Working with Type: Approaches on Generative and Evolutionary Typographic Creation

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Abstract

Typography is the main way of visualising the language. The selection and use of a font give indications regarding the subject we are addressing. Thus, this process gains more importance to graphic designs since it adds context to the designs. The emergence of desktop publishing allowed innovative and unexpected explorations in the design field. The recent advances in Artificial Intelligence may have a similar, or even bigger, impact in the field. In this paper, we present a series of experiments on the generation of type design that take advantage of these new technologies and possibilities. All the presented projects explore the use of colour and movement to create unique and dynamic glyphs. Our goal is to understand: (i) how can we take advantage of technology to generate type designs; (ii) how data can influence the design of type; (iii) how can a logotype convey information; and (iv) how can we take advantage of evolutionary computation to create type.

Keywords

Type Design, Typography, Generative System, Data-driven Identity, Evolutionary System

1. Introduction

The way we communicate is a unique characteristic that defines us as human beings. Typography is a way of visualising language [1]. To designers, typography is valuable as it adds a layer of content and the choice of a typeface gives indications regarding the subject that is being addressed. Later on, the emergence of desktop publishing allowed innovative and unexpected explorations in the design field. The use of computer code in typography helped the automation of the design process; computers are now able to create new unique letterforms. In this paper, we present a series of experiments of generative, data-driven and evolutionary type systems, some of them never published before. Each experiment aimed to explore a different way to create type; we explore the use of layers, modules and skeletons as the basis to create glyphs. Our goal was to understand: (i) how can we take advantage of technology to generate projects of type design; (ii) how data can influence type design creation; (iii) how can a logotype convey information; and (iv) how can we take advantage of evolutionary computation to create type. With all these experiments we want to extract some ideas and conclusions that can support or contribute to similar projects in the field. This paper is organised as follows. Section 2 presents

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related design projects in the domains of generative, data-driven and evolutionary type design. Section 3 presents a series of approaches on generative and evolutionary typographic creation. The sub-section Generative Layered Type Design presents a layered type design system that explores the use of layers as a way of varying the glyphs 'weight. The sub-section Dynamic and Generative Identity presents a typographic identity create in a real-world scenario and that makes use of the layers and rotations to add dynamism to the identity. The first and second sub-section are projects that were never been published. Sub-section Data-driven Logotypes describe the development of logotypes to the facilities of the University of Coimbra and of its students. The last sub-section, Generative and Evolutionary Type Design System, presents a more complex evolutionary system that generates typefaces by the recombination of skeletons of existing typefaces and its posterior filling. Section 4 discussions and compare the developed experiments. Finally, Section 5 summarizes our work and presents a future research direction.

2. Background

In the early years, typographers created alphabets built with pure and uncorrupted letters. However, at the beginning of the twentieth century, the emergence of the avant-garde movements transformed the outdated aspects of vision and expression [2]. Later on, the technological revolution created new possibilities for typographic experimentation. According to Helfand [3], typography in book design has a series of conditions that must be complied, whereas the screen typography has a higher degree of freedom – it "dances, sings, shouts" [3]. Now, typefaces can have varying shapes and be on a constant change. Laika [4] is a dynamic typeface that changes its appearance according to exterior data. The user can adjust the weight, contrast, size of the serif and slant of the typeface in real-time. The evolution of tools of type creation allowed the interconnection of different areas such as design, typography and music. Now, we can change letter shapes according to nature noises (e.g., [5]) or music. Typography Music [6] is a project that allows the creation of typefaces composed of layered modules. The shape of the modules changes with the type of music, for instance, if it is an organic sound the modules are circles, to analogue sounds are octagons and to digital sounds are squares. We can also express emotions related to the meaning of the text (e.g., [7, 8]), and even make typefaces evolve through time, based on the sounds that they "hear" (e.g., [9]). Nowadays, there are a set of projects that are inspired by Darwin's theory of evolution and provided the creation of a wide range of alternative designs that can be used as stimuli for inspiration. GenoTyp [10] is an evolutionary system that generates typefaces by combining genetic characteristics of different fonts. The system allows the combination of different typefaces and manipulation of their genomes, the combined typefaces must have to be compatible.

