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The Process of Transferring a Draft Sketch from Small to Large Scale in order to Create Street Artworks: A Case Study Supported by the "DDArtS" System

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Large scale paintings, the so-called murals, are created by artists on vertical surfaces of tall buildings or walls through procedures that require talent, patience, experience and a lot of attention. Very few art forms can be presented on such a scale. Spatial and environmental constraints when creating a mural, whether under legal assignment or illegally, must be taken very seriously, as they pose many risks and are also defined by various restrictions that the stakeholders need to know and outweigh, throughout the design process. One of the most important, perhaps, spatial restriction in the production of large scale painting projects on vertical surfaces, is the need for transposition and creation of a small draft sketch from a paper or a monitor onto the wall. Before anything else, what usually comes as a first step to approach the problem is to measure the vertical surface. It is necessary to determine the size and position of the drawing in proportion to the surface. It is also useful to make a first delimitation of the area by marking specific points, as for example the corners of the surface, or placing the central or parallel axes. These particular steps are of high importance among others, and the use of technology can assist in their quicker and easier implementation. In this paper, traditional and modern techniques used by artists to create drafts and transfer them on large scale surfaces are being described, along with their specific advantages and disadvantages. Moreover, the contribution of other scientific fields in the aid of this artistic challenge, such as engineering, robotics or programming is listed, followed by certain examples from around the world. Conclusively, in the final part of this paper, the second Version of DDArtS (Digitally Drawn Street Art System) is presented. The systems' components and functionality is customised to assist the artist on creating a draft for large scale vertical surfaces. DDArtS is scion of the ongoing research being held for the last two years in the interdisciplinary field of Street Art and Design, in the Department of Products and Systems Design Engineering of the University of the Aegean in Syros.

Street art. Design. Mural. Draft.

1. INTRODUCTION

The ongoing doctoral research at the Department of Product and Systems Design Engineering of the University of the Aegean, concerning the designing of a system that will be able to assist in the creation of large-scale artworks, demands the parallel in-depth study of the culture of Street Art and mural painting. Street artists around the world create their works with a variety of techniques ranging from sticker art to installation to murals. As Lindsay Bates (2014) writes:

> The mediums vary from yarn installations, to laser light shows, to wheatpasted posters, and even modifications to streetscape features such as signs and streetlamps. In some instances, they can appear to be so commonplace it can be challenging to distinguish street art from sanctioned public works.

There are two basic categories of murals, concerning the legal framework in which they are executed. The legitimate ones and those that are painted illegally. The first ones can be commissioned works of art, or may simply be creations allowed by the owners of the walls or the surfaces on which they are made. It is difficult for large-scale murals to be done illegally, both because of their size, but also because of the high demands on materials and equipment. However, there are plenty of artists who are engaged in unsanctioned mural making, as well as countries with legislation that does not prohibit this type of activity and its' practicing does not incur fines or penalties.

The definition of a commissioned art project refers to an artwork that can be done under written or verbal permission or obligation. Unassigned or illegal projects are being made in public spaces by artists who are motivated by the need for creation. These artists and creators are as free as the works they produce (Kuittinen 2015, p. 8). Legal paintings and street artworks differ from the illegal bombings and graffiti in many ways. Street Art emphasises on the depiction of characters and environments and, secondly, helps on maintaining the walls "clean", preventing the occurrence of additional vandalising operations (Bruce 2013).

There are many different types of frescoes and mural painting and each type has its own challenges. A mural artist wants to ensure the success of the mural by following a reliable methodology of multiple steps. Further reference to murals, painting techniques and the way technology and design can help in creating them were reported in the first paper, in which the DDArtS system was originally presented (Xyntarianos-Tsiropinas & Spyrou 2016).

2. DRAFT CREATION AND METHODS FOR TRANSFERRING IT ON A SURFACE

One of the key steps before engaging with the full-scale artwork, is the creation of a draft. According to the Merriam-Webster dictionary, the term draft refers to a preliminary sketch, outline, or version of a certain artwork or design (Merriam-Webster n.d.). Its importance is major for many kinds of projects, ranging from design to architecture, engineering to construction and painting to movie-making.

> The creative sparks that come from putting pen to paper are not only important in graphic design, of course. Sketchbooks are used day-to-day by people from all walks of life and professions including fine artists, architects, fashion designers and animators (Manco 2007, p. 6).

