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Methodology of Colour Selection for Steel Girder Bridges

Sélection de la couleur pour des ponts à poutres en acier

Farbauswahl für Stahlträgerbrücken

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SUMMARY
Aesthetics of structure is described in terms of its form and colour. Aiming at establishing rational colour selection procedure for steel bridges, the use of landscape colour-mesh technique and photo colour-simulation technique was investigated. The case studies with girder-type bridges suggested the practicability of these methods.

RESUME
L'esthétique des structures est exprimée en termes de forme et de couleur. Pour établir un procédé rationnel de sélection de la couleur pour des ponts en acier, un réseau de paysages-référence et une simulation photographique des couleurs sont examinés. L'étude du cas du pont en acier a montré la praticabilité de la méthode.

ZUSAMMENFASSUNG
Der ästhetische Eindruck der Konstruktion wird von der Form und der Farbe beeinflusst. Mit Hilfe der Landschaft-Farbmaschentechnik sowie einer farbphotographischen Simulation wurde versucht für Stahlträgerbrücken eine ästhetische Farbwahl zu treffen. Einige Beispiele von Versuchen an Trägerbrücken zeigen die Anwendbarkeit der Methode.

1. INTRODUCTION

Aesthetics of structure is described in terms of its form and colour, and assessed in view of beauty of the structure itself and harmony with the surrounding landscape. In general, steel structures can be artificially coloured by painting. The colour selection of these steel structures has been usually relied on individual taste of engineers and technological aspects of paints.

The present contribution is extracted from the committee report, of which the first author was a chairman and aims at establishing more objective and universal colour planning procedure for steel highway bridges to select the colour harmonizing with surrounding landscape.

2. METHODOLOGY OF COLOUR PLANNING

The colour selection procedure is shown in Fig. 1, in which

1) Zoning: although a highway route passes through different landscapes, the use of different colour for each bridge results in lack of uniformity and increase of maintenance cost. It is then recommended to select a bridge colour for a landscape zone.

2) Policy of colour selection: it is preferable to establish basic image, such as harmony or contrast, for the interaction of structure and landscape according to the site, scale and type of the structure.

3) Landscape colour is recorded by either photographing or direct colour measurement from appropriate points of sight. The change of landscape colour due to seasons, weather and so forth should be taken into account.

4) Selection of assessment technique is concerned with the work just mentioned above. In this study the practicability of the four techniques shown in Fig. 2 was investigated. Although the photo-montage method has many advantages, it is relatively laborious and expensive. The result of the landscape colour-mesh technique is as shown in Fig. 3, which is useful to describe the composition of landscape colours from direct measurement at the site and find objectively the basic colours of the landscape.

5) Selection of several proposed colours will be done by one of the following methods:
(a) personal decision by the experts concerned
(b) use fo psychological assessment techniques in combination with photo-colour-simulation
(c) use of colour matching practice, referring to Table 1 where the public reactions to bridge colour from semantic differential test are reflected to.

6) A bridge colour to be adopted is finally selected from those mentioned above, on the basis of technological aspects of painting and judgments of engineers and colour experts.

3. HUMAN RESPONSE TO BRIDGE COLOUR

In order to investigate the applicability of the foregoing procedures, the case studies were conducted with the following two multi-span plate girder bridges under planning:
1. To-ne River Bridge with a total length of 627 m, which is located in the landscape incluing wide water surface surrounded by flat terrain
2. Kosuge Viaduct located in hilly fields with scattered water surfaces.

The colours selected for the former are listed in Table 2. Image survey due to the semantic differential test was conducted with the colour slide projection of the photo-montage of To-ne River Bridge and the synthetic photograph of Kosuge Viaduct, together with other two girder bridges already constructed in this area according to similar colour planning technique. The number of subjects who are not the experts in this field was 30 combining equal number of males and females, college students and adults, respectively.

