

# STARTS Residency Public Report Inside-Out

C. Vogler

# Abstract

DNA is the blueprint of life. The artwork Inside-Out aims to bring knowledge about the information stored in our cells to the surface by making artistic fashion pieces and knits based on genetic research from the Tech project partner ChromDesign.

Combining science, fashion and technology, the artist Carolin Vogler created wearable pieces portraying genetic structures and laboratory processes through visual aesthetics. During exhibitions, visitors can actively explore the artwork with multiple senses, even actively engaging in replicating a DNA sequence as colour patterns on a knitting machine to get a sense of the complexity of biological processes. The artwork shall encourage visitors to learn about the biological processes and structures that inspired prints and knits; and by doing so, explore a part of their own body.

The technological partner, the Centre for Genomic Regulation (CRG), provide the biological content, trainings and a workspace to the artist. Access to different departments and laboratories at the CRG transmitted the artist a well-rounded picture of the diverse work connected to research projects.

Both residency partners, the artist and CRG, closely cooperated, interchanged experiences and knowledge, mutually benefitting from the co-creation experience.

They organized a roundtable session at the European Researcher's Night in Barcelona to present their residency. Further talks and workshops to share the artist's approach with scientists and provide a different design-inspired angle to their lab routine. Additional presentations and exhibitions to scientific and non-scientific audiences in Barcelona as well as international design lectures featuring the co-creation are planned for 2020.

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Genetics: the scientific study to genes, gene variations and how characteristics are inherited in organisms<sup>1</sup> **Chromatin:** "Chromatin is a mass of genetic material composed of DNA and proteins that condense to form chromosomes during eukaryotic cell division. Chromatin is located in the nucleus of our cells."<sup>2</sup>

**HOXA4:** a house keeping gene on chromosome 7 important in the early stages of human development. It "may regulate gene expression, morphogenesis, and differentiation."<sup>3</sup>

<sup>&</sup>lt;sup>1</sup> Genetics https://en.wikipedia.org/wiki/Genetics

<sup>&</sup>lt;sup>2</sup> R. Bailey"What is Chromatin's Structure and Function?" published online 30.10.2019, https://www.thoughtco.com/chromatin-373461

<sup>&</sup>lt;sup>3</sup> HOXA4 https://en.wikipedia.org/wiki/HOXA4



### I. INTRODUCTION

For the artistic STARTS residency Inside-Out the scientific project ChromDesign represented by FUNDACIO CENTRE DE REGULACIO GENOMICA (CRG) co-created with the artist Carolin Vogler. This residency was managed by ARTSHARE INVESTIGAÇÃO TECNOLOGIA E ARTE, LDA as the VERTIGO / STARTS Residencies Partner.

ChromDesign is a European network of research institutions training 13 PhD students and investigating how the threedimensional chromatin organisation influences gene regulation and the creation of diseases and malformations.<sup>4</sup> Aiding in the cross-country and cultural exchange of information throughout specialised research groups, the project is promoting innovation through international knowledge exchange.

The international project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement No 813327.

Carolin Vogler is a German artist with a background in fashion, marketing and maker experimentation on the quest of creating more sustainable solutions in fashion production and consumption. She works with a mix of traditional techniques and new technologies to create wearable artwork.

As artist and tech partner are based in Barcelona, they had the chance to directly work together throughout the entire 6 months residency.

ChromDesign provided the artist access to high-level research expertise on epigenetic exploration in order to create a unique artwork reflecting this research field: a challenging task, given the highly technical and specialised information within the investigation.

It was the first contact for the artist with epigenetic content and a laboratory environment. Thanks to a close collaboration with the CRG communications and International Scientific Affairs (ISA) team, the adaptation was fast and they facilitated all needed knowledge to fully interact with the scientists without misunderstandings.

Science is often associated with analytical rational decisions while art is seen as a passionate, more emotionally driven field. By combining these unlikely sectors a unique outcome and surprising symbiosis was expected, exploring similarities and differences of the two.

