Our senses are lost online: Investigating how aesthetics might be used to ground people in Cyberspace

Key words: Aesthetics, visualisation, problem solving, perception, sensation, affective, experience design

Introduction

"Cyberspace, like the Americas, has been proclaimed the "new world". A new world however, is always posed as the correlate and other of an old world. In this way the new world is situated under the conceptual domination of the old." [17]

The term *cyberspace* was coined by William Gibson, who used it in his book, Neuromancer (1989). Gibson [15, pg. 128] defines cyberspace as "a consensual hallucination". Cyberspace also describes the virtual environment of the Internet [26], alongside its more whimsical portrayal as a global village [17]. The Internet has become ubiquitous, available to anyone with a device and connection, easier to find than clean drinking water in some countries. Beyond being *easily* and *constantly* accessible, it is increasingly remoulding our social realities, the way we communicate, and the way we behave [1]. Certainly, cyberspace is an area of information that does not correspond with the physics of the environment in which our bodies spend time, and when interacting in this environment we become almost desensitised to our physical surroundings [27]. By entering into the world of cyberspace, we change the way we find one another, communicate with one another, participate, interact, and work with one another [7]. Though it has been observed that "humans and other animals are remarkable in their ability to navigate through complex, dynamic environments" [14, pg. 67], this statement refers principally to our sensed physical world. This raises the question of whether we can adapt traditional real-world navigation techniques to fit cyberspace or, more crucially, can cyberspace be designed to fit better with us? Given the new space, and potential dangers, can an active process, requiring mental engagement and attention to the environment one is trying to navigate (aka wayfinding [3, 9]) be nurtured? This paper reports on a preliminary exploratory study that aims to examine the effect of aesthetic elements in a graphical map type problem on how participant's make sense of and then solve the problem of how to navigate from A to Z; a version of the Shortest-path problem in graph theory [13]. Against this backdrop, the greater research goal is to pave the way for further studies into how people make sense of their personal navigation through cyberspace. By more deeply understanding people's perceptions of the aesthetics of a navigation problem space – particularly the ways in which people value and connect with the design elements and how these affect the decisions made – it is envisioned that a sense of grounding in the space can be developed that will resonate with people and how they navigate.

There are no signposts in Cyberspace

Real environments are described in terms of the distances, sizes, shapes, and orientations of objects and surfaces [14]. Wayfinding through these environments involves "the consistent use and organisation of definite sensory cues from the external environment" [24, pg.6]. These cues can ground individuals (i.e. give someone a basis or benchmark to support decisions) and include visual sensations such as colour, shape, depth and motion, as well as other sensory cues. These can also incorporate a sense of gravity and egomotion, and possibly even electric or magnetic fields [24]. A *real world* environment that is intelligible not only offers scope for greater personal security but also heightens the potential depth and intensity of Human experience [24].

During the Middle Ages in the UK, there were no signposts, and certainly no GPS; to navigate effectively over a distance, and thus find their way from place to place, people relied on human co-operation [2]. In cyberspace, we have medieval roads; once again neither signpost nor GPS exist, and no single person knows all of the routes across the vast and growing space. To compound this problem, cyberspace provides an alien sense of time and distance. Unsurprisingly, humans become disembodied in cyberspace and this quickly changes how they think, feel and behave [1]. In their *Atlas of Cyberspace,* Dodge and Kitchin [12] described cyberspace as *'an enormous and often confusing entity'* that impacts on social, cultural, political and economic aspects of everyday life. They saw it as a space that can be difficult to monitor and navigate; they spent five years exploring rich and varied visual representations of cyberspace's diversity, structure and content to further improve people's understanding of and navigation within it. More recently, Legg [23] discusses the importance of situational awareness in cyberspace (i.e. the perception and comprehension of the current situation, and the projection of future status) stating that the big challenge lies in facilitating the user's understanding through effective visualization. Moreover, some feel that producers of these current 'cyberspace' visualizations focus too narrowly on adversarial security issues, ignoring important perceptions and narratives of individual and community security [18]. Others argue that many of the ways in which we discuss, imagine and envision the internet rely on inaccurate and unhelpful spatial metaphors [16]. As we move towards the design for the more human dimension of cyberspace, it is important to note that the aesthetic aspects of visualisations are themselves a way of securing trust [8]. We believe that we firstly need to understand the impact of these aesthetic aspects on how people perceive and sensually ground themselves in a navigation problem space before we can attempt to fully explore what this means for the design of a 'safer' cyberspace. The study documented in this article focuses on the aesthetic elements of a navigation problem space and in doing so, aims to investigate how the aesthetics informs and supports the decisions people make as they try to solve the problem of getting from A to Z.

