



Urquhart, Lewis William Robert and Wodehouse, Andrew (2017) The emotive qualities of patterns : insights for design. In: Proceedings of the 21st International Conference on Engineering Design. Design Society, Bristol, pp. 109-118. ISBN 9781904670964 ,

This version is available at <https://strathprints.strath.ac.uk/61769/>

Strathprints is designed to allow users to access the research output of the University of Strathclyde. Unless otherwise explicitly stated on the manuscript, Copyright © and Moral Rights for the papers on this site are retained by the individual authors and/or other copyright owners. Please check the manuscript for details of any other licences that may have been applied. You may not engage in further distribution of the material for any profitmaking activities or any commercial gain. You may freely distribute both the url (<https://strathprints.strath.ac.uk/>) and the content of this paper for research or private study, educational, or not-for-profit purposes without prior permission or charge.

Any correspondence concerning this service should be sent to the Strathprints administrator: strathprints@strath.ac.uk

The Strathprints institutional repository (<https://strathprints.strath.ac.uk>) is a digital archive of University of Strathclyde research outputs. It has been developed to disseminate open access research outputs, expose data about those outputs, and enable the management and persistent access to Strathclyde's intellectual output.

THE EMOTIVE QUALITIES OF PATTERNS: INSIGHTS FOR DESIGN

Lewis William Robert Urquhart & Andrew Wodehouse

University of Strathclyde, United Kingdom

INTRODUCTION

Work in experimental aesthetics and visual perception has spanned the last century, but the analysis of design and artistic artefacts with respect to human emotion is still emerging (Desmet & Hekkert 2014). In the realm of design theory, a great deal of work has been produced recently regarding the emotive qualities of artefacts and interactions including the important studies by Patrick Jordan (2002) and Don Norman (2004). These studies and others have tended to be orientated around the cognitive processes of design experience – our interaction with objects as a process eliciting emotive change. While this work has proved seminal for deepening our understanding of these processes, we seek to bring the analysis back to a more traditional study of form explicitly, and what form means to us as observers. In this case we will be looking at the form and structure of patterns. Patterns have been used as a feature in art, design and architecture for thousands of years and are an important part of the story of art and design having come to feature on a wide variety of objects in a huge multiplicity of styles. From the classical Greek styles that were typically simple and geometric to the Art Nouveau movement which developed a highly organic, complex and non-linear aesthetic (Howard 1996), patterns have been features of them all.

Many are specifically related to a time, place or culture while others have a more universal appeal. It is the nature of these connections we are trying to address with this work. What is the specific appeal of some patterns? Does angularity as opposed to curvature play a role in how they are emotionally perceived and semantically understood? These are deep questions about how we perceive the world and the artefacts that populate our lives. Creative expression through, and interpretation of form, what has been called the “aesthetic encounter” is a highly complex and nuanced phenomenon, the understanding of which has to consider a large body of social and cultural factors (Csikszentmihalyi & Emery Robinson 1990). Patterns Recent work in experimental aesthetics has suggested that human beings have a very strong and possibly innate preference for curved forms as opposed to angular forms (Bertamini et al. 2016). This fact is critical for fully addressing why certain forms or motifs appear at particular times historically and help us conjecture about how form within art or design or pattern is supposed to be perceived – how the creator developed it on an emotive level, if at all. The emerging research in design, interaction and emotion tells us that we have highly complex relationships with the artefacts that populate our lives where products can affect us at an almost immediate instinctive level or as Desmet and others (2008) and Krippendorff (2005) have shown, meaning can develop over a period of time, derived from the interactions we have had with a particular object.

This research draws on these studies and allows us to examine form both as a process of instinctual emotive analysis and as a process of meaning making. Patterns use a wide variety of motifs, some of which are transcultural and can mean many things to different people, and some of which are more specifically symbolic. It is this aspect that we also seek to investigate – how embedded particular culturally symbolic form are and how this understanding can be applied within the context of design practice and the creation of emotionally rich objects.

