# Measurement of Design Impact

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## Summary

Awareness of the science of the appearance can help the designer create and construct a more effective space – whether that consists of packaging, interiors, cityscapes or a plate of food. This paper examines the current status of appearance science having direct application to the work of the practical designer using a vocabulary common to both disciplines. The way has been paved by the work of Shigenobu Kobayashi (a designer) and Paul Green-Armytage (a design teacher) and studies on food products and food consumption environments. The paper consists of, first, a brief account of the application of bipolar scales to quantify both the physical properties of the scene as well as our expectations of the scene and, second, the quantification and understanding of scene impact. These techniques detail how individual elements of a designed space, such as materials, design and illumination, contribute to specific desired aspects of the space.

## Introduction

The designer has always relied on the scientist and technologist to supply new and improved materials for use in exterior and interior environments. The scientist can now help the designer by offering a new science for quantification of the appearance of a design. This can aid the designer in the production of a more acceptable product or a more effective space. Appearance science of materials involves consideration of the optical properties of each phenomenon of appearance, such as translucency, gloss, surface texture and colour, and appearance science of the design. Much of this research is of most assistance to the materials scientist rather than the designer and will not be considered further here. This paper examines the current status of that aspect of appearance science having direct application to the work of the practical designer using a vocabulary common to both designer and scientist.

To a large extent, appearance images of whatever environment we happen to be viewing control our expectations of that environment and the actions we subsequently undertake. The designer seeks to control these expectations through manipulation of, for example, the building, interior décor, packaging or store layout design. Expectations arise as a result of our interpretation of the perceived product or scene. This applies to all scenes, most of our understanding of the scene arising from our visually perceived properties of the scene. A number of aspects of the scene may contribute to the perception of expectations and impact, as indicated in Figure 1.

Colour: Design & Creativity

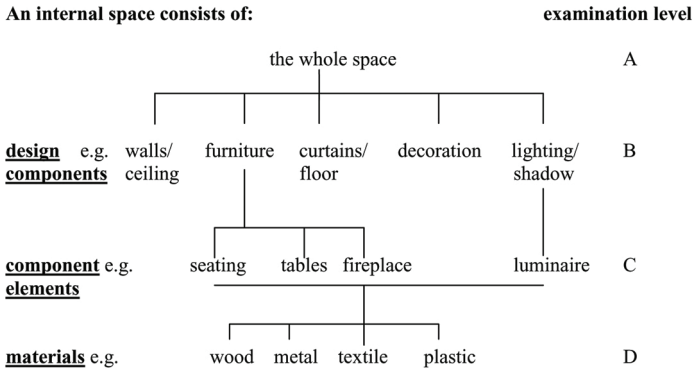


**Figure 1** Structure of an internal scene and the image decision levels

Expectation decisions of an interior taken by a consumer can be made at any one of the levels A to D indicated in the figure, and for any consideration of the effectiveness of a space these must be taken into account. Understanding expectations and impact depends upon the ability to closely specify the environment. It has been suggested that the total appearance philosophy, originally developed for the description and appearance analysis of foods [1], could be extended to a number of other designed environments such as advertisements, architectural spaces, and the performing and fine arts [2]. The present availability of better methods of environment specification makes it possible to more closely define and understand our surroundings.

A successful designer–scientist dialogue will assist in the optimisation of consumer expectation-perceptions of a space, as well as improving communication between designer and materials scientist. Three languages can be used in the description of a space: physics, psychophysics and expectations. They are linked in that physics can be used to understand and define the psychophysics of a space that involves the use of words of visual criticism (for example, words of colour or gloss). The vocabulary of visual criticism is used to define and understand expectations we have of the space. Of paramount importance to the methodology of design specification is the use of a language familiar to both designer and scientist. Hence, the remainder of the paper will employ only psychophysical and expectations vocabulary.

This paper is confined to a review of methodologies suitable for the quantification of the visually perceived total appearance properties of the designed environment and includes examples drawn from interiors, packaging and the townscape. It is in two parts, the appearance properties of the design and the impact of the design.

