Crowdsourced Feedback With Imagery Rather Than Text: Would Designers Use It?

David A. Robb[1]   **Stefano Padilla**[1]   **Britta Kalkreuter**[2]   **Mike J. Chantler**[1]

[1]School of Mathematical and Computer Sciences, [2]School of Textiles and Design,
Heriot-Watt University,
Edinburgh, UK. EH14 4AS
{dar14, s.padilla, b.kalkreuter, m.j.chantler}@hw.ac.uk

ABSTRACT

Cognitive styles theories suggest that we divide into visual and verbal thinkers. In this paper we describe a method designed to encourage visual communication between designers and their audiences. This new visual feedback method is based on enabling fast intuitive selections by the crowd from image banks when responding to an idea. Visual summarization reduces the massed image choices to a small number of representative images. These summaries are then consumed at a glance by designers receiving the feedback leading to thoughtful reflection on their designs. We report an evaluation using two types of imagery for feedback. Twelve designers took part, receiving visual feedback in response to their designs. In semi-structured interviews they described their interpretation of the feedback, how it inspired them to change their designs and contrasted it with text feedback. Eleven of the twelve designers revealed that they would be enthusiastic users of a service providing this new mode of feedback.

Author Keywords

Crowdsourcing; visual; design; feedback; perceptual; emotional; imagery; image; summarization.

ACM Classification Keywords

H.5.3 [Information Interfaces and Presentation]: Group and Organization Interfaces

INTRODUCTION

For many people images are a medium preferable to text [27]. Yet, with the exception of star ratings [34], most feedback formats focus on text and they suffer from other limitations [32,17]. Work on crowdsourcing design feedback has been done and effective systems have been developed to gather it from paid non-experts [37, 19]. However, we have developed a new way to leverage

participation in feedback from crowds through enabling easy, intuitive and engaging image selection as the medium. Visual feedback summaries stimulate thoughtful reflection in designers (Figure 1). We were originally motivated to apply this new feedback method (Figure 2 overleaf) to fashion design. However, in an evaluation of the method (described later), designers in the domain of interior design received the visual feedback and compared it with text. While aware of the scope for ambiguity in images the designers took inspiration from them and were motivated to make changes in their designs. They were enthusiastic to make use of a service which would provide them with more of this form of feedback.
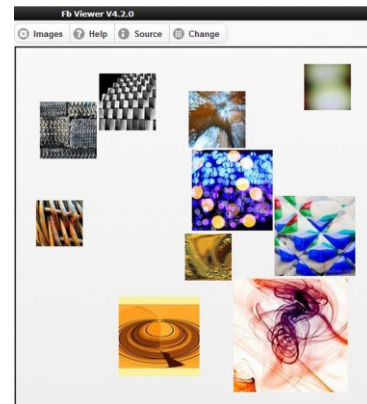

Figure 1 -Example of a visual feedback summary produced from a crowd's abstract imagery responses. This is a screenshot of feedback viewed by a designer participant during the evaluation study described in this paper.

The contributions of this paper are:

- The description of a method of obtaining image-based feedback allowing designers to elicit the intuitive perceptual and emotional reactions of a crowd to their designs in a visual format.
- The application of image summarization to the massed image selections of a crowd.
- An evaluation of this feedback method with designers who put forward their designs, viewed the visual reactions, and were given the opportunity to contrast the novel visual feedback formats with text feedback.

Figure 2 (overleaf) illustrates the visual design feedback method highlighting the areas of novel contribution. In the
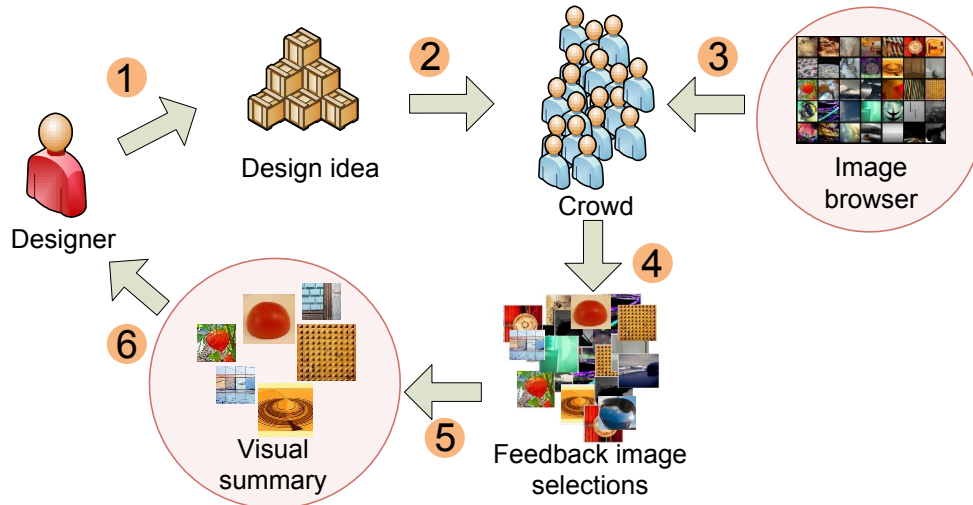
Figure 2 - The visual feedback method: 1-Designer presents design; 2-Crowd views design; 3- Crowd responds by selecting images from browser; 4- Image selections collated; 5-Visual summary generated; 6 Designer views feedback summary. The contributions are: images as a feedback medium; image summarization applied to crowd communication; an evaluation of the method.

rest of this paper, in *Background and Related Work*, we discuss areas lying behind our motivation including work on psychology and some of the drawbacks of conventional feedback. We also discuss previous work related to our implementation. In *Components of the Feedback Method* we focus on two aspects of that implementation: the image browsing interface and the generation of the visual summaries. The *Evaluation*, and *Results* sections describe how the evaluation was conducted and the results which flowed from it. Finally, in the *Discussion*, and *Conclusion* sections we discuss the implications of the results and suggest directions for the future of this novel visual crowd communication format.

