neujean parking garage, which we liked a lot. I have taken over the sixth floor, and he is working on the roof with a wood construction painted yellow (which I chose, for that matter), a kind of observation platform that juts out into the void. I hid the sixth floor and his painted wood enters into my space, where I placed lamps that change the color of his work from yellow orange (on his level) to lemon-red (on mine); in other words, the color of his piece is at times lemon-yellow and at others bright red. Each level of the parking garage has its own color code, and level six is dark grey. I repainted all the parts that were originally grey in a grey-pink. When Adrien's structure is lemon-yellow, you feel as if you are on a normal level of a parking garage, but suddenly, when its structure becomes red, the grey parts of the garage become red too. It's a bit the haunted parking garage.

(A/R) You scheduled a two-day conference this spring, which will finally take place in November. The program reveals that your research was not limited to a process aiming for technical performance and the production of a tangible result, but that it also had a critical side, that it tries to reveal the historical, social, and ethical context for using light.

(A.L.) Yes, absolutely. I launched the project at La Cambre in collaboration avec Marjolijn Debulpaep from the KIK-IRPA national heritage fund, where she established the preventive conservation unit. The first day is devoted to color and light at the intersection of the arts and sciences, and the second day will deal with the issue of light for museums and art conservation issues. The participants will include Stefan Michalski, a member of the international committees that, more than thirty years ago, established the rules for museum conservation in terms of light, for example the indicated number of lux for a drawing, and so on. Given the radical change in technology that the appearance of LEDs represents, he is now working on new standards. Agnes Brokerhof will also be there; she does somewhat the same thing that Michalski does, but from the viewers' perspective. She studies how to adapt lighting to people and situations. She thinks about how spectators perceive the aging of artworks. She asks ethical questions about the dangers to which artworks are submitted to allow people to see them.

(A/R) There are also ethical questions tied to potentially manipulative uses of lighting.

(A.L.) That's another aspect of it, in fact. Kevin Smet will talk about his participation in the most recent version of an international system for evaluating color renderings. There is a whole psychological side to this issue of color preference. When you ask people about their recollections of colors, they systematically choose more intense colors than the ones they actually saw. That suits big companies just fine, as this gives them a scientific justification for using lights to amplify their merchandise. It's a bit problematic. I've already seen a piece of salmon under the white lights of supermarket refrigerators; it was bright orange, and very attractive, but it was totally pale away from that light. And there's one other thing. When the company Osram won the contract for lighting the Sistine Chapel, they immediately said that they could "improve" Michelangelo's colors... That is of course highly problematic. People need to be aware of this. Art students should know these things and understand that the color of the light and the effect that light can have on colored surfaces are two independent things. (A/R) The undoubtedly unintentional

ambiguity of your research has been that in trying to increase the possibilities of manipulating white light for esthetic and scientific purposes, you are to some extent helping open a pandora's box...

(A.L.) Yes, exactly. That's my job. Pandora's box is at LMNO. Many people, even scientists, don't know that you can manipulate color to such an extent. Of course I am taking advantage of the fact that this sector is almost entirely deregulated, but at the same time, I am aware that someone who works in marketing might see my exhibition and that it may give them some ideas... I try to be careful about what I'm doing.

- La lumière est invisible, LMNO Gallery, Brussels, September 4–October 24, 2020; 5, 4, 3, 2... sans jaune/sans rouge, Art Public, Liège, August 1– October 31, 2020; The Light House, Villa Empain, Brussels, October 22, 2020–January 31, 2021.
  Belgian Fund for Scientific Research.
  - Belgian Fund for Scientific Research. The Brussels-based association Jeunesse et Arts Plastiques is developing an educational program on contemporary art through lectures, film screenings, publications, and other means.

## CAPTIONS

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- fig. 01 View of workshop, assembly of a synthesizer. Photo credit: Adrien Lucca.
- fig. 02-03 View of installation : *5, 4, 3, 2... sans jaune/sans rouge*, 2020. Public Art Triennale, Liège, 2020. Photo credit: Adrien Lucca.
- fig. 04 View of workshop: Pedro Ruxa working on *Red-many* n°5 (*large*), August 2020. Photo credit: Adrien Lucca.
  fig. 05-07 *Red-many* n°5 (*large*), 2020, pigment on paper,
  - programmed white light. Photo credit: Adrien Lucca.