Little is taught in primary and secondary education about chromatin biology, resulting in only few members of today's society knowing about the structures and processes happening in their cells. This gap in knowledge can be seen as a fundamental need that the co-creation was built on. Inside-Out proposes to educate, surprise and create interest in new audiences by presenting them scientific content in new more approachable and familiar ways. The artwork wants to inform about the beauty and mysteries hidden in human cells. The artwork shall spark curiosity in visitors to learn about the scientific backgrounds of the artwork and ease the communication of complex scientific data.

# II. ARTWORK

Genetics are a topic that concerns all of us, the base of our being. Besides playing a major role in human malformation and cancer, the investigation into chromatin structures reaches to explain the mysteries of human existence. Although all humans carry chromatin in their cells, only few know what their genetic code looks like and how to interpret its information. Deciphering the content of complex scientific papers, Inside-Out aims to take a closer look into the work at the laboratory and its research to make this research field more accessible to the general public.

The project has as a goal to bring the blueprint of life hidden in our cells to the surface and translate it into fashion and knits.

4 ChromDesign Project description on website: https://www.chromdesign.eu/about/, funded under the European Commission H2020 framework programme.

Besides sparking curiosity, the artwork wants to communicate some of the processes and results of the laboratory work to new audiences opening up to non-scientific targets. While research papers and their content are reflected in the news, only people affiliated to the sector have witnessed daily routines at laboratories. By giving visitors a glimpse of the happenings at the lab, this sterile imagined environment that is often associated with machinery gets humanised. A main objective is to reach audiences that are usually scared off by scientific jargon of publications yet may want to get involved in public outreach activities or learn more about current research topics.

Fashion and knits were chosen as a communication medium as their structure reminds microscopic images of chromosomes. Especially in knitting, a single thread creates an entire garment without being cut or knotted. The behaviour of DNA is similar where entire organisms are created from a strand of DNA.

The colours chosen for the artwork refer to the hues of tools at the laboratories while all prints are inspired by 3D renders of chromatin data and Hi-C matrices from which so called TADs (Topologically Associating Domains) can be visualised (Please refer to Image A, B and C of the Appendix).

Besides showcasing research results, the artwork uses prints inspired by processes used at the laboratory to make these findings. While being a resident at the laboratory, the artist realised that several steps and experiments are needed to confirm a single research hypothesis. These processes are not only visually appealing and technologically fascinating but also almost unheard of to the general public or even when research findings are presented in mainstream media. Yet without them, no results would have ever been possible.

Some garments reflect the processes of Hi-C map matrices as prints, removable fluorescent marking and highlight techniques as well as reflective garment parts that are only visible when observed with the use of technology, in this case a flashlight.

An aspect of the residency that very much surprised the artist was the use of plastic at the laboratory. This contrast of working with biological material using artificial materials is reflected in the material choices of the artwork: some use 100% wool, while others reflecting the processes are made from Polyester.

Another important factor shaping the artwork came from an observation of use of technology versus manual labour at the lab. While Carolin Vogler had expected to find very machine driven and automated processes, it turned out that new research questions ask for new processes and therefore involve many manual work steps. The creation of these workflows is entirely dependent on human creativity and experimentation. The artwork creation reflects this aspect. While some items were manually sewn or hand-knit, others use sublimation technology and laser cut to create the final pieces.

To offer visitors a multi-sensory experience the outcome of the residency is providing a visual, tactile and interactive part throughout the exhibition.

#### The artwork consists of the following items:

# • Couture Dress with reflective elements and underskirt (Images D, E, F in the Appendix): Sublimated Polyester Silk, hand-sewn

The print on the dress was inspired by three dimensional chromatin visualisation by Mike N. Goodstadt, Martí-Renom Lab. These visualisations help determine the physical structure and dynamics of chromatin. The top further shows stylized laboratory equipment.

• Chromosome Condensation Top (Images G, H in the Appendix): Wool, hand-knitted

This top represents the condensation of chromosome territories within the cell nucleus. For instance, the gene-rich chromosomes tend to be located towards the center of the nucleus and the gene-poor in the nuclear periphery, and active genes within the chromosomes are located in decondensed chromatin regions with respect to inactive genes which are located in more condensed regions. It can be observed that from the centre outwards, chromatin is more condensed.