BACKGROUND AND RELATED WORK

Visual Versus Verbal
Cognitive styles are frequently used in industry to predict individual performance in a range of situations [16]. They have also been used to inform aspects of teaching and learning [2]. While research since the 1950's produced several models of cognitive styles [16, 26], in a review, Riding & Cheema [27] identified two main dimensions: 1) visual-verbal and 2) holistic-analytic. It is the work in this field that lies behind a broad acceptance that some people prefer, and are more suited to, consuming information visually rather than verbally (or textually). Also, cognitive styles are independent of gender, age, and intelligence [26]. The method we describe will offer a feedback channel suited to those who prefer a visual medium.

The Importance of Intuition
Dual process theory is used to explain the apparent duality in the way that people make decisions; some decisions are arrived at slowly following a logical and analytic process, whereas intuition leads to a fast, almost effortless

conclusion. The theory terms the fast intuitive process as *System 1* and the slow deliberative process as *System 2* [11]. It is actually *System 1* that takes care of most of our every-day decision making and it is this, along with its frequent unconscious involvement in our analytical decision making [11], that make it a valid feedback strategy to embrace *System 1,* by encouraging intuitive responses.

Conventional Methods for Gathering Feedback
While our motivation in developing this new method of visual feedback was a positive one, seeking a stimulating alternative to conventional methods for gathering feedback, here we briefly describe some of the shortcomings in conventional methods of computer mediated feedback.

Questionnaires can be affected by biases such as selective non-response [23]. Feedback forums also have their drawbacks. The picture they provide can suffer from overly negative responses. Customer feedback reviews via comment forums can lack input from moderate opinion holders reflecting only polarized views. Also contributors can be motivated to make their own opinion predominate [32]. If discussion on a forum develops this way, then the wisdom of the crowd as described by Surowiecki [31] is compromised as it depends on the independence of each crowd member. In addition, online reviewers are usually not encouraged to write about their emotions as subjectivity lessens the clarity of their message [17] despite the emotional impact of any product or design being an important aspect of its success.

Our new reaction method based on images, will provide an alternative which aims to avoid, or suffer less from, these drawbacks. Any selective non-response profile is likely to be different because potential respondents wary of conventional questionnaires may find responding via images more appealing and so take part. As no text is used

contributors cannot argue for their view over others thus democratizing the contribution weights. Spontaneity and subjectivity will be recognized as inherent in the medium.

Crowdsourcing Design Feedback
Crowd feedback can be obtained through blogging or involvement in communities such as *Dribbble*. However, the level of commitment required to participate in such online communities [3] limits their accessibility; participants tend to be motivated to develop their own skills and status [36], thus representing more professional opinion rather than that of the eventual target audience for a given design. Alternatively paid participants can be engaged on services such as *CrowdFlower* [6]. Recent work by Xu et al. [37] describes a crowdsourcing tool for efficiently obtaining, specific, objective, feedback on graphic designs from paid crowdsourced workers in a structured way avoiding the need for a designer to have expertise in constructing human interface tasks. The feedback method we describe in this paper is intended to complement rather than compete with such systems by encouraging the participation of volunteer crowds perhaps engaged through social media.

Image Summarization
A disadvantage of images as feedback medium is that prompting a crowd to respond with visual feedback would result in a deluge of images rapidly overwhelming those receiving the feedback (assuming the crowd was large). Therefore a method of summarizing the massed image selections of a crowd is needed.

The representation of a large quantity of images by their reduction to a concise subset of representative images has been addressed in work on automated photo collage generation and for image browsing. One approach defines "representative images" as images that are interesting but different. Images are ranked by importance based on computer vision techniques such as face detection [28]. The choice of high ranking candidate images is then filtered so as to rule out near duplicate images by using similarity data based on color histogram techniques. Another approach to the reduction is by clustering the images and choosing representative images based on the cluster structure. Egorova et al [9] use source and date/time metadata as the data for clustering. Fan et al [13], in their work to improve browsing in large image collections, use tags already associated with the images to allocate images to topics. Within topics the images are then clustered based on similarity data calculated from color, texture and interest point features.

These methods all rely to some extent on computer vision techniques to measure the similarity between images. Clark et al. [1] have shown that in the case of texture images computer vision techniques produce similarity data that does not match human perceptions. Indeed the summarization methods which use metadata and tags are

seeking to address the semantic gap between what can be deduced about the meaning of the image from its features and what the image actually means to a viewer. Our approach to summarization, which we describe later, uses perceptual data and thus seeks to avoid the semantic gap problem.

Abstract and Emotional Imagery
As our visual feedback method needs images for its medium we consider two types of imagery for use:

The role of emotions in intuitive thinking, decision making, and information processing is recognized in psychology literature [33, 18]. Approaches such as Kansei engineering [22] exemplify how consumer emotions can be factored into product design. Mood boards are perhaps a more established creative and analytical tool used by designers when formulating a design idea. Images and objects are arranged together to develop a mood or perceptual and emotional theme. Abstract images are often used for this to avoid specific figurative connections [14]. However, figurative images can be used to access emotions in a more specific way and can be categorized according to their affective properties [21]. Emotive images would be suitable for fast intuitive feedback as people rapidly and reliably interpret the emotion content of images [15].

