ARCHITECTURE, SCIENCE AND COLOUR IN BRITAIN 1945-1976

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Submitted in requirement for Ph.D. in Architecture

at University College London

September 1999

ABSTRACT

The development of a scientific theory of colour and of standardized colour ranges by a small group of modernist architects is a fascinating but little-known episode of post-war British architectural history. In many articles, official publications, and conferences, and from within key organizations of the building industry, these architects promoted a theory of colour selection and application based on seemingly 'functional' and 'rational' criteria such as the 'aesthetic of the structure', the character of the building and its occupants, and the improvement of lighting and vision. Architects were also concerned with the standardization of colour, leading, from 1955 until the late 1970s, to 'architectural' ranges responding to 'functional' needs being published as official British Standards.

Colour in modern architecture has only recently become the subject of critical historical studies. Its belated reassessment by historians is, in part; related to modernism's own rejection of colour, which was seen to belong to the transient and decadent phenomena of decoration and fashion. Yet, many modernist architects persisted in thinking about and applying colour in their buildings.

This thesis explores some of the different and complex meanings of colour as well as the ambivalent role of science in post-war British architecture. It shows that the scientization and standardization of colour after the war was in part an attempt by architects to maintain and make acceptable a new decorative theory and practice of colour in face of the dominant ideology of science promoted by the Welfare State, and of the modernist hostility to decoration. It shows that colour was then such an

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ACKNOWLEDGEMENTS

My thanks to Adrian Forty for his help, enthusiasm and encouragements over many years. Many thanks to David Medd who answered my questions and lent me many of his useful and interesting documents on colour. Oliver Cox, as well as Bill Allen, Bruce Martin, Don Mason (formerly at ICI Paints), Mary de Saulles, Helma Jotischky (Paint Research Association), G. Moyes (NPEAC), Michael Keyte, Patrick Baty, and many others were also very generous with their time and material on colour.

INTRODUCTION

'But does not ingenuity consist in the finding or creating of connections between apparently extraneous orders of ideas?' Primo Levi[1]

To those who ask what is my thesis about, I reply: 'colour in modern architecture'. Reactions to my reply, I quickly noticed, usually took one of three forms. In one, my interlocutor will mention that he or she has just redecorated the kitchen, the living room or the bathroom. A second reaction is to adopt a look that expresses their amazement that such a mundane subject as interior decoration should be stretched to a doctoral thesis. And a third is to exclaim: 'but is not modern architecture all white?'. Perhaps not entirely coincidentally, these three spontaneous reactions correspond to some of the main historical problems in the study of colour in modern architecture. The first reminds us of the persistently and fundamentally decorative nature of colour, even in modern architecture. The second, on the other hand, mirrors the typically modernist contempt for and denial of decorative colour, conveyed most vividly in the widespread assumption that there was no colour (apart from white!) in modern architecture.

It is only in the last few years, as part of the continuous reassessment of the modern movement, that modern colour and its contradictions has been made the subject of critical historical studies. Mark Wigley's White Walls, Designer Dresses is indisputably the most important of these recent works in the English language. In it, Wigley uncovers the role and meaning of the ubiquitous white wall in modern architecture, showing that this apparently

neutral, undecorated surface only symbolized the rejection and absence of decoration and was in fact nothing other than a new, modern form of decoration. The white wall, Wigley explains, also was intended to signify how timeless, eternal, and beyond fashion modern architecture was. Yet, while the rejection of fashion was a central tenet of the modern movement, many of its proponents were themselves keenly interested in, if not actively involved with clothes and fashion. Wigley shows, indeed, that many architects interpreted the surfaces of modern architecture, on Semperian lines, as clothing. Most interestingly, Wigley demonstrates that contrary to received opinion, polychromy was an integral though rapidly suppressed part of modern architecture. This sublimation of polychromy, he argues, was due partly to the unavailability, for financial and technological reasons, of colour reproduction, but also, more importantly, to concerted actions by the 'guardians' of modernism, in particular, the thoroughly anti-fashion historians who chose to silence from history this dangerous reminder of the decorative and therefore transient nature of modern architecture.[2]

Le Corbusier is one of the modern architects whose work and ideas Wigley analyses at length. He quotes in particular from a text, 'Polychromie architecturale', first written in 1931 but which was, significantly, only published integrally in 1997 (two years after Wigley's own book). This text shows that Le Corbusier, a central figure in modernism, regarded colour as an important and fascinating subject, a fact well borne out by his buildings, but the text's long sojourn in obscurity, and only recent emergence is indicative of the suppression of colour in the modern movement. In 'Polychromie

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[1] Primo Levi, If This A Man (London: Abacus, 1987), p. 153.

architecturale', Le Corbusier developed, as we shall see, much as British architects did in the 1950s, a rational theory of colour application. Like British architects, he also designed in 1931 and again in 1959, a 'standard' range of colours for a Swiss wall-covering company. (These ranges of wall paper colours selected by Le Corbusier have been reissued with the unpublished texts of Le Corbusier in 1997, and are promoted as a 'precious work instrument' for architects and designers).[3]

Penny Sparke has interesting points to make about modernist conceptions of colour, from the different perspective of the history of 'feminine culture' since the nineteenth century. In the last chapters of her book on the 'sexual politics of taste', she shows how attitudes to and choices of colour were one of the ways in which conflicts and interactions between modernism and a stereotypically 'feminine culture' in the 1950s were played out. For example, while modernism advocated a controlled and restrictive approach to colour, manufacturers and sellers of consumer goods, increasingly aware of the crucial role of women in consumption in the 1950s and eager to attract their attention, produced objects in an ever greater variety of colours (including pink, a colour modernists would not normally tolerate). With this, Sparke argues, began the erosion of masculine, modernist establishment culture, a process which continued in the youth culture of the 1960s: to rework a well-known saying, personal tastes (in colour) are always political.[4]

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[2] Mark Wigley, White Walls, Designer Dresses: The Fashioning of Modern Architecture (Cambridge, MA and London: MIT Press, 1995).

[3] Le Corbusier, Polychromie architecturale: Le Corbusier's Color Keyboards from 1931 and 1959, ed. by Arthur Rüegg, 3 vols (Basel, Boston and Berlin: Birkhäuser, 1997). There is no evidence, to the best of my knowledge, that British architects knew of Le Corbusier's 'standard' ranges of colour.

[4] Penny Sparke, As Long as It's Pink: The Sexual Politics of Taste (London: Pandora, 1995), pp. 188, 195-6, 203.

