Figure-Ground Distribution and Media Translation Based on Digital Image Analysis: A Study on the Formal Mechanism of Aubrey Beardsley's Black-and-White Decorative Images

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Abstract. Aubrey Beardsley's black-and-white illustrations are highly recognizable, yet existing studies mostly interpret his style from art historical and symbolic perspectives, leaving cross-sample analyses of how black-and-white structures generate viewing pauses, pressure-type organization, and boundary complexity insufficient. This study adopts an interdisciplinary approach integrating art design and digital technology, proposing a figure-ground distribution analysis method based on digital image analysis. Eight representative samples from Beardsley's early, middle, and late periods were processed via unified grayscale conversion and binarization, from which black-white area ratio and junction density were extracted. Three formal variables (black mass intensity, negative space function, line density) were constructed, and three visual-organization indices (pressure-type, stage-type, and labyrinth-type organization) were synthesized. Results show early-period samples have balanced indicators with narrative-focused figure-ground relationships; middle-period samples feature prominent black mass intensity and negative space function to reorganize viewing rhythm; late-period samples exhibit increased line density and local gradients, with complexity derived mainly from boundary densification. This study demonstrates that digital image analysis can transform empirically judged formal features into describable, comparable, and verifiable structural indicators, providing a transferable framework for digital publishing, visual communication, and interface hierarchy design.

Keywords: Digital image analysis; Aubrey Beardsley; figure-ground relationship; visual design;

1 Introduction

Beardsley's black-and-white illustrations are often described as grotesque, decadent, or strongly decorative. As E. H. Gombrich observed, Beardsley rose to fame through his unparalleled black-and-white illustrations; although black and white are extremely simple means, he handled them in a manner that appears both strange and enduring [1]. Yet

R. Zur et al. (eds.), *Proceedings of the 2026 5th International Conference on Art Design and Digital Technology (ADDT 2026)*, Advances in Computer Science Research 131,
https://doi.org/10.2991/978-94-6239-737-8_78

many discussions still summarize the effect of this language through stylistic impressions. A more detailed formal account is needed to explain how black and white organize figure and ground within the picture and how they repeatedly produce experiences of pause, pressure, and estrangement in different works.

Existing research has generally followed three paths. The first starts from the cultural context of the late nineteenth century and the genealogy of Aestheticism and Decadence, arguing that the two are not a simple sequence of cause and effect but companion formations: one seeks to escape social discipline through pure art, while the other confronts social order by revealing evil and desire [2]. The second focuses on the illustrations for *Salome* and emphasizes their intertextual relation with Wilde's text, their reconstruction of line, and their visual rewriting of desire, violence, and the gaze [3]. The third traces the formal sources of Beardsley's decorative language, including Pre-Raphaelite composition, Japoniste flatness, eighteenth-century French ornament, and page-layout traditions [4]. These studies provide an important foundation, but they leave room for a more operational analysis of the internal relation between black mass, white space, and line density.

On this basis, this paper introduces digital image analysis and structured coding into art-historical formal analysis to examine how figure-ground relations organize viewing rhythm and media recognition in Beardsley's black-and-white images. The aim is not to replace humanistic interpretation with measurement, but to provide a comparable method for black-and-white visual communication analysis in the digital era [5].

2 Research Objects and Digital Image Analysis Methods

In this paper, figure-ground distribution does not mean a simple division between subject and background. It refers to the adjustable relation between figure and ground in terms of boundary ownership, area proportion, and readability hierarchy. In Beardsley's black-and-white images, the ground may be treated as illumination, as a stage-like reserve, or as a symbolic space of moral judgment. Correspondingly, the figure may remain a narrative subject, dissolve into ornament, or reverse its position and become a visual ground that governs emotion and meaning.

2.1 Concept Definition and Variable Framework

The differentiation of figure and ground is a core issue in Gestalt perceptual organization. Within a configured field, some objects emerge as figures, while others recede as supporting ground [6]. Closed regions tend to be perceived as figures, while open regions tend to be perceived as ground. Texture density further affects this relation: denser regions are more likely to be read as figure, and changes in density may strengthen or reverse the original figure-ground relation [7]. Thus, the recognition of a subject depends not only on iconographic content, but also on whether boundary ownership and figure-ground cues are stable. When the background becomes a readable shape or competes with the subject for shared contours, the relation becomes unstable, and the viewer's

uncertainty increases. Beardsley's images repeatedly exploit this perceptual mechanism [8].