Considering the above factors, we deployed two types of imagery in our evaluation: 1) a relatively abstract image set to provide a wide ranging and non-specific image pool with which designers would already be comfortable; and 2) an emotive image set built specifically to provide images communicative of emotions relevant to design conversation.

COMPONENTS OF THE FEEDBACK METHOD
In this section we focus on two steps in the feedback method as implemented for our evaluation study: intuitive image selection, and visual summary generation (steps 3 and 5 in Figure 2). We describe the construction of the image browsers along with the methods used to gather perceptual data on the image sets they hold. Then we describe the method used to generate visual summaries of image selections drawn from the browsers.

Intuitive Image Selection
Two image browsers were created to allow designers to experience two styles of image feedback, abstract and emotive, during the evaluation.

Abstract image browser
The abstract image browser was created by gathering the images, obtaining perceptual similarity data about them, and assembling them in a browser. Creative Commons licensed images tagged with the word, *abstract*, were gathered from *Flickr*. Images with writing, people, or conventionally framed objects or scenes were discarded. 500 were randomly selected from those that remained.

Obtaining the perceptual data and assembling the browser were done as described in Padilla et al. [24]. We used free sorting of 100 reference images by lab participants to generate a 100x100 similarity matrix. Then Amazon Mechanical Turk workers were asked to identify reference images that they viewed as similar to the remaining 400 query images. The query images were added incrementally to the matrix. Each time, their similarity vector was calculated as the average of chosen reference images' similarity vectors. The similarity matrix was used to train a rectangular self-organizing map (SOM) [35]. This informed the construction of an interface in which, each cell of the SOM was presented as a stack of images, the top image of each stack being the stack's centroid image. The features of this interface which make it intuitive to use when browsing are: a) stacks contain similar images, b) tapping or clicking the top image of a stack reveals the images in the stack, and c) adjacent stacks on the SOM contain images which are similar, while stacks far apart on the SOM contain dissimilar images (see Figure 3).
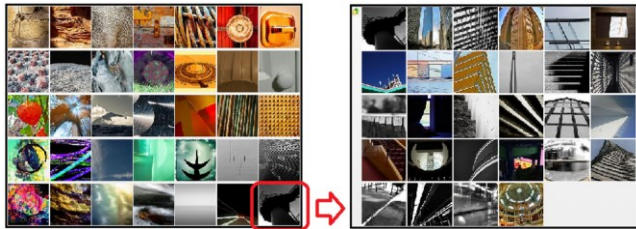

Figure 3 - SOM browser interface. Tapping or clicking the top image of a stack reveals the full stack. On the left is the top level of the SOM. On the right is the bottom left stack opened.

Emotive image browser
Although presented and organized in a similar way to the abstract browser the emotive image browser offered a different a set of images focused on emotion expressiveness. A survey, of staff and students of a design institution identified a subset of 19 terms from Plutchik's model of emotions [25] as being relevant to design feedback. 2000 Creative Commons licensed images associated with these terms were gathered from *Flickr* and *Google*. The images were then tagged with emotion terms by participants recruited via *CrowdFlower* using a drag and drop interface. This categorization produced a normalized emotion category frequency vector for each image. By filtering the images on this vector, the best 10 (approx.) images for each of the 19 emotion categories were identified. A SOM browser containing 204 images based on their emotion category vectors was assembled, resulting in image stacks containing emotionally similar images.

Visual Summary Generation
Any selection of images (or *feedback image selection)* chosen from the abstract image browser can be summarized by selecting a number of representative images; then arranging and sizing them according to the perceptual

relationships and popularity within the feedback image selection. This is automated by a 4-stage algorithm:

1. Define an *n* dimensional similarity space (*S-space*) to describe likeness between the *n* images in the image set.

2. Cluster the feedback image selection in *S-space* to condense the feedback down to representative images.

3. Reduce the dimensionality of the *S-space* into a lower dimension space (3D) using multidimensional scaling (MDS) [5].

4. Project the 3D MDS space, describing the representative images, onto a 2D non-overlapping visual summary space.
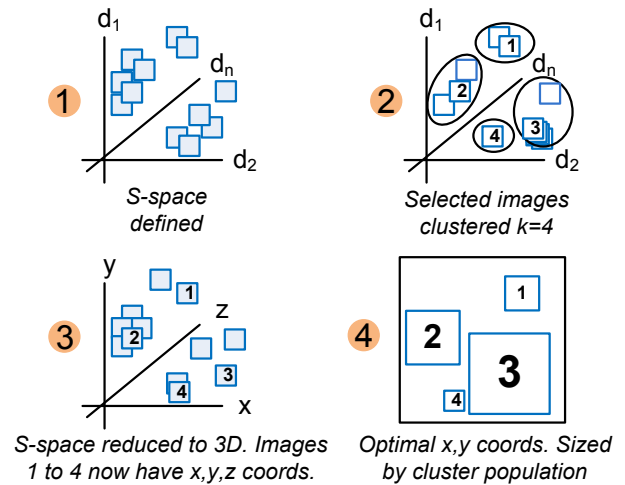

Figure 4 – The steps of the summarization algorithm.