1 PATTEN USE - HISTORY AND THEORY

With the development of art generally, the nature of pattern changed constantly. The Greeks and later the Romans cemented what are now called the “Classical” aesthetic style which has remained influential especially in the Western tradition up to the present day (Boardman 2001). Recent history has indeed seen a huge expansion in pattern usage. During the period that is now known as the Industrial Revolution, the capacity for mass producing products accelerated hugely. Particularly in the area of textiles, metal work and ceramics – the industrialisation of these product types put new demand into the market and more designs began to materialise as the consumer base gradually widened. Key figures such as Josiah Wedgwood and William Morris developed patterns that became hugely popular and

aesthetically influential through their respective work with ceramics and textiles (Forty 1986). This set the scene for the present day where patterns are a principal feature of the fashion industry with different permutations being introduced every season appropriated from a range of cultures including India, China and Africa – subtle reinventions of know patterns to continuously whet the appetite of consumers.

1.1 Pattern creation

Patterns, as conventionally conceived, consist of a number of important elements, limited but not restricted to repeatability, symmetry, infinite coverage of a plane, breakdown into simple shapes or rules, colour and symbolism. It is the repeatable nature of the forms or motifs that allow them to cover a theoretically infinite plane without gaps or the rearranging of the elements – this is technically known as a “tiling” pattern. Repeating forms that may have gaps but still cover the plane is known as an “all-over” pattern.

The creation of patterns follows simple structural rules using shapes that allow repetition to emerge. Ching and Juroszek (1998) defined shape as a “characteristic outline or surface configuration of a form” that can only exist in reference to other shapes; shapes are the key constituent in a pattern. Structural elements are used to define and develop shapes within the context of a pattern. Work analysing these structural elements has been extensively undertaken by Michael Hann (2012; 2013). Hann shows that points and lines are the basis of structure and are the sources from which all geometry is created – points determine position and are dimensionless entities. Line can be considered as a moving point or the path between two points, a change from one state to another. The concept that line can convey some kind of energy or relates to natural forces or states of change has been explored in some depth by Ingold (2015), Barratt (1989) and earlier by D’Arcy Thompson who conjectured that the form of living creatures could be conceived as a “diagram of forces” (Thompson 1917). These are important insights to consider when assessing the visual elements of patterns.

As Hann (2012) elucidates, patterns utilise the immense power of symmetry to create a state of non-randomness and apparent order. With respect to all over patterns, four symmetry operations are key; *A) Translation B) Rotation C) Reflection D) Glide reflection* – which are illustrated in Figure 1 below. It is from these simple rules that the complexity seen in patterns emerges. Variations in design elements, motifs and degrees of repetition and rotation culminate in the overall aesthetic effect of a pattern design. Hann notes that pattern motifs can achieve a maximum of a six-degree rotational symmetry based on one of the five Bravais lattice frameworks. Additional visual factors such as proportion, order vs disorder and simplicity vs complexity, also play a role in the overall visual experience.

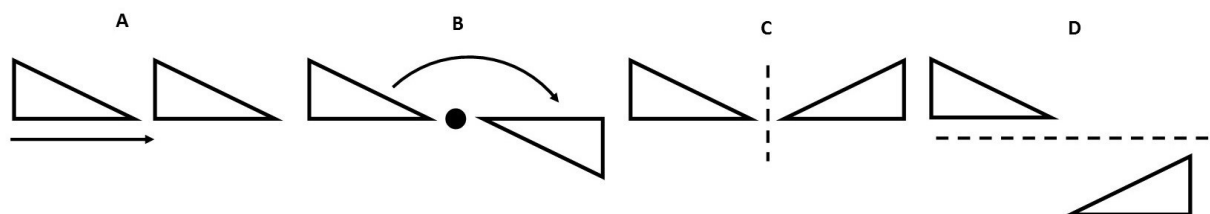


Figure 1: Symmetry operations – (A) Translation, (B) Rotation, (C) Reflection, (D) Glide reflection (adapted from Hann 2012)

2 PERSPECTIVES OF FORM

The way we perceive form has been the subject of a number of important studies in experimental psychology and design over the last century and is relevant for our analysis of pattern. Patterns are geometrically multifarious varying in complexity and structure. In order to understand them more deeply, we must first analyse their geometric foundations – the shapes that make them up. It is here that we must consider work on visual perception where many of the studies have used forms of abstraction to approach the analysis; considering simple representation of curvature and angularity which ultimately are the basis of all two-dimensional geometry.