The draft is the basic guide for the artist and the artists choose many different mediums to create their drafts. Recently, digital software is being used a lot in murals and Street Art, where also exists the possibility of creating a two-dimensional mock-up using a photo of the surface that is going to be painted. Of course, there are artists who prefer the traditional way of drawing their drafts on paper.

In most Internet searches on "how to paint a mural" there is a huge number of directives, steps or advice, by individual artists or by groups, often in form of videos, articles on web pages, interviews, etc. However, most sources consent that the next step after creating a draft, either on paper or digitally, is transferring it on the desired surface.

Before anything else, the measurement of the surface can be very helpful to the rest of the procedure. It is necessary to have an idea of the projects' size in proportion to the surface. It is also very useful to make a first delimitation of the wall by marking specific points, the corners for example, and drawing a central line. If the draft is ready to be transferred onto the wall, there are a few different methods to do so, as listed:

Transfer paper – This technique is used very often, especially by beginners wishing to transfer their projects to large surfaces. It relies on the use of transfer paper, also known as graphite paper – a paper surface coated with a kind of material like powder, which is mounted onto another surface when pressure is applied. It exists in different shades, allowing the selection of shade that creates greater contrast to the colour of the surface that is going to be painted. In short, transfer paper is very like carbon paper, which is placed under a writing paper, and a copy of what is written is transferred to the lower sheet. Graphite paper especially designed for artists is much cleaner than carbon paper, leaving behind fewer residues and dirt, while its' traces are also easier to be erased. It is a medium that has high precision, but cannot easily be used on uneven surfaces.

Pounce Pattern – The traditional method of transferring outlines onto other surfaces is this ancient technique which is also called pouncing. Pouncing refers to the use of graphite or coal which with gentle, consecutive blows or rubbing, is transported through small holes of a paper to another surface, forming the outlines of a pattern or a drawing. The holes are made with the help of

special tools, such as a pounce wheel or an awl. This technique is highly reminiscent of the stencil, with the difference that in this case the perforated part forms only the outline of the design. A major disadvantage is the time required to create the holes of an intricate design, and that the transferred draft on the wall or the surface will be quite dirty. The methods' benefit is that the perforated paper can be reused many times and the transfer of the pattern is very fast.

Projectors – A project or an art projector can be a very useful tool for artists of different skill levels. Street artists, painters or muralists often use projectors to magnify and transfer the image from a small picture on a large canvas. There are five main types of projectors: LED projectors (also called digital projectors), opaque projectors, slide projectors, LCD or DLP projectors and overhead projectors. With a LED projector, the artists can transfer their drafts on any surface, even on rough surfaces or on different levels, and the only thing they need to do is trace the outlines on the surface where the image is illuminated. Some LED projectors can even operate in daylight, allowing the artists to work at day. Moreover, the use of projectors for transferring projects on a large scale, also shows how the development of technology helps in basic issues of art and creativity. One of the disadvantages of this method is the price, but with the passage of time, cheaper models are available that can be used solely for artistic purposes.

Grid – The gird is a traditional low-cost and low tech method for reproducing or upscaling an image from one surface to another. The grid method can be applied to enlarge or transfer drawings or sketches in any artistic style. It can be a quite lengthy process, depending on how large and detailed the final project will be. This process is not as fast as using a projector or a transfer paper, but helps on the improvement of observational and drawing skills, which are crucial for an artist. In short, a grid is generated on the reference image, and then a second one of equal ratio on the work surface. Then the new image is drawn piece by piece to the new canvas, focusing on one block at a time, until the entire image has been transferred. To use this method, all is needed is a ruler, a small-sized copy of the reference picture and a pencil to draw the grid lines on the image.

Direct drawing – Many street and Graffiti artists consider these techniques as invalid or "fake" because the work is not direct and spontaneous, and many technological aids are used in each of them. In direct drawing, artists simply stick a copy of their design on the wall and begin to draw the basic outlines until they complete their draft. Throughout the process they are taking steps back to see the project from a distance and at the same time adjust and improve the necessary areas. Of course, this process requires a lot of patience, skill and thought, while at the same time the artwork should always be viewed from afar so that the artist is sure that everything is going as planned. Large scale painting is a demanding procedure and a lot of time can be spent erasing and redesigning parts of the project. But among the advantages of this process is the entertainment provided and the probable "pleasant accidents" that may enhance the artistic project.