For our evaluation experiment, the algorithm was applied as follows. 10 was chosen as *k*, the number of representative images; large enough to describe a spectrum within a selection but small enough to keep the summaries concise allowing display on an iPad. (Figure 4, illustrating the stages diagrammatically, uses *k*=4 for simplicity). The *S-space* was defined by the perceptual similarity data gathered to build the SOM browser interface. The clustering was done by applying *k*-means clustering [12] dividing each feedback image selection into 10 clusters. The image chosen to represent each cluster was the image closest to that cluster's centroid. In this way the summarization algorithm takes account of popular choices as a cluster's centroid is drawn towards those images chosen repeatedly. The size of each image on the summary is proportional to the cluster population. A 3D representation of the *S-space* is calculated using MDS. The summarization algorithm uses the 3D coordinates of the 10 representative images to calculate an optimized plane on which to project the 10 images. Finally the images are rendered, placing them as close as possible to their designated positions while avoiding overlaps; this being done by successively placing the images in order of

popularity and applying a heuristic search of the remaining 2D summary space. Although overlapping images may be more aesthetically pleasing, it might have caused some meaningful or affecting part of an image to be obscured. Anecdotally, we have found that designers find this presentation convincing as it provides them with insight into the structure of the image set. A similar method was used to summarize selections from the emotive image browser. See examples of visual summaries in Figure 1 and Figure 6.

EVALUATION
To find out if designers would value the new visual feedback formats, we evaluated the method with a group of 12 interior design students (*designer participants*). This was done using a qualitative methodology involving semi-structured interviews and a grounded theory approach using open coding [30, 4]. Although the focus was on the views of the designers, a different 32 participants provided the feedback for the designs and we took the opportunity to ask those *feedback participants* about their preferences. All the participants (the designer participants and feedback participants) were students enrolled on a contextual studies course and received course credit for participating.

The stages of the evaluation are set out in the same sequence as the steps of the feedback method outlined previously in Figure 2.

Step 1- designer presents design
Each designer provided an image depicting one of their designs. The design domain was *interior design* and they were a diverse selection at various stages of development; they included an abstract concept design and a photo of a mobile paper sculpture fully executed. Figure 5 shows D8's prototype design for a store interior.
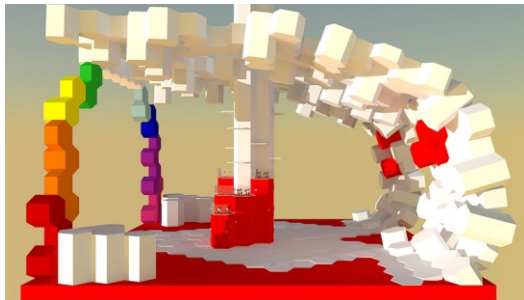

Figure 5 - A prototype for a store interior. (By permission D8).

Steps 2 and 3-feedback participants respond to design
Using a web application, the feedback participants representing the crowd each viewed a random selection of 6 designs. For each design, each feedback participant 1) viewed the design 2) was shown the question, "How did the design make you feel?" and 3) gave their response to the question in three formats: by selecting three images from the *abstract* browser, selecting three images from the

emotive browser, and entering text. The order in which the three response formats were presented was randomized for each feedback participant. Each image response consisted of three images in case participants felt a combination of emotions. After completing the task, the feedback participants were asked in a questionnaire to rank the feedback formats in order of preference.

Step 4 – Collation of feedback responses
The responses of the 32 feedback participants were recorded in a database. Each had viewed half of the 12 available designs, thus the feedback responses of about 16 feedback participants were aggregated for each design. The feedback for each design, in the three different formats, was collated by running queries on the database.
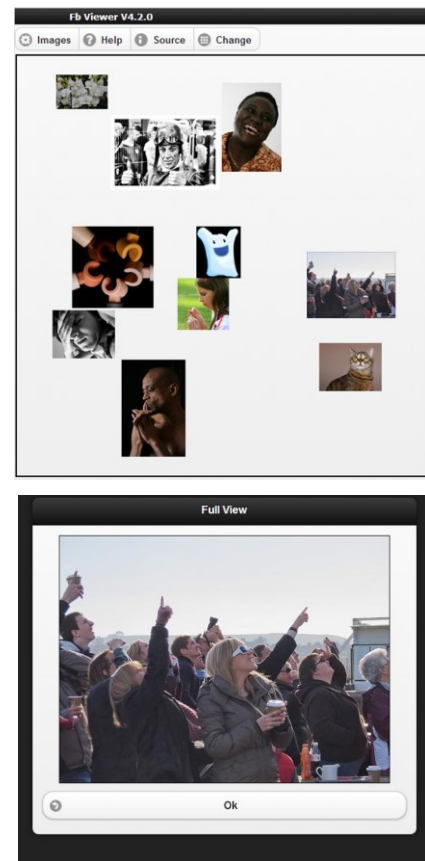
Figure 6 –Top: The visual summary of the emotive image responses to D8's design. Bottom: A component image viewed during interaction with the summary.

Step 5- Summary generation
The image responses to each design were summarized according to the algorithm described previously, producing two visual summaries to accompany each design, one of abstract and one of emotive images (Figure 6). Defining *S-space* and dimensionality reduction could be carried out beforehand as these involved calculations on the whole of each image set independent of any participant responses. The clustering was done after collection of feedback

participant's image responses. (These stages of the summarization were implemented in MATLAB). The rendering of the visual summaries, was carried out by the web application used to display the summaries (implemented in JavaScript and PHP). The text responses for each design were simply collated as randomly ordered lists.