Aesthetic Grounding and the Senses

The ancient Greeks described the *aesthetic* as the ability to receive stimulation from one or more of our five bodily senses, basically as sensation. Pragmatically, aesthetics facilitate an engaged interaction through the use of sensory stimuli [11]. Taking advantage of the wide knowledge base regarding visual properties in aesthetically experiences [22], this research is looking to bring into cyberspace the intense focus, strong emotions, and active reflection afforded by the aesthetic, and draw on an individual's senses, intuitions, past experiences, and intellect to make sense of an environment or situation.

The visualisation of information has traditionally been very much about enhancing the user's interaction with information [28]. A functional visualisation should present the information in a way that engages the viewer's attention, facilitates reading of the data and enables the user to detect underlying patterns and trends. The key outcome is that the visualisation relieves cognitive burden and speeds up processing and interpretation [5]. Nevertheless, the progress made in information visualisation has occurred at different speeds for sciences, and arts with little discourse between the fields [20]. The current research is interested in the interplay between the aesthetic, cognitive, and affective processes in problem solving (i.e. making sense of a visualisation). In particular, how (if) the intake of aesthetic information in a problem space can influence or change the understanding of how to get to the solution. As Lang [21, pg.6] points out, aesthetics has "to be recognized as not just being a by-product of science (for example like all these nice images of mathematic fractals) but an integral part of science."

In his thought-provoking paper "Feeling and Thinking: Preferences Need No Inferences" [29], Zajonc discusses the possibility that the very first stage of the organism's reaction to stimuli and the very first elements in retrieval are affective. Zajonc [29] claims that it is possible for us to like something or be afraid of it before we know precisely what it is and perhaps even without knowing what it is. Since then, many researchers have explored what has become known as automatic affective processing; the idea that organisms are able to determine whether a stimulus is good or bad without engaging in intentional, goal-directed, conscious, or capacity demanding processing of the (evaluative attributes of the) stimulus [19]. In line with this, we are interested in how aesthetic stimuli might be used to encapsulate "a person's full relationship – sensory, emotional and intellectual" [25] and in doing so affect their perception and interpretation of a navigation problem space. As research highlights [6], aesthetics can be strategically patterned in a digital space to suggest, coax and guide users towards "expected" and "intended" experiences. It is true that there is an element of unpredictability around the aesthetic, but we feel that this unpredictability opens up many exciting doors for the design of spaces such as cyberspace. This is particularly true if one considers "the role of the artist [designer] is not so much to construct the artwork but rather to specify and modify the constraints and rules used to govern the relationship between the audience" [4, pg.1].

Study

This is a preliminary study with the specific goal to inform further exploratory research. It took place at Melbourne University in October 2017 and aims to give some initial insight into individuals' understanding of a problem space and how aesthetics might affect the solving of the problem. One hundred and twelve psychology students between the ages of 18-30 years completed the study. The study took approximately forty minutes in duration. It followed a standard within-subject design. All graphics were generated using *Adobe*

Fireworks CC software and *Google Maps* was used to identify the predicted paths (i.e. the quickest route) that were used for the design of each graphic. The experimental procedure was approved by the Ethics Board of The University of Melbourne and subjects provided written consent for study participation and the academic use of de-identified data.

Data Collection

The study was conducted using the Qualtrics online survey software. Participants were presented with a series of thirty-six problems: graphically represented map type problems of six cities presented in six different forms (see fig.1). These included grid, satellite, 3D satellite, edge, aesthetic and network.