• Chromatin Top (Images I, J in the Appendix):



Sublimated Polyester Silk,

This top shows a chromosome print on the lower part and wool applications in the upper part similar to chromatin.

# • Hi-C Plaid skirt with reflective applications (Images K, L, M in the Appendix):

Sublimated Organdi tull with reflective elements reacting to flash light

Hi-C chromosome contact map matrices show the distance of chromosomes to one another in a three-dimensional space, as well as the distances between regions of the same chromosome. The darker the areas the closer they are. This skirt shows matrices of the human chromosomes 13 and 14 to one-another as well as to themselves (13 to 13 and 14 to 14). As their natural pattern reminds of highland-plaid they have been edited, cut and overdrawn with plaid designs.

• Discovery Top (Images N, O in the Appendix):

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Hand-knit and -hand-woven top with movable contrasting buttons

The front of the top shows two orange buttons. These contrasting buttons stand for fluorescent markers that are used to highlight promoters, proteins or antibodies when researching different parts of the chromatin. Depending on what the wearer wants to highlight she can move them on the knit.

The back of the top was half-woven on a self-made loom, the parts of the weave that are completed stand for the known facts and knowledge in genetics while the loose threads symbolise areas still waiting to be explored.

### • TAD scarves (Images P, Q in the Appendix):

Sublimated Polyester Silk

"Inside the nucleus the DNA strands of [...] humans are organized into three-dimensional units called Topologically Associating Domains (TADs)."<sup>4</sup> ChromDesign scientists like Stefan Mundlos study how disease-causing mutations influence the formation of TADs and their role in gene regulation<sup>5</sup>. The design of the scarves is based on matrices of TADs on chromosome 5.

#### • Painted Brother KH860 knitting machine with 2 punch cards

Laser-cut punch cards that are based on the DNA sequence of the house keeping gene HOXA4. This gene is part of a group interesting to the ChromDesign project investigating gene regulation and human diseases.

While the finished garments showcase chromatin structures and lab processes, the knitting machine can be used for live knitting demonstrations at exhibitions. Punch cards that represent the DNA sequence of the gene HOXA4 can be inserted into the machine and, by moving the carrier, be transformed into colour patterns of the knitting machine. This interactive element displays a symbolic DNA replication. As the machine is old and occasionally drops a stitch, error in replication and their influence in the entire knit can be experienced and explain how with time also biological processes can produce more errors.

# III. METHODOLOGY

Throughout especially the first part of the residency, the artist spent long hours in the laboratory, meeting with scientists, and exploring their work. Following scientists around the lab, she learned about their practices, routines and challenges. Assisting experiments, looking at bioinformatic data and renders of 3D chromatin as well as experiencing the daily dynamics at the institute an artistic idea was shaped, prototyped and changed at the premises of the tech partner. The artist translated her experiences working at the laboratory into knits and fashion pieces.

By the time the artistic exploration began, an experimental approach similar to actions at the lab was applied.

# Action driven creation

By allowing experimentation to venture from the original draft and listen to new influences and knowledge gained at the project partner's premises the project organically took shape, changed and advanced throughout the residency before resulting in an adaptation of the originally proposed artistic elements. By creating multiple small scale samples of textures, colours and thread sizes helped prepare the final set up of the knitting machine and knitting patterns of the top. The prototyping was accompanied with sketches and mood boards. The digital print designs were made on base of actual renders and microscopic images, tracing, overdrawing and layering several scientific data sheets and images.

# Manual craft vs. use of technology

Mixing manual and machine driven production methods the artwork hugely reflects the manual and technological use at the lab. While technology is needed to support some steps of the research at the lab many actions related to hand-on experiments are being conducted manually.

In my artwork this is mirrored by combining hand and machine-knitting, marbling and sublimation of digital designs.

#### System oriented design approach

Importance of submerging in the experience I decided to spend the full residency period directly working at the CRG Barcelona to experience life at the laboratory to the fullest and use the experiences of witnessing work of different departments to craft a full picture of the spectrum of work and parts needed to create a whole in research.