3. Approaches on Generative and Evolutionary Typographic Creation

3.1. Generative Layered Type Design

This experiment explores the use of layers as a way of varying glyphs' weight. It was inspired by an article of the *Computer Graphics and Art magazine* of 1978 that explained a method to create textures through the application of layers to drawings previously made. In our project, we decide to explore this idea in the typographic field. To archive this, we draw a series of glyphs and, we develop a method to create layers with the same shape as the glyphs previously drawn but on different scales. To do that, we define the size of the smallest layer. Then, according to the number of layers that we wanted to draw, we define the size for the other layers between the size of the smallest layer and the original glyph. Each layer is composed of a series of random characters or punctuation marks. In the central part of each layer, the characters have 50% of probability of been drawn. The system allows the creation of glyphs with more or fewer layers, depending on our needs or taste. Fig. 1 presented a preview of generated 'n's.

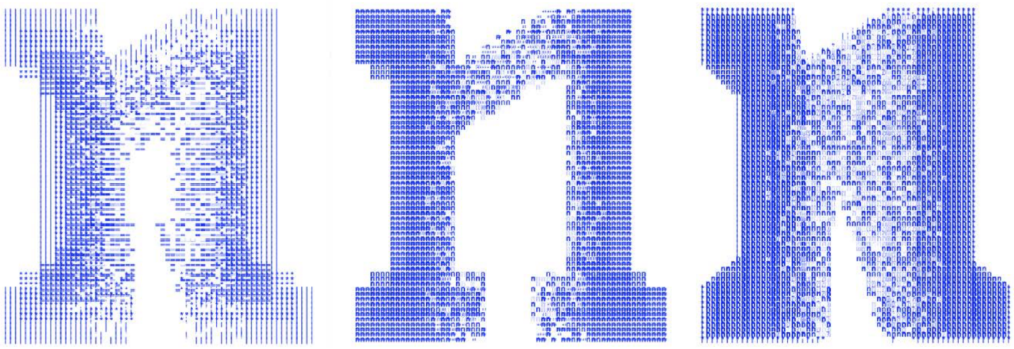

Figure 1: Generated glyphs in the system developed on the Generative Layered Type Design project.

Later, we develop a more complex system to compose posters to a fictitious conference (Fig. 2), using the generated glyphs. The glyphs have a random position and rotation within the stipulated values. Besides, the colour of the generated posters is random, but it descends from the colour of the last generated poster.

3.2. Dynamic and Generative Identity

This experiment appeared in the context of the creation of the identity and respective website for TROPO — *Anthropocenic Ontologies in Portugal* —, a research project of CES — *Center for Social Studies of the University of Coimbra.* Our goal was to create a typographic identity that could combine visual themes of connected aspects of the research project. Since the concept of the Anthropocene highlights the profound impact of human activity on the planet — to the extent that it is making impacts at the geological level — we decide to use stacked layers which suggest geological layering. We also used the concept of the spiral and which refers to