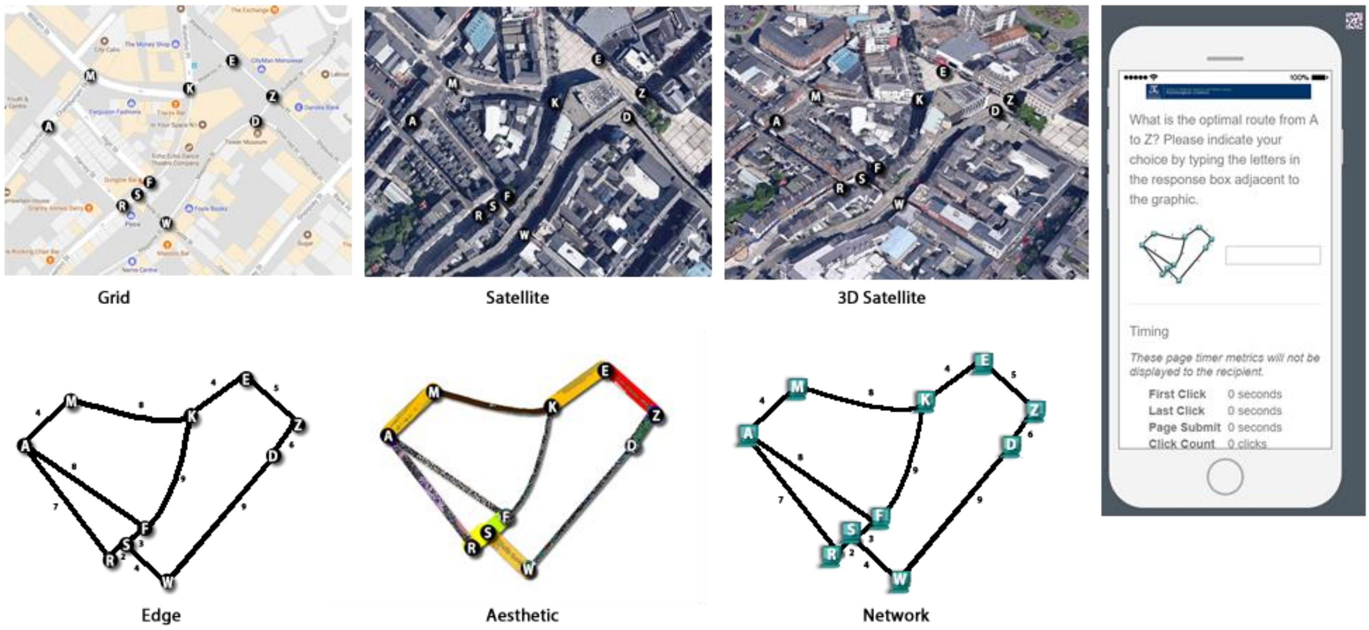

Fig 1 Map type problem of Derry city presented in six different forms

Participants were asked to find the *optimal* route through the map (from A to Z), and to subsequently clarify what they interpreted as *optimal*. After each randomly presented set of graphical representations (see fig 2), participants were asked about the strategies they used for solving the problem, and the thoughts they experienced during it.

