

# STARTS Residency Public Report

## Transhuman Expression: Human-Machine Interaction as a Neutral Base for a New Artistic and Creative Practice

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*Transhuman Expression* is an interactive room installation created by Liat Grayver in collaboration with weDRAW in the context of a Vertigo STARTS Residency programme at Casa Paganini | InfoMus (Genova, Italy). Data captured via motion detection of visitors is analyzed, processed and projected on large screens positioned in the exhibition area. The design and implementation for the artwork was structured in three development stages, each focussed on the completion of specific components of the work. The second of these stages involved the participation of a group of children recruited by weDRAW. Contributions to the project brought by the Artist and the Technical Partner were mutually beneficial, each gaining new knowledge and perspectives for their own ongoing work in artistic and technological fields. The collaboration benefitted, was built on and furthered experiences that both have had in ongoing work exploring points of convergence of artistic and scientific practices (for the Technical Partner this extends back to the 1990s). Grayver's work in robotics-assisted painting gained new tools that can be integrated into the system she works with (at the University of Konstanz), while the weDRAW team has acquired new perspectives on the range, scope and scale of real-time, automated movement analysis. The tools and experiences resulting from this residency have immediate and long-term impact for the Artist and the Technical Partner; components of the artwork can easily be incorporated into current and upcoming artistic work and scientific research.

**Index Terms** — Contemporary painting practices, generative art, movement analysis, pedagogical art, robotics-assisted artwork.

### I. INTRODUCTION

During the course of a STARTS Residency programme at Casa Paganini | InfoMus (Genova, Italy), Berlin-based Liat Grayver (Artist) collaborated with the European Union Horizon 2020 ICT project weDRAW (Technical Partner) on the creation of an interactive room installation in September-December 2018. Using motion detection, data processing and projections, the work investigates the relation between physical actions and visual representation with the goal of creating a new artistic tool that can also be pedagogically repurposed.

Behavioural and decision-making patterns are extracted from the physical actions of visitors to the exhibition space, analyzed and projected in the room in real time with the goal of encouraging them to become active participants in the exploration of this

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interactive and location-specific generative artwork. Further, and with particular relevance to school children, the work assists in the perception of basic mathematical and geometrical principles, which could be rewarding in terms of their learning paths, and at the same time be helpful in encouraging teachers to not evaluate their students' work as "good" or "bad", but rather to better understand the structure of thoughts behind it. More broadly, the work reflects on pedagogical aspects of how we learn from and process received information, stimulating us to re-evaluate our own learning methods.

## II. ARTWORK

The interactive room installation *Transhuman Expression* examines and reflects upon the artistic potential of the structure as well as the experience of the medium of painting positioned within the context of contemporary technological innovations. Methods of information visualization in the post-digital age constitute a key focus. In its current form, the work results from the convergence of several concepts intrinsic to recent works and collaborative projects in which the Artist varyingly employed robotic technologies, motion tracking, video art, printmaking and painting. As a whole, this generative artwork investigates the relation between physical, human-level activities and machine-based systems, both of which act — within a feedback system — synchronously upon each other via structures built using data extracted from the physical actions of participants (visitors) in the exhibition area.

Participants are fitted with motion-tracking sensors before entering the exhibition space. Once inside they are free to move about as individuals or to interact with other visitors. The computer system recognizes the movements and evolution of both individual participants and group dynamics taking place within the space, and continuously registers data relating to these actions. The data is analyzed, processed and visualized according to different rules of representation defined by the Artist in collaboration with weDRAW. The entire process takes place in real time (as it occurs "on stage"), i.e. participants see the live video projection (output) that results from their actions (input). They are free to explore and examine how they become part of a larger structure of situations and constellations: how their own movement, in relation to the space and to other participants, shapes the visualization. The interactive nature of the platform thus stimulates visitors to explore various ways to manipulate (control) the ever-changing state of the continuously evolving digital-painting artwork.

One of the key interests in presenting the visualization of subject matter in the form of a room-size composition is the formalization of rules and protocols for the repetition of a specific creative act, as well as for its recognition, such that the *act itself* can then feature as the primary subject matter of the work. In recent works, for example, the Artist explored the *act of creating* a painting from the perspective of its most primordial act — the process of committing a singular brushstroke to canvas or paper.<sup>3</sup> The *identity indicators* of such artworks are located and perceived within the experience of understanding the artistic and production process, rather than externally represented as a singular artistic object. In *Transhuman Expression*, a similar approach to the exploration of the creative process is extended into open space using advanced technological means — here, the canvas is replaced with a room of variable size and the brushstrokes with visitors to the installation work. Using motion tracking, movement analysis and data processing, pre-defined characteristics of temporally based physical activities can be digitally recorded as they occur in a given space (gallery, theatre, hallway or outdoor square), and some or all of this data can subsequently be extracted, decomposed and recomposed into the material world in the form of a new artwork. As this process is made visible to the participants, it translates into an artistic experience that assists them in the discovery of patterns and structures, the perception of which can help augment their understanding and appreciation of artwork in general.