2.1 The emotion in curves and angularity

Much research has shown a more positive connection emotionally and semantically to curved objects. At the cognitive level, it has been suggested that emotions serve as an “adaptive function” that can be

affected by interaction with form – this event is conceptualised as an appraisal (Arnold 1960). Early studies in human visual perception and psychology showed that there was some link to curved objects and positive emotive interpretation. In a seminal study by Poffenberger and Barrows (1924), they showed that an angular jagged in the form of a wave was associated with words such as “serious” and “hard” and that curved lines were associated with “gentle” or “playful”. The emotion could be changed by changing the angle of the line’s inflection – a point also intimated by the design theorist Rowena Reed Kostellow (Hannah 2002). A latter set of studies by Collier (1996) found similar results looking at a range of simple stimuli. Additionally, a more recent set of experiments testing observer responses to curves and angularity in a range of contexts showed that observers are definitely drawn more towards curvature but do not necessarily dislike angularity (Bertamini et al. 2016). Based on this antecedent work on visual perception, Mothersill and Bove Jr (2015) have developed a model of form and emotion that illustrates how subtle changes in the characteristics of simple shapes can fundamentally change the emotive interpretation of a form.

2.2 Meaning and symbolism

Emotion is one important factor in the visual experience of form, another is the meaning that is derived from the form. Important insights regarding the interpretation of meaning in abstract shapes come from the school of Gestalt psychology. The Gestalt school put forward a holistic approach to form interpretation where the visual elements are considered all at once where “the whole is other than the sum of its parts” – visual elements with potentially symbolic cultural importance may only be intelligible when seen in the context of the whole (see Pinna & Reeves 2009 for further insights). This is critical to consider when analysing patterns that are comprised of multiple visual elements. Recent work in Gestalt theory has shown that small deviations in familiar geometric shapes induce what is called a “sense of happening” in observers – meaning is ascribed to a very abstract form (Pinna 2010). This “sense of happening” should be considered when assessing the geometric properties of patterns as its presence may significantly alter emotive interpretations of a form or sets of forms.

3 ASSESSING EMOTION AND MEANING IN PATTERNS

How can patterns relate to discrete emotive experiences or semantic values? Given the history of pattern use across the world, it is likely they have strong emotive and semantic connotations for human observers. Our hypothesis is that particular patterns will have strong emotive and semantic connotations for human observers. More specifically, with respect to earlier research into aesthetics, it is proposed that the more angular pattern structures will inspire more negative emotions. The curved forms are more likely to elicit emotions of a positive nature.

3.1 Workshop approach

With close reference to David Wade’s pattern source book (1982) and other online sources, sixteen patterns were chosen on the basis of their form and structure. We spent time categorising the patterns into three groups – angular, curved and mixed. The vast majority were easy to identify with a specific group given the dominance of certain structural features but others were slightly more challenging owing to optical illusion effects where angular forms configured in a specific way can appear to be curving overall (a phenomenon discussed by the Gestalt theorists (see Ellis, 1938)). If the effect was strong enough, these patterns were categorised as “mixed” which was the case for one of the patterns, pattern 3. Overall, six patterns were categorised as structurally angular, six as curved and three as mixed; a good range of form diversity for considering their emotive and semantic differences.

The workshop exercise included 12 student participants from design and engineering backgrounds. The students were then split into focus groups of either two or three members. During a short pilot study, it was deemed that groups of more than three were less able to quickly assess patterns for emotive value within the allotted time - disagreeing over particular elements, thus the groups were limited to three people. Each group was required to observe a pattern for a total of two minutes and assign a maximum of three emotive and three descriptive (semantic) values to each using a provided worksheet. The worksheet contained emotive terms such as “anger” or “joy” which would be used to describe the patterns. These terms were selected with close reference to the models of emotion found in work by Plutchik (2001) primarily, and also by Shaver and others (1987). Not only did this research provide a large array of emotive terminology, the models also propose the levels of intensity that each emotion is

subjectively experienced, relative to the others - an important factor to consider. A list of descriptive (semantic) terminology was also included but participants were not required to use this, it was only used as a source of inspiration.

We wanted the analysis to be done rapidly – a more intuitive reaction to the emotional content of the form as opposed to an in depth micro analysis. The patterns were displayed in no particular order and were all presented as monochrome – while colour is an important element of patterns, we were only interested in reviewing the raw form qualities. The sixteen patterns used for the experiment are shown in Figure 3 with a caption detailing their assigned category. The order in which they are presented is the same order used for the workshop.