# IV. CO-CREATION PROCESS

The ChromDesign team at the CRG was very supportive, providing a space to work, access to the laboratories as well as organized sessions with different team members to learn about their research and assist experiments and the analysis of findings.

As the scientific partner was very patient and took time to discuss their research on a regular basis, communication was easy and fruitful. The entire team was very supportive in the residency process, providing needed information and explanations.

Their ISA and communications team further arranged participation in international and cross institutional events like the European Researchers' Night 2019, published press releases about the co-creation and together with the PRBB Barcelona created a short video introducing the project to internal stakeholders at the institute. On 27th of September 2019 the Inside-Out residency partners took part in the "Nit Europea de la Recerca 2019"/European Researchers' Night in Barcelona. Together with ChromDesign PhD students based at the CRG, the artist prepared a wool installation at the Fab Café Barcelona playfully providing basic information about chromatin and the functions of histones (Image M in the Appendix). Luciano Di Croce and Carolin Vogler further took part in the roundtable discussion and exhibition "Bridging STEM to STEAM: Why art can be more than a communication tool in science and technology?" This panel discussion addressed current experiences working on the residency project. They also deliberated on how art and science can collaborate for a mutual benefit creating surprising and innovative outcomes.

Taking part in weekly lab meetings, the artist was able to integrate herself into the scientific routines.

The trust between the project partners showed also in invitations to internal laboratory meetings as well as the participation in the annual ChromDesign meeting with the entire consortium on  $16^{th}$  and  $17^{th}$  of September 2019 in Copenhagen. Meeting project members from different institutions throughout Europe and discussing the artistic and scientific project together resulted in interesting insights about the self-perception of scientists and their hopes for the future of the field that strongly influenced the artistic vision. The meeting with all ChromDesign partners reassured the artistic thesis that the human aspect of science should be the centre of the artwork, leading to the decision that wearable art is a suitable medium to display biological structures on the outside of the body.

The artist was entirely in charge of the production process of the artwork, renting facilities and machinery to laser cut and sew several art-pieces as well as hire external services for sublimation and video production of the residency video. In order to internally communicate the project, share experiences and knowledge, presentations were given to CRG staff members and PhD students. Encouraging interdisciplinary work, bold ideas and design thinking.



Throughout the entire residency, there has been vivid communication between the different departments at the CRG and the artist in order to plan meetings, create communication strategy and outreach actions. Spending the entire residency at the CRG helped gaining a deeper understanding of processes related to scientific work and its organization and management.

The knowledge exchange between the project partners exceeded the artistic project and resulted in workshops given at the hosting institution nurturing interdisciplinary practices and applications.

## V. IMPACT

# A. Research Impact

As an important result of the residency, the scientific project has the chance to use the residency as well as the artwork as a communication and educative tool for non-scientific audiences. It assists the scientific partner in reaching an audience that would normally not be in contact with science. As a consequence of the successful collaboration between the artist and the technological partner, the residency has encouraged and motivated the CRG communications team to explore other collaborations with artists to communicate science and to engage with non-scientific audiences. Both partners are hoping for an increased interest in science and participation in outreach activities after exhibition of the artwork. Increased media interest of non-scientific publishers can be expected.

It further enables to explain how innovation could impact practice and ultimately improve the tech project's outcome. It helped younger scientists practice their communication skills when interacting with the artist.

An additional aspect of the residency is to show scientists that their work has aesthetic value and appears fascinating to people from different sectors. Routine often lowers the perception of value appreciation of tasks, by presenting their work through fresh eyes, scientists can re-experience the interest for their field and explore parallels in their work and the artwork in a playful way.

Interaction with the artist encouraged scientists to think beyond the limitations of current technologies and allow ambitious ideas and estimations for the future. Exchanging points of views and discussion possibilities of connecting information of different fields and finding analogies from one sector to another will hopefully spark beneficial ideas for research and internal procedures.

#### B. Artistic Impact

On an artistic level, the residency had a huge influence on work and planning. Following the scientists at the lab built many new impressions that provide material or further artwork and will hopefully result in future collaborations. Since the team is working with living materials, the factor of time is treated in a very different way compared to other sectors where everything constantly has to be optimized and sped up. It was a very valuable experience to see the teamwork, materials and workflows first hand. The synthesis of high technology and manual labour at the laboratory was very impressive, the artist gained new knowledge and a better understanding of scientific workflows and research.