## Appearance Properties of the Design

In this paper the term ‘appearance’ is restricted to the visually perceived properties of materials, for example, materials from which a piece of furniture is made. Appearance consists of:

– visual structure, including size and shape;
– surface texture, e.g. roughness;
– colours and colour pattern;
– gloss and gloss pattern; and
– translucency and translucency pattern.

For some perishable materials, such as foods, also included are temporal properties, i.e. how these appearance properties change with time. Appearance properties are essential to the understanding of the performance of materials and the development of new materials for use by the designer. These physical and psychophysical properties are under active consideration by the CIE (the International Commission on Illumination) [3].

The term 'total appearance' is used to describe the impact and expectations generated by the arrangement of materials in view, for example, the design of an item of packaging, or the placing of furniture and distribution of illumination in an interior. Also, included is input from our other distance senses, for example, the smell of the bakery but this paper is confined to visually perceived attributes.

The approach is characterised by the use of bipolar scales to quantify both the physical properties of the scene as well as our expectations of the scene. In this way, those elements of a designed space contributing to specific desired aspects of the space can be identified.

The physical attributes of an interior design directly contribute to our expectations of the space. The designer designs a space so that its function and communication of its message are maximised within the aim of making the world a more beautiful place. If spaces can be analysed it will become possible to identify those specific design elements critical to the achievement of optimal customer expectations. When a scene is viewed there may be a specific visual impact, such as an impression of a strident use of colour. Alternatively the impact may be of a specific expectation, such as 'cleanness' and 'elegance', relevant to our impending involvement with the scene. For any object, scene or space there are five types of expectation, all of which are visually assessed:

– 'safety' – how safe am I in this space or using this product?
– 'identification' – what is this, what specific properties does this object, person or scene have?
– 'usefulness' – how useful will this object or scene be to me?
– 'pleasantness' – how pleasant will be my involvement with this space or object?
– 'satisfaction' – when I have finished my involvement with this scene how satisfied shall I be?

For each type of person, space or scene, there will be specific identification expectations. For example, food on a plate will possess visually assessed flavours and textures. For eating and drinking interiors, the customer view of the space will consist of identification expectations of 'cleanness', 'comfort', 'privacy', 'elegance' and 'quality' [4]. All such images as well as impact images can be scaled using conventional bipolar scales.

All images are generated from our perceptions of the physical properties of the design. That is, through our perceptions of the design elements of the scene, of the materials from which the scene is constructed, through the appearance properties of the materials and construction of the scene and through the scene illumination. These elements combine to create the scene we perceive when we walk through the door. The physical properties of the design can be described in terms that incorporate pragmatic bipolar scales such as:

– size ('small' to 'large')
– ceiling height ('low' to 'high')
– 'enclosed' to 'in open air'
– 'silent' to 'noisy'
– 'dark' to 'light'

 

– illumination ('uneven' to 'even')
– colourfulness ('low' to 'high')
– colours ('soft' to 'hard')
– colours ('warm' to 'cool')
– texture variation ('low' to 'high')
– plants ('low' to 'high usage')
– plants ('artificial' to 'real')
– 'plain' to 'decorated'
– decoration ('aged' to 'new')
– tabletop ('rudimentary' to 'sophisticated')
– 'clean' to 'dirty'.

Relationships between the two sets of scales, i.e. the physical and the expectation properties, can then be determined so that the generation of specific expectation images can be optimised in the design. Note that the two sets of scales have no correspondence. For example, increase in the visually appreciated 'elegance' of an interior dining area can be achieved by increasing the perceptions of 'texture variation' and increasing 'cleanness' (very high significance 0.1%), by increasing decor 'colourfulness', amount and newness of the 'decoration', 'tabletop sophistication' and increasing the expectation of 'silence' (all high significance 1%), and decreasing 'illumination level', increasing 'unevenness of illumination' and increasing 'softness of colours' (all significant 5%).

This is a powerful tool for the designer. However, it may not include a measure or complete description of the initial impact of the space (or package or human being or building façade).