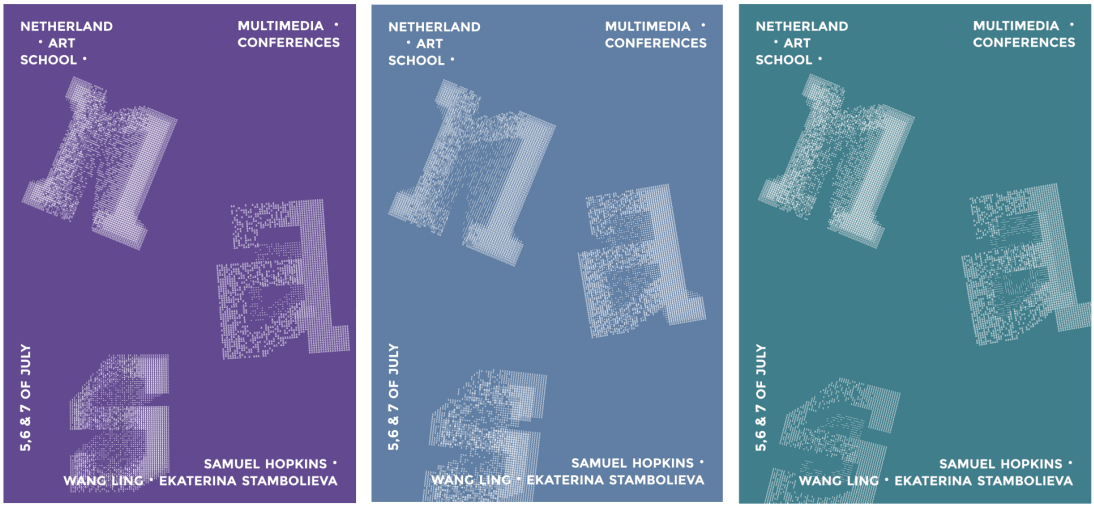

Figure 2: Generated posters for a fictional conference generated on the Generative Layered Type Design project.

the entropic aspect of environmental problems, in the sense that negative effects of climate change, deforestation, desertification, ecosystem collapse and so on, are not isolated problems but tend to have unpredictable and ever-worsening effects. We start the development process by the creation of the logotype with the word 'Tropo'. For us, besides the two graphic concepts expressed previously (layers and spirals), we wanted to add dynamism to the identity, our goal was to create glyphs that could change and succeed both statically and in motion. To archive this, we design simple lettering composed by the letters that constituted the word "tropo". Then, similar to the latest experiment, we generated a set of layers to each glyph, in this case, bigger than the glyph. To archive this, we calculate the midpoint of the first layer, the glyph. Then, we traverse all the points of the layer to calculate the points of the next. According to the position of each point, we add or subtract, a predefined value to each point to move it further away from the midpoint. After that, we add the spiral concept by applying rotations to each layer. The rotation applied in each layer was based on the rotation of the previous layer. After the creation of the static logotype, we applied it to on a website (for more information visit: https://tropo.ces.uc.pt/). We decide to use of the movement of the mouse to change the parameters of the logotype (Fig. 3). According to its position, we can increase or decrease the rotation and space between layers.

3.3. Data-Driven Logotypes

These two experiments explore how data can influence the design of logotypes and how they can convey information. We use the University of Coimbra, in Portugal, as a case study to develop data-driven logotypes for its faculties and, subsequently, for its students.

Data-driven logotypes to faculties. For this experiment, we decide to generate logotypes based on data to represent faculties. Every faculty has multiple courses, and consequently a substantial number of students. Having the diversity of the different faculties in mind it