Although more concerned with colour in art, John Gage's Colour and Culture has nonetheless extremely interesting implications for the study of colour in modern architecture. In its chapters, which deal with a wide range of subjects such as the concepts and debates on colour in antiquity, the theme of the rainbow in art, or the links between colour and music, we are shown that what we see as colour is to a large extent formed by the ideas we have about it, and that those ideas are neither eternal nor universal, but rather changing, fragile and always historical.[5]

While there has already been a major study of colour in modern architecture, and Le Corbusier's papers on colour and colour ranges have been published (in part to serve as a source of inspiration for contemporary practising architects), the development of a theory of colour and of colour ranges by British architects after the second world war had not as yet been the object of any substantial historical study. In this thesis, I propose to look at

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[5] John Gage, Colour and Culture: Practice and Meaning from Antiquity to Abstraction (London: Thames and Hudson, 1993). There are few useful critical studies of architectural colour or modern architectural colour. Most recent writing amounts to either unsophisticated interpretations of historical changes in architectural colour, or simplistic accounts of architects' own approaches to colour. See for example, Tom Porter 'Architectural Form and Colour', in Companion to Contemporary Architectural Thought, ed. by Ben Farmer and Hentie Louw (London: Routledge, 1993), pp. 309-16; Charles A. Riley II, Color Codes (Hanover and London: University Press of New England, 1995); Augustine Hope, Margaret Walch, The Color Compendium (New York: Van Nostrand Reinhold, 1990); 'Colour in Architecture', Profile No. 120, AD, 66 (1996). A number of studies on continental modernism include interesting insights on the theory and practice of architectural colour. See for example, Kristiana Hartmann, Franziska Bollerey, 'The Case of Taut', trans. by Frank Spadaro, in 'Colore: divieti, decreti, dispute/Color: Prohibitions, Decrees, Contraversies', Rassegna, 7 (1985), 108-109; De Stijl et l'architecture en France, ed. by Yve-Alain Bois and Bruno Reichlin (Bruxelles: Pierre Mardaga, 1985). Much less attention has been given to British post-war theory and practice of colour in Britain. Andrew Saint, Towards a Social Architecture: The Role of School Building in Post-War England (New Haven and London: Yale University Press, 1987) devotes a few paragraphs to colour in schools and mentions the work on colour standards, but his interpretation of these developments is superficial; T. W. A. Whitfield, M. O'Connor, T. J. Wiltshire, 'The British Building-Colour Standards: A Model for International Application', Color, 11 (1986), 215-22, is a rare but uncritical account of post-war 'architectural' colour standards. Lesley Jackson, 'Contemporary': Architecture and Interiors of the 1950s (London: Phaidon Press, 1994), is useful on the commercial and popular trends in decoration in the 1950s. Abundantly illustrated, it complements Penny Sparke's sharper analysis of the subject in As Long as It's Pink. Mark Crinson, Jules Lubbock, Architecture: Art or Profession? (Manchester: Manchester University Press, 1994) is a polemical account of British architectural education. It points out how colour was included in the modernist curriculum as a scientific part of architecture.

how and why, in the late forties, a small group of architects working at the Hertfordshire County Council on the design of prefabricated schools, set out to devise a 'methodical' approach to colour selection and application, and a corresponding range of colours called the Archrome, especially for schools. Turning to their advantage a drive for standardization among paint manufacturers, architects led the development of a second range of colours 'for buildings' which became an official British Standard in 1955. In the late fifties, this small group of architects was increasingly interested in the idea of scientific colour co-ordination or harmony between factory-coloured building products. To implement their idea they envisioned a collection of 'systematically related' colours or framework from which smaller ranges could be extracted. This however was only approved as a draft proposal in 1972, and its final version, in 1976, marked the end of this particular episode of British architectural history.

It was not colour but the relationship between science and architecture which was my initial interest when I began my thesis. Of all the aspects of architecture susceptible to scientific study, such as structural engineering, building construction, lighting or acoustics, colour seemed to me the oddest and most fascinating. Unlike the relatively straightforward and uncontroversial fields of structural engineering or acoustics, scientific colour already embodied a contradiction in terms, of rationality and beauty, of function and intuition. It inspired in architects an abundant literature linking colour to an astonishing variety of other subjects, from paint production, the theory of standardization, and principles of modern decoration, to better lighting and vision in buildings and systems of colour classification and identification. The colour ranges and standards themselves, with their colour patches, seemed beautiful but at the

same time, mystifying objects. This history of scientific colour also provoked many questions in my mind. Why was colour, which before the war had been largely regarded as a matter of intuition, as lying in the realm of decoration, become after the war scientific? Why did architects press for a science of architectural colour at that particular moment? Why were architects so eager to standardize colour? And why what architects termed a 'functional' theory of colour seem to my eyes indistinguishable from a loose collection of aesthetic prescriptions?

This thesis will attempt to answer those questions by examining, in the first chapter, the theory of factory colouring, from which architects borrowed extensively to construct their science of colour. The following chapter argues that the scientization of colour was in part an attempt by architects to maintain and make acceptable a decorative theory and practice of colour in face of the dominant ideology of science promoted by the Welfare State, and of modernism's apparent hostility to decoration. The third chapter traces the development of colour standards. It shows that contrary to architects' claims, standards contributed little to increased industrial productivity, and that their main purpose was to make colour appear more rational and scientific. The fourth chapter is a critical survey of some of the other strategies used by architects to scientize colour, including the development of a theory of functional colour and in the late fifties, of a theory of colour co-ordination, and the promotion of the Munsell classification system as a scientific representation of how we think and see colour. The study of the history of post-war architectural colour will show that science was to a large extent a rhetoric used by architects to maintain their professional prestige and appear modern, but

towards which they felt much ambivalence. It will show that science in architecture had less to do with progress and efficiency than with the development and legitimation of a new, modern aesthetics.

CHAPTER I

COLOUR IN THE FACTORY

The theories and practices of factory colouring were a direct influence on the development of a modernist and scientific conception of architectural colour in the post-war period. It was moreover in relation to factory buildings that a number of architects were first involved in the development of such a conception of colour. With its claims to a scientific approach to colour, with its premise that the main purpose of colour was to ensure the welfare of the occupants of a building, and that, just as any other part of the building environment, colour directly affected the behaviour and state of mind of human beings, this science of factory colouring was for modern architects a useful model for their new theory and practice of colour. In part because of its perceived role in the war effort and the post-war economic recovery, factory colouring had also the advantage of being the object of a seemingly consistent and tested body of theory readily available to architects.