## Impact Description

The initial impact of a space may be an expectation, for example the cleanness of a dining space. Alternatively, the impact perception may be caused by any element of the design physics, for example, the furniture, decoration or lighting. The methodology for the categorisation of the integrated impact of the space is built upon the work of Shigenobu Kobayashi (a designer) [5] and Paul Green-Armytage (a design teacher) [6] and studies on food products and food consumption environments.

Colour is a major constituent of images generated and may be present in a design as a colour theme, contrast, balance and harmony. There are two useful approaches to describing and specifying colour impact. Green-Armytage [6] has designed a useful tool that describes colour themes and impact in terms of standard terminology. Colours are grouped into regions described as, for example, 'vivid', 'pale' or 'light'. Townscapes have colour impact describable in these terms [7]. The different sets of heritage colours recalling the Spanish past of Old San Juan, Puerto Rico and the specified Art Deco district of Miami, USA are contrasted in Figure 2. Impact contrast colours, to be seen in part of the city of Stockholm, Sweden are indicated in Figure 3.

The second approach to colour description is the colour image scale [5]. Although for millennia, colours have been described as 'hard or soft' or 'warm or cool', artists have not described them in a quantitative way. Kobayashi showed that impact and expectations of colours and colour combinations can indeed be quantifiably expressed in a designer helpful