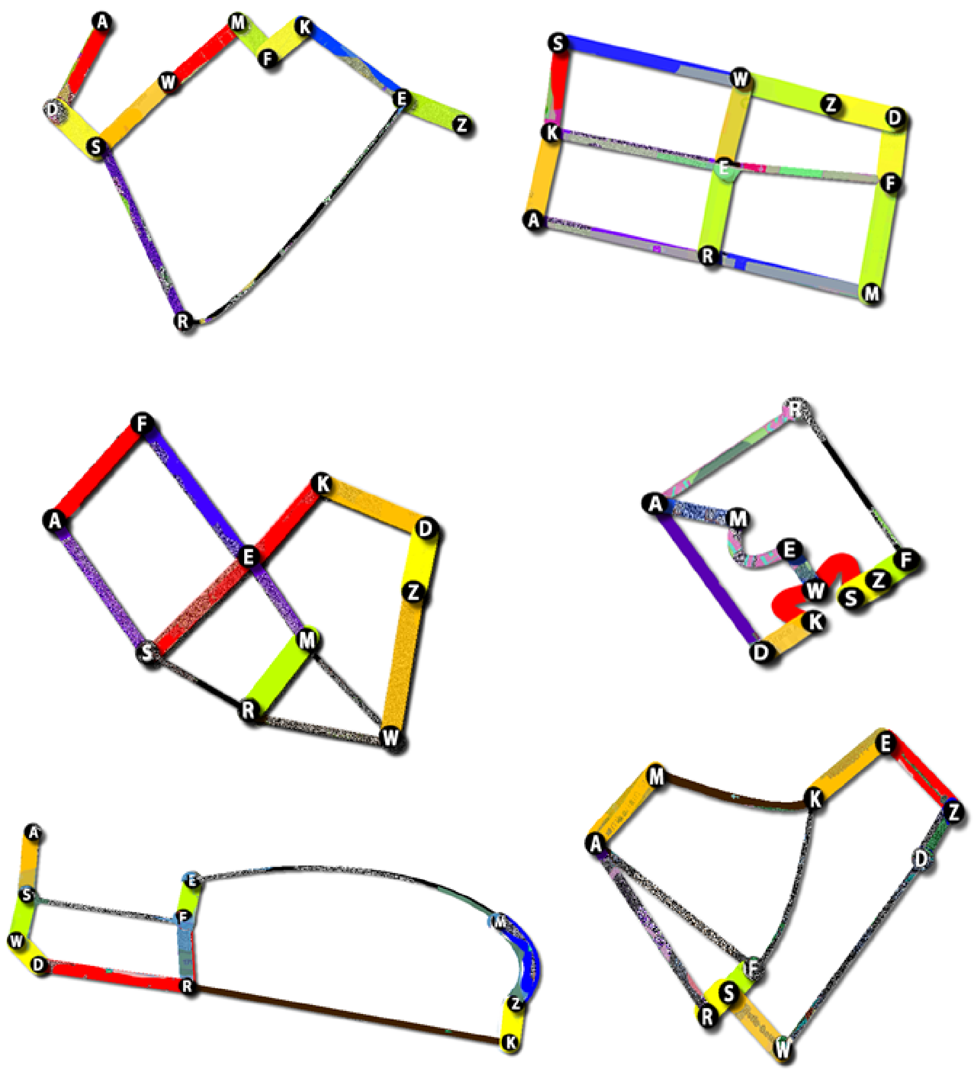

Fig 2 The set of 'aesthetic' graphical representations for all six cities

These open-ended questions included:

- *What strategies have you applied to enable you to determine the optimal route between A to Z?*
- *In your opinion, what did the elements presented in this graphic mean?*
- *What did you understand by the term optimal route? Did that understanding change across the different graphics?*

After all six sets of graphical representations were presented, participants were asked to rank a sample graphic from each set in terms of: easiest to determine the optimal route between A to Z; most difficult to determine the optimal route between A to Z; and in order of preference. All participant data was securely collected using the Qualtrics software; the data included details such as how long it took the participant to solve the problem (i.e. how long it took them to do the 'first click' and then to click the 'submit' button).

Data Analysis

The highly responsive Qualtrics platform allowed for the collecting of both quantitative and qualitative data from both factual (closed) and open-ended questions. The ANOVA statistical procedure was used to analyse data from the quantitative closed questions. To further investigate possible relationships, causes and affects of the aesthetics in each navigation problem space, a qualitative thematic analysis was also undertaken. The aim of this was to further investigate the differences across the different graphics, and in doing so, to allow for flexibility to concentrate on specific areas of interest while also revealing other emerging areas. The following section highlights and discusses the results of both the quantitative and qualitative analysis of the data.

Results and Discussion

As mentioned previously, the experimenter-defined *optimal* solution (based on a Google Map prediction) was the quickest pathway. This solution was similarly arrived at for the majority of the cities tested (five of six). In terms of ease of processing, participants reported the grid graphic was the easiest graphic to work out the optimal path on, and also the most preferred (33% participants ranked the grid as their most preferred graphic, 14% preferred the node graphic, and 10% preferred the aesthetic). The 3D satellite and the aesthetic graphic were perceived as the most difficult to interpret for optimal solution.

The average time spent on the each set of graphical representations (choosing the *optimal* solution) for each city can be seen in Table 1.

Average time spent on problem	**Grid**	**Satellite**	**3D satellite**	**Edge**	**Aesthetic**	**Network**
Cork	25.88272	42.02405556	NA	35.89142857	20.16732836	37.83386813
Derry	21.7743125	23.41836607	25.16733333	40.78684677	20.52432743	76.71856303
Glasgow	21.64188889	45.55616129	24.17174545	42.03176543	38.76712963	29.96908333
Sydney	30.53561905	27.05235354	28.42233735	38.78348485	20.77687755	57.73961111
York	36.91813333	29.44054	41.20633333	38.10739423	25.33060256	43.24154444

Table 1. Average time spent on problem (note: NA represents 'No Answer' as no optimal solution was achieved for the 3D satellite graphic for Cork city)

The tendency to outline the predicted (shortest) path was significantly different between graphical representations $F(4.21, 462.89) = 34.73$, $p < .001$ (see fig. 3 for illustration of average number selecting predicted path across cities). The shortest path was followed most frequently in the Edge graphic. The frequency with which the shortest path was selected was significantly higher in the Edge graphic compared to the Grid (mean difference = .12, $p < .001$), Satellite (mean difference = .18, $p < .001$), 3D Satellite (mean difference = .27, $p < .001$) and Aesthetic (mean difference = .15, $p < .001$) graphics, but not the Network graphic (mean difference = .02, $p = 1.00$), which had a similarly high average of individuals who selected the shortest route using it. Similarly, the participants selected the shortest route using the network graphic, with a significant higher rate of shortest route chosen in the Network graphic compared to the grid (mean difference = .01, $p = .02$), satellite (mean difference = .16, $p < .001$), 3D satellite (mean difference = .25, $p < .001$), and aesthetic (mean difference = .17, $p = .001$) graphics. The 3D satellite graphic provided the least number of instances in which participants selected the shortest route, with the rate being significantly lower than the grid (mean difference = .16, $p < .001$), satellite (mean difference = .01, $p < .001$), and aesthetic (mean difference = .13, $p < .001$) graphics.