Already during the second world war, architects had experimented with colour, not only in factories, but in hospitals, and in hostels and welfare buildings for mobilized workers. The Ministry of Works built a large number of hostels and welfare buildings and colour was used extensively as an economical and easily applicable finish. In addition, colour could create the 'cheerful surroundings' thought to be appropriate to the mostly single and female occupants of these buildings. Decorative schemes followed recommendations produced by the Ministry of Planning. Like all other aspects of life during wartime, colour was also regimented. Thus, a standard range of colours was developed for a large programme of hostels designed under William Holford.

The range was divided into four 'related' groups, A to D. Each was based on two or more complementary colours, with black and white, from which were mixed the other colours in the group. The basic complementary colours in group A, for example, were yellow, violet, yellow-green, and orange, and in the 'related' group B, were yellow, red, and blue violet. The four groups in the range were said to allow different colour schemes for different rooms, which would nonetheless be related to each other, thus maintaining a sense of unity throughout the building.[6] Another application of the Ministry's guidelines was for a hostel for one thousand war workers built in 1943. One article described how colour would cheer the troops with only a restrained palette:

> Although the hostel has been constructed as economically as is consistent with efficient use, an attempt has been made to make the rooms as attractive as possible by the employment of bright colours in the wall finishes and furniture. These colours have been restricted to four paints and four distempers, and their colours, carefully considered with the fabrics and furnishings, should be a pleasing change from the drabness of factory surroundings.[7]

Camouflage was another aspect of wartime colour which was familiar to architects. Techniques of camouflage included the application of different colours in order to change or emphasize the appearance of an object, and the exploitation of the withdrawing and advancing effects of juxtaposed colours. This last technique had been used in 'stair-halls, corridors and small rooms' of war-time hostels to make them appear larger.[8] However, partly because of the

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[6] 'Hostels', AJ, 95 (1942), 167-89 (pp. 186-87).

[7] 'A War Workers' Hostel: An Article Describing a Recently Completed 1,000-Person Standard Hostel Erected in the Country', Building, 18 (1943), 70-74 (p. 74). For other applications of the Ministry's recommendations, see 'Hostel in North Wales by Wood, Goldstraw and Yorath', AJ, 96 (1942), 295-98 (p. 296); 'Hostel in North Wales', ABN, 174 (1943), 73-77 (pp. 76-77). Howard Robertson mentions the use of colour in 'industrial and miners hostels' and in merchant navy clubs during the war. Howard Robertson, Modern Architectural Design, rev. ed. (London: Architectural Press, 1952), p. 196.

[8] W. A. Allen, 'Colour in Buildings', RIBAJ, 53 (1946), 282-88 (p. 283); see also Hugh Casson, 'Editors Only', AR, 119 (1956), 344, on a Camouflage exhibition at the Imperial War Museum: Casson called for camouflage principles to be revived; see also Andrew Saint, Towards a Social Architecture: The Role of School Building in Post-War England (New Haven and London: Yale University Press, 1987), p. 21.

desire for a clear break with wartime aesthetics, neither of these experiments was to have the durable impact of factory colouring on post-war architectural colour.

1. FACTORY REFORM MOVEMENT

Factory colouring was closely related to the theories of scientific management. Pioneered by the American Frederick W. Taylor at the turn of the century, scientific management brought together in a unique ideology of social control, notions of scientific study of management, methods of factory organization, and techniques of quantification and rationalization of work. At a time of mounting tension between capital and labour, Taylor promised an end to class struggles through increased industrial productivity and prosperity brought by the application of scientific management to factory life.[9]

In Europe, more skilled workers with greater control over production led to the development of a different form of scientific management. With workers able to resist the rationalisation of work processes advocated by American scientific management, employers and managers had to place greater emphasis on the peripheral aspects of work. Indeed, to pacify a well organized workforce, and increase productivity during the first world war, British industrialists evolved, a decade ahead of the Americans, their own 'human relations' approach to management. In the tradition of Quaker philanthropic industrialism, this approach aimed to enlist workers' cooperation by demonstrating a concern for their welfare beyond the minimal requirements of

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[9] F. W. Taylor, The Principles Of Scientific Management (New York and London: Harper, 1911); Judith Merkle, Management and Ideology: The Legacy of the International Scientific Management Movement (Berkeley: University of California Press, 1980), pp. 2, 15, 98.

the Factories Acts.[10] As Merkle points out, one aspect of American Scientific Management which the British did take up was the 'scientific' measurement of workers' productivity. However, rather than concentrating on work processes or output, measurements were characteristically carried out on conditions affecting safety and health, giving rise to what Merkle has termed a 'scientific humanism' within British welfare ideology.[11] Among the conditions which were quantified were those which were part of the factory environment, such as lighting, temperature, and ventilation. A similar shift towards the building environment occurred in American scientific management. This was due in part to the introduction within scientific management of the ideas of welfare work, which promoted the betterment of workers through benefits, amenities and pleasant and safe surroundings towards efficiency and industrial peace, and of applied industrial psychology, with its implicit belief that the environment determined workers' behaviour.[12]

Thus, from the first world war on, improvements to factory conditions were, along with schemes such as pensions, sickpay and profit sharing, considered by the industrial welfare movement as an important factor in increasing labour productivity and ensuring its docility. Pressed by groups such as the Industrial Welfare Society, environmental reforms ranged from the 'beautification' of factories by means of ornamented facades, gardens and cheerful interior decoration, the improvement of lighting, heating and

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[10] Merkle, pp. 2, 6, 30, 229; Robert Loader, 'The Architecture of Efficiency: Architecture and the Development of the Model Factory in Britain 1914-1925' (unpublished master's thesis, University of London, 1989), p. 17; Robert Fitzgerald, British Labour Management & Industrial Welfare (London: Croom Helm, 1988), p. 208.

[11] Merkle, p. 232: 'The Taylorites' organizational work for World War I in the United States had influence in that it pressed the British to adopt scientific standards for the measure of labor productivity in terms of certain variables. But the variables they chose to measure were those that affected health and welfare.'