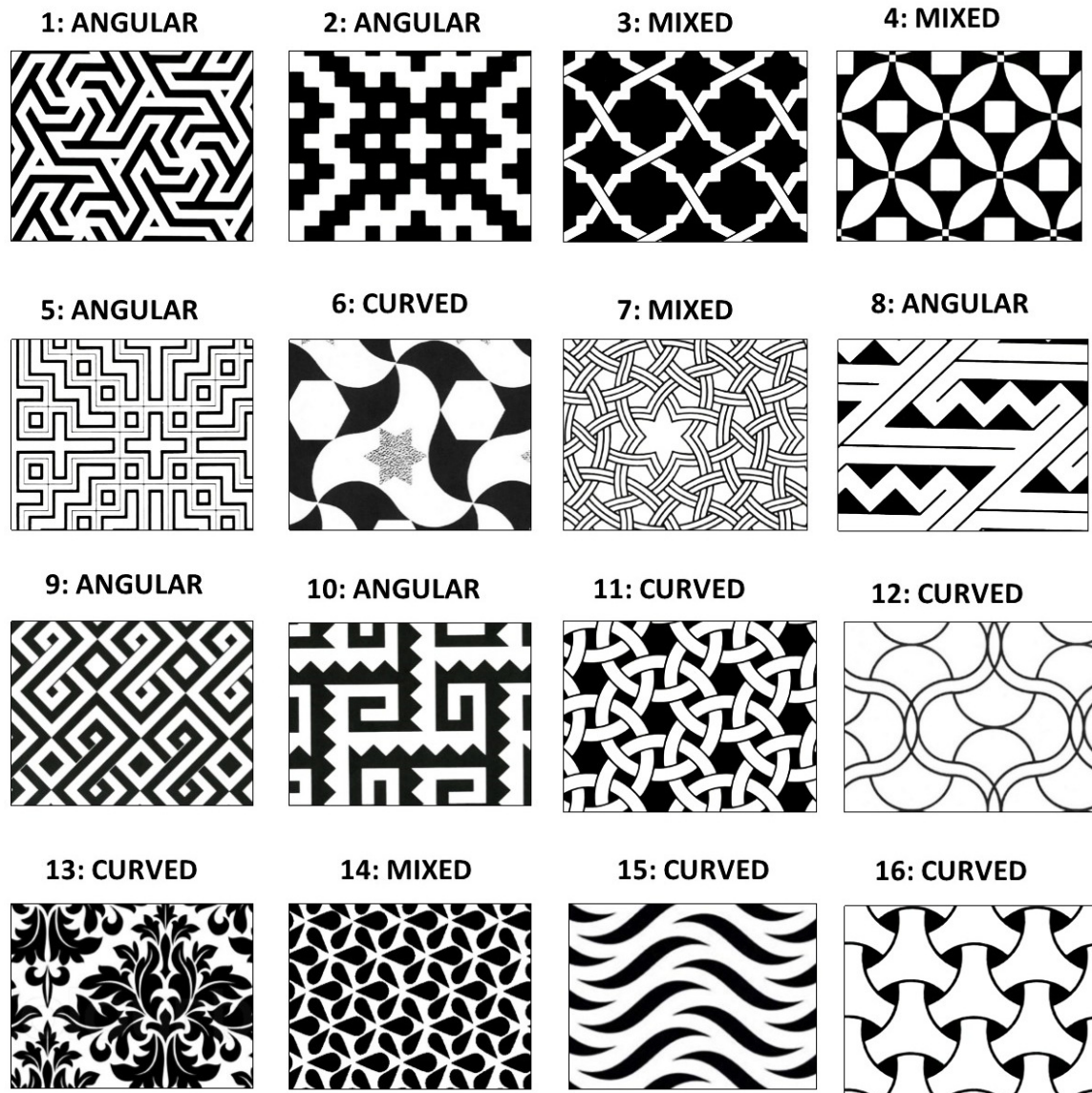












Figure 2: Patterns utilised during workshop experiment, adapted from Wade (1982) and open source material







4 RESULTS

As discussed within the experiment approach section, we made use of a broad range of patterns from a variety of cultural backgrounds. David Wade’s patterns source book “Geometric Patterns and Borders” (1982) proved instrumental in finding a set of appropriate patterns to use for the workshop experiment. Patterns 13, 14 and 15 were adapted from open source material. Following the workshop, a period of analysis was undertaken where the results were checked for trends. While it was rare for all of the teams to produce identical emotive and descriptive values for a specific pattern, there were frequent similarities

in terms of broad emotion type and experiential intensity, “joy” and “excitement” for example. While these are recognised as different emotions, they can both be categorised as positive and of high intensity. This is the approach taken during the analytics. The results from the workshop are summarised below in the table. For the majority of the patterns emotive and semantic values were quite clear, some results were however inconclusive where the emotive trends are noted as weak.