On a personal level, it was very interesting to know how scientists deal with failure of experiments. How they emotionally disconnect from their work without losing their passion for it. The analytical techniques on how to adjust experiment procedures after an unintended outcome, improved the artistic prototyping approach, replacing materials step by step in order to find the perfect match and create something new.

The residency gave the artist the opportunity to create work on international scale as a co-creation, which will hopefully pave the way for further interdisciplinary co-operations throughout Europe in the months to come.

# VI. ART-SCIENCE INTER-RELATIONSHIPS

As in science, also the artistic methodology started with observation, gaining a deeper understanding of biological procedures and theory. I consider the art-science relationship very harmonious. As both fields share curiosity, creativity the art of observation and experimentation towards the unknown there has been a solid base while differences in knowledge and work approaches were embraced and studied to reach a better understanding. Science is often associated with analytical rational decisions while art is seen as a passionate more emotionally driven field. By combining these unlikely sectors a unique outcome and surprising symbiosis was expected exploring the similarities and differences of the two. Just like in art there are diverse directions and jobs in genetic research teams: experimental biologists, bio-informaticians, groups focusing on cell cultures...

This diversity paired with a diverse team can not only bring better results but also 360 degree applications of the same.

Being part of the ChromDesign team and affiliated research groups throughout the residency I felt very welcome and my opinions valued in discussions.

The most important influence of both fields is that they challenge the status quo and pave the path to a dream of solutions and improvement, emotionalising and empowering people.

Combined they give way to ambitious new concepts allowing scientists to reach far beyond the specific constraints of their current research topics and artists to prove their vision. Art and science complement one-another very well and provide space for further interactions. In the end science and art are not that different at all.

# VII. FUTURE DIRECTION AND ACTIONS

After completion of the artistic work, both project partners are preparing presentations of the co-creation results in form of exhibitions and talks. So far, an internal exhibition at the CRG Barcelona and the PRBB scientific park is planned to thank the involved scientists and officially communicate the results of the project. Carolin Vogler has been approached to give a lecture at Fabricademy, the new textile academy, telling students across the world about her experience in an online lecture. Moreover, the ChromDesign communications team and artist are currently reaching out for possibilities to display the art in a fashion show or exhibition in Barcelona besides the STARTS Residency Days in Paris in February 2020. Several of the ChromDesign Consortium partners showed interest in displaying the artwork at their research institutions.

Both partners will remain in contact in order to measure the impact of the co-creation on society and their innovative research.

#### VIII. CONCLUSION

"Like science, art challenges perceptions and expands people's minds. Science and art can be greater together than the sum of its parts [...]<sup>35</sup> Marta Solis Public Engagement and Science Education Officer at CRG.

Spending time together, exploring the work of each project partner has been a very enriching experience for both parties. Besides learning about epigenetics and biological processes, it showed the artist and scientists very distinct ways of approaching research questions. In addition to providing knowledge, the residency brought together people of different backgrounds, it created awareness of the unexplored secrets in the field of epigenetics, giving opportunity to future collaborations and explorations. Witnessing the creativity and team work at the laboratory has made a large impact on the artist. She is now curious to see where the co-creation will lead both partners once exhibited to the public.



<sup>5</sup> Interview recorded for the video of the residency result in November 2019



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Scientific matrices provided by Martí-Renom Lab.

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Image C: TADkit Sample Matrix

# **Images Artwork**

• Couture Dress with reflective elements and underskirt



Images D-F: Couture Dress

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• Chromosome Condensation Top







Images G, H: Chromosome Condensation Top

• Chromatin Top



Images I, J: Chromatin Top



• Hi-C Plaid skirt with reflective applications



Images K & L showing the Hi-C Skirt, Image M Reflecting details on Hi-C Plaid skirt



• Discovery Top



Images N: Discovery Top

• TAD scarves



Image O: Detail Discovery Top Button



Images P, Q: TAD Scarves

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