Step 6 – Designer views the feedback
In the interviews each of the 12 designer participants was shown the three forms of response gathered from the feedback participants who viewed that designer's design. A web application was used to facilitate the presentation of the response formats. The designer participants viewed them on an iPad and were encouraged to interact with them. They are interactive in that each of the component images can be viewed at full size by tapping it or clicking with a mouse. The lists of text comments were scrollable. The interviews lasted approximately 45 minutes. Each started with a 15 minute warm-up consisting of a walk-through of the two image sets, how they were constructed and how selections from them can be summarized. The designers were asked to talk about how they used images in the design process and about their designs so as to establish the development stages of the designs. During the rest of the interview the three forms of feedback were revealed to the designer in a random order, with the designer interacting with the feedback on an iPad (Figure 6) while the same feedback and their design were displayed on a monitor for discussion (Figure 7). Prepared questions probed aspects including the interpretation of component images on the summaries and their opinion of the effectiveness of a given format at communicating emotions. Additional questions followed up points raised by the designers. Audio recordings were made and transcribed.

RESULTS
This section details the main themes and evidence for them arising out of the interviews with the *designer participants*. However, first we briefly report the preferences of the *feedback participants* for the different response formats:

Feedback participant preferences
The feedback participants were asked to rank the feedback formats in order of preference in a brief post-task questionnaire. 31 of the 32 feedback participants responded (See Table 1). The highest ranked format was abstract images (average ranking 1.81); i.e. responding with images from the abstract image browser was the format ranked highest for preference overall by those giving the feedback. Thus, quantitatively, it can be seen from Table 1 that 20 out of 31 chose one of the image formats as their first preference (15 for abstract images and 5 for emotive).

Theme 1 Inspiration to make changes
An example of a designer participant being immediately inspired to make a specific change to her design is shown

here, after viewing her abstract image feedback summary: "*I was looking at [it] and thinking that was earthy and very cold, it is not the environment I really wanted. So yes, it is making me think, definite change of textures, if that is how they see it as cold and mechanical. I didn't think that would be the reaction you would get but that is good though. Good feedback*" [D11]. Sometimes a less specific change was motivated. Here, after viewing emotive image feedback: "*I'd make it a nicer visual. I'd make… I'd refine it a bit more. I'd put more detail into it. I think. 'Cause it [her design image] is a bit boring.*" [D6].

Rank / Format	1	2	3	No. of Responses	Average ranking
Abstract	15	7	9	31	1.81
Text	11	10	10	31	1.97
Emotive	5	14	12	31	2.23
Total	31	31	31		

Table 1 - Feedback participants' preference rankings of the formats. Abstract and Emotive were image formats. The average ranking for each format is calculated by giving each number of responses a weight equivalent to its rank, adding them and dividing by the number of responses. Note: with rankings a lower value means a higher ranking.

Designers found motivation in the visual feedback for design changes. The abstract image feedback was being read for color and texture ideas while the emotion, *boredom*, was being read from the emotive image feedback prompting change. Here the emotion being read was negative and this is discussed in another theme below, "*Negative feedback*".

Figure 7- Interview setting.

A quantitative analysis of inspiration by format perhaps indicates the potential of the image formats: 11 of the 12 participants were asked about motivated changes after the first feedback was revealed. (Other themes were pursued in the remaining interview). The order was randomized, 3 saw text first, 4 abstract images, and 4 emotive images. 5/11 described some form of change motivated by the first feedback: text 0/3; abstract 2/4; emotive 3/4. Thus, in our study, where it was possible to isolate inspiration to a single format, none were inspired by text while 5 participants drew some inspiration from images after viewing their first feedback.

Theme 2 Interpreting the Feedback
While viewing and exploring a visual feedback summary, designer participants would develop their interpretation of the feedback. Here while viewing emotive image feedback on her design for a bar interior and successively expanding the individual component images: "*Mmm. I think they are talking about the mood in this one. How, like, people here, socializing; they are happy. Something crazy going on here [little laugh]. And, [I] don't really understand this one here. Like you can just sit down by yourself and get lost in your thoughts..*"[D5].

A similar process seemed to occur with ambiguity in the text feedback with the designers assigning a message or messages to comments and groups of similar comments e.g.: "*[quoting from her text feedback]"planning and organizing, sense of group". Yeah, 'cause it's sort of the way that the chairs are laid out and stuff.*"[D12].

The designers were aware of the issue of ambiguity but when encountering it they proceeded to assign a message to an image or group of images on a summary (or indeed even to text which was ambiguous).

Here D8 saw an advantage in the ambiguity of image feedback offering an escape from the harshness of text: "*People's opinions are always put across by text and whether that's a good thing or a bad thing I don't know because it gets your point across in a very direct manner?...Whereas maybe from these images especially the emotive ones, you can take out of it what you want a bit more? So maybe if you are a bit sensitive about your design you could take out the good things*"[D8].

Theme 3 Abstract image summaries as mood boards
The abstract image summaries were likened to mood boards. While talking about her abstract feedback summary:"*...Just sort of represents what is actually there [in her design]...because it is outdoor there is a lot of green and a lot of wood...Yes the look is similar to what my mood board would look like before it.*" [D12]. She continued on this theme later when suggesting that she would use the abstract image feedback as a presentational tool for describing the design to others including those who commissioned the design: "*...to show like it was a presentation and you were then saying, "Well, I've actually surveyed all these people and this is what they thought of it", and then to show that [indicating the abstract summary].*" [D12]. Here two uses of the abstract image feedback are indicated. Firstly it could act as a form of reverse-engineered mood board confirming that the designer's originally planned "mood" for the design was being communicated as intended. We saw this operating in the negative when D11 (quoted in Theme 1) was motivated to make a change because she was responding to her mood-board-style reading of her abstract feedback. Secondly, the abstract feedback can be used to demonstrate perceptions of the design when presenting it to a client.