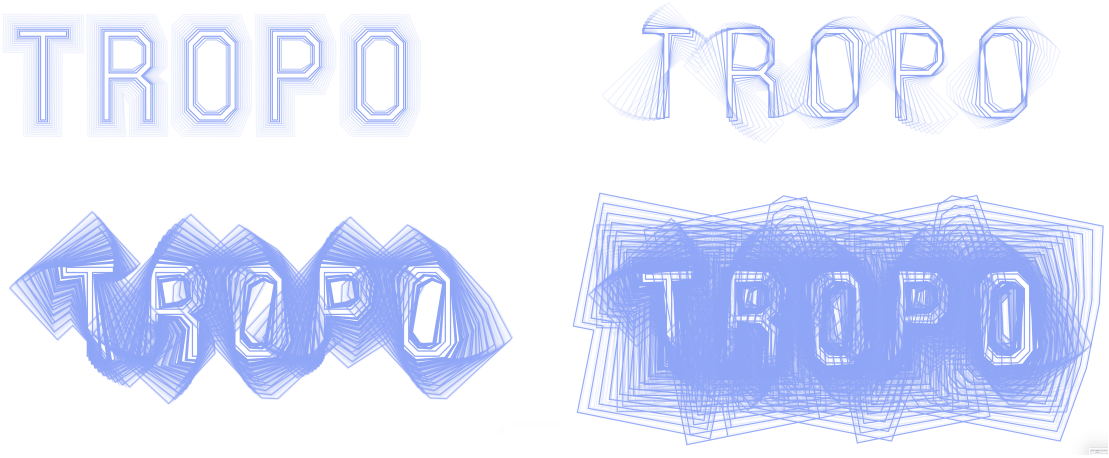

Figure 3: Screen prints of logotype generated on the project Generative Layered Type Design project.

becomes natural to choose various typefaces to represent this diversity. To achieve this, we picked four categories of typography classification and for each one of them, we adopted some typefaces. The logotype created for each faculty was developed from its acronym. For each letter of the acronym, we overprint the chosen fonts. The main goal is to uniform the group's characteristics of the chosen fonts. After the letterforms were produced, we needed a way to fill the shapes. The next step was the development of a grid over the shape previously generated. To each logotype, we decided to use information about: (i) the nationality, (ii) the gender and (iii) the number of students in each faulty. Throughout the development of this project we test different approaches, but, in the end, we related the number of students with the density of the elements, we established a module previously drawn to each nationality and colour to each gender. To distinguish the elements of each gender, we decided to use layers. The layers were superimposed, but not aligned. To visualise all the elements, we applied the multiply effect and we rotate the modules of the male gender. Fig. 4 presents the final logotypes. The main goal of this project is to create logotypes which collect information about the spectrum of students in each faculty. Therefore, we can compare the diversity of students present in each faculty, both in gender and nationality. The logotypes adapt to the current students so they can evolve with the entry of new students. A more expanded version of this work can be found in [11, 12].

By observing the logotypes, we can distinguish the various faculties by observing the densities, for instance, FCTUC is the faculty with more students and FCDEFUC is the one with less. Besides, FCDEFUC it is also the faculty with more male students than female.

Data-driven logotypes to each student. After generating the logotypes for the faculties of University of Coimbra we believe that the system could also be applied to represent other kinds of data. In this experiment, we generate individual logotypes for students. We use academic data of the students — current course type (e.g. bachelor's degree or master's degree), done credits, and previous courses — to better identify each student. We decide to use fictional data because this kind of data of each student is not publicly available. In the logotypes, each layer represents a course attended by the student; the colour used by each layer indicates the type of

Figure 4: Generated fictional logotypes to the faculties of the University of Coimbra. The logotypes were developed on the project Data-driven logotypes to faculties.

the course it represents; and the modules used in each layer identify the different courses. The number of done credits affects the density of the logotypes, for that reason, when a student stars studying at the university does not have any credits done and neither a logotype. Fig 5 presents some of the generated logotypes. A more expanded version of this work can be found in [12].

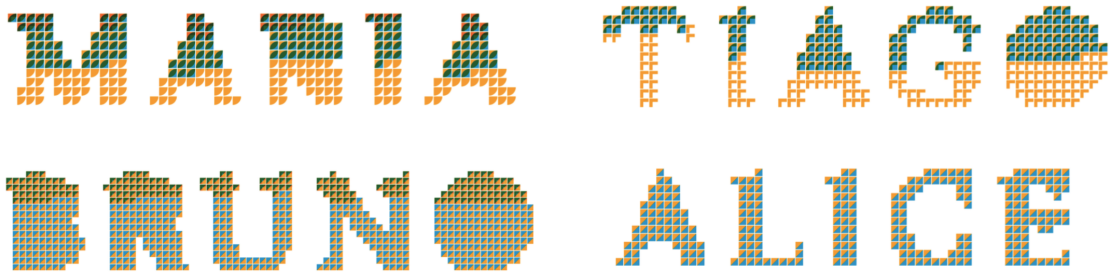

Figure 5: Some generated fictional logotypes to students of the University of Coimbra. The logotypes were developed on the project Data-driven logotypes to each student.