[12] Reinhard Bendix, Work and Authority in Industry: Ideologies of Management in the Course of Industrialization (Berkeley, LA, and London: University of California Press, 1974), pp. 290, 294; Loader, pp. 4, 19.

ventilation, to the provision of hygienic lavatories, generous cloakrooms, rest rooms, canteens, clinics and recreation facilities.[13]

It was in this context of the development of British scientific management that, between the wars, colour began to be seen as a valuable element in a reformed factory environment. The architect Cecil Handisyde affirmed in 1937: 'the mere altering of the colour of the paintwork may make for brighter and more cheerful conditions to the considerable benefit of workers with, very possibly, an increase in output as a result.' The belief that colour had beneficial effects on workers' health, morale and productivity was also expressed in an article on 'Beauty in the Factory': 'There are many opportunities for colour in the factory. The effect of light and cheerful decorations on health, spirits and output is, in many firms' experience, real and measurable.'[14]

But the theory and practice of colour in factories would not have had so much attention were it not for its reinforcing the belief, central to the 'human relations' school of management, that employers really had their employees' happiness at heart, so maintaining good industrial relations and ultimately safeguarding the interests of employers. As Loader points out, new factory architecture between the wars was presented as the physical embodiment of a

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[13] Loader, pp. 21, 26, 61; Victoria Perry, Built for a Better Future: The Brynmawr Rubber Factory (Oxford: White Cockade, 1994), p. 28. See Robert F. Wilson, 'Introductory Paper', in 'Colour and Lighting in Factories and on Machines: Report of Course' (unpublished typescript, November 1948), pp. 2-9 (p. 2), for an example of post-war rhetoric on the improvement of the factory environment: 'We should appreciate the fact that this scientific development ['improvement in surroundings' of factories and offices] represents a major change in national and international life.'; 'The 1951 Building Research Congress, London', RIBAJ, 58 (1951), 462-67 (p. 467): 'Physical provision, even of the highest order, will not provide a satisfactory environment unless works relations are good, and they are not likely to be good unless the worker is convinced that his employer has taken thought for his safety, health and comfort during working hours.'

[14] Cecil C. Handisyde, 'Modern Industrial Architecture', IW, 19 (1937), 18-24 (p. 23); 'Beauty in the Factory', IW, 19 (1937), 25-28 (p. 27). Loader notes that the beneficial effects of colour on workers' efficiency had been discussed, particularly in American journals of psychology, since the turn of the century (p. 60).

seemingly revolutionized relationship between capital and labour.[15] Likewise, displays of colour, as well as the assurance that these had undeniable beneficial effects, were meant to signal the advent of enduring changes in social relations. In the immediate aftermath of the second world war, the role of colour in creating the right 'atmosphere' for the highly expectant and newly demobilized troops and workers did not escape the attention of industrialists and managers:

> In the critical period ahead we must not overlook any factor which can contribute towards the general re-energising of the civilian population, and there is no doubt that good lighting, cleanliness, pleasant colour, and good order, are closely linked in themselves, and are together of value to morale.'[16]

2. SCIENTIZING FACTORY COLOUR

The architect William Allen wrote an article in 1946 surveying the recent trends in colour for buildings, including the 'utilitarian' use of colour in factories. This approach to colour, he observed, aimed to improve the vision, safety and morale of the worker and was based on scientific research. Pointing to the American lead in the field, Allen called for a more systematic and scientific study of factory colour in Britain: 'It is obvious that in a development of this kind, potentially affecting the welfare of so many individuals, it is desirable to help it along in every possible way, at the same time giving it whatever study is necessary to ensure that practice is following sound lines.'[17] In a memorandum on colour in factories issued after the war by the Research Association of British

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[15] Loader, pp. 1, 52.
[16] Stanley A. Wood, 'Colour in Industry: (1) The Relation of Light to Colour', IW, 27 (1945), 186-87 (p. 186).
[17] Allen, 'Colour in Buildings', p. 286.

Paint, Colour and Varnish Manufacturers, and overview of the latest information on factory colour was presented as a tentative basis for a science of colour: 'Our appreciation of colour seems to be a simple matter of likes and dislikes, but to place it on a scientific basis presents many baffling problems, the solution of which would, in many cases, be of practical as well as of theoretical interest.'[18]

In the 1940s, the scientific basis of factory colouring consisted largely of various notions and principles lifted from the disciplines of lighting engineering, physiology of vision and psychology.

Lighting and Vision

The association of colour with lighting was undoubtedly the most important strategy in scientizing factory and architectural colour. Starting with Newton, scientific research into colour had long been linked to that of the phenomenon of light. An extensively researched subject, both as a physical phenomena and in its more practical aspects of illumination of human activities, lighting was regarded by the industrial welfare movement as an influential feature of the working environment, particularly during wartime blackouts. From the 1930s, colour and lighting in the factory were joined in the recognized principle that pale colours, by virtue of their high reflection factors, were an economical means to raise illumination levels in the factory.[19] John Bickerdike, an architect and colleague of William Allen at the Building Research Station (BRS), described the further benefits of light colours. His account of a wartime

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[18] Paint Research Station, Research Memorandum No. 122, 'The Painting of Factories: Colour and Psychology', (unpublished typescript, November 1945), p. 1.
[19] See G. P. Crowden, 'Working Environment and Fitness', IW, 19 (1937), 33-39; S. J. Patmore, 'Factory and Workshop Lighting under War Conditions', IW, 21 (1939), 387-91; G. V. Downer, 'The Importance of Good Lighting', IW, 21 (1939), 430-32.

management initiative to 'improve the working environment of their staff' by painting building and machinery in light colours pointed out that such a scheme not only apparently alleviated fatigue and other negative effects of the blackout in the factory, but contrary to expectations, also virtually eliminated the need for machine maintenance. Light coloured machines, it had been observed, made the worker proud of his machine, thus encouraging him to take greater care of it.[20]

It was initially the association of colour with the objectives of scientific management and welfare ideology, and increased state intervention in industrial welfare, which provided the impetus for research into factory colouring within the BRS. A government institution committed to the scientific study of all aspects of building, the BRS did foster attempts at evolving a body of rational rules of colour practice, and was later to take a leading role in the development and promotion of a science of architectural colour.[21]

Reflection factors, which provided the scientific legitimation for the principle of using light colouring in factories, were essential in establishing a rational basis for the selection and application of colours. Expressed as a percentage of light reflected by a coloured surface, reflection factors represented a measurable relationship between colour and light, and a means to put tangible and reassuring numbers on colours.[22] It is not surprising therefore that reflection factors were continuously invoked by architects

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[20] J. B. Bickerdike, 'Colour in the Factory: Four Years' Experience', IW, 28 (1946), 129-30.

[21] For the growing involvement of the state in industrial welfare during and after the second world war, see Fitzgerald, British Labour Management, pp. 212-40.