## III. METHODOLOGY

An iterative design and development cycle for the artwork involved participants with different skills and backgrounds, and included the artist, computer scientists and engineers, a group of children and six master's students in Digital Humanities at the University of Genova. For their first contact, the Artist presented her ideas and artistic concepts and the Technical Partner presented the available technologies (notably those developed in the framework of the weDRAW project). Brainstorming

<sup>3</sup> See, for example, the room installation *Traversing the Threshold* (2018), notably the freely hanging rice paper and ink works.  
<http://liatgrayver.com/traversing-the-threshold>

sessions followed that helped progressively converge the artistic and technological ideas, taking into account conditions such as an extremely limited timeframe and seeking to maximally exploit existing resources in service of the evolving concept of the artwork.

It was decided that the most time-efficient approach would be to develop the work in stages, each of which would concentrate on one or more specific components of the project. Further, in order to focus the tasks as well as give the team points at which progress could be measured, three “deliverables” would delineate the overall project.

As an exploratory work in the earliest weeks of the project, the Artist used a video of two dancers provided by the Technical Partner to extract and reduce motion data into visual representation as a means to investigate movement as a medium. Through the collaboration of computer scientist Antonín Šulc (University of Konstanz), three motion analysis programmes were created to track simple parameters such as velocity, distance and direction, each describing a different interpretation of the time-based perspective on the changing situation when the artwork is running.

For the second stage, a group of children from a local school was invited by weDRAW to participate as an audience and test group. Movement analysis was used to structure easily comprehensible visual concepts for these young collaborators: lines (trajectories) and forms (grouping). This created a reductive link between time- and location-specific physical acts (movement) and their visual representation (at the moment digital) as a platform to explore and understand structural elements in a controlled environment.

The third stage for the artwork was concentrated on the final technical and structural development. The visualization platform was built using EyesWeb (previously developed by the Technical Partner) and the integration of the motion-capture system was completed. In parallel, the design, construction and installation of the physical framework (scaffolding, screens, cameras, etc.) for the entire installation was undertaken. The final interactive installation was featured at the end of the residency in a public exhibition, and also presented digital works by collaborators at Casa Paganini that complemented the artwork created by the Artist and Technical Partner.

#### IV. CO-CREATION PROCESS

The first two months of the project involved continuous exchange of information between the Artist and Technical Partner in order to familiarize each side with the other’s work, experiences and skill sets, and to conceptualize the artwork itself. In order to adjust to unanticipated time restrictions, it was decided very early on to focus efforts primarily on the development of the visualization system for the live movement tracking, and to relegate initial plans for more extensive exploration of pedagogical applications of the project components to a future stage of research and implementation.

The weDRAW team created the technology and the system architecture for the artwork. EyesWeb, an open software platform developed by the InfoMus Lab (Casa Paganini) since 1997 that supports the design and development of real-time multimodal systems and interfaces, was integrated as the base of the system. It was used to track the visitors’ movements, to compute movement features and to generate multisensory feedback; data from a motion-capture system (cameras, sensors and computers) was used for this purpose. The software was optimized for this stage of the work by Simone Ghisio (weDRAW; InfoMus; University of Genova).

With the collaboration of Monica Gori, Scientific Coordinator of weDRAW, a group of school children was involved in a prototype session led by Grayver that incorporated some of the pedagogical aims of the initial project. The children were assigned tasks to create geometric forms both individually and in groups, with different colours assigned to different forms to help in their recognition of the visualization of their behaviour in the space. The overlapping of images also served to introduce the children to basic levels of abstraction.

Grayver conceived and coordinated the construction of the physical installation, which comprised three projectors, each assigned one of the three different visualizations to project on three large, transparent black screens hung in the exhibition space. This approach arose out of Grayver’s recent practices exploring layering of materials and using transparency and light as artistic materials. The projected images are thus visible from both sides as well as on the frescoed walls beyond the screens.