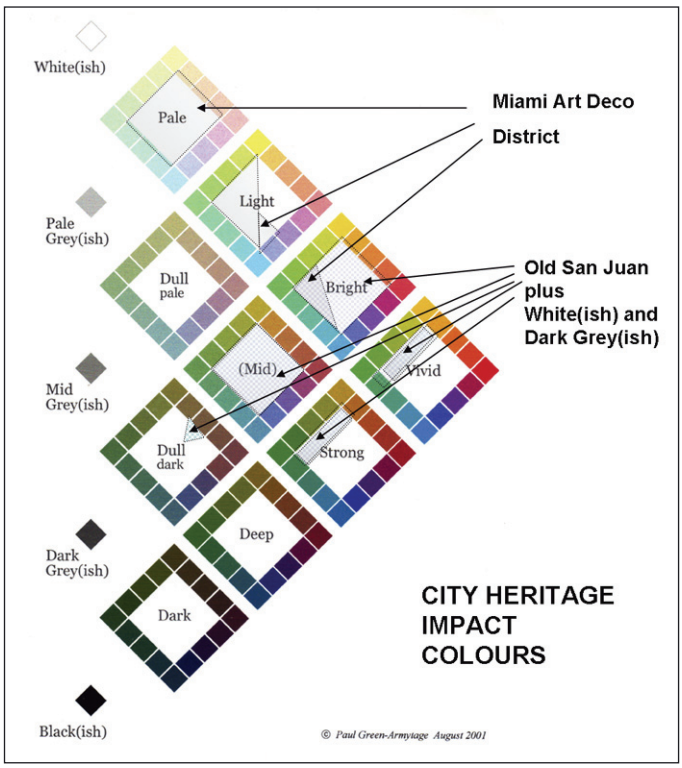


**Figure 2** Different heritage colours specified for areas of San Juan and Miami

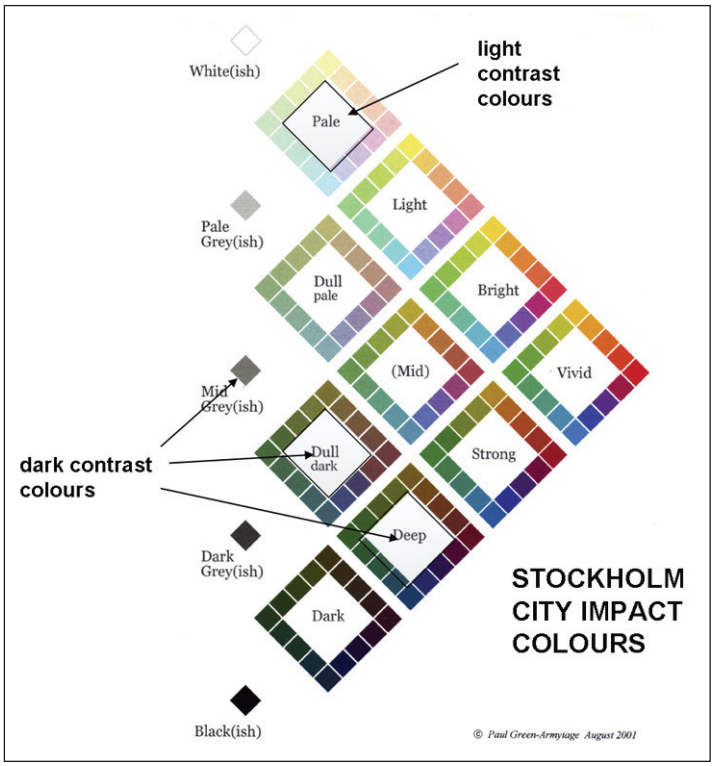


**Figure 3** Contrasting colours to be seen in the city of Stockholm, indicated on Green-Armytage's colour chart [7]

way using a diagram whose axes are 'warm' to 'cool' and 'hard' to 'soft', and 'clear' to 'greyed'. Kobayashi extended his approach from colours to many other aspects of the environment. He described, for example, ceramics, patterns, landscapes, cityscapes, human faces in terms of his two major axes; warm/cool and hard/soft [8]. In this paper, it is proposed that this designer-friendly description can be extended from colours to materials, to lighting and to elements of the design, as well as to the whole Gestalt design itself [9]. It is further proposed that if the components of the design, contributing to the perception of hardness, can be identified then these can be reduced to produce a softer space.

 

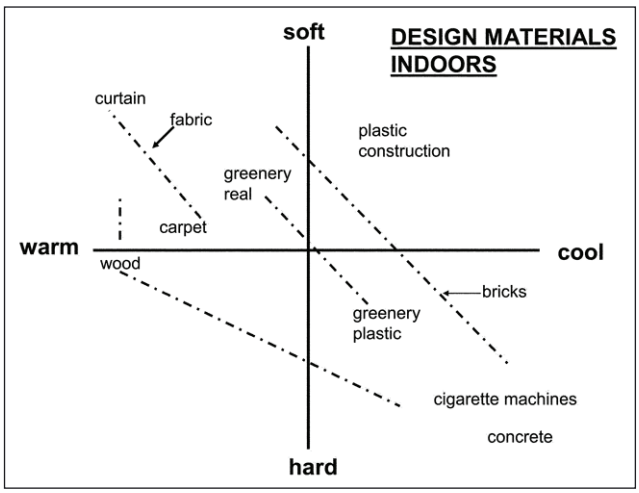


**Figure 4** Interior design materials in terms of warm/cool and hard/soft axes

It is proposed, therefore, that each element of the design (for example, furniture, décor and lighting) can be described in terms of warm/cool and hard/soft. For example, as the size of the space increases the image tends to move towards 'hard' and 'cool', and as the proportion of curves in the design increases the image moves towards 'soft', and as the regularity of the space increases the image moves towards 'hard'. The materials from which the scene is constructed can be described in the same way. Hence, curtain material is 'softer' than rugged carpet, wood is 'softer' that metal, concrete is 'harder' than painted wall plaster, and arm chairs are 'softer' than stackable plastic chairs, while bricks can be of different degrees of perceived 'hardness' governed by the smoothness of the finish (and the colour). Flowers on the restaurant table recognised as being made of plastic are 'harder' and 'cooler' than flowers or greenery recognised as being of natural origin (Figure 4).

Similarly, illumination can be depicted in terms of warm/cool and hard/soft. Increasing colour temperature increases 'coolness', greater intensity has greater 'coolness' and 'hardness', greater uniformity of illumination increases 'coolness' and excessive glare increases 'hardness' (Figure 5). Examples are shown in Figure 6.