[22] Ministry of Education, BB9, Colour in School Buildings, 2nd edn (London: HMSO, 1956), pp. 49-50; H. L. Gloag, 'The Development of the Use of Colour in British Factories', in Building Research Congress 1951: Papers Presented in Division 3 (London: Building Research Congress, 1951), pp. 181-83 (p. 181); W. A. Allen, R. G. Hopkinson, 'Lighting of Buildings: Part II', RIBAJ, 58 (1951), 272-78 (pp. 273, 275). See also William Allen, The Development of a Factory Colour Treatment', in 'Colour and Lighting in Factories and on Machines: Report of Course' (unpublished typescript, November 1948), pp. 19-23 (p. 19). On reflection factors, Allen concluded: 'Thus we can arrive at one criterion for the choice of any colour.'

throughout the first decades of the post-war period, as they undoubtedly help to impart an objective air to their colour practice.

The use of light colours in factories and the concomitant reference to high reflection factors had already received ample official support during the war. The Ministry of Works' Post-War Building Studies No. 12 on lighting, published in 1944, pointed out how the reflection produced by 'light decorations' influenced levels of illumination. In its Fifth Report published in 1940, the Departmental Committee on Lighting in Factories advised that all interior walls, ceilings, floors as well as plant be of a light colouring, the high reflection factors thus obtained helping to counter the gloominess of blacked-out factories.[23] A Research Memorandum of the Research Association of British Paint, Colour and Varnish Manufacturers affirmed that pale colours with their high reflectance values made lighting more efficient, and therefore more economical to run, and improved the safety and morale of staff. Two tables supported these statements, one demonstrating that the increase in the reflectance values of ceiling, walls and floor resulted in an increase of illumination on horizontal surfaces, the other listing the reflectance values of the lighter colours within the British Standard 381C range, as a guide to help achieve recommended reflectance values for ceiling, walls and floor. These tables were not simply a means of conveying the necessary information. Like reflectance values, tables were meant to present an image of scientific order and predictability, the processed, compartmented data denoting the extent to which colour could now be rationalised. The presence of tables within report on colour in factories was thus another means to make colour appear as

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[23] Building Research Board, Post-War Building Studies No. 12, The Lighting of Buildings (London: HMSO, 1944), p. 11. This study was largely written by architects William Allen and C. C. Handisyde (p.

scientific, a belief which was crucial to the development of a modern doctrine of colour.[24]

A further benefit high reflection factors were thought to bring to factory life was the improvement of workers' vision. During the war, the British scientific journal Nature published a review of an American colour experiment which claimed that light colours on machines allowed workers to see better, as a result of more light being reflected off the machines, thus raising levels of illumination around the work, and of increased brightness and colour contrasts between the machine and the materials handled.[25]

Architectural Physics

Theories and practices aiming at improving vision were another important source of scientific legitimation for post-war architectural colour. Good eyesight was considered crucial to workers' welfare and to industrial productivity, and had been related since the 1920s to higher levels of illumination.[26] However, around the time of the second world war, it was increasingly argued that good vision was not simply a matter of raising lighting levels but was also affected by subjective perceptions of lighting, such as the sensation of glare.[27] Based on pioneering research which established links

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2); Ministry of Labour and National Service, Fifth Report of the Departmental Committee on Lighting in Factories (London: HMSO, 1940), p. 8.

[24] Research Memorandum No. 122, p. 5.

[25] 'News and Reviews: Colour of Machines and Workshop Efficiency', Nature, 150 (1942), 19. See also Research Memorandum No. 122, p. 3.

[26] For importance given in industrial welfare to vision and light, see for example Matthew Luckiesh, Light, Vision and Seeing: A Simplified Presentation of Their Relationships and Their Importance in Human Efficiency and Welfare (New York: Van Nostrand, 1945); H. C. Weston, Sight, Light and Efficiency (London: H. K. Lewis, 1949), p. v; Post-War Building Studies No. 12, p. 8; DSIR, Illumination Research, Technical Paper No. 10, Effect of Distribution and Colour on the Suitability of Lighting for Clerical Work (London: HMSO, 1930); Medical Research Council, The Relation between Illumination and Efficiency in Fine Work-Typesetting by Hand, by H. C. Weston, A. K. Taylor (London: HMSO, 1926).

[27] Faber Birren, 'The Functional Use of Colour', in Building Research Congress 1951: Papers Presented in Division 3 (London: Building Research Congress, 1951), pp. 176-80 (p. 176); R. G. Hopkinson,

between the physiology and psychology of vision and lighting, a new, so-called subjective approach to lighting emerged after the second world war.

The engineer Ralph Hopkinson and his colleagues in the Physics Division of the BRS actively embraced this new theory, and lambasted the 'computational approach' used by lighting engineers as unsatisfactory. This approach, they argued, had had as its main goal the attainment of a specific level of lighting and, having abstracted all design elements to their mathematical expression, concluded with an equation which determined the final design of the lighting system. Allen wrote of the lighting engineer: 'he is disciplined into a way of thinking which tends to avoid relying on imagination, and he comes to consider lighting as a geometrical or arithmetical puzzle which can be solved by calculation alone.'[28]

The reforms in building science promoted by architects in the post-war period, and to which the work of Hopkinson was closely allied, were crucial to the development of a less 'computational' theory and practice of lighting. Architects argued that building science, as based narrowly on the scientific disciplines of physics and chemistry and on engineering, failed to take account of the users of buildings, and to yield results readily applicable to architectural design. Their response to the perceived shortcomings of building science was to establish, within the new Architectural Physics Division at the BRS, what had been variously designated as 'environmental' science, 'architectural' science, or psychophysics.[29] This new field related the physical study of aspects of the

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'Brightness, Contrast and Glare', in 'Colour and Lighting in Factories and on Machines: Report of Course' (unpublished typescript, November 1948), pp. 38-45 (p. 38) (also as DSIR, BRS, Note No. E149, 'Brightness Contrast and Glare', by R. G. Hopkinson (unpublished typescript, February 1949)); R. G. Hopkinson, The Evaluation of the Built Environment (London: H. K. Lewis, 1966), p. 7.

[28] W. A. Allen, R. G. Hopkinson, 'Lighting of Buildings: Part I', RIBAJ, 58 (1951), 222-25 (p. 222).