2.2 Indicator System and Coding Standards

The indicator system decomposes figure-ground distribution into three variables**.** Black mass intensity (Mass) refers to the coverage ratio, visual weight, and dominant position of black solid areas. It may strengthen the subject through contour emphasis and compositional gravity, or it may intensify emotional tension through concealment and pressure. Negative-space function (Void) refers to whether white areas remain passive background or are organized into viewing structures with the functions of pause, spotlight, enclosure, or direction. Line-density gradient (Line) refers to how direction, density, rhythm, and pattern repetition intervene in figure-ground relations. Higher line density increases edge information and makes figure-ground assignment less stable, thereby intensifying competition for boundary ownership[9]. This variable-oriented design also responds to recent calls for critical uses of AI in digital art history, where measurement must be framed by explicit interpretive categories [10].

Black Mass Intensity (Mass). This variable refers to the coverage ratio, visual weight, and dominant position of black solid areas. It may strengthen the subject through contour emphasis and compositional gravity, or it may intensify emotional tension through concealment and pressure [11].

Negative-Space Function (Void). This variable refers to whether white areas remain passive background or are organized into viewing structures with the functions of pause, spotlight, enclosure, or direction [12].

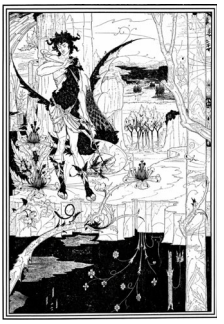
Line-Density Gradient (Line). This variable refers to how direction, density, rhythm, and pattern repetition intervene in figure-ground relations. Higher line density increases edge information, links black and white areas, and intensifies competition for boundary ownership [13].

To reduce interpretive bias, this paper applies supplementary coding rules. When darkness and weight are mainly caused by solid black areas, the effect is coded primarily as Mass. When darkness and complexity are mainly caused by dense lines, stippling, or pattern accumulation, it is coded primarily as Line. Void is evaluated according to whether the white area forms a structure that can hold, enclose, or direct attention. If white space is continuously invaded by line and pattern, its score is reduced and the invasion is recorded in the Line dimension.

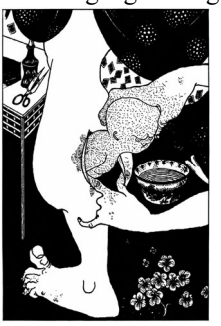
2.3 Sample Selection and Digital Image Processing Flow

The sample selection follows the principle of cross-stage and cross-media comparability. Eight representative works by Beardsley are selected, covering book illustration, decorative image, and periodical cover contexts: *Siegfried* (Fig. 1(a)), *The Child in the Calf* (Fig. 1(b)), *The Climax* (Fig. 1(c)), *The Peacock Skirt* (Fig. 1(d)), *The Black Cape* (Fig. 1(e)), the first-issue cover of *The Yellow Book* (Fig. 1(f)), the first-issue cover of *The Savoy* (Fig. 1(g)), and an illustration for *The Rape of the Lock* (Fig. 1(h)). The goal

is not statistical representation of the entire oeuvre, but a horizontal comparison of how black-and-white decorative language changes across stage and medium.



(a) *Siegfried*

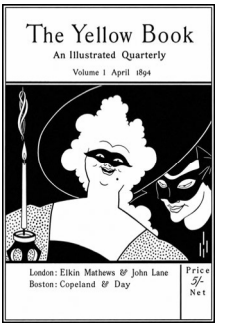


(b) *The Child in the Calf*

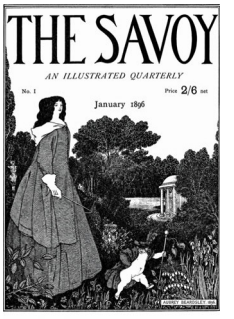
(c) *The Climax*

(d) *The Peacock Skirt*

(e) *The Black Cape*



(f) *The Yellow Book* cover



(g) *The Savoy* cover

(h) *The Rape of the Lock* illustration

Fig. 1. Unified processed image plate of eight Beardsley samples.[4]

At the level of digital image analysis, the eight samples are processed through a unified workflow**.** Each image is cropped to its effective frame to remove margins and page information, then converted to grayscale and adjusted for contrast in order to reduce differences caused by source material, scanning quality, and printing state. Black-white area ratio, black-white boundary density, and the difference between high-density and low-density local windows are extracted as weak quantitative references. Because the original images differ in size and aspect ratio, density windows are defined proportionally rather than by fixed pixels. Boundary density is defined as the ratio between adjacent black-white pixels and total image pixels, providing an auxiliary indicator for line density and edge complexity [14]. A recent study of edge-direction distribution in paintings supports the use of contour orientation and edge organization as measurable clues for pictorial dynamism [15].