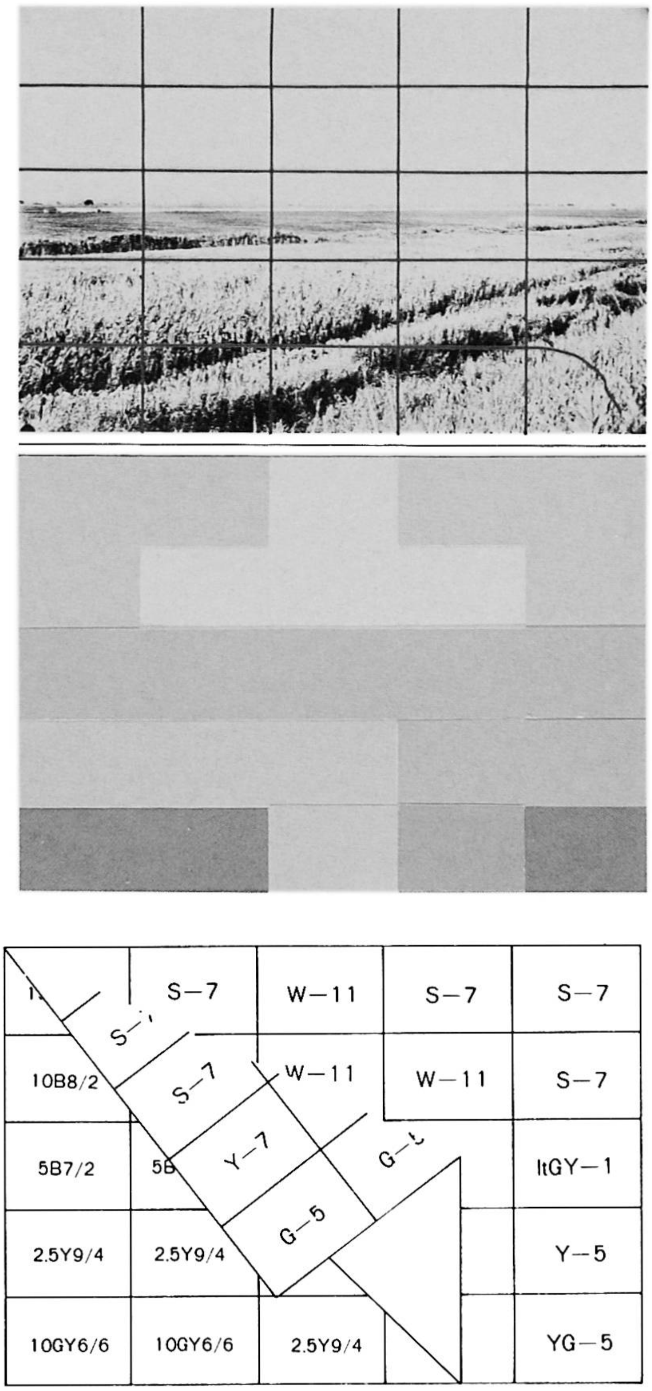

Fig. 3 Example of Colour Mesh Data

The mean rating and the standard deviation of human response to the samples as a whole were calculated from the results of the above test. Further a factorial loading for each adjective scale was obtained as shown in Table 3. The results suggest that the connotative meaning of bridge colours in the present case is primarily measured along the evaluative and activity dimensions. The concept of bridge colours could then be plotted in two-dimensional semantic space as in Fig. 4. Although the present case studies were confined to the girder bridges located in rather flat terrains, which resulted in very small contribution of potency dimensions, location of the colours in semantic space is respectively different in both model bridges.

The investigation was repeated with different kinds of people, that is the group of bridge engineers and colour designers, respectively. The results are as shown in Table 2, where it is noted that the colours given high appraisal were mostly not those selected from the resembling landscape colour-simulation technique. Clean and vivid colours seemed to appear in the landscape colour-mesh technique, while colour processing affects the results from the photo-colour-simulation methods.