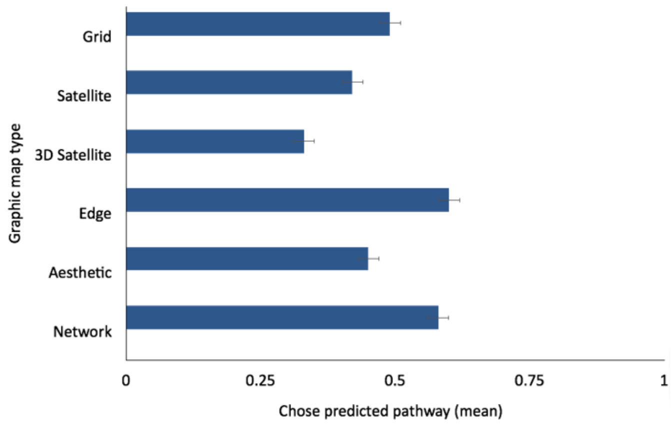

Fig. 3 Illustration of average number selecting predicted path across cities

The above analysis is an indication of the shortest path, rather than the subject-defined optimal path. We therefore use a qualitative approach to further investigate the differences across the different graphics. Figure 4 highlights that the words *route, shortest,* and *distance* appeared most frequently in the data gathered from participants answers to the question: *What strategies have you applied to enable you to determine the optimal route between A to Z?* For all six sets of graphics, it is demonstrably justified that the strategies were concerned with some form of working out of the shortest route or the route with the shortest distance. Also, *numbers* were of clear importance to participants' strategies in the edge and network graphics whilst other words similar in meaning to *shortest* such as *least, smallest*, and/ or *lowest* were found in all graphics except the satellite graphic.

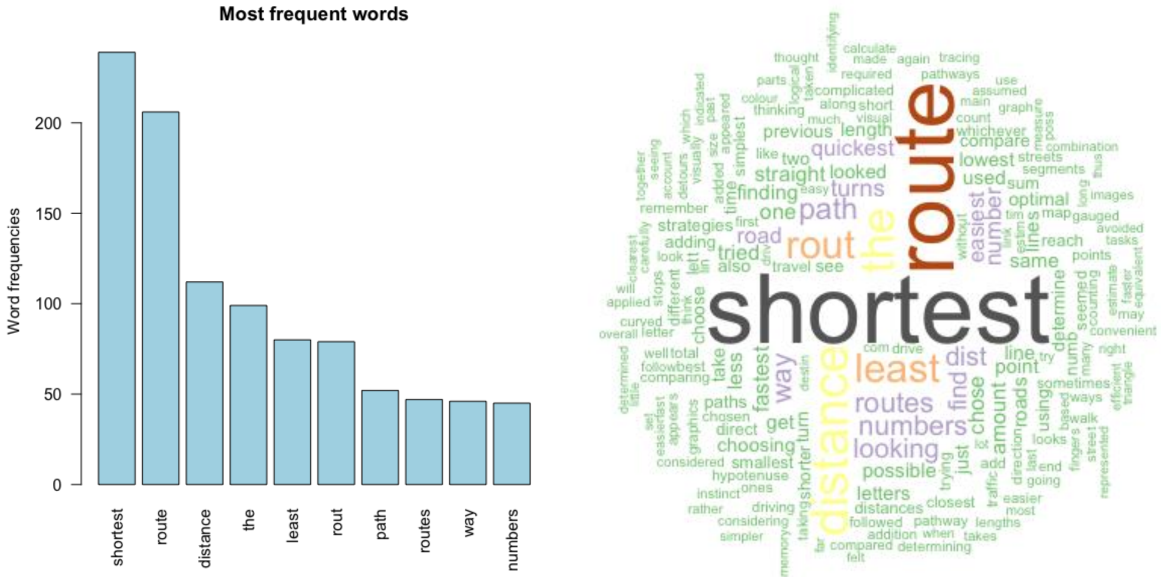

Fig. 4: Word frequency count regarding words used across the six graphics

By conducting the thematic analysis to further probe the strategies implemented by participants, a number of themes (e.g. analysis, gut feeling, and embodiment) emerged. Participants seemed to take an analytical approach to solving the problem, trying to make sense of the elements in each of the problem spaces in order to work out the solution. For example, participants developed strategies to work out: the shortest route, the route with the least turns, the route with the most straight-lines, the route with the least distance and the cleanest route etc. As the following comments demonstrate, some graphics afforded more straightforward analytical access than others:

> *Find the closest route to as the crow flies, keeping in mind road direction.*
> **(Participant in the grid graphic)**

