FRACTAL HIERARCHY IN WILLIAM MORRIS'S DESIGNS: EXPLORING THE FACTORS BEHIND IMPROVED QUALITY OF LIFE FOR THE COMMON PEOPLE

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ABSTRACT

In this paper, building on the pioneering research on "fractal fluency" by Richard Taylor et al., the author examines the fractal properties of William Morris's designs, as well as the hierarchical structure and homogeneity across different levels. The methodology employed in this study involves image analysis using the box-counting method. The concept of "fractal" discussed in this paper refers to "statistical fractals" and is distinguished from "strict fractals" such as the "Mandelbrot set." Furthermore, drawing on Kaplan's "Attention Recovery Theory (ART)," the paper argues that Morris's fractal designs, which mimic natural growth processes, likely brought a new appreciation for nature to society and contributed to improving the quality of life for the common people of that era.

Keywords: fractal, box-counting method, Attention Recovery Theory

1 INTRODUCTION

This study aims to examine, through his own works, the impact that the textile designs created by William Morris had on improving the quality of life for people living in the late 19th century. Morris is often referred to as the "father of modern design" and was the figure who initiated the lineage of modern design—from the Arts and Crafts movement to the Bauhaus. The motivation for this study is to explore the source of the innovation he brought about. In this paper, we will examine the wallpaper he designed as one aspect of this inquiry.

Following the Industrial Revolution, wallpaper became mass-produced and widespread among the general public with the advent of the cylinder printing press (patent obtained by Potters & Ross in 1839). However, products of the time were often of poor quality, imitating realistic paintings, or featured simple geometric grid patterns tailored to the machinery; issues included visual fatigue caused by uneven composition and psychological oppression resulting from a "cold grid" Morris's work serves as an antithesis to these trends [1].

This study compares pre-Morris wallpaper with Morris's works using the concept of "fractal fluency" proposed by Taylor et al. (a perceptual characteristic in which a moderate fractal dimension, D = 1.3–1.5, reduces physiological stress in humans) [2].Note that this paper deals not with geometric fractals, but with random "statistical fractals" found in nature. The aim is to measure and verify the fractal dimensions of both and to clarify the underlying factors contributing to the comfort of Morris's designs in living environments.

2 METHODS AND SUBJECTS / THEORETICAL FRAMEWORK

The box-counting method was used to measure the fractal dimension (D-value) [3]. The work selected for analysis is Morris's "Willow Bough" (1884) (Fig. 2). The work chosen for comparison is a pre-Morris piece, "Floral Bouquet in Rococo Scroll Border" (circa 1850–1860) (Fig. 1).The latter is a work that depicts flowers such as roses and dahlias in a three-dimensional and realistic manner, as if in a painting, and frames them within a luxurious Rococo-style border. It is one of the classic examples that was harshly criticized at the time as a "design that forcibly places three-dimensional realistic paintings on a two-dimensional wall" and as "unnatural and in poor taste."



Figure 1. *Floral Bouquet in Rococo Scroll Border*, maker unknown, circa 1850–1860



Figure 2. *Willow Bough*, William Morris, 1887

We cropped each of these images into individual units intended for wallpaper patterns, and to ensure uniform conditions, we resized them into 1,024-pixel squares. We then performed multi-scale sampling by taking samples from seven locations on each image using squares with sides of 128px, 256px, and 512px, enabling us to measure objective changes resulting from variations in the cropped size.

Furthermore, to prevent errors caused by differences in line thickness, measurements were performed using automated skeletonization to standardize line thickness and automated image binarization to convert the image colors to black and white.

3 RESULTS AND ANALYSIS

The results of the image measurements based on the method described in the previous section are as follows.