Table 1 Colour Matching in Bridge Design

Semantic dimention	Govering scales / Pattern of matching	Same		Resemblance		Contrast	
		hue	tone	hue	tone	hue	tone
Evaluative	Harmonious with ladnscape	o	o				
	Blameless		o				
	Beautiful			o	o		o
Activity	Gay and showy					o	o
	Individual				o	o	o

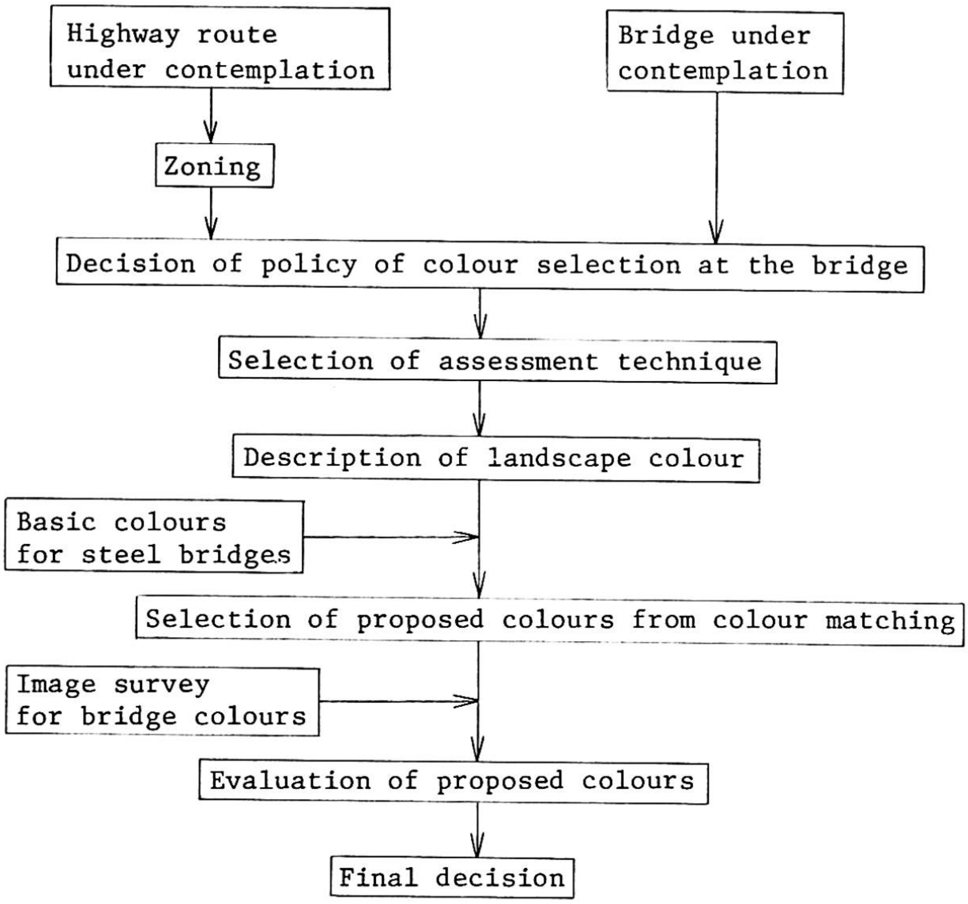

Fig. 1 Flow Chart of Colour Selection Procedure

Table 2 Colours selected for To-ne River Bridge

Colours	Method used*			Appraisal**			Image of bridge colour	
	A	B-1	B-3	P	E	C		
Bright yellow green	o		o	o	o	o	harmonious	
Light purplish blue	o		o	o		o		
Deep purplish blue	o			o	o			
Light blue			o	o				
Light grey	o		o	o	o	o	blameless	
Vivid purplish blue	o	o					beautiful	
Bright yellow	o	o						
Bright greenish yellow	o		o	o	o			evaluative
Bright greenish blue	o					o		
Bright blue	o			o				
Bright purplish blue	o	o		o				
Light yellow	o		o	o	o	o		
Light greenish blue	o		o	o				
Vivid blue		o	o		o			
Light green			o	o		o		
Vivid yellow green	o						showy	activity
Coral			o	o				