Table 1: Emotive values and semantic association of 16 patterns

Pattern	Ascribed emotive values	Semantic associations
1 	<ul style="list-style-type: none"> • Strong trend towards negative emotions • Medium to high intensity • Key values: “anger” “aggression” “nervousness” “uncertainty” 	<ul style="list-style-type: none"> • Strong associations with angularity and complexity
2 	<ul style="list-style-type: none"> • Moderate trend towards negative emotions • Medium intensity • Key values: “indifference” “distraction” “nostalgia” 	<ul style="list-style-type: none"> • Strong associations simplicity, confusion and instability
3 	<ul style="list-style-type: none"> • Strong trend towards negative emotions • High intensity • Key values: “anger” “contempt” “amazement” 	<ul style="list-style-type: none"> • Strong associations with tradition and sophistication • Additional associations included strength and power
4 	<ul style="list-style-type: none"> • Moderate trend towards positive and neutral emotions • Medium intensity • Key values: “affection” “joy” “distraction” 	<ul style="list-style-type: none"> • Associated with tradition and decoration • Additional associations included simplicity and playfulness
5 	<ul style="list-style-type: none"> • Moderate trend towards negative emotions • Medium intensity • Key values: “uncertainty” “apprehension” “intrigue” 	<ul style="list-style-type: none"> • Associated with confusion and irrationality
6 	<ul style="list-style-type: none"> • Strong trend towards positive emotions • High intensity • Key values: “joy” “excitement” “love” “affection” 	<ul style="list-style-type: none"> • Associated with fun, fluidity and instability
7 	<ul style="list-style-type: none"> • Weak trend towards positive emotions • Low intensity • Key values: “vigilance” “trust” “serenity” 	<ul style="list-style-type: none"> • Strong associations with power, heaviness and symbolism
8 	<ul style="list-style-type: none"> • Strong trend towards negative emotions • Medium intensity • Key values: “nervousness” “uncertainty” “apprehension” 	<ul style="list-style-type: none"> • Strong associations with angularity and spikes • Additional associations included insecurity and instability
9 	<ul style="list-style-type: none"> • Strong trend towards negative emotions • High intensity • Key values: “rage” “grief” “disturbance” “uncertainty” 	<ul style="list-style-type: none"> • Associated with evil, power, heaviness and solidness
10 	<ul style="list-style-type: none"> • Strong trend towards negative emotions • High intensity • Key values: “fear” “nervousness” “distraction” 	<ul style="list-style-type: none"> • Strong associations with wackiness, instability and confusion • Additional associations included wild animals

11 	<ul style="list-style-type: none"> • Strong trend towards <i>positive emotions</i> • Medium intensity • Key values: “trust” “acceptance” “optimism” “serenity” 	<ul style="list-style-type: none"> • Strong associations with tradition and symbolism • Additional associations included security and strength
12 	<ul style="list-style-type: none"> • Moderate trend towards <i>positive emotions</i> • Medium intensity • Key values: “serenity” “love” “joy” “affection” 	<ul style="list-style-type: none"> • Strong associations with fluidity, lightness and curvature • Additional associations included surprise and mysteriousness
13 	<ul style="list-style-type: none"> • Strong trend towards <i>negative emotions</i> • High intensity • Key values: “disgust” 	<ul style="list-style-type: none"> • Strong associations with decoration and tradition • Additional associations included wealth and sophistication
14 	<ul style="list-style-type: none"> • Strong trend towards <i>negative emotions</i> • Medium to high intensity • Key values: “uncertainty” “sadness” “anger” 	<ul style="list-style-type: none"> • Association with curiousness
15 	<ul style="list-style-type: none"> • Strong trend towards <i>positive emotions</i> • Medium to high intensity • Key values: “serenity” “ecstasy” “love” “joy” 	<ul style="list-style-type: none"> • Strong association with waves, fluid and lightness
16 	<ul style="list-style-type: none"> • Strong trend towards <i>positive emotions</i> • Medium to high intensity • Key values: “trust” “excitement” “interest” “anticipation” 	<ul style="list-style-type: none"> • Association with strength, power and solidness • Additional associations included organic