> *I used spatial reasoning to differentiate between domestic and public land in order to determine which route is optimal.* **(Participant in the satellite graphic)**

> *Using my fingers to trace the paths. I also carefully looked at the images to see if there is an actual route or not but sometimes it is far too difficult to assume whether if there was a viable route or not especially on more crowdier looking images.* **(Participant in the 3D satellite graphic)**

> *Assuming that the numbers adjacent to the lines indicate the length of the line, the sum of each possible pathway was calculated and the pathway with the lowest value was selected.* **(Participant in the edge graphic)**

> *thinking about fastest way to get from a to z. looking at the cleanest route. I was drawn to the wider lines, brighter colours, route that felt faster overall*
> **(Participant in the aesthetic graphic)**

> *I added the numbers together for each possible route and chose the route with the lowest number, which to me represented the shortest route*. **(Participant in the network graphic)**

Though the analytical approach to problem solving was predominately used, there was also the distinct use of intuition, instinct, and gut feelings when participants described the strategies used to solve the problem:

> *I used my intuition to find out what route takes less distance like the previous parts.* ***(Participant in the grid graphic)***
>
> *sometimes i just picked the routes that seemed least complicated i.e. with less checkpoints/changes in direction, but sometimes the number of letters in between didn't actually indicate a shorter route. I think I just followed my instincts* ***(Participant in the satellite graphic)***
>
> *observing, intuition* ***(Participant in the 3D satellite graphic)***
>
> *Hypotenuse of triangle, simplicity of route. Eyeballing route and following gut.* ***(Participant in the edge graphic)***
>
> I chose whichever was the quickest whilst also being less complicated (having less turns/changes in direction) I mostly used my instinct ***(Participant in the aesthetic graphic)***
>
> *Intuition* ***(Participant in the network graphic)***

There was also evidence that participants were imagining or trying to embody themselves in the problem space in order to solve the problem:

> *I imagined I was a cyclist this time - thus avoided going against traffic (i.e., avoided one-way streets that were in the opposite direction to where I was heading). I tried to stick to the route of shortest distance and fewest turns.* ***(Participant in the grid graphic)***
>
> *Tracing out the most logical path. I imagined myself walking through the street and thinking of which way I would go.* ***(Participant in the satellite graphic)***
>
> *Attempted to picture myself at A trying to get to Z and which route I would take* ***(Participant in the 3D satellite graphic)***
>
> *Thickness of each line represented the sturdiness of the track. People who choose the thicker lines may be dependent on support and not as self-assured so they require a sturdy track while others who are confident with their decisions and path in life choose the thinner lines.* ***(Participant in the aesthetic graphic)***

While participants tended to seek embodied solutions in the grid, satellite, 3D satellite, and aesthetics graphics, the edge and network number graphics highlighted very little or no evidence of applying this embodying strategy to solving the problem. Interestingly, when asked *"In your opinion, what did the elements presented in this graphic mean?"* we can see again that the word *numbers* was quite relevant for participants in the edge and the network graphics but clearly did not appear in the top ten most frequent words from the other graphics. The word *Colour* features and was of significance only in the aesthetic graphic (see table 2) and initially it was found to be confusing for many participants:

> *I have no idea what the colours were supposed to represent*

> *I'm not sure what the colours and thickness meant.*

In comparison, the *numbers* in the edge and network graphics were much more transparent:

> *The elements were the numbers that indicated distance*

> *The numbers were possibly the time that it takes to traverse the space between each relevant point*

Participants used the representational geographical features available in the grid, satellite and 3D satellite graphics, referencing these with words such as *map, street, road* and *building*. Interestingly, the participants note *roads* in their interpretation of the aesthetic, as well as the geographically representational satellite graphics, but also tend to use the word *line/s,* which appears in the edge, the network as well as the aesthetic graphic. In view of this, it is important to note that participants in the aesthetic graphic were seemingly taking on board both the representational (road) as well as the more abstract (line) elements in their quest to find meaning. Indeed, while participants were making sense of similar elements in all graphics (e.g., *route, point, letters* etc.), there were clear differences in the impressions being formed. In summary, the main elements in the grid, satellite and 3D satellite graphics were more representational in character (i.e. *map, street, road* and *building*) whist the edge and the network graphics (line, numbers, distance etc.) were clearly more abstract. As highlighted, the aesthetic graphic is seen to have some leanings across both.