* see Fig. 2, ** P: non-experts, E: engineers, C: colour experts

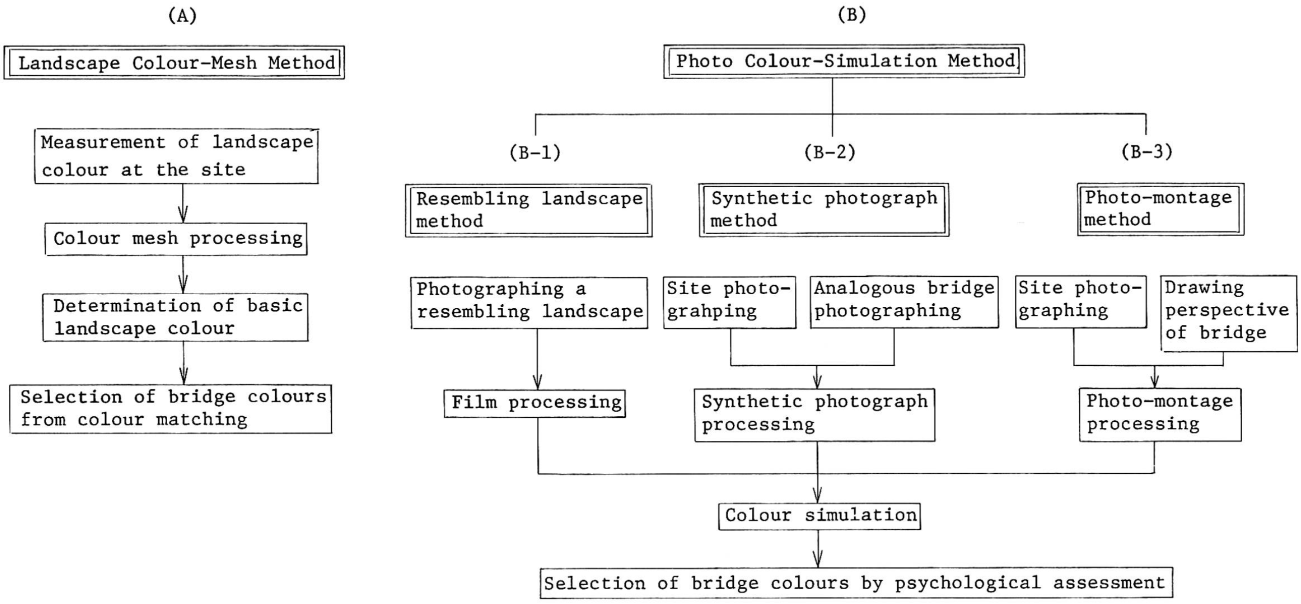

Fig. 2 Colour Selection Methods for Steel Bridges

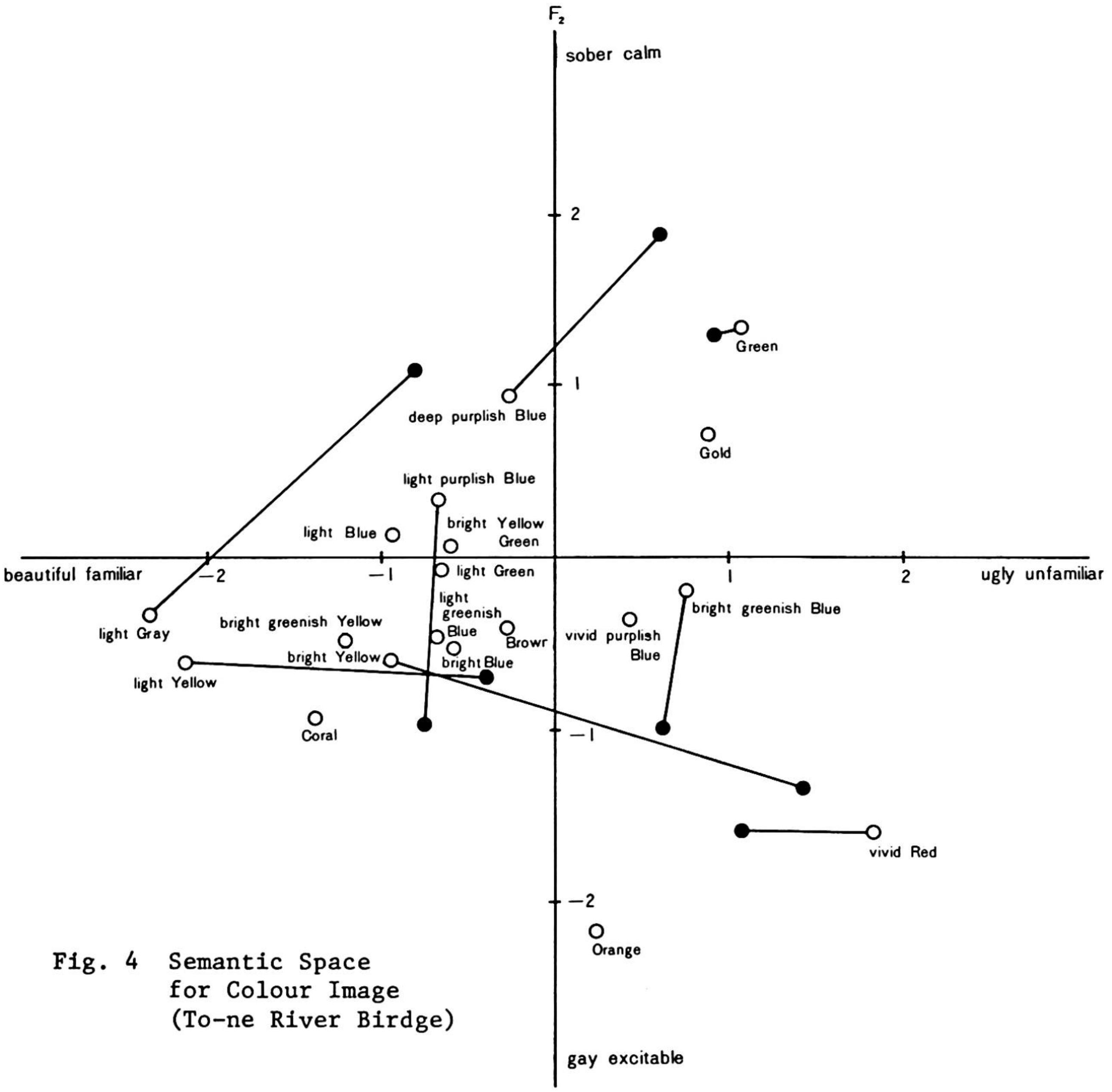

Fig. 4 Semantic Space for Colour Image (To-ne River Birdge)

Table 3 Factorial Loadings for Scales of Meaning

Scales	Factor I (Evaluative)	Factor II (Activity)	Factor III (Potency)
1. beautiful	0.941	-0.107	0.065
3. dislike it	-0.899	0.331	-0.177
10. good	0.851	-0.438	0.191
6. familiar	0.769	-0.496	0.282
2. factitious	-0.672	0.626	-0.031
9. dissonant	-0.663	0.602	-0.303
4. spacious	0.599	-0.270	0.331
5. gay	-0.250	0.910	-0.261
12. excitable	-0.265	0.849	-0.269
8. placid	0.484	-0.800	0.145
11. individual	-0.324	0.752	-0.495
7. simple	0.232	-0.427	0.701