Leading up to the final presentation, the Artist and Technical Partner invited six master's students in digital humanities to contribute to the project. They were asked by the Technical Partner to develop a separate work for the exhibition that would be positioned at the installation's entrance. The integration of this Kinect-based digital work in the exhibition was supervised by the Artist and transformed the visitor's movements into trajectories, thus serving as an introduction to the installation. During the exhibition the students greeted visitors and introduced them to and prepared them for their experience with the works. Prior to the exhibition they had also taken on the tasks of creating and distributing online and print publicity.

## V. IMPACT

### A. Research Impact

The residency had a very positive impact on the research activities carried out at Casa Paganini, both independently and in the framework of EU-funded research projects such as weDRAW. The development of the artwork helped the Technical Partner address several existing research challenges as well as some that emerged during the course of the residency.

Much existing work concerning the analysis of human full-body movement in areas of human-computer interaction and robotics is limited to the single individual. The scaling of movement analysis qualities from individuals to groups explored in this collaboration strengthened a core research area for the Technical Partner, i.e., real-time, automated analysis of group motor behaviour, movement qualities and social signals. A related development with equally important impact is the ability to analyze movement qualities at different temporal scales.

A major goal of weDRAW consists of developing social games for supporting children in learning geometry. In this framework, the residency was an important occasion for brainstorming and for generating new ideas for this purpose, and the perspective of an Artist was an excellent complement to the skills and experience of the Technical Partner. The expertise acquired in the course of this collaboration will continue to feed into ongoing work in pedagogical areas.

### B. Artistic Impact

The facilities at Casa Paganini investigate the potential and results of human creativity through interactive methodologies: computer-to-machine (simulated to real) and man-to-machine (artist working together with the machine). This interdisciplinary working platform, which brings together computer scientists, pedagogical programmes and artists, has stimulated a large range of questions regarding the use of advanced technologies in contemporary creative practice.

The data captured in such a project can be stored and later used in other artistic contexts. For example, the analysis of individual and group movement using motion-capture technologies can stimulate artists to explore new means of visual representation based on organic movement. The analysis also reflects tendencies in social behaviour, such as the individual's perception of the self and the group.

There is further relevance in terms of fundamental questions in the Artist's ongoing research and artistic practice in robotics-assisted painting. How does one incorporate the use of computers and machines in the very intuitive and gestural practice of making a painting? How can one decompose the physical act of making a mark to a bodily movement (machine), taking both logical decisions (computer) and emotional intentions (artist) into account?

## VI. ART-SCIENCE INTERRELATIONSHIPS

Liat Grayver's artistic work in recent years has increasingly involved collaborations with computer / machine engineers and art theorists / practitioners on the practical and theoretical side, respectively. Research and projects at the Casa Paganini | InfoMus lab, where the weDRAW project is developed, has always straddled the intersection of science, technology and the arts.

Since February 2016, the Artist has been collaborating with Prof. Oliver Deussen (founder of the e-David project run by the Visual Computing Group of the University of Konstanz) on the use of robotics as a painterly tool. Complementarily to this ongoing exchange, in order to collect information and investigate parallel contemporary researches relevant to her cross-disciplinary artistic research and practice, she has communicated and worked with MIT's StartLab and Tel Aviv University's

Curiosity Lab. In 2017, Grayver invited Joerg Fingerhut (Artistic and Scientific Director of the Association of Neuroesthetics) to give a presentation and lead a panel discussion as part of her exhibition *Brushstrokes in the Digital Age: Interdisciplinary research in painting and robotics*. The room installation she developed in 2018, *Traversing the Threshold*, was comprised of robotics-assisted calligraphic works made with contributions by computer scientist Marvin Gülzow (e-David Project PhD candidate) alongside video works made by and in collaboration with media artist Marcus Nebe. This project, realized with the assistance of robotic technologies, stretched into and exposed the temporal and physical space of the artist’s creative process through the mediums of painting and video.

The team leading the weDRAW project at Casa Paganini | InfoMus has over two decades of experience in collaborating on artistic productions and leading international research projects. For example, interactive onstage technologies were designed and developed for Italian composer Luciano Berio’s staged musical works *Outis* (Teatro alla Scala, Milan, 1996) and *Cronaca del Luogo* (Salzburg Festival, 1999). Interactive installations have also been presented in several important public events, including the Venice Biennale (2005), Auditorium di Roma (2007), the European FET Conference and Exhibition (2011), and at the European Union (EU) ICT Conference “Create, Connect, Grow” (Vilnius, 2013).