Grayscale conversion, binarization, area measurement, and boundary-density extraction are used here as established image-processing operations to produce weak quantitative references for cross-sample comparison. Since this preprocessing may simplify paper texture, line quality, ink variation, and publication-version differences, the

numerical results are used to support, rather than determine, the coding of Mass, Void, and Line.

After image processing, the three variables of Mass, Void, and Line are coded on a five-point relative scale. The coding procedure combines an initial holistic assessment with interval review under the same sampling conditions. The coding criteria in Table 1 were refined during trial coding and review, allowing the comparison to remain transparent and repeatable across samples.

To clarify the relationships among sample selection, image preprocessing, weak quantitative measurement, local window comparison, and structured coding, this paper summarizes the digital image analysis and iterative review process as shown in Fig. 2.

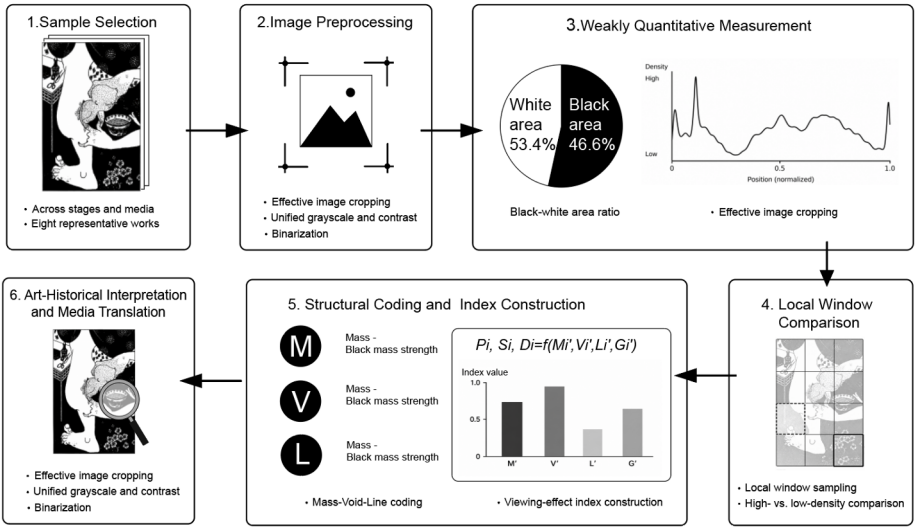


Fig. 2. Iterative review workflow for image processing, measurement, coding, and interpretation.

3 Cross-Stage Comparative Analysis of Figure-Ground Distribution

Based on structured coding and weak quantitative processing, the eight samples show clear differences in figure-ground distribution across stages. The following discussion compares early, middle, and late works and explains how the combination of Mass, Void, and Line organizes viewing paths and generates different effects.

Table 1. Mass-Void-Line coding scale and criteria (relative level).

Indicator	Low (1-2)	Medium (3)	High (4-5)
Mass: black mass intensity	Mainly outlines or small shadows; subject remains clear	Concealment and layering coexist; visual weight is evident	Black blocks dominate the picture, establish strong gravity, or

Indicator	Low (1-2)	Medium (3)	High (4-5)
			create pressure and interruption
Void: negative-space function	White areas remain passive background with weak pause function	White space combines spatial support and rhythm pause, but enclosure or direction is weak	White space is organized as stage, spotlight, or directional field and controls the viewing path
Line: line-density gradient	Sparse line; weak ornament; hierarchy is clear	Moderate density; ornament and subject remain balanced	Dense line or pattern dominates; hierarchy becomes delayed or labyrinthine

Table 1 lists the relative level criteria for Mass–Void–Line and serves as a unified reference for coding and review in this paper. This table does not undertake the function of stage induction; it transforms subjective descriptions into specific conditions to ensure that different samples can be compared according to the same standard.

Table 2. Overall coding of the eight samples on three indicators.

Sample	Stage/Medium	Mass	Void	Line
Siegfried	Early/book illustration	3	3	3
The Child in the Calf	Early/symbolic image	4	4	3-4
The Climax	Middle/*Salome*	4	5	3
The Peacock Skirt	Middle/decorative illustration	4	3.5	3.5
The Yellow Book cover	Middle/periodical cover	3	4	2
The Black Cape	Middle/decorative illustration	4	5	2
The Savoy cover	Late/periodical cover	3	4	4
The Rape of the Lock illustration	Late/book illustration	3	2	5

Based on Table 2, the stage difference can be summarized as follows: the early period maintains narrative legibility and stable figure-ground relations; the middle period reorganizes viewing through black-mass dominance and staged negative space; and the late period creates boundary ambiguity and viewing delay through dense line invasion.