Theme 4 Negative feedback
This theme merited division into sub-themes:

Theme 4.1- Abstract imagery not seen as negative
Negative feedback was a topic arising in discussion from participants while viewing text feedback and emotive image feedback. However it was not mentioned by any participant while viewing the abstract image feedback. Combining this with the observation that changes could be motivated by the abstract feedback (see Theme 1) suggests that the abstract feedback can be inspirational without being perceived as threatening or negative.

Theme 4.2 - A tendency to focus on negative feedback
There was a tendency for participants to focus on negative feedback e.g. they would skip positive text comments and alight on the negative. This was acknowledged in discussion by one participant who had skipped to a specific negative comment: "*Just 'cause the first two sounded quite positive. [laughs]… I was enjoying reading it up to there [laughs].*" [D7]. Another participant when it was pointed out that the text list contained more positive comments than negative: "*You just can't help but read the bad stuff*". [D6].

Negative feedback was also perceived in emotive image feedback. Participant D3's emotive image feedback summary contained only one negative image out of ten. (The image showed a man covering his eyes with his hand). The size of the images on the summaries varied with the population of the feedback cluster they represented, but the single negative image that D3 chose to dwell on only represented just 20% of the total area covered by all ten images on the summary. D3's words are quoted in Theme 4.3 below as they also apply to that theme.

We interpret this focus on negative feedback as the designers valuing the negative feedback over the positive however unpalatable it might be for them.

Theme 4.3 - The impact of negative text compared to negative emotive images.
One participant felt that negative feedback received via the emotive images was more impactful than text. Here she is referring to the single negative image in the summary: "*I think the emotive images are quite hard to look at because it is peoples' emotions towards your, design. And if an image is that big, it does kind of pull you back and like, "Why?".*" And then, "*When you look at the images, they'll be stuck to you. Whereas the writing, it doesn't really stick much to you. You just read it and you're like "Ok." But the images, you're like "Wow!" It's almost like you can see that person's emotion when they are picking this image.*" [D3]. For another participant negative feedback via text was more impactful than the emotive image feedback: "*Looking at that [the emotive image summary], I'd say I'm more relaxed looking at the images than the text… this girl's bored and that guy's confused [pointing to component images in the emotive summary]. It's just less*

threatening than the text.... So the images are a good idea in that way." [D6].

This difference over which format, emotive images or text was harsher for delivering negative feedback could be affected by individual participants' different cognitive styles. Alternatively it could be due to differences in the specific designs involved and their reception by the feedback crowd. Irrespective of this disagreement between the designers on whether negative feedback had more impact as text or as emotive images this does demonstrate that the designers were able to read negative feedback via the emotive image format. Thus, because they showed a keen interest in negative feedback, this indicates that the emotive image feedback would be of value to them.

Theme 5 Effectiveness at communicating emotions
When asked how well the text feedback answered the question "How did the design make you feel?", here D6 points out that the text comments had actually strayed into a critique rather than talking about feelings: *"No-one's really said how they feel really. Well, [quoting from the text feedback] "I felt uninspired" There's one. But that's it... Yeah. I think the emotive images work better than the text…'Cause it's fair enough if they were critiquing it, but they're not. They're meant to be saying how they feel and no-one's really [done that]."* [D6]. Another participant: *"What they said in the text isn't exactly feelings"* [D8]. Those designers clearly think that the emotive images have allowed those giving the feedback to focus on communicating their emotions more effectively than when using text. Another participant on the effectiveness of images for emotion: *"I like that [emotive image summary]. [be]cause it shows emotion as well, yes, mostly like emotions that people would feel…It's a good way of getting their understanding."* [D2].

Theme 6 A service offering the visual feedback
After discussing the feedback formats participants were asked if they would use an Internet service which allowed them to upload a design and receive feedback in the *visual* formats. Ten of the designers answered emphatically in the positive, one was neutral and one (D12) initially wished for text feedback but moved on to develop the idea of using the abstract feedback as a presentation tool. One participant was particularly effusive: *"I'd love that! I'd absolutely love that yeah!"* [D8]. From this it is clear that the designer participants valued the visual feedback formats and wanted more.

DISCUSSION
Before discussing the results we first point out that the nature of the sample for our evaluation means that we should be cautious about generalizing from our findings. The feedback participants may not be representative of the general population; as students in a contextual studies course it is possible they could hold some non-typical attitudes about design communication and imagery. Equally, the designer participant group might not be considered representative of all designers as they were student interior designers. However, the participants' experience of this new form of visual communication has provided a window into the likely appeal of the visual feedback formats.

Responding with images
The rankings of the response formats by the feedback participants (Table 1), giving the highest ranking to abstract images as a response format, show that for some people, perceptually organized image banks would be valued as a way of giving feedback ahead of text. The fact that some participants preferred text and some preferred images as a response format is not a surprise as this fits with the prediction of cognitive styles theory that some of the participants are likely to be more visual than verbal and vice-versa.