It is also suggested that the dynamics of design impact as a whole can also be pictured in terms of the two axes and that all of these elements can be combined together in the construction of a space, as shown in Figure 7. An initial space (1) has been assumed to be neither 'warm' nor 'cool' and neither 'hard' nor 'soft'. To divide the room we include concrete dividers (2), this immediately increases 'hardness' and 'coolness' of the space. Covering the concrete dividers and walls with white plaster and illuminating the space with neutral lighting increases 'softness' and 'warmth' (3). Including wooden furniture (4a) will increase 'warmth', while inclusion of metal furniture (4b) will increase 'hardness'. The addition of 'warm' lighting will make the space 'warmer' (5a) and softer, while using 'cool' lighting will increase 'coolness' (5b). Painting the wooden furniture with a 'warm' colour will increase 'warmth' and 'softness' of the space (6) [9].

The question arises as to the linearity and additivity of such an approach to interior design space. For example, materials and colours used in the scene shown in Figure 8 illustrate contributions from each of the main elements of the scene, i.e. the walls, flooring and furniture/construction features.

It has yet to be shown whether calculation of, say, the weighted arithmetic means of each component result in a true reflection of the initial

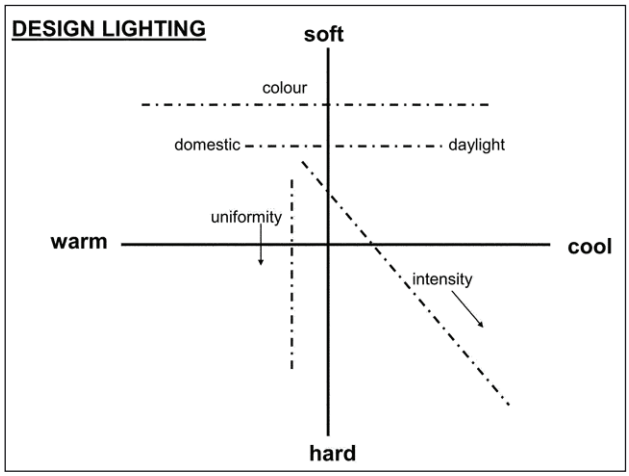


**Figure 5** Elements of illumination in terms of warm/cool and hard/soft dimensions

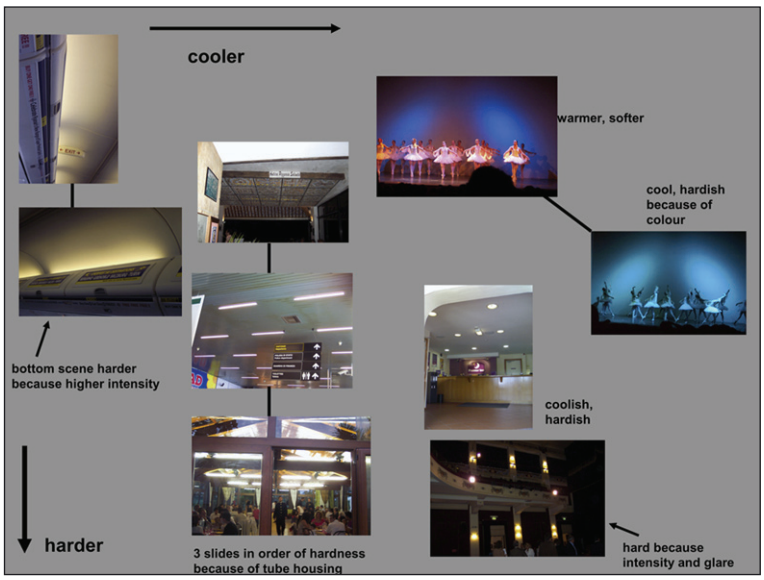