5 DISCUSSION - WHAT PATTERNS MEAN TO US

Emotion and meaning are embedded within the form of patterns. This study has shown that particular forms and form relationships have discernible emotive and semantic content for observers. With respect to the previous research efforts into visual perception, our study corroborates with these other experimental studies. If we consider the form and structural elements of each pattern, there appears to be some correlation between angularity and negative emotive association. In contrast, there also appears to be some correlation between curvature and positive emotive associations although the trends are perhaps weaker than the negative emotive trends.

5.1 Angularity

What is of immediate interest is how the different patterns can elicit different intensities of emotive feedback. The seminal work of emotional psychology by Robert Plutchik allowed us to map the general level of intensity of the emotions elicited by the patterns by relating them to his models (2001). Considering that every single angularly dominant pattern used for the experiment was associated with negative emotions, we must look to the emotive intensity and the semantic links for the true insights. Pattern 1 for example is highly angular utilising six-fold rotational symmetry that appears to intricately connect. This was associated semantically with complexity and emotively with “anger” and “contempt”. Interestingly, if we compare this result with the result for pattern 9, the emotive qualities noted as “rage” and “grief” are similar. Pattern 9 is in some ways aesthetically similar to pattern 1 – both are moving across the plane at non right angles and in addition, both seem to have spiral-like formations. Pattern 9 did however have much clearer semantic values, associated strongly with power, heaviness and even evil.

Other similarities included patterns 8 and 10. Both had negative emotive association which were the same or semantically similar but of varying intensities – “nervousness” and “apprehension” noted for pattern 8 and “fear” and “nervousness” noted for pattern 10. Interestingly, if we consider the structure and form of the pattern we see the same structural element, a jagged form. Poffenberger and Barrows

(1924) noted a similar result in their early work where a jagged line was associated with the words “hard”, “serious” and “powerful”. In a general sense, all of the patterns with a form that was structurally angular were related to negative emotions and were frequently aligned (semantically) with concepts of power, strength and on several instances with confusion and instability.

5.2 Curvature

In contrast to the patterns with an angular structure, the patterns based on curves trended towards positive emotive associations corroborating with the results from Bertamini and others (2016) among other studies. If we first consider the results for patterns 6, 12 and 15 – all three dominated by large curves – we see similar emotive responses. All are related to feelings of “joy”, “love”, “affection” “serenity” and even “ecstasy” and all semantically associated with fluidity. Aesthetically, two patterns are structurally similar in form, largely constructed from large interlocking curves similar to sinusoidal wave forms. It is perhaps the patterns aesthetic similarity to waves that means both were related to the concept of water or fluids. This could also explain the emotive associations – the energy of free flowing water could relate to the excitement and happiness that feelings of love and affection bring. As Kostellow Reed had noted, the character of abstract shapes is affected by the direction and inflections meaning that wave forms with frequent undulations could easily convey positivity (Hannah 2002). Pattern 15 is rather directly related to wave forms and from an aesthetic stand point appears like the abstract representation of a river or flowing water. It was unsurprising in this instance that this pattern was related to fluid and waves. Interestingly, pattern 12 was considered “mysterious” and pattern 14 “curious”, though it is unclear why this is the case.

Patterns 7 and 11 which also contained structurally similar features have aligned emotive relationships. Pattern 7 was considered to contain both angular and curved forms but features large ring-like forms directly comparable to the forms within pattern 11. Notably, both patterns were associated with the concept of trust and serenity. This is perhaps due to the aesthetic of the pattern being strongly symbolic of these concepts in some way – the structure of interlocking rings could imply a sense of “togetherness” and, by extension, possibly relating to the concept of friendship. Pattern 11 notably contains a “Verica Piscis” form which was used commonly throughout Byzantine and Renaissance art as a symbol of Christ (Lawlor, 1989) – this deep cultural meaning may be influencing the observers at some level. Semantically, the forms were also considered similarly; many groups felt the forms had a symbolic nature and in addition felt the forms connoted the related concepts of strength, power and security. Also of note are the results for pattern 16 which were emotively and semantically parallels of patterns 7 and 11, pattern 16 is very noticeably different in form. The reason for the similar responses is conceivably due to the interlocking structure of the forms. An interlocking structure in some configuration seems to suggest to observers the concept of “togetherness” and by extension the emotion of trust. The semantic responses of strength and power seem to suggest that people relate these concepts with the emotive quality of trust.