It takes a lot of patience and effort for the completion of a large-scale artwork, regardless of the method used. The above methods are focusing on the transferring of the draft, which is one of the limitations and difficulties that may appear during the creation of a mural. However, there are several other challenges related to spatial and environmental constraints, such as the need to reach high or inaccessible spots on buildings or to encounter intense weather conditions, such as rain and wind.

3. ART AND TECHNOLOGY – RELATED WORK

A lot of artists are turning to scientific and technological methods in search of radical ways to improve their work and expand their audience. Additionally, they set new boundaries, needs and desires that they then try to fulfil by discovering their own tools, processes and methodologies and turning them into material that can be presented in artistic activities or public performances. Sometimes, they invent ways to visualise the results of their research and they also use emerging technologies thus obtaining their own innovative role in research and development. Finally, they join forces with theorists, sociologists and philosophers, clarifying and "debunking" science and strengthening the position of society, giving it the power to participate in the public debate (Wilson 2010, pp. 11,12).

There are for example, as written by Stephen Wilson, several hybrid art-technology programs that attempt to capture the movement of hands while drawing or moving objects in the air. With the use of computers and sensors the "translation" of gestures in abstract music or computer animation is possible, as in the case of the French audiovisual format SSS – Sensors_Sonics_Sights or the Quartet project, where individuals with expertise in engineering, music, dance and other media are working together and experimenting to create art based on movement and gestures (Wilson 2010, p. 133). Many of similar research projects can be found in the papers presented and published by the *Electronic Visualisation and the Arts* conference.

Many research projects that connect Graffiti and Street Art with informatics and robotics are based in similar technologies, as for example the Mobispray, the CAP (Computer Aided Painting) that uses an airbrush, the Automated Graffiti Robot, the Robotagger, the MIT's Clever Drone (Stinson 2016), or the Tele-Graffiti. The design and implementation of the first version of DDArtS is based in this philosophy. The revised version of DDARTS and all of its' components, which was redesigned to assist the artist in the creation of the draft, and not the entire artwork, is presented below.

4. DIGITALLY DRAWN STREET ART SYSTEM VERSION 2

4.1. DDArts V2 – Draft Creation

For the best adaptation of the system, specific design guidelines had already been followed for the first version. Some of the most important were lightness, transportability and the ability to operate using spray paint, so that the artist can carry it and set it in operation easily. Many of the existing commercial and Arduino systems do not work with spray cans, even if they can produce multicolored art, but the outcome of the mural looks "mechanised".

So, by recognising the need to create a mural that will look "natural", as if drawn by a human hand, it was decided that DDArtS' V2 function would be centred in the creation of the draft. This decision worked efficiently in inspiring and controlling the research team to work with a view of perfecting the systems' functionality in a way that:

- The system will be anchored on the desired surface to which it will transfer the outlines of the predesigned digital draft.
- The system will use spray paint (spray can with a cap) to paint the draft. The choice of painting with an airbrush, a spray gun or other means of spraying is inappropriate, because it would require the use of extra containers for the paint and a piping system for its' transportation. That would make the system bigger and complicate its' functionality.
- The system will use only one spray can to paint the draft. When the paint is finished, it can be replaced. In any case, the draft usually is monochromatic.
- In version 2, the system will not be programmed to fill in areas of the draft. There are artists who choose to use another type of paint (latex, oil-based, etc.) with tools like paintbrushes to fill certain areas of their painting. Others may decide not to use a solid colour filling but a gradient.

Hence, one of the most difficult parts in the process of painting a mural or a street artwork, the creation and transferring of the draft sketch, will be resolved. This phase requires a lot of the artists' time and demands special attention and skill to be made properly. Additionally, when the outline of the drawing has been placed on the exact space of the surface, the completion of the rest of the artwork will be much easier for the artist. Some of the outlines of the draft may be covered and others remain, but the result will seem, and it will be, natural.

In a few words, the aim of the DDArtS V2 is to help the artists' workflow in the part of the draft creation, but when this function is perfected, the system can be further developed to be used in other stages, or even for the whole process, as it was foreseen in the original design. For more information on the systems' features and operation, please refer to the first DDArtS paper.

4.2. DDArtS V2 – Components

DDArtS V2 consists of three basic parts and five more individual accessory parts which were designed using the parametric design platform "part" of CreoParametric Cad system. The final assembly was mounted using the "assembly" platform of Creo. The use of the parametric design system at the product design process was necessary since it enabled the precise production of the parts. It also helped on executing the necessary design optimisation focusing on the topology of the Centre of Gravity (CoG) of the system (University of Victoria n.d.).