**Figure 6** Examples of scene illumination variables in terms of warm/cool and hard/soft directions

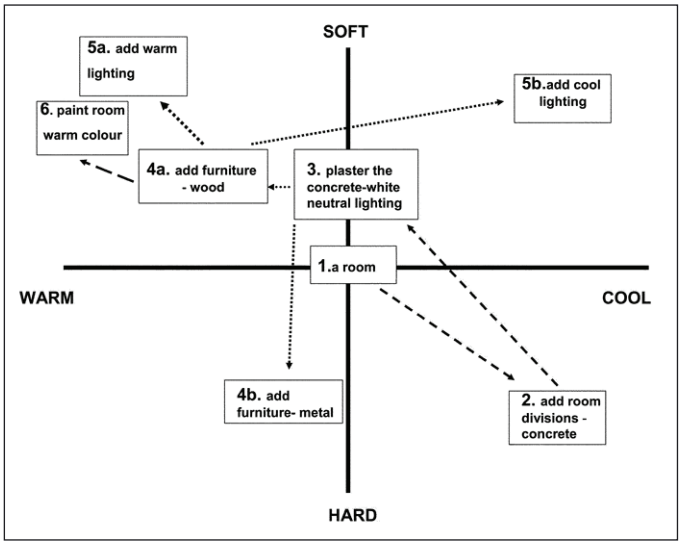


**Figure 7** Dynamics of the design input in terms of warm/cool and hard/soft axes

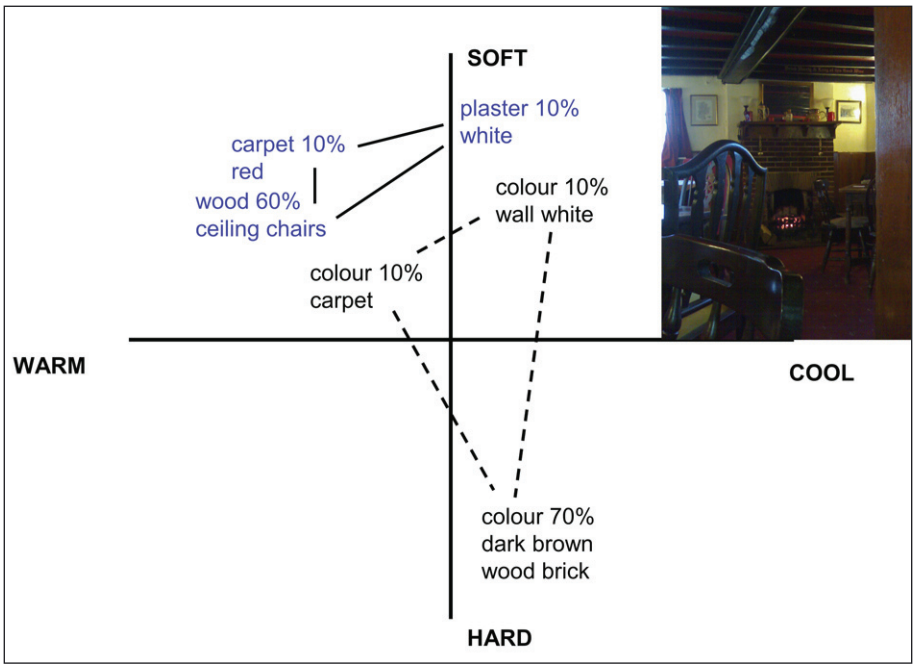


**Figure 8** A postulated design space in terms of warm/cool and hard/soft dimensions

 

impact received by the viewer of the scene. However, it has been shown that colours and colour combinations in psychophysical spaces such as 'warm' to 'cool' and 'hard' to 'soft' behave linearly and additively [10]. Ou *et al.* [11] carried out a study to develop colour science based models to predict the colour emotion results from a panel of observers. These tools can be used to describe colour impact in townscapes, interiors, food, coatings, textiles and packaging.

The immediate impact of any design can be thought of and probably quantified using the total appearance philosophy extensions of the proposals of Kobayashi and Green-Armytage.

## Summary

As outlined in this paper, we have the basis for a thorough understanding of design and impact in terms of appearance properties of the space. A successful designer–scientist dialogue will assist in the optimisation of consumer expectation-perceptions of a space, as well as improving communication between designer and materials scientist. Although perception of a space is perceived as a Gestalt phenomenon, the way such feelings and emotions are created can be understood in terms of the design elements and components.

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