Grid		**Satellite**		**3D Satellite**		**Edge**		**Aesthetic**		**Network**	
30	NA	29	NA	30	NA	35	distance	28	NA	35	distance
30	map	19	points	16	letters	34	numbers	27	lines	33	numbers
15	points	18	roads	16	roads	25	NA	16	different	28	NA
14	roads	17	map	14	route	16	letters	14	represent	17	letters
10	routes	12	letters	12	buildings	15	lines	14	points	16	points
9	letters	12	road	12	different	13	points	11	letters	15	lines
9	streets	9	streets	12	map	12	route	11	routes	13	route
7	buildings	9	routes	10	points	11	represented	11	roads	11	distances
7	road	9	route	10	routes	11	represent	10	colours	11	routes

Table 2 Q2. *In your opinion, what did the elements presented in this graphic mean*? The top ten most frequent words (Note: NA represents 'No Answer')

Participants’ understanding of the “optimal route” were similar to the predicted (i.e., shortest) route outlined by the experimenters: When asked, *“What did you understand by the term optimal route? Did that understanding change across the different graphics?”* the two most frequent words to appear from a word frequency analysis of the data across all graphics include *route* and *shortest*. The word *fastest* appears in all graphics except the aesthetic graphic whilst *distance* is a concept that features in the grid, edge/node, aesthetic and network/numbers graphic only.

Participants’ understanding of the optimal route (i.e., shortest route) did not change across the different graphics. Participants nevertheless made concerted and varied effort into making sense of the varying graphical elements. For example, in the edge graphic, participants calculated the numbers whilst in the aesthetic graphic, there was an obvious conflict and initial confusion around the elements, simultaneously found meaning for each element.

> *I thought that the thicker lines provided a sort of terrain (i.e. grass, concrete, etc.) for the route compared to the thinner ones. Along with this, the different colours were different variations of the same terrain (i.e. tall grass, short grass).*
>
> *The lines with different colour and thickness might represent traffic and road conditions, e.g. red means very crowded, thin lines represent narrow streets, thick means spacious.*
>
> *The colour present the condition of the route such as red colour represent crowded.*
>
> *The colours might show different types of traffic, e.g. heavy or light.*
>
> *The colour seems like represent if this route has traffic problem. In my mind, the red usually represent the traffic jam.*
>
> *The colour means the crowded and busy street. Red means traffic jam.*

The data retrieved from these open-ended questions identified a range of new questions not previously fully conceptualised. These include how design might nurture both intuitive and analytic approaches in problem solving and how the benefits of embodiment may be incorporated into a problem space. It also highlights the immediate impact of elements such as colour, scale, and texture in wayfinding. On reflection, these findings have not only given us the scaffolding to explore other aesthetic cues that might further impact the viewer but also different arrangements of one or more of these cues. On one level, this paper has exposed us to the impact of the design on affording intuitive and analytical approaches to problem solving. On another, it has introduced us to the potential of the aesthetic cue and particularly elements such as colour, scale and texture to really ground the participant in making sense of the problem.

Conclusion

As humans, we take cues on how to act and behave from the physical environment we are in. This preliminary study focused on aesthetic cues in a map type graphical problem; the researchers were interested in the way that participants engaged and interacted with those cues and the impact they had on solving the navigation problem. As we have seen from the results the graphics that mapped familiarly physical surrounds (e.g., satellite images) encouraged embodied approaches to problem solving, whereas graphics that were pared back encouraged analytic and mathematical approaches to problem solving. The aesthetic graphic was found to sit somewhere in the middle highlighting the potential impact of elements such as colour, scale, and texture in the problem-solving process. While this study is a first step in investigating aesthetics in a problem space, much more work is needed. In particular, the application of several aesthetic elements in one map type graphical problem did seem to overwhelm participants causing confusion and at times misunderstanding. Further studies are currently being developed to investigate the impact of the aesthetic elements in isolation within the problem space. As, cyberspace does not have the same depth of physical cues as the physical world, and it is possible that, due to people's inability to ground themselves in a physical and time-oriented world, they have become more disinhibited and disembodied [10]. It is envisioned that the process of exploring aesthetics and the impact that it has on participant's experiences of finding the optimal path will produce potential hypotheses for further study. Of particular interest is the power of the aesthetic to ground the participants in the problem space whilst influencing the paths taken. This, we believe, could uncover new meaning and significance for the design of the cyberspace environment and particularly the support visualisation tools that could be developed to help people's navigation of that space.

References

(1) M. Aiken. (2016). The Cyber Effect: A Pioneering Cyberpsychologist Explains How Human Behavior Changes Online. Spiegel & Grau.

(2) V. Allen & R. Evans (2016). Roadworks: medieval Britain, medieval roads. Manchester University Press

(3) C. Calori & D. Vanden-Eynden (2015). Signage and Wayfinding design. Wiley Publishers.