Casa Paganini | InfoMus has hosted EU-funded projects in the context of the fifth, sixth and seventh Framework Programmes on ICT. Most of these projects, for which the lab has often assumed the role of Coordinator, have investigated the relationships between art and technology from a variety of perspectives. For example, the Future and Emerging Technologies (FET) project Social Interaction Entertainment Using Music Performance (SIEMPRE) studied computational models and techniques to measure non-verbal expressive, emotional and social signals in music ensembles. Two Horizon 2020 projects explored the pedagogical aspects of movement learning: for *Wholodance*, systems were developed to support dance learning in collaboration with choreographers and dancers, whereas in Technology-Enhanced Learning of Musical Instrument (TELEMI), movement qualities of violin playing were investigated in order to design systems supporting violin students in their learning activities. Research output is typically presented in public contexts: results from a further Horizon 2020 project, DANCE, were used in *Atlante del Gesto*, a laboratory on dance and gesture led by choreographer Virgilio Sieni, which resulted in four public performances in Genova.

## VII. FUTURE DIRECTION AND ACTIONS

The research and production for this artwork greatly benefitted from the important contributions and perspectives offered by the University of Genova and the Casa Paganini’s InfoMus Lab, and this collaborative project between the Artist and the Technical Partner has indeed already opened various dialogues — in terms of both artistic and scientific research — for continued work and collaboration related to the artwork.

### **Liat Grayver — Robotic Technologies**

In her ongoing work with the e-David project (University of Konstanz), the Artist has built an extensive library of brushstrokes, gestures, trajectories and patterns that can be called up for use and executed by the painting robot. Further pattern and texture resources can be made available to current and future collaborators on the e-David project by integrating data captured during the residency, or new data generated using the software developed there, into this growing library.

In its current state, the analysis software responds to the following parameters: proximity, direction of movement and speed. However, this could be adjusted with relative ease to accommodate multi-sensory functionality such as voice activation, or localization and analysis of particular types of movement made by each player.

The artwork itself has from the start been conceived as a “modular” interactive room installation / exhibition so that components can be added or removed, and the entire work scaled according to the individual needs of future venues. For this reason it can easily travel to be presented in other cities and public locations. Indeed, fragments of the work are already set to feature in several upcoming exhibitions the Artist has scheduled for 2019–20:

- Jüdisches Museum Berlin (June 2019)
- Kunstraum Kreuzlingen, Switzerland (November 2019)
- Centre Pompidou (Paris), as part of the Vertigo STARTS 2020 exhibition (March 2020)
- Richentalsaal, Konstanz (spring 2020)

#### **weDRAW / Casa Paganini | InfoMus — Continued Work in Movement Analysis**

The artwork has provided not only an optimal test case for upcoming research by the Technical Partner but also technological tools with immediate application. Notably, the ability to analyze movement qualities at different temporal and locational scales is a key factor in a new Horizon 2020-funded project, EnTimeMent, coordinated by Casa Paganini starting in January 2019.

Casa Paganini | InfoMus is already working on plans for the investigation of temporal dynamics of movement features and to the analysis of movement qualities in groups in order to characterize interpersonal dynamics. Following such research, a new instance of the artwork could be designed and developed where automatic measurement of movement qualities in the group control the features of the generated strokes and drawing in real time. A first prototype in this direction is expected to be presented at Casa Paganini in May 2019 on the occasion of a workshop held in the framework of Eurographics 2019, the 40th Annual Conference of the European Association for Computer Graphics.

### VIII. CONCLUSION

The residency undertaken at Casa Paganini was ultimately a very fruitful arts and sciences collaboration that succeeded in defining and exploring common ground for artistic and scientific research and practice.

The Artist and Technical Partner are pleased not only with the results of the movement tracking and analysis aspects of the project but also with the indications that have arisen for many further applications that remain to be explored. For both parties, the collaboration opened up new realms of visualization of bodily movement that can be utilized in the arts and scientific sectors alike.

The artwork was well received by a very curious public attending the final exhibition. The interest by the users was most encouraging and we look forward to being able to build on the flexible framework developed during the residency to present this and related work to other audiences.

Because of the convergence of differing thought and expression systems inherent to the arts and sciences sectors, an important trial and error period is an essential component in the context of such cross-discipline collaboration. Unfortunately, in order to ensure sufficient experimentation, reflection, feedback and corrective phases, the project had to be scaled down due to time restrictions that were beyond our control.

Future instances of the project would require more time for adjustments and development than was possible in the present context. That said, and despite the limited forays we were able to make (for the same reason), we remain very optimistic about the broader pedagogical relevance, applications and potential of the project, and look forward to exploring this aspect of the artwork more extensively in future iterations.

### ACKNOWLEDGMENTS

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