Table 3. Black-white area ratio and boundary density comparison.

Sample	Black/white ratio	Boundary density (%)	High-density window (%)	Low-density window (%)
Siegfried	27.3/72.7	30.23	70.79	15.43
The Child in the Calf	52.2/47.8	6.74	14.68	1.76
The Climax	46.8/53.2	7.84	16.35	1.96
The Peacock Skirt	33.3/66.7	13.29	22.93	4.51

Sample	Black/white ratio	Boundary density (%)	High-density window (%)	Low-density window (%)
The Yellow Book cover	40.0/60.0	7.77	15.09	1.56
The Black Cape	50.5/49.5	4.29	7.08	0.37
The Savoy cover	50.4/49.6	22.99	81.2	5.5
The Rape of the Lock illustration	31.9/68.1	31.7	67.9	4.4

Table 3 shows that black-white area ratio alone cannot explain Beardsley's visual organization. The Black Cape has a nearly balanced black-white ratio of 50.5/49.5, but its boundary density is only 4.29%, indicating that its effect comes less from boundary complexity than from the confrontation between large black areas and negative space. Therefore, it is closer to a stage-like viewing composed of black mass dominance and negative space support. By contrast, The Rape of the Lock illustration has a lower black ratio of 31.9%, but its boundary density reaches 31.7%, showing that late-period complexity depends more on dense line, stippling, and pattern invasion than on black mass alone. Higher junction densities usually correspond to denser line and pattern details, supporting the high Line scores above.

Table 3 provides a quantitative side reference for the coding results in Table 2, which does not replace the structural judgment in Table 1 but provides a verifiable common scale for cross-sample comparison and is used to test the applicable boundaries of the judgments in Table 2 across different works.

3.1 Early Period: Contour, Narrative Space, and Black-White Rhythm

The early works are often associated with the influence of Burne-Jones and the Pre-Raphaelites. From the perspective of figure-ground distribution, however, the key issue is not subject matter but control over boundaries and decorative order. In *Siegfried* (Fig. 1(a)), the vertical frame compresses characters, action, and props into a legible narrative hierarchy. Black areas mainly emphasize contours, stabilize visual gravity, and provide local concealment. White areas carry spatial and narrative information while also offering limited pauses for the eye. The line density of drapery, plants, and rocks remains moderate. Mass, Void, and Line can therefore all be read as middle-level variables, and the viewing path remains close to traditional narrative illustration.

In the more symbolic images of the same period, black mass gradually shifts from contour emphasis to the control of attention and emotional tension. In *The Child in the Calf* (Fig. 1(b)), black areas no longer merely support realistic depiction. They compress white space and make negative shapes unstable, suggesting tension between body, object, and surrounding field. The uncanny effect is therefore produced by an uneven allocation of figure-ground weight rather than by subject matter alone.

3.2 Middle Period: Figure-Ground Reversal and Viewing Control

In the middle period, Beardsley organizes figure-ground relations more systematically. Black areas and decorative patterns expand and surround narrative subjects, making the

hierarchy between subject and background more reversible. At the same time, white areas are organized as staged, spotlight-like voids, causing the gaze to move between black mass and negative-space pauses. *The Climax* (Fig. 1(c)) is a typical example: large black areas at the bottom and right establish a strong base and frame; dense texture in the upper left and the figure's hair create a clear Line gradient; and the central white area becomes an enclosed field of suspension. The result is a staged pause in which absence becomes a readable form [16].

The middle-period pattern can be summarized through three tendencies. First, Mass increases in coverage and visual weight. Second, Void is no longer passive background but becomes an inspectable stage. Third, Line plays an active role in connecting dense ornament with pure black or white fields [17]. *The Peacock Skirt* (Fig. 1(d)) and *The Black Cape* (Fig. 1(e)) both establish mood through extensive black areas, but they do not use black in the same way: one emphasizes ornamental rhythm and surface, while the other turns white space into a strong visual support. The same comparison can be extended to the periodical covers of *The Yellow Book* (Fig. 1(f)) and *The Savoy* (Fig. 1(g)), where figure-ground organization becomes part of publication identity.

3.3 Late Period: Viewing Delay Produced by Stippling and Dense Pattern

Late works are often described as more decorative, symmetrical, stippled, and embroidery-like [18]. From the figure-ground perspective, their key change is that black-white opposition is no longer produced mainly by large black blocks, but by gray surfaces formed through stippling, fine line, and dense micro-pattern. In the illustration for *The Rape of the Lock* (Fig. 1(h)), both subject and background are covered with fine texture. Black and white masses are broken into continuous ornamental bands. Mass becomes less coercive, Void loses the staged openness of the middle period, and Line becomes dominant. Figure-ground boundaries grow ambiguous, forcing viewers to identify forms through prolonged scanning.