Table 1. D-values for each scale and region in Figure. 1

Sampling frame	Loc 1	Loc 2	Loc 3	Loc 4	Loc 5	Loc 6	Loc 7
128 px	1.412	1.419	1.465	1.096	1.510	1.106	1.556
256 px	1.489	1.689	1.212	1.537	1.625	1.664	1.193
512 px	1.843	1.830	1.838	1.866	1.845	1.893	1.837

Table 2. D values for each scale/site in Figure. 2

Sampling frame	Loc 1	Loc 2	Loc 3	Loc 4	Loc 5	Loc 6	Loc 7
128 px	1.504	1.490	1.425	1.420	1.398	1.442	1.598
256 px	1.767	1.743	1.764	1.724	1.751	1.765	1.785
512 px	1.934	1.927	1.930	1.921	1.921	1.920	1.925

Table 3. Mean D values and standard deviations (σ) for each scale in the analysis

Sampling frame	Figure 1. Average D-value / (Standard Deviation)	Figure 2. Average D-value / (Standard Deviation)
128 px	1.3665 / (σ = 0.1740)	1.4681 / (σ = 0.0638)
256 px	1.4870 / (σ = 0.1909)	1.7569 / (σ = 0.0184)
512 px	1.8504 / (σ = 0.0204)	1.9255 / (σ = 0.0048)

We measured seven randomly selected 128-pixel sections from Figure 1. The results show that the lowest D-value was 1.096 and the highest was 1.556 (Table 1), with a standard deviation of 0.1740, indicating variability depending on the location of the section (Table 3). However, the average D-value was 1.3665, which falls within Taylor's range for fractal fluency. The standard deviation also showed significant variation for the 256px and 512px samples.

When we measured seven randomly cropped sections of Figure 2 at 128px, the lowest D-value was 1.398 and the highest was 1.598 (Table 2), but the standard deviation was 0.0638, indicating minimal variation (Table 3). Furthermore, the average D-value was 1.4681, which also falls within Taylor's range of fractal fluency. For 256px and 512px, it was found that as the image was enlarged, the D-value increased, approaching that of a two-dimensional plane, while the standard deviation remained stable with little variation.

4 DISCUSSION

The experimental results show that at the 128px scale (the distance at which a person approaches the wallpaper and recognizes the leaves), both cases met Taylor's comfort threshold (D = 1.3–1.5) in terms of their mean values. However, in Figure 1 (Flowers and Columns), the standard deviation (σ = 0.1740) is high, indicating significant variation across different locations. In contrast, Figure 2 (Morris) is stable across the entire area with σ = 0.0638, allowing observers to experience consistent comfort regardless of where they look. Furthermore, as the scale is enlarged (to 512px), Figure 2 converges to a two-dimensional plane with overwhelming uniformity, achieving σ = 0.0048.

This "multiscale duality" can be explained by environmental characteristics in Kaplan's Attention Recovery Theory (ART) [4][5].Whereas wallpaper of a previous era forced residents to expend active attention, Morris's "Willow" provides "fascination" that stimulates spontaneous human attention through local (128px) geometric fluctuations, while ensuring "extent"—harmony in the space—through the minimal standard deviation at the macro level (512px). In

other words, through his editorial design, Morris is believed to have created a “foundation for visual attention recovery” that alleviates the mental fatigue of urban dwellers, thereby contributing to the improvement of people’s quality of life.

5 CONCLUSION

It appears that fractal fluency is not achieved simply by having nature present. This is because Figure 1, used in the experiment, also depicted numerous flowers, which are natural elements. It becomes clear that what Morris did was, in essence, an act of curation and design: he first decomposed nature, identified its essence, and then restructured it to fit the context of the living environment.

This study did not directly conduct an affective response evaluation through subject experiments. However, it revealed that Morris’s products met the mathematical environmental benchmark of “fractal dimension 1.3–1.5”—a standard for which Taylor et al. have demonstrated physiological stress-reducing effects—across the entire design at a specific scale. This confirmed that, emerging from the poor visual environments of the Industrial Revolution, Morris’s designs gradually spread into the living spaces of the common people and were able to function as a foundation for daily life that brought about their physiological and mental harmony.

This paper is a comparative case study (preliminary examination) focusing on Morris’s “Willow” and a representative example of pictorial wallpaper patterns from an earlier era. The high standard deviation observed in the earlier sample mathematically suggests remnants of the pictorial composition of the 1840s.The control of multiscale structures demonstrated in this study is a manifestation of the curatorial process through which Morris reinterpreted the essence of nature for the living space; it can be said that this went beyond mere decoration to serve as a catalyst for bringing a new, harmonious understanding of society and nature to the common people of the time. A future task will be to further increase the number of samples analyzed and statistically verify the trends in average variance across different eras.

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