The three basic CAD files were exported as *.stl* (stereo lithography) files in order to be printed on a rapid prototyping machine using FDM technology (Fused Deposition Modelling). The building material was acrylonitrile butadiene styrene (ABS). This specific material was chosen because it produces prototypes with a low molecular weight that are particularly durable and resistant to stresses. The final products' arrangement is an isosceles triangle where the upper base part, which will be called *Main Frame* (Figure 1), is positioned at the top. Each equal side of the triangle is comprised of a plate with holes at the ends of its geometry. This part will be called *Triangle Side Edge* (Figure 2). The base plate includes a cylindrical surface in the middle of its' geometry. This part will be called *Triangle Base Edge* (Figure 3).

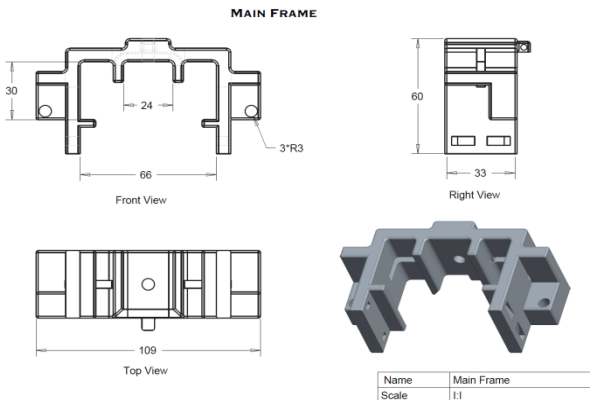

Figure 1: *Main Frame – Basic Dimensions*

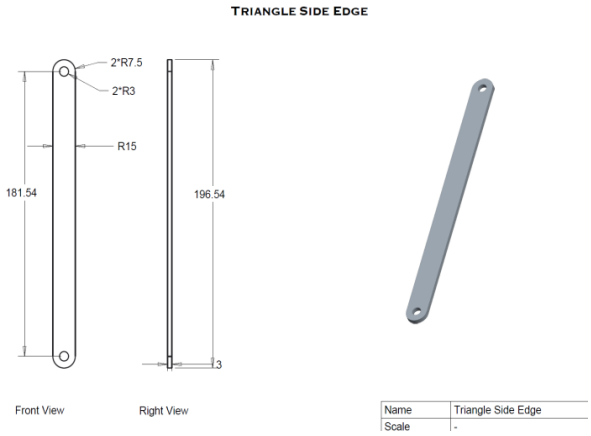

Figure 2: *Triangle Side Edge – Basic Dimensions*

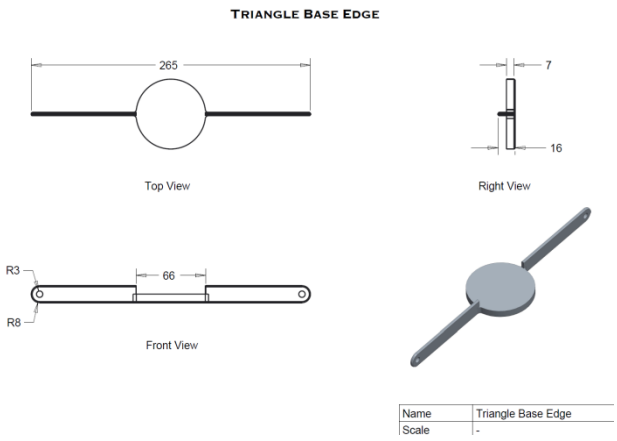

Figure 3: *Triangle Base Edge – Basic Dimensions*

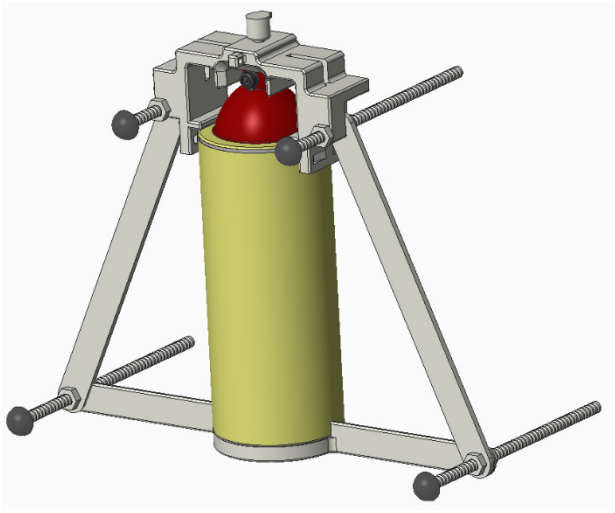

Figure 4: *DDArtS V2 – Final assembly*

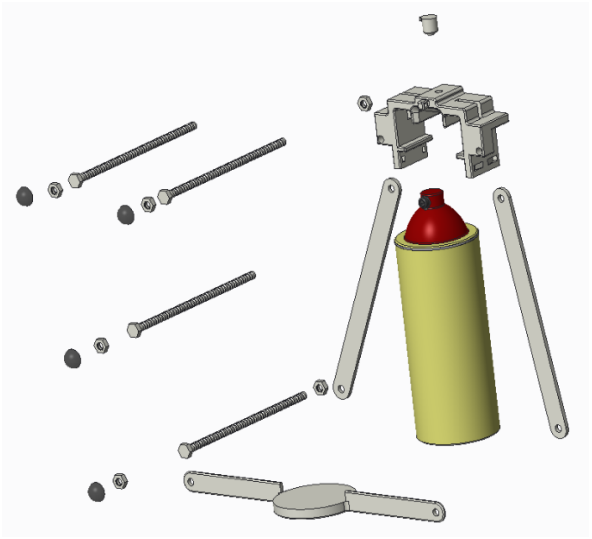

Figure 5: *DDArtS V2 – Exploded view of the assembly*

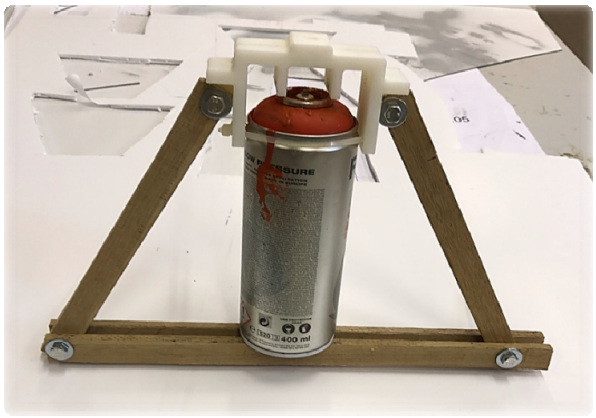

Figure 6: *DDArtS V2 prototype – Printed Main Frame and wooden Side and Base Edges*