(4) L. Candy & E. Edmonds (2002). Interaction in Art and Technology. Crossings: eJournal of Art and technology. 2. (1). Available from: http://crossings. tcd.ie/issues/2.1/Candy/ (19/02/2018).

(5) S. Card & J.D. Mackinlay & Shneiderman (Eds.) (1999). Readings in Information Visualisation using Vision to Think. USA: Morgan Kauffmann Publishers.

(6) F. Carroll (2010). 'Designing (for) experiences in photorealistic VR environments'. New Review of Hypermedia and Multimedia, 16, pp. 181-194. Available from: http://dx.doi.org/10.1080/13614561003710250

(7) G. Cartwright (1994). Virtual or Real? The mind in Cyberspace. The futurist.

(8) A. Carusi (2008) Scientific visualizations and aesthetic grounds for trust. Ethics and Information Technology 10: 243–254.

(9) N. Cheng, (1998). Wayfinding in cyberspace. Negotiating connections between sites. CAADRIA '98 : Proceedings of The Third Conference on Computer Aided Architectural Design Research in Asia. eds. T. Sasada, S. Yamaguchi, M. Morozumi, A. Kaga, and R. Homma. April 22-24, 1998. Osaka University, Osaka, Japan. Pp. 83-92

(10) J. Davidson et al. (2017). Enhancing Police and Industry Practice. Available from: https://www.mdx.ac.uk/__data/assets/pdf_file/0017/250163/ISEC-report-FINAL.pdf (19/02/2018)

(11) J. Dewey (1934). Art as Experience. London: The Berkley Publishing Group.

(12) M. Dodge & R. Kitchin (2000). Mapping cyberspace. New York: Routledge.

(13) E. W. Dijkstra, (1959). A Note on Two Problems in Connexion with Graphs. Numerische Mathematlk, 1, 269-271.

(14) B.R. Fajen & F. Phillips (2013). Spatial Perception and Action. In Handbook of spatial cognition by Nadel, L. & Waller, D. APA Books, 2013

(15) W. Gibson. (1989). Neuromancer. New York: Berkley Publishing Group. pp. 128.

(16) M. Graham (2013). Geography/Internet: Ethereal alternate dimensions of cyberspace or grounded augmented realities? The Geographical Journal. doi: 10.1111/geoj.12009

(17) DJ. Gunkel & AH. Gunkel (1997). Virtual geographies: The new worlds of cyberspace. In critical Studies in Mass communication 14, 123-127.

(18) P. Hall, C. Heath, L.Coles-Kemp; Critical visualization: a case for rethinking how we visualize risk and security, Journal of Cybersecurity, Volume 1, Issue 1, 1 September 2015, Pages 93–108, https://doi.org/10.1093/cybsec/tyv004

(19) D.J Houwer & D. Hermans (2001) Automatic affective processing, Cognition & Emotion, 15:2, 113-114, DOI: 10.1080/02699930125900

(20) G. Judelman (2004). Aesthetics and Inspiration for Visualization Design: Bridging the Gap between Art and Science. In: Eighth International Conference on Information Visualisation, 14-16th July, London, UK. Los Alamitos, California: IEEE Computer Society. Pp.245-250. (Online). Available from: http://www. gregjudelman.com/media/judelmanIV04paper.pdf (21/02/2018).

(21) A. Lang (2010) The aesthetics of information visualization. Technical Report, University of Munich, Department of Computer Science. (Online) Available at: https://www.medien.ifi.lmu.de/lehre/ws0809/hs/docs/lang.pdf (21/02/2018)

(22) H. Leder, B. Belke, A. Oeberst & D. Augustin (2004). A model of aesthetic appreciation and aesthetic judgments. British Journal of Psychology, 95, 489-508.

(23) P. Legg (2016) Visual analytics for non-expert users in cyber situation awareness. International Journal on Cyber Situational Awareness, 1 (1). ISSN 2057-2182

(24) K. Lynch (1960). The image of the city. The technology Press & Harvard University Press. Cambridge

(25) J. McCarthy & P. Wright (2004). Technology as Experience. Massachusetts: MIT Press.

(26) D. Rajnovic (2012). Cyberspace – What is it? (Online). Available from: https://blogs.cisco.com/security/cyberspace-what-is-it (28/02/2018)

(27) J. Suler (2004). The online disinhibition effect. Cyberpsychology & behavior,7(3), 321-326.

(28) J.S.Yi, Y.A.Kang, , J.T. Stasko, J.A. Jacko (2007). Toward a deeper understanding of the role of interaction in information visualization. IEEE Trans. Vis. Comput. Graph. 13(6), 1224–1231 (2007)

(29) R. B. Zajonc (1980). Feeling and thinking: Preferences need no inferences. American Psychologist, 35(2), 151-175