Notably, the only pattern based purely on a curved structure to inspire negative emotive feelings was pattern 13. Participants noted that the pattern elicited a feeling of “disgust” and that it reminded them of traditional decorations associated with wealth and sophistication. This is the only example where the patterns seem to inspire a reflection on social class. Pattern 13 is a Neoclassical design and would be similar to those used on the wallpapers of stately homes of the 18th century. It is interesting how these types of patterns, once so associated with beauty and cultural richness inspired visceral feelings of disgust in the modern day participants of this study.

5.3 Key findings

Considering the previous studies of angularity and curvature in terms of human visual perception, our results corroborate with these findings on a number of levels. Additionally, we would like to conjecture that the geometric complexity and potential symbolic nature of patterns can fundamentally alter our emotive and semantic interpretation of them. As a logical extension of Gestalt holism where the contextual nature of form alters its meaning. We put forward three key finding from this work;

1. *The more complex nature of pattern form and the structural relationships of the form influence the emotive feedback. Our results largely corroborated with previous studies analysing curvature and angularity but presented radically different semantic values for the forms*

2. *Patterns that included curved interlocking features were on were notable for the strong feedback they received. This study suggests that curved interlocking features are emotively associated with “trust” and semantically associated with “power”, “security” and “solidness”*
3. *Patterns including wave forms were always associated semantically with “fluidity” suggesting there is some sort of intuition that links these abstract forms with the physical element of water*

5.4 Applications for design

This paper has so far discussed the emotive and semantic values of a range of patterns. We must consider how these findings can be applied within design practice and the wider context of design research. What is important to address is how particular forms and structures convey very specific emotions and meanings. We have shown that generally curved formations lead to positive emotions like joy and serenity and angularity conveys a range of more negative emotions like nervousness and anger – this can easily be applied in a wide variety of product contexts tailored to specific market niches. There is already a large market for smart phone and laptop casings or "skins". The use of pattern on these product types is already wide spread. What we ask with this work is how pattern use can be more emotionally rich and more intelligently used. Creative expression through pattern - we would argue - is a valuable form of artistic practice but this work frames pattern in the context of complex emotional feedback.

We additionally propose that insights may come from considering pattern structures within a three-dimensional context. Considering the technological developments in numerically controlled machining and additive manufacturing allowing for new frontiers in geometric complexity to be readily customisable and economical, it would be interesting to examine whether some form of three-dimensional translation of a pattern would still influence an observers emotive and semantic interpretations in the same way; would interaction with this physical manifestation change the interpretation? Could a product interaction experience be enhanced by the use of three-dimensional patterns? Work on design interaction theory has shown how particular physical characteristics or feedback mechanisms can actually teach the user in how to use a product (see van der Linden et al. 2011 for an interesting example of this). Such features may be beyond the scope of purely aesthetic (non-mechanical) features but it is an interesting speculation whether or not pattern form can guide users in a particular product context. These questions are certainly worth asking and could offer new frontiers in creative expression for design practitioners.

6 CONCLUSION

Following a review of the history of pattern use and the theory behind their form and creation, this study has presented the results from a workshop experiment analysing responses to the aesthetic of patterns. We concluded that patterns dominated by curved forms were associated with positive emotions such as “joy” or “excitement” whereas patterns dominated by angular forms are always associated with more negative emotions such as “anger” or “nervousness”. These results corroborate with findings from a wide range of other studies. It is clear that the differences in form between the patterns subtly varied how they were emotively interpreted and unpicking this could be the topic of a future study. Semantically, the pattern interpretations were hugely diverse and surprisingly did not necessarily relate to the emotive interpretations. One very clear result was the relationship between the emotion of “trust” and patterns containing interlocking features. We propose that in some sense this form motif is highly symbolic of trust as a concept and is in some way ingrained. Also, we noted that abstract wave-like forms are always associated with fluidity and we speculate this is most likely a direct aesthetic comparison; the pattern literally looks like waves or flowing water. Patterns are an important part of the story of the visual arts and have not been fully appreciated for their emotive complexities. There is scope for the design industry to use pattern as a means of producing more emotionally rich objects and in turn provide new layers of meaning in the experience of using products.