The individual pieces of the final product are three screws M6 * 1.5, six nuts M6 * 1.5, four spherical wedge endings on the edges of each screw and, finally, an electrical piston (plunger) (Figure 4, Figure 5, Figure 6).

4.3. DDArtS V2 – Functionality

4.3.1. Stability – Centre of Gravity
The position of the Centre of Gravity (CoG) is very important for the systems' stability when in motion. If the position of the CoG is wrong, then it will cause a "turning effect" and the system will have Unstable Equilibrium. To ensure better stability while the system is in motion, the position of the CoG needs to be preserved. For the Stability Equilibrium to be maintained while the product is moving, the CoG must continuously be on the Line of Gravity.

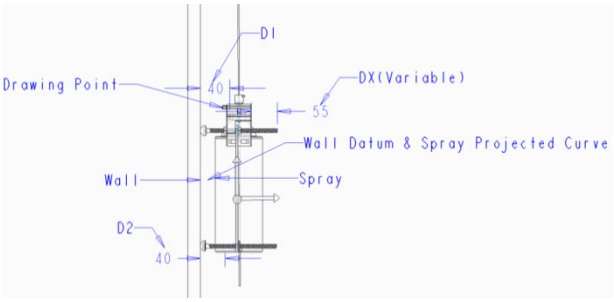

Figure 7: *Design limitations – Geometric parameters*

For the system to be functional, the chosen geometry must be preserved, while simultaneously a worthy spraying quality will be provided. To achieve that quality, there exist some basic geometric parameters (Figure 7)**:**

- The distance (D1, D2) between the surface and the spray cap that must always be D1=D2.
- The strain point (Drawing Point) that must be as much closer to the cap as possible for the spraying to be more accurate.
- The Wall Datum and the Projected Curve of the spray that must always be parallel to the surface, so that the spraying can be done vertically.
- Finally, the Dx parameter that is a variable whose value determines the topology of the CoG of the system.