The two types of imagery
With designers finding the abstract imagery non-threatening yet still inspiring, and many feedback participants preferring that format, the abstract image set is the image format embraced by the participants in the study. However, the emotive imagery seemed to help the feedback participants focus on communicating their emotions rather than giving a conventional critique with text and both types of image provoked reflection in designers albeit in different ways. Cognitive factors of emotions affecting intuitive decision making [33] and being easily read in images [15] may have come into play in affecting participants' comparative impressions of the two image sets.

Scalability
The summarization algorithm allows the image selections by crowds of unlimited size to be encapsulated in a small number of representative images. Both of the two image sets are able to be augmented by adding further images or refreshed by replacing old images with new ones along with accompanying perceptual data.

Possibilities for a new service
The finding in Theme 6 that, overwhelmingly, the designer participants wished to use an internet service offering these visual formats, shows an appetite among designers for them. Figure 2 shows the possibilities for successive co-design cycles allowing presentation of a prototype, then feedback, then design changes, further feedback and so on. Indeed the designer participants were unanimous that the best use of such a service would be in developing and refining a prototype design via crowd feedback. Social networks can be a useful source of feedback on ideas [8] and could be a good conduit through which designers could use the new mode to leverage participation in feedback. In particular, photo sharing social media are likely to be frequented by users already open to responding visually.

Offering images as a response format could become popular among such users with a visual cognitive style and committed users might enjoy being involved in the development and expansion of the imagery. Visual co-design cycles may, as a design develops, accrue additional benefits. These could include the building of a following for a designer through segmentation of the visual feedback crowd. When this scenario was put to one designer participant she responded: "*That's a million dollar idea! You should get an app!*"[D1]. Another benefit could flow from adding value to any resulting product by compiling records of the co-design cycles into an attractive, visual, development narrative to be attached to the product. Such added value not only has economic benefits but because it is effectively resource-free compared to say, a garment, there is an environmental sustainability benefit when people buy fewer products on which they place higher value [29].

Applicable domains

Although originally motivated by fashion designers and evaluated with interior designs, we believe this method of feedback would work well for any aesthetic design particularly where first impressions are important; e.g. product and graphic design in automotive, food, travel and other sectors. Feedback using images need not be restricted to design conversation or co-design activities. The emotive image format might enliven or further increase the accessibility of the comments page of any web video clip for example. Another benefit of using banks of images as the medium for an online conversation would be in avoiding the cost of comment moderation. Web sites where online discussion takes place have to deal with unsuitable posts. Some automated filtering can be done but manual intervention by moderators is often required [7]. Many systems rely on users reporting abusive posts, in effect crowdsourcing the task. However, before a report is received damage will already have been done. In this new visual feedback method the feedback is drawn from given image sets, thus, the problem of unsuitable posts is avoided.

Cultural and emotional aspects of imagery

While some aspects of emotional imagery are considered universal and thus bridging cultures, such as some facial expressions [25, 10], other aspects of imagery, such as color, can vary between cultures in their emotional associations [20]. While images provide for non-verbal communication which should be language independent and thus have an advantage over text, intercultural differences may need to be taken into account. An investigation of cultural differences in the interpretation of the image banks built for the evaluation would help improve the formulation of further image banks.

CONCLUSION

In this paper we set out a novel method of enabling visual communication between crowds and designers. The crowd comments intuitively with images on an idea and these responses are summarized in succinct, visual, reports. We described an implementation of the method involving intuitive image browsers and image summarization, based on perceptual data. Two types of imagery, abstract and emotional were used. This was evaluated in a qualitative study with interior designers. These designer participants received feedback about the emotional impact of their designs and were able to contrast the visual feedback formats with text feedback. They voiced views indicating, for example, that the abstract image feedback provided an instant impression of the perceived mood in their design and that the emotive imagery had helped those giving the feedback to focus on emotions rather than straying into conventional critiques encouraged by text. While aware of ambiguity being inherent in images, the designer participants freely interpreted the image feedback. They found motivation for change in the images while finding none in text. They were interested in the text, particularly in negative text feedback, but not inspired by it in the same way as with images. For those giving the feedback, a quantitative analysis of their preferences showed that, for some, responding with images was preferable to text (in the case of our feedback participant group the majority preferred the visual formats). While a small minority of the designer participants wished for the visual feedback to be accompanied by text, all but one desired to use an internet service that offered the visual feedback. We discussed the possibilities for this visual feedback method beyond simply being a communication medium more engaging for people with a visual cognitive style. These possibilities include use as a means of connecting designers to a following; as a tool for co-design; and adding value through narrative creation.

REFERENCES

1. Clarke, A.D., Halley, F., Newell, A.J., Griffin, L.D. and Chantler, M.J. Perceptual similarity: a texture challenge. In *Proc BMVC*, (2011).

2. Coffield, F., Moseley, D., Hall, E. and Ecclestone, K. *Should we be using learning styles?: what research has to say to practice*. Learning & Skills Research Centre. (2004).

3. Cook, E., Teasley, S.D., and Ackerman, M.S. Contribution, commercialization & audience: *understanding* participation in an online creative community. In *Proc Group2009*, ACM (2009), 41-50.

4. Corbin, J. and Strauss, A. *Basics of qualitative research: Techniques and procedures for developing grounded theory*. Sage. (2008).