REFERENCES

- Arnold, M.B., 1960. *Emotion and Personality*, Volume 1, Columbia University Press.
- Barratt, K., 1989. *Logic and Design : in art, science & mathematics*, Design Press.
- Bertamini, M. et al., 2016. Do observers like curvature or do they dislike angularity? *British Journal of Psychology*, 107(1), pp.154–178.

- Boardman, J., 2001. *The Oxford History of Classical Art*, Oxford University Press.
- Ching, F.D.K. & Juroszek, S.P., 1998. *Design drawing*, John Wiley & Sons.
- Collier, G.L., 1996. Affective synesthesia: Extracting emotion space from simple perceptual stimuli. *Motivation and Emotion*, 20(1), pp.1–32.
- Csikszentmihalyi, M. & Emery Robinson, R., 1990. *The Art of Seeing: An Interpretation of the Aesthetic Encounter*, Getty Publications.
- Desmet, P.M.A. & Hekkert, P., 2014. Special Issue Editorial : Design & Emotion.
- Desmet, P.M.A., Ortíz Nicolás, J.C. & Schoormans, J.P., 2008. Product personality in physical interaction. *Design Studies*, 29(5), pp.458–477.
- Ellis, W.D., 1938. *A source book of Gestalt psychology*, Routledge.
- Forty, A., 1986. *Objects of desire: design and society since 1750*, Thames and Hudson.
- Hann, M., 2012. *Structure and Form in Design: Critical Ideas for Creative Practice - Michael Hann* - Google Books, Bloomsbury.
- Hann, M.A., 2013. *Symbol, Pattern & Symmetry: the cultural significance of structure*, Bloomsbury.
- Hannah, G.G., 2002. *Elements of Design: Rowena Reed Kostellow and the Structure of Visual Relationships*, Howard, J., 1996. *Art Nouveau: International and National Styles in Europe*, Manchester University Press.
- Ingold, T., 2015. *The Life of Lines*, Routledge.
- Jordan, P.W., 2002. *Designing Pleasurable Products: An Introduction to the New Human Factors*, CRC Press.
- Krippendorff, K., 2005. *The Semantic Turn: A New Foundation for Design*, CRC Press.
- Lawlor, R., 1989. *Sacred geometry : philosophy and practice*, Thames and Hudson.
- van der Linden, J. et al., 2011. MusicJacket—Combining Motion Capture and Vibrotactile Feedback to Teach Violin Bowing. *IEEE Transactions on Instrumentation and Measurement*, 60(1), pp.104–113.
- Mothersill, P. & Bove Jr., V.M., 2015. The EmotiveModeler: An Emotive Form Design CAD Tool. *Extended Abstracts of the ACM CHI'15 Conference on Human Factors in Computing Systems*, 2, pp.339–342. Available at: <http://dx.doi.org/10.1145/2702613.2725433>.
- Norman, D.A., 2004. *Emotional Design: Why We Love (or Hate) Everyday Things*, Basic Books.
- Pinna, B., 2010. New Gestalt principles of perceptual organization: an extension from grouping to shape and meaning. *Gestalt Theory*, 23(1), pp.11–78.
- Pinna, B. & Reeves, A., 2009. From perception to art: how vision creates meanings. *Spatial Vision*, 22(3), pp.225–272.
- Plutchik, R., 2001. The nature of emotions: Human emotions have deep evolutionary roots. *American Scientist*, 89(4), pp.344–350.
- Poffenberger, A.T. & Barrows, B.E., 1924. The Feeling Value of Lines. *Journal of Applied Psychology*, 8(2), pp.187–205.
- Shaver, P. et al., 1987. Emotion knowledge: Further exploration of a prototype approach. *Journal of personality and social psychology*, 52(6), pp.1061–1086.
- Thompson, D.W., 1917. *On Growth and Form*, Cambridge University Press.
- Wade, D., 1982. *Geometric Patterns and Borders*, Wildwood House Ltd.