In these logotypes, we can conclude that Bruno is the student with more credits made. He and Alice have modules in common, so they did the same course, although Bruno has already made credits in another course.

3.4. Generative and Evolutionary Type Design System

An approach focused on skeletons extraction and their anatomical deconstruction. This experiment has a complexity superior compared to the previous ones. The project was

born under the need to creating tools of typographic creation that established a balance between what the user can determine and what the system does autonomously. We wanted to generate typefaces that could express the typographic legacy, but we didn't want to use a typeface hand-drawn for the structure. To archive this, three aspects were worked out: (i) the development of the structure of the typefaces generated and the codification of the different elements of the anatomy of the letter in different layers; (ii) the combination of layers of different typefaces; and (iii) the creation of typefaces through the generation/ modification of the elements of these layers. Until now, nearly all of the previous explorations created typefaces that were quite similar to each other in all generations. For that reason, our first goal on this project was the creation of the structure of the typefaces. To archive this, we extract the skeleton of existing typefaces. After some experimentation, we found the Zhang-Suen Thinning Algorithm [13] that aims to extract the structural lines of a binary image. With the extracted skeletons, we divide it into different parts and recombine the extract skeletons creating new dynamic skeletons. To fill the generated skeleton, we use different shapes (e.g. circles, triangles, squares, or abstract shapes) repeatedly over each stroke of the final skeleton. We decide to use the same colour and/or the same shape to identify the input typeface of each stroke. The variety of parameters allowed the generation of typefaces very different from each other. Fig. 6 shows some generated glyphs. A more expanded version of this work can be found in [14].

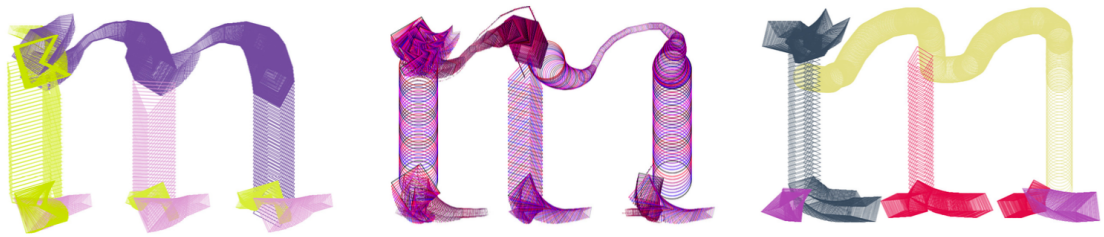

Figure 6: Some created 'm's generated on the Approach focused on skeletons extraction and their anatomical deconstruction. A video about this work can be found at https://vimeo.com/374483091

Interactive evolutionary system on type design creation. Interactive evolutionary system on type design creation. After the last experiment, we believe that we had much more to explore with the system. In the previous system, we had created a series of parameters for the creation of typefaces, but most of them were random and did not allow the user to create a typeface that he/she liked. With that in mind, we decide to create a GUI to facilitate the process of creating a font on the previously developed system. Besides, we believe that expanding the system to one that evolves could give the user not only what he wanted, but also new possibilities that would be unthinkable for him/her. We create an evolutionary system (Fig. 7) that employed a Genetic Algorithm to evolve the input parameters of the generative system — Approach focused on skeletons extraction and their anatomical deconstruction. The genotype of each individual is composed of a list of tuples containing integers, and consequently, each tuple represents a stroke of a glyph. Each stroke has a set of parameters such as the input typeface, the used shape, the shape's scale, the number of shapes or density, the shape's colour, the opacity of shape's fill, the opacity of shape's contour, the skeleton's opacity and the width of the shape's contour. At

the beginning of the evolutionary process, users can choose the parameters that want to evolve and then, they can guide the evolution process by choosing those they like the most. A more expanded version of this work can be found in [15].