5. Cox, T.F. and Cox, M.A.A. *Multidimensional Scaling (Second Edition ed.)*. Chapman & Hall/CRC. (2001).

6. CrowdFlower, http://www.crowdflower.com (last accessed Sept.20th 2014)

7. Delort, J.Y., Arunasalam, B. and Paris, C. Automatic Moderation of Online Discussion Sites. *IJEC*, 15(3), (2011), 9-30.

8. Dow, S., Gerber, E., and Wong, A. A pilot study of using crowds in the classroom. In *Proc CHI2013*, ACM (2013), 227-236.

9. Egorova, M., Safonov, I. and Korobkov, N. Collage for Cover of PhotoBook. In *GraphiCon*, (2008), 160-163.

10. Ekman, P. Expression and the nature of emotion. Approaches *to emotion.* Lawrence Erlbaum Associates (1984), 319-344.

11. Evans, J. St B. T. Two minds rationality. *Thinking & Reasoning*, 20(2), Routledge (2013), 129-146.

12. Everitt B. *Cluster Analysis*. Heinemann. (1974).

13. Fan, J., Gao, Y., Luo, H., Keim, D.A. and Li, Z. A novel approach to enable semantic and visual image summarization for exploratory image search. In *Proc MIR2008,* ACM (2008), 358-365.

14. Garner, S. and McDonagh-Philp, D. Problem interpretation and resolution via visual stimuli: the use of 'mood boards' in design education. *J Art Design Educ*, 20(1), Blackwell (2001), 57-64.

15. Junghöfer, M., Bradley, M.M., Elbert, T.R. and Lang, P.J. Fleeting images: A new look at early emotion discrimination. *Psychophysiology*, 38(2), Cambridge Univ Press (2001), 175-178.

16. Kozhevnikov, M. Cognitive styles in the context of modern psychology: Toward an integrated framework of cognitive style. *Psychol Bull*, 133(3), APA (2007), 464-481.

17. Lee, J., Park, D.H. and Han, I. The effect of negative online consumer reviews on product attitude: An information processing view. *Electron Com R A*, 7(3), Elsevier (2008), 341-352.

18. Lerner, J.S., Small, D.A. and Loewenstein, G. Research Report Heart Strings and Purse Strings Carryover Effects of Emotions on Economic Decisions. *Psychological Science*, 15(5), APS (2004), 337-341.

19. Luther, K., Pavel, A., Wu, W., Tolentino, J.-l., Agrawala, M., Hartmann, B., Dow, S.P. CrowdCrit: crowdsourcing and aggregating visual design critique. In *Proc CSCW2014*, ACM (2014), 21-24.

20. McCandless, D. *Information is beautiful*, Collins. (2009).

21. Mikels, J.A., Fredrickson, B.L., Larkin, G.R., Lindberg, C.M., Maglio, S.J. and Reuter-Lorenz, P.A. Emotional category data on images from the International Affective Picture System. *Behav Res Methods*, 37(4), Springer (2005), 626-630.

22. Nagamachi M. Kansei engineering: a new ergonomic consumer-oriented technology for product development, *Int J.Industrial Ergonomics* 15(1) (1995), 3-11.

23. Oppenheim A.N. *Questionnaire Design and Attitude Measurement*, Heinemann, (1966).

24. Padilla, S., Halley, F., Robb, D. and Chantler, M.J. Intuitive Large Image Database Browsing using Perceptual Similarity Enriched by Crowds. In *Proc CAIP2013*, Springer (2013).

25. Plutchik, R. *Emotions and life : perspectives from psychology, biology, and evolution (1st ed.),* APA. (2003).

26. Riding, R.J. On the nature of cognitive style. *Educational Psychology*, 17(1-2), Routledge (1997), 29-49.

27. Riding, R.J. and Cheema, I. Cognitive Styles - an overview and integration. *Educational Psychology*, 11(3-4), Routledge (1991), 193-215.

28. Rother, C., Bordeaux, L., Hamadi, Y. and Blake, A. AutoCollage. *ACM Trans. Graph*., 25(3), (2006), 847-852.

29. Sanders, L. and Simons, G. A Social Vision for Value Co-creation in Design. (Value Co-Creation) *Open Source Business Resource*, (2009).

30. Strauss, A.L. *Qualitative analysis for social scientist,* Cambridge University Press. (1987).

31. Surowiecki, J. *The wisdom of crowds: why the many are smarter than the few and how collective wisdom shapes business, Economies, Societies and Nations*. Anchor. (2004).

32. Talwar, A., Jurca, R. and Faltings, B. Understanding user behavior in online feedback reporting. In *Proc EC2007,* ACM (2007), 132-142.

33. Tiedens, L.Z. and Linton, S. Judgment under emotional certainty and uncertainty: the effects of specific emotions on information processing. *J Pers Soc Psychol*, 81(6), APA (2001), 973.

34. Tsytsarau M. and Palpanas T. Survey on mining subjective data on the web. *Data Min Knowl Discov* 24(3), ACM (2012), 478-514.

35. Vesanto, J., Himberg, J., Alhoniemi, E. and Parhankangas, J. Self-organizing map in Matlab: the som toolbox. In *Proc. Matlab DSP Conf*, (1999), 35–40.

36. Xu, A., and Bailey, B. What do you think?: a case study of benefit, expectation, and interaction in a large online critique community. In *Proc CSCW2012*, ACM (2012), 295-304.

37. Xu, A., Huang, S.-W. and Bailey, B.P. Voyant: Generating Structured Feedback on Visual Designs Using a Crowd of Non-Experts. In *Proc CSCW2014,* ACM (2014), 37-40.