This viewing delay can be explained as a redistribution of the three variables**.** Line density becomes more homogeneous and draws viewing into a slow search among small differences. The uncanny effect therefore arises from cumulative viewing load and unstable boundary ownership. Research on visual complexity and Gestalt-related preference similarly shows structural complexity can affect visual attention and aesthetic judgment [19].

3.4 Exploratory Comparison of Visual-Organization Indices

On the basis of the three formal variables Mass, Void, and Line, together with the local density gradient, this paper further constructs three visual-organization indices to compare the relative strength of black-mass dominance, staged negative space, and boundary densification across samples. The indices are calculated from standardized variables: the dominant variable is assigned double weight, while modifying variables are assigned single weight.

Let $N_{b,i}$ denote the number of black pixels in sample i and$N_{w,i}$denote the number of white pixels. The black-pixel ratio B_i is defined as:

$$B_i = \frac{N_{b,i}}{N_{b,i}+N_{w,i}} \tag{1}$$

Let$N_{e,i}$denote the number of adjacent black-white boundary pixels in sample i and $N_{t,i}$denote the total number of pixels. The overall boundary density E_i is defined as:

$$E_i = \frac{N_{e,i}}{N_{t,i}} \times 100\% \tag{2}$$

For the high-density and low-density local windows in sample i, E_i^h and E_i^l denote their respective boundary densities. The local density gradient G_i is defined as:

$$G_i = E_i^h - E_i^l \tag{3}$$

The local density gradient measures the internal contrast between dense detail and open pause. A higher G_i value indicates a stronger contrast between intensive scanning areas and local suspension areas.

Following common procedures in composite-index construction, the five-point coding scores and the local gradient are placed on a common scale through range transformation [20]. Because the coding scale ranges from 1 to 5, if the raw scores of sample i are Mi, Vi, and Li, their normalized values are defined as follows. The standardized values M'_i, V'_i, and L'_i represent the relative strength of black-mass dominance, negative-space organization, and line density within the sample set.

$$M'_i = \frac{M_i-1}{4}, V'_i = \frac{V_i-1}{4}, L'_i = \frac{L_i-1}{4} \tag{4}$$

The local gradient G_i is also normalized through range transformation to obtain G'_i:

$$G'_i = \frac{G_i-min(G)}{max(G)-min(G)} \tag{5}$$

On this basis, P_i, S_i, and D_i denote the pressure-type, stage-type, and labyrinth-type organization indices, respectively, and are defined as follows:

$$P_i = \frac{2M'_i+(1-V'_i)+(1-L'_i)}{4}; S_i = \frac{2V'_i+(1-M'_i)+(1-L'_i)}{4}; D_i = \frac{2L'_i+(1-V'_i)+G'_i}{4} \tag{6}$$

The three indices use theoretical weighting rather than empirical regression weighting. The weighting scheme follows the constitutive variable of each index: pressure-type organization is centered on black-mass dominance, so Mass receives double weight; stage-type organization is centered on the enclosure, suspension, and spotlight function of negative space, so Void receives double weight; labyrinth-type organization is centered on line density and boundary complexity, so Line receives double weight and the standardized local density gradient is added as a modifying term. The 2:1:1 weighting therefore does not represent an empirically measured proportion of psychological effect, but expresses the hierarchy of formal variables within each type of visual organization.

Table 4. Visual-organization indices of the eight samples.

Sample	Pressure-type P	Stage-type S	Labyrinth-type D	Dominant organization
Siegfried	0.500	0.500	0.551	Relatively balanced; labyrinth-type organization slightly higher
The Child in the Calf	0.531	0.531	0.398	Pressure-type and stage-type organization balanced
The Climax	0.500	0.688	0.278	Stage effect dominant
The Peacock Skirt	0.562	0.469	0.449	Pressure effect dominant
The Yellow Book cover	0.500	0.688	0.212	Stage effect dominant
The Black Cape	0.562	0.750	0.125	Stage effect dominant
The Savoy cover	0.375	0.562	0.688	Labyrinth effect dominant
The Rape of the Lock illustration	0.438	0.250	0.893	Labyrinth effect dominant

Table 4 confirms the stage differences suggested above. Early samples remain relatively balanced, while middle-period works show stronger stage-type organization: *The Climax, The Yellow Book* cover, and *The Black Cape* all exceed 0.68 on this index. *The Black Cape* is especially revealing: despite its 50.5% black-mass ratio, its pressure-type index does not rise accordingly, showing that concentrated silhouette can create spotlight-like arrangement rather than pictorial suppression. Late samples show stronger labyrinth-type organization, with *The Savoy* cover at 0.688 and *The Rape of the Lock* illustration at 0.893, both reflecting boundary densification, line guidance, and density gradients.