Figure 7: Population of letterings generated by the evolutionary system of the project Interactive evolutionary system on type design creation.

4. Discussion

We explore different approaches to create type. In all of them, we use layers as a way to add dynamism and meaning to the generated glyphs. The emerging demand for visual identities that are based on letterforms designed specifically for them raises the potential of this research. By observing all the generated glyphs of each approach, we can observe that they are unique from each other and different from the traditional typographic creation. Besides, the use of layers and colours gives new possibilities to the type-design creation field. The experiments *Data-driven Logotypes and Generative and Evolutionary Type Design System* are just possible thanks to the mixing of layers and colours. Moreover, the first one wouldn't make any sense if the logotypes were black. Even if we create another way to represent the variables, the layers would not work. The first and the second experiment — *Generative Layered Type Design and Dynamic and Generative Identity* — use layers in a different way. The colour is not as relevant as in the other experiments because they don't need colour. Instead, they have a unique dynamism. The way layers are created is similar in both. However, in the first — *Generative Layered Type Design* —, glyphs have dynamism by overlapping layers. In our opinion, what makes the first approach

relevant is the crossing of a set of textures created with the characters and punctuation marks. In the second approach — *Dynamic and Generative Identity* —, the layers have no background and therefore what makes the font interesting is the application of rotations that implies the crossing of layers. In all the experiments, typography is used to add a layer of knowledge about what we wanted to transmit. However, in the *Data-driven Logotypes*, this aspect is more visible because we are using external data to influence how the glyphs are generated. The experimental results demonstrate how data can influence the design of logotypes and how they can convey information. On the other hand, in the *Dynamic and Generative Identity* experiment, there was also data to influence the logotype, as the movement of the mouse changes the design of the letters. On the other hand, the remaining experiments are also appropriate to work with external input data due to because they have a series of parameters used to generate the glyphs. Besides, with the digital revolution, more fonts appeared, but with them emerged the uncertainty of their quality. The last experiment tries to create a tool that establishes a balance between what the user can control and what the system performs autonomously. The system allows the creation of unique glyphs through the crossing of existing font skeletons and posterior filling. The system allows the creation of different glyphs, however, they always need a typeface as input. This leads to the generation of glyphs that have a visual style similar to each other. In the future, it could be interesting to create more tools that give to the user greater freedom in the creation of type, while promoting the typographic quality of the outputs. We think that all the experiments present different and unique ways of designing type in the modern world. The use of layers and colour is useful to combine varied information and to turn a visual identity more appealing. Nonetheless, we think that to implement these experiments in a real scenario, in exception of the *Dynamic and Generative Identity* which is already real, some aspects such as the legibility and other graphic details would have to be further refined. For instance, we identify one limitation of the glyphs generated with our systems: legibility in small sizes. In some experiments, this issue is more evident, for instance in *Data-driven Logotypes*, where the visual variables of each logotype need to be comprehended in order to interpret the information of the faculty that it represents.

5. Conclusion

In this paper, we presented a series of experiments on the domains of generative, data-driven and evolutionary type design. We presented: (i) a type design system that explores the use of layers as a way of varying the glyphs' weight; (ii) a typographic identity that uses layers and rotations to add dynamism and allow the user to control it; (iii) data-driven logotypes; and (iv) an evolutionary type design system that generates typefaces by the recombination of skeletons of existing typefaces and its subsequent filling. With these projects, we noticed that it is possible to create dynamism with the use of technology. Besides, we generate unique results when we add input data. Future research will focus on: (i) the application of these experiments in a real-world scenario with input data to influence the design parameters of the glyphs; (ii) the creation of glyphs that can adapt their detail depending on the font size; and (iii) the study of the generation of monochromatic layered glyphs.

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