[29] Saint, Towards a Social Architecture, pp. 25, 85. For the development of an alternative approach to lighting design after the second world war, see Post-War Building Studies No. 12; Hopkinson, 'Brightness,

building environment such as acoustics, heating and ventilation, and especially lighting, to that of their subjective effects on users, with the aim to set down rational principles of architectural design.[30]

However, the emergence of 'architectural' science was not merely, as architects and their allies claimed, a response to the perceived sterility of traditional pre-war building research but was, in part, motivated by professional survival and the desire to establish a properly architectural expertise in building science, distinct from that of scientists and engineers. After the second world war, architects fought hard to raise their status within the building industry and within British society as a whole. They took on a new identity centred on scientific expertise. By founding a properly 'architectural' science, architects could appropriate part of the field of building science, and at the same time, demonstrate the expected interest and expertise in science. The new environmental sciences also gave architects another opportunity to claim a greater understanding of human behaviour and desires, and to reinforce their post-war image of socially dedicated professionals. Indeed, their new angle on what was in the main technical services, their emphasis within a scientific approach on human physiological and psychological reactions, their concern with aspects of the building environment most conspicuously related to the senses, allowed architects boast of a unique, more humane approach to building science.

A central concept in architectural science was that of the 'user requirements'.[31] However, much more than a simple reference to the

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Contrast and Glare', pp. 38, 44; 'Colour and Lighting in Factories and on Machines: Report of a Conference', RIBAJ, 56 (1949), 136-37 (p. 136).

physiological and psychological needs of the occupants of a particular building, the concept served to express, and keep alive in the minds of clients and public, the humanist aspirations of British post-war architects. Social purpose was one of the fundamental tenets of the modern movement and a main component of the architects' professional identity after the second world war. Yet, as both Peter Malpass and Alan Lipman have argued, the professional realities of post-war architects were at odds with this well-intentioned social ideology. As the major commissioners of buildings in post-war Britain, engaging in large-scale building programmes destined to a mass clientele, the state and local authorities became the main source of employment for many architects. These new conditions created bureaucratic and class barriers between architects and the prospective occupants of the buildings.[32] Architects had thus no direct knowledge of the people on whose needs their designs were apparently based. A myth constructed by architects from second-hand, seemingly scientific knowledge lifted from various experts such as sociologists, psychologists and physiologists, the 'user' played an important role in masking and compensating for this lack of a direct experience and knowledge of the occupants of buildings, and therefore, in maintaining the belief that architects were, as they claimed, genuinely concerned with the welfare of human beings. But in a sense, the term user is also indicative of the new professional situation of architects, where it became necessary to name and distinguish the voiceless, anonymous recipients of the architecture from the state or local authority who acted as clients and dictated the brief of the project. As Brian Finnimore

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[30] Hopkinson, Evaluation, p. 9.
[31] Hopkinson, 'Brightness, Contrast and Glare', p. 38.
[32] Peter Malpass, 'Professionalism and the Role of Architects in Local Authority Housing', RIBAJ, 82 (1975), 6-28 (pp. 9, 25); Alan Lipman, 'The Architectural Belief System and Social Behaviour', British Journal of Sociology, 20 (1969), 190-204 (pp. 197, 199).

makes clear in regard to building system consortia in the 1950s, the myth of the user could also conveniently obscure the less altruistic motivations of architects, such as financial gain and greater control over the building industry. The user as a rationale for the architects' design was favourably contrasted with the crassly commercial and industrial motivations of other agents in the building industry, thereby making architects appear as disinterested professionals whose services were of benefit to the whole of society.[33] This myth of the scientifically defined occupants of buildings was not new to post-war British Modernism, but was central to the modernist tenet of functionalism and the related theory of architectural determinism, the former positing that architectural form did not ensue from stylistic whims but from the scientifically assessed needs of the client, the latter, bringing the argument full circle, that architecture had therefore the power to satisfy needs and shape social behaviour, and ultimately, make people happy.[34]

Two other concepts, 'quality' and 'comfort', advertized the caring, humanist side of architects within architectural science, and were particularly important to the new subjective approach to lighting championed by Hopkinson and his colleagues at the BRS. Critical of the emphasis in contemporary lighting engineering on quantity as the solution to better lighting and on physical measurements as sole means of assessment, Hopkinson forwarded the criterion of 'quality' as the most important for good lighting. Unlike quantity, the assessment of quality was entirely a matter for the subjective judgement of users. 'Light measuring instruments', Hopkinson wrote, 'whilst they are essential tools in the work of this appraisal [of lighting], should not be

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[33] Brian Finnimore, Houses From the Factory (London: Rivers Oram Press, 1989), p. 143.
[34] Lipman, p. 190, Architecture Culture 1943-1968: A Documentary Anthology, ed. by Joan Ockman with

implicitly relied upon as a guide to quality. The final judge of the efficiency of lighting is the user himself.'[35] It was a fundamental law of functionalism that the needs of users were at the basis of modern architecture. But post-war architects now questioned the functionalist denial of individual desires and its replacement with what they saw as a somewhat crude, and overly scientific definition of human needs. As part of their efforts to reintroduce human values into modern architecture, a number of architects with an interest in research were in favour of a revision and refinement of the studies of basic needs such as air, light and space, which had dominated pre-war functionalism. In the late sixties, Hopkinson summed up the new approach to lighting research: 'A new kind of psychophysics has therefore had to be developed, to answer the questions, not 'can you see, are you able to recognise what this is?' but the more difficult questions 'can you see easily, is this light uncomfortable, does this light distract you?' which the older disciplines were not prepared to investigate.'[36] Modern architecture, they believed, was not concerned with style, but nor was it solely about the fulfillment of primary physical and social needs. It was also about responding to the untold, subjective desires of users.

Yet, to preserve their image of scientifically proficient professionals, modern architects strove to present their architecture as the result of rational and objective processes. Resting largely on subjective or 'psychological' impressions, the assessment of 'quality' in lighting was, in comparison to measurable factors such as levels of illumination, notoriously difficult to investigate scientifically.[37] This problem of providing a quantifiable and

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Edward Eigen (New York: Columbia University Graduate School of Architecture, Planning and Preservation; Rizzoli, 1993), p. 178-79.

[35] Hopkinson, 'Brightness, Contrast and Glare', p. 44.

[36] R. G. Hopkinson, Lighting and Seeing (London: William Heinemann, 1969), p. x.