The indices in Table 4 should therefore be understood as image-feature-based measures of formal organization rather than direct measurements of psychological response. Recent image-analysis research similarly demonstrates that pixel-level structural stability can provide a quantitative measure of image clarity and compositional organization [21].Their interpretive connection with viewing experience is grounded in existing perceptual research: studies of Gestalt figure-ground organization show that boundary ownership and figure-ground cues shape object recognition [12]; scan-pattern research indicates that image complexity affects fixation distribution and viewing paths [13]; computerized measures of visual complexity demonstrate that edge density and related boundary features correspond to perceived complexity [14]; and recent eye-tracking research further suggests that compositional complexity and Gestalt organization influence visual attention and aesthetic preference [19].The relationship between these indices and actual viewer response remains open to further validation through user studies or eye-tracking experiments.

4 Media Interface and Communicative Translation: From Illustration to Periodical Cover

Beardsley's black-and-white decorative language is not merely an internal pictorial experiment; it is also a visual scheme closely coupled with print media. In books and periodicals, Mass, Void, and Line shape not only the internal viewing path of an image, but also the communicative function of the publication.

Late nineteenth-century reproduction and printing favored clear contours and high-contrast structures, while delicate tonal gradations were easily lost in mass printing and reduction. In this context, Void should not be understood only as empty background. It is a structural resource that offsets printing noise and keeps clean, stable reading areas within the image. Mass provides visual gravity at the level of page design, enabling an image to attract attention during quick browsing. Line further maintains stylistic recognition through stable rhythm and pattern organization. Thus, the black-and-white figure-ground mechanism possessed a strong reproducibility advantage, helping Beardsley's art circulate widely through decorative images, illustrations, magazines, books, and later woodcut reception [22]. As Yoshikazu Uchiyama noted: "There have been two revolutions in printing: the first with the invention of the press, the second with Beardsley's unique black-and-white method—a different, inexpensive form of printing." [23]

Once placed in books, illustration is not simply an explanation of the text. It functions as a rhythmic unit in the reading process and can actively alter reading speed and pauses. Some of Beardsley's illustrations correspond only loosely to the textual plot; their emphasis falls instead on decorative structure and formal language, which weakens the subordination of image to text [24]. *The Black Cape*, for example, is only loosely connected with the plot and more closely resembles an autonomous display of black-and-white blocks and costume pattern [25]. This autonomy is consistent with Beardsley's own emphasis on flat color blocks and compositional pattern rather than descriptive color [26]. Large areas of negative space produce immediate visual noise reduction and draw the reader out of continuous text, while line density and ornament extend the time spent on the surface of the image. Illustration therefore shifts from narrative supplement to the active organization of viewing and reading rhythm.

When the same mechanism enters the periodical cover, its function extends from internal image organization to public communication. The covers of *The Yellow Book* and *The Savoy* share a similar page structure: title and issue information at the top, image below. In terms of the three variables, the upper information area relies on Void to provide a stable reading entrance; the lower image area uses Mass to establish visual gravity; and Line integrates text and image through borders and pattern. Yet the two covers express different media positions. *The Yellow Book* uses a yellow ground with black line-and-mass illustration to strengthen visual capture and periodical recognition, This point is corroborated at the level of dissemination: while the general British public may not have read *The Yellow Book*, they would have undoubtedly experienced the striking sensory impact of its yellow cover. while *The Savoy* pushes the image forward as an aesthetic object through denser line drawing and surface detail [27]. The cover is therefore not a purely formal choice, but a visualization of the periodical's stance, temperament, and implied audience [3].

5 Translation Value for Contemporary Digital Visual Design

From the perspective of contemporary digital visual design, Beardsley's black-and-white figure-ground mechanism is not only a historical case in illustration, but also a transferable compositional resource. In digital publishing, electronic covers, and mobile thumbnails, Mass can improve recognition efficiency under rapid browsing conditions. Large black areas, strong contours, and high-contrast structures help establish an immediate visual focus on small screens. Void can function as information partition, reading pause, and interface breathing space, clarifying the hierarchy among title, image, and auxiliary information. Line corresponds to texture density, border rhythm, and visual path guidance, extending viewing time and encouraging detailed exploration.