4.3.2. Design optimisation in Creo Simulate.
It is evident that the limitations and parameters that need to be calculated to achieve optimum movement of the system are many, and the problem to be solved is quite demanding. Also, for such products with complex geometry that consist of more than one part, the position of the CoG is difficult to be calculated using math types. In general, determining the CoG is a complicated procedure because the mass (and weight) may not be uniformly distributed throughout the object.

In the case of DDArtS, a parametric cad system like Creo can provide all the appropriate tools that can be used to calculate the CoG ceaselessly, while maintaining the necessary limitations to the designed requirements that have already been decided. Creo parametric can dynamically calculate the DX parameter (variable) that was set to control the CoG for the system to attain Stability Equilibrium.

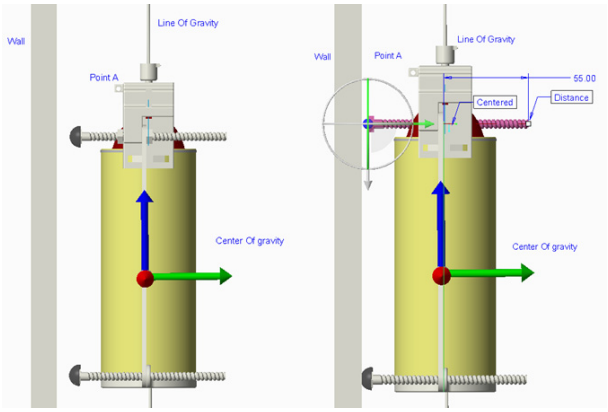

Figure 8: *Stability Equilibrium at rest (no motion)*

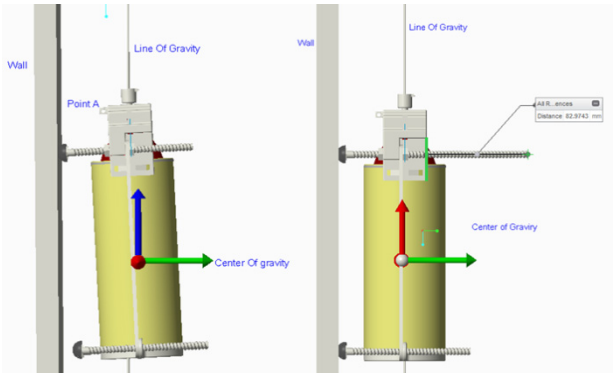

Figure 9: *Unstable Equilibrium due to resultant force on Point A (left) – Stability Equilibrium while on motion (after the optimisation test) (right).*

While at rest (no motion), the system has Stability Equilibrium and the CoG is on the Line of Gravity (Figure 8). But due to the resultant force on Point A the product leans in front (towards the surface) while the CoG moves out of the Line of Gravity and the system becomes unstable (Figure 9). By running the optimisation test in Creo Simulate, the DX parameter is automatically calculated and the right amount of weight is added in the system by changing the height (DX) of the two upper screws to maintain Stability Equilibrium while the system moves. The first step of the procedure that follows to calculate the DX variable is to load all the

constraints (parameters) in the analysis platform of Creo Simulate. Then an optimisation test is run and the software finds the best value for the DX parameter in which all the above limitations are met and the CoG is on the Line of Gravity. The software returns the right value (83mm) for the DX variable.

5. CONCLUSIONS

The presentation of the renewed DDArtS system, its' components and its' method of operation, shows the difficulties involved in settling the complex problem of drawing large-scale murals. By targeting on the primary function of assisting the artist in the draft creation, only a fraction of the problem can be viewed. By dividing the process and dealing with separate parts each time, the specific issues of each part will be better addressed.

Moreover, it will be understood if the artist can rely on the use of the system for specific stages of the process. In a future experiment where the artist will use the system in an artistic project, the conclusions drawn will help for further development. Hopefully, there will also be several quantitative and qualitative results, such as for example, the time it takes for the system to create a draft and if it is less than the time needed by the artist. Also, on the quality of the draft lines and if they are acceptable for a large-scale artwork. There will also be important information on how each individual artist will decide to utilise the system, depending on the workflow that is followed.

Conclusively, a first step in recognising the design process and technical requirements of this artistic activity has been made, but the journey to build this system is still at its beginning. Dealing with individual parts of the process has helped in understanding the nature and amount of the actions that need to be taken to address the design challenges that will arise in the future. Finally, the creation of DDArtS is a very interesting subject of research, with potential that gradually begin to appear.

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