[37] On 'environmental science', see Saint, pp. 25, 85; for new approach to lighting, and the concept of quality

therefore reliable basis to the subjective assessment of quality was, paradoxically, central to the BRS's approach to lighting after the second world war. Regarded as essential to the resolution of this thorny problem were the new 'methods of sensory evaluation', which sought to quantify the subjective sensations experienced by observers.[38]

In 1965, Hopkinson remarked on the prominence given to the study of vision in the environmental sciences, which stemmed from a preoccupation with problems of natural lighting in buildings. The post-war theory and practice of lighting was indeed overwhelmingly concerned with the improvement of vision.[39] Thus, one important objective of the methods of sensory evaluation in relation to quality of lighting was 'visual comfort', defined by Hopkinson as 'the absence of a sensation of physiological pain, irritation or distraction.'[40] This simple term 'comfort' was particularly potent in architectural science. With its reference to this elusive state of psychological and bodily contentment, it gave the impression that the architects' approach to building science reached to the intimate and hitherto ignored aspects of life in buildings, helping to reinforce the humanistic image of the profession.

The main subjective factors said to influence visual comfort, as well as visual performance, included brightness, contrast and glare. Brightness was the result of light being reflected off surfaces and into the eyes, and was what allowed objects and surfaces in the environment to be seen. It had, in place of levels of illumination, become a central concept in the post-war theory and

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and its assessment, see Hopkinson, 'Brightness, Contrast and Glare', pp. 30, 38, 41, 44; Post-War Building Studies No. 12, pp. 7, 8, 74; M. Hartland Thomas, 'The Influence of Technical Research on Design and Methods of Building', RIBAJ, 55 (1948), 188-94 (p. 189).

[38] Hopkinson, 'Brightness, Contrast and Glare', p. 44; Hopkinson, Evaluation, p. 3.

[39] See Hopkinson, Evaluation, p. 7; Hopkinson, Lighting and Seeing, p. xi.

[40] R. G. Hopkinson, 'The Brightness of the Environment and its Influence on Visual Comfort and Efficiency', Building Research Congress 1951: Papers Presented in Division 3 (London: Building Research

practice of lighting. Indeed, good lighting was then simply equated to appropriate 'brightness distribution'.[41] Contrasts were thought to be crucial to visual perception, and brightness contrasts were regarded by lighting researchers as an essential aid to vision and as adding character to the environment. Excessive brightness contrasts were however one of the cause of glare which, to post-war experts, was a major obstacle to good quality lighting.[42]

Lighting and Colour Principles

Based on subjective studies of these factors and on current research work on light and vision, a set of broad, so-called scientific principles of lighting in the workplace were established, which were geared at visual comfort and efficiency. The 'environmental brightness pattern' was the overriding concern of the new approach to lighting. Inspired by the American practice of 'brightness engineering', it pointed to the importance of considering the lighting not only of the work but that of its surroundings as well. Partly because of the eye's natural attraction to the brightest and most colourful objects, the task was to be the brightest part of the visual field, thus helping the worker concentrate on his work. However, too great a contrast between the brightly lit work and the darker environment was likely to produce glare.[43] The mechanism which allowed the eye to adjust to different brightnesses was often

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Congress, 1951), pp. 133-38 (pp. 133, 136-37).

[41] Hopkinson, 'Brightness, Contrast and Glare', p. 39; Ward Harrison, Phelps Meaker, 'Brightness and Glare: General Review', Building Research Congress 1951: Papers Presented in Division 3 (London: Building Research Congress, 1951), pp. 128-32 (p. 128); G. Pleijel, 'Reflected Daylight and Model Studies', Building Research Congress 1951: Papers Presented in Division 3 (London: Building Research Congress, 1951), pp. 167-71 (p. 167).

[42] Hopkinson, 'Brightness, Contrast and Glare', pp. 41, 44.

[43] BRS, Golden Jubilee Congress Proceedings June 1971 (London: HMSO, 1972), pp. 27-30; Hopkinson, Lighting and Seeing, p. 4.

called upon by lighting experts to understand and help develop practical solutions to glare and other problems in lighting.[44] Research showed that while the eye could adapt to a wide range of brightnesses, from night skies to sunlit landscapes, it ceased to operate effectively when highly contrasting brightnesses were present simultaneously in the field of vision, as in the case of glare, producing sensations of visual discomfort and disability in the observer. Following studies of the problem, various solutions were proposed to help reduce the sensation of discomfort caused by glare. In conditions of 'uniformly bright surroundings', glare from a window, light fitting or brightly lit task could be reduced by raising levels of brightness in the environment, either, as Hopkinson suggested, 'by better distribution of the available illumination, or by the use of decorations of higher reflection factor.'[45] In a more complex 'environmental brightness pattern', glare discomfort was best alleviated by the technique of 'contrast grading'. Hailed by Hopkinson as 'a major factor in the lighting design of the future', contrast grading consisted of gradually blending the glare source into its darker surroundings by means of an area of intermediate brightness.[46] An example, and one cherished by British modern architects, was the traditional Georgian window, with its deep, light coloured reveals providing a transition between the glaring sky and darker interiors. A touch of scientific exactitude was added to lighting practice by the establishment of precise brightness ratios of working plane to local surrounds to general environment. American lighting specialists recommended a ratio of

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[44] Allen, Hopkinson, 'Lighting of Buildings: Part I', pp. 222-224.
[45] Hopkinson, 'Brightness, Contrast and Glare', p. 44; Hopkinson, 'Brightness of the Environment', p. 135.
[46] Hopkinson, 'Brightness of the Environment', pp. 135, 138; Allen, Hopkinson, 'Lighting of Buildings: Part I', pp. 224, 225.

3:1:1/3 but BRS experiments pointed to brightness ratio of 10:1:1/10, said to leave more freedom to designers.[47]

Modern theories of colour design adopted by architects after the second world war were closely modelled on these principles of lighting for better vision.[48] The improvement of vision and the visual mechanisms involved were thus, as in lighting, central to these scientific theories of architectural colour. At the first Building Research Congress held in London in 1951, the well-known American colour consultant Faber Birren spoke of the 'applied science of colour conditioning' whose results could be precisely ascertained by means of instruments and ophthalmological data, and which fulfilled a definite purpose: that of good seeing:

> Functional colour is not in the least interested in personal opinions about colour or artistic notions as to its emotional appeal. Quite the contrary, the best of scientific practice requires that colour be applied to make seeing easier, to smooth out unfavorable contrasts, minimise constant eye adjustments, draw attention to tasks and hazards - objectives which, fortunately, may follow technical method and be accurately measured in their effectiveness.[49]

Likewise, the BRS architect and self-styled colour expert H. L. Gloag began his address to the conference by emphasizing the role of scientific research on colour, light and vision in the elaboration of modern principles of colour use, which in factories, centred upon easing the workers' visual task. 'Much of the work involved in industry', Gloag explained,

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[47] Hopkinson, 'Brightness of the Environment', p. 136; Allen, Hopkinson, 'Lighting of Buildings: Part II', p. 272.

[48] 'Much modern colour work is done without the realization that light will play a part in the picture formed for the viewer; light and colour go together in one concept of design.' Allen, Hopkinson, 'Lighting in Buildings: Part II', p. 273; 'It is not difficult to explain the vital role of colour in illumination, and to point out that functional colour is of great importance in establishing an ideal seeing condition.' Birren, 'Functional Use of Colour', p. 176.

[49] Birren, 'Functional Use of Colour', p. 176.

requires some measure of visual concentration, and there are many occasions when the work makes exacting and prolonged demands of this kind. In such cases, there is special emphasis on the aspects of colour relating to visual performance, and analysis of the part which colour can play in improving conditions and thus reducing strain follows directly from scientific investigations.[50]

Robert F. Wilson, the art director of the British Colour Council, expressed similar views at the 'Colour and Lighting in Factories and on Machines' conference in 1948: 'Colour is not an end in itself, it must be used with a purpose. We must remember that factory decoration is not interior decoration. Colour should be the workers' guide and assist him in his visual problems.'[51] Following closely on these lines, the BRS colour policy disputed the idea of colour in factories being based on arbitrary decisions, and forwarded a 'functional approach' as the key to successful colour schemes. Here too, the primary function of colour was the improvement of work; here too vision, or as Allen put it, 'the operation of the eye nerve system', was at the core of this functional approach to colour.[52]

Several of the architects' attempts at a scientific methodology of factory colouring thus revolved on claims to improve the workers' visual task. The most important way in which many believed colour could ease the workers' visual task, and a fundamental principle therefore of factory colouring, was to make the work the centre of visual attention.[53] As we have seen, it was generally assumed that both contrast and brightness captivated the eye and made for better vision. Here an objective of colour treatment was thus to develop these features of contrasts and brightness in the work itself. The machine was the

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[50] Gloag, 'Development of the Use of Colour', p. 181.
[51] Robert F. Wilson, 'Introductory Paper', in 'Colour and Lighting in Factories and on Machines: Report of Course' (unpublished typescript, November 1948), pp. 2-9 (p. 6).
[52] DSIR, BRS, Note No. D68, 'Appraising the Results of Functional Colouring', by W. A. Allen (unpublished typescript, March 1949), p. 1.

first target of the factory colour treatment. On the one hand, it was to provide an appropriately contrasting background for the material processed. Recurrent suggestions included a neutral, greyish hue for multi-coloured materials, and complementary colours such as 'tan' to set off the bluish tints of steel, or blue for wood to be seen against.[54] On the other hand, to make the work itself 'the brightest thing in view', the machine and its immediate surroundings were to be painted in a colour slightly darker and of a lower reflectance factor than that of the material being handled by the worker.[55] Not all of those dispensing advice on colour agreed on these principles of machinery painting. For one, the application on machines of darker colours contradicted the earlier bias towards lighter colours; the use of complementary colours was berated by Gloag, while the American practice of applying different colours to different parts of the machine, variously patented under such names as '3D Seeing' or 'Colour Dynamics', was rejected by some in favour of simplicity and uniformity in factory colouring.[56]

Colour could further help to make the work the centre of visual attention by eliminating sources of visual distraction around the work, such as brightness contrasts and particularly glare. Indeed, colour was seen to have a crucial role in contrast grading which, as a favoured method of fighting glare, was a much used rationale for the selection of colours in factories.[57] Thus a commonly prescribed course of action was that all surfaces near rooflights, light fittings and windows, including window bars and surrounds, should be

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[53] Allen, 'Development of a Factory Colour Treatment', p. 19.
[54] Allen, 'Development of a Factory Colour Treatment', p. 22.
[55] Gloag, 'Development of the Use of Colour', p. 182; Allen, 'Development of a Factory Colour Treatment', p. 19.
[56] Research Memorandum No. 122, p. 2; Allen, 'Development of a Factory Colour Treatment', p. 22.
[57] See Gloag, 'Development of the Use of Colour', p. 182: 'A gradation in the intensity of all factors from the object of attention to the general surroundings is the key.'; DSIR, BRS, Note No. B33, 'The Use of

painted in white or pale colours with reflection factors of no lower than 55 per cent. Away from sources of light, darker hues were allowed. (Fig. 1) In a colour treatment of a woollen weaving shed devised by H. L. Gloag of the BRS, a red and a blue, respectively of 20 and 30 per cent reflection factors, were chosen for walls removed from direct views of the sky. The choice of such low reflection factors was also apparently dictated by the necessity to avoid distracting contrasts of brightness, this time between the work, here cloths of generally low reflection factors, and the walls which formed the visual background to the work.[58]

This whole approach to colour which proposed to improve vision was wholeheartedly espoused by BRS colour boffins.[59] Simply put, a colour treatment took its lead from the work, especially the materials used; light colours were applied around light sources while for the remaining surfaces, colours in between those dictated by the work and the lighter colours were recommended. Research on light and vision and ensuing lighting practices had been a main source of inspiration for the elaboration of these modern rules of factory colouring, and were instrumental in making those rules appear reassuringly scientific. Subjective studies, which aimed to quantify subjective experience, were particularly significant in the endeavour to scientize colour, for they signalled that even this previously uncharted domain of personal impressions was now within the analytical grasp of science. In a sense, they offered a useful model of scientific subjectivity, allowing colour to retain its inevitably subjective nature while at the same time implying that it was open to scientific rationality.

Colour in Factories', by W. A. Allen (unpublished typescript, July 1948), pp. 8, 9.
[58] Allen, Hopkinson, 'Lighting of Buildings: Part II', p. 273; H. L. Gloag, 'Colour in a Woollen Mill', AJ,

By the late forties, colour experts had produced a body of principles for the use of colour in factories aiming at the worker's welfare and efficiency.[60] Derived from a heady mixture of scientific theories, engineering practices and safety prescriptions, this new theory and practice of factory colouring was nonetheless raised by the experts to the status of specialized and scientific knowledge: 'Colour schemes for production areas involve too many technical and psychological aspects to be regarded as matters solely for interior decorators or industrial designers.'[61]

However, apart from the likes of Allen, Gloag, or Bickerdike, few architects then presented themselves as experts in colour science, whether in relation to factories or other buildings. In 1946, William Allen was indeed asking of factory colouring: 