The three mechanisms summarized in this paper can therefore be translated into contemporary design methods. Mass corresponds to the control of visual gravity in covers, posters, and interface home screens. Void corresponds to white-space organization, layout partition, and reading rhythm in digital publishing, web typography, and interface navigation. Line corresponds to texture, frame, path, and detail density in brand identity, exhibition guidance, and decorative digital visual systems. In this sense, black-and-white figure-ground relations can become a formal language for explaining contemporary layout design, cover design, and interface hierarchy.

For the reuse of historical visual resources, this method also changes the way Beardsley's images are understood**.** They are not merely style samples to be quoted, but formal mechanisms that can be decomposed, compared, and redesigned. Digital image analysis does not replace art-historical interpretation; rather, it offers historical images a route into contemporary visual production. This allows the study of Beardsley's black-and-white images to move from art-historical explanation toward current issues in digital publishing, black-and-white visual communication, and the redesign of cultural visual resources. This position is consistent with recent arguments that digital art history should be understood as an interpretive field rather than a merely instrumental application of tools [28].

6 Conclusion

This paper has used figure-ground distribution as its core framework to analyze three formal variables in Beardsley's black-and-white images: black-mass dominance, negative-space function, and line-density gradient. Three figure-ground modes can be identified. First, black coverage and interruption create pressure-type organization. Second, staged negative space creates stage-type organization. Third, the continuous invasion of boundaries by line and pattern creates labyrinth-type organization. These modes dominate different stages in different ways: early works maintain legibility through contour and partition; middle works reorganize viewing paths through black-mass dominance and staged white space; late works create viewing delay through stippling and dense line.

Methodologically, the paper introduces digital image analysis and structured coding into formal art-historical research. Black-white area ratio, boundary density, local-

window difference, and visual-organization indices provide a repeatable auxiliary scale for cross-sample comparison. Within this methodological position, the framework functions as a customized analytical use of mature image-processing techniques, linking measurable image features with historically situated questions of style, medium, and design translation. The purpose is not to reduce Beardsley's visual experience to numbers, but to make deep formal analysis more transparent and comparable. Beardsley's black-and-white images therefore help us rethink late nineteenth-century visual culture and also provide transferable formal references for contemporary digital publishing, black-and-white visual communication, and the redesign of historical visual resources. At the same time, computational methods can only assist formal analysis; the cultural meaning, visual mechanism, and media position of artworks must still be interpreted through historical and humanistic inquiry [29].

References

1. Gombrich, E. H.: The Story of Art. Phaidon Press, London (1995). URL: https://www.academia.edu/4722284/
2. Ma, F.: The Artistic World of Beardsley. Hunan Fine Arts Publishing House, Changsha (1988). URL: https://search.worldcat.org/search?q=Beardsley+Ma+Fenglin
3. Wei, J.: Aubrey Beardsley: The Flowers of Evil, the Art of Beardsley's Illustration. Jiangsu Phoenix Literature and Art Publishing, Nanjing (2018). https://search.worldcat.org/search?q=Aubrey+Beardsley+Flowers+of+Evil+Wei+Junlin
4. Wei, J.: The Collected Illustrations of Aubrey Beardsley. Haiyan Press, Zhengzhou (2005). URL:https://search.worldcat.org/search?q=%E6%AF%94%E4%BA%9A%E5%85%B9%E8%8E%B1%E6%8F%92%E7%94%BB%E9%9B%86
5. Mansfield, E.: Introduction: Art History after Computer Vision. The Art Bulletin 106(2), 6-10 (2024). https://doi.org/10.1080/00043079.2024.2296269
6. Cacciamani, L., Skocypec, R. M., Flowers, C. S., Perez, D. C., Peterson, M. A.: BOLD activation on the groundside of figures: More suppression of grounds that competed more for figural status. Cortex 158, 96-109 (2023). https://doi.org/10.1016/j.cortex.2022.10.011
7. Peterson, M. A.: Ambiguity and Reentrant Processing in Object Detection. Current Directions in Psychological Science 34(3), 180-187 (2025). https://doi.org/10.1177/09637214251314755
8. Peterson, M. A., Campbell, E. S.: Backward masking implicates cortico-cortical recurrent processes in convex figure context effects and cortico-thalamic recurrent processes in resolving figure-ground ambiguity. Frontiers in Psychology 14, 1243405 (2023). https://doi.org/10.3389/fpsyg.2023.1243405
9. Skocypec, R. M., Peterson, M. A.: Semantic Expectation Effects on Object Detection: Using Figure Assignment to Elucidate Mechanisms. Vision 6(1), 19 (2022). https://doi.org/10.3390/vision6010019
10. Impett, L.: Digital Art History as Critical AI. The Art Bulletin 106(2), 11-14 (2024). https://doi.org/10.1080/00043079.2024.2296270
11. Arnheim, R.: Art and Visual Perception: A Psychology of the Creative Eye. University of California Press, Berkeley (1954). URL: https://www.ucpress.edu/book/9780520243835/art-and-visual-perception

12. Wagemans, J., Elder, J. H., Kubovy, M., et al.: A century of Gestalt psychology in visual perception: I. Perceptual grouping and figure-ground organization. Psychological Bulletin 138(6), 1172-1217 (2012). https://doi.org/10.1037/a0029333
13. Bradley, M. M., Houbova, P., Miccoli, L., Costa, V. D., Lang, P. J.: Scan patterns when viewing natural scenes: emotion, complexity, and repetition. Psychophysiology 48(11), 1544-1553 (2011). https://doi.org/10.1111/j.1469-8986.2011.01223.x
14. Redies, C., Bartho, R., Kossmann, L., Spehar, B., Hubner, R., Wagemans, J., Hayn-Leichsenring, G. U.: A toolbox for calculating quantitative image properties in aesthetics research. Behavior Research Methods 57(4), 117 (2025). https://doi.org/10.3758/s13428-025-02632-3
15. Deliege, A., Dondero, M. G., D'Armenio, E.: On the Dynamism of Paintings Through the Distribution of Edge Directions. Journal of Imaging 10(11), 276 (2024). https://doi.org/10.3390/jimaging10110276
16. Wang, P., Xun, W.: Japanese elements in Beardsley's illustration art. Arts Exploration 25(2), 131-132 (2011). DOI:10.3969/j.issn.1003-3653.2011.02.046.
17. Xu, J.: The decorative art style of Beardsley's black-and-white illustrations. Hundred Schools in Arts 31(2), 207-209 (2015). URL: https://search.cnki.net/
18. Zheng, H., Yao, H.: Artistic characteristics of Beardsley's late illustrations. Art Research 5, 86-88 (2019). DOI:10.13944/j.cnki.ysyj.2019.0365
19. Beder, D., Pelowski, M., Imamoglu, C.: Influence of Complexity and Gestalt Principles on Aesthetic Preferences for Building Facades: An Eye-Tracking Study. Journal of Eye Movement Research 17(2) (2024). https://doi.org/10.16910/jemr.17.2.3
20. Usubiaga-Liano, A., Ekins, P.: Methodological choices for reflecting strong sustainability in composite indices. Ecological Economics 221, 108192 (2024). https://doi.org/10.1016/j.ecolecon.2024.108192
21. Chan, S. T., Fried, E.: Structural stability and thermodynamics of artistic composition. Proceedings of the National Academy of Sciences 121(51), e2406735121 (2024). https://doi.org/10.1073/pnas.2406735121
22. Liu, X.: Revisiting the inspiration of Selected Works of Beardsley for Chinese emerging woodcut: from Lu Xun's need and introduction. Social Science Front 10, 188-198 (2025). URL: https://search.cnki.net/
23. Uchiyama, K., Nara, K., Han, Z.: Lu Xun and Woodcut. People's Fine Arts Publishing House, Beijing (1985). URL: https://search.worldcat.org/search?q=Lu+Xun+and+Woodcut+Uchiyama
24. Tang, H., Jiang, Y.: A comparative study of the illustration styles of Beardsley and Mucha. Art Evaluation 22, 28-30 (2018). DOI:CNKI:SUN:YSPN.0.2018-22-015.
25. Zhang, K.: Astonishing Beardsley. Shaanxi Normal University Press, Xi'an (2005). URL: https://search.worldcat.org/search?q=%E6%83%8A%E4%B8%96%E6%AF%94%E4%BA%9A%E5%85%B9%E8%8E%B1
26. Zitu Master Image Series Editorial Department: Master Image Series: Beardsley. (2003). URL:https://search.worldcat.org/search?q=%E6%AF%94%E4%BA%9A%E5%85%B9%E8%8E%B1+%E5%A4%A7%E5%B8%88%E5%9B%BE%E5%85%B8
27. Zhang, S.: The founding of The Yellow Book and the British 'Yellow Nineties'. Foreign Literature 3, 44-53 (2024). DOI:10.16345/j.cnki.cn11-1562/i.2024.03.005.
28. Impett, L., Offert, F.: There Is a Digital Art History. Visual Resources 40(2), 186-209 (2024). https://doi.org/10.1080/01973762.2024.2362466
29. Wasielewski, A.: Computational Formalism: Art History and Machine Learning. MIT Press, Cambridge, MA (2023). https://doi.org/10.7551/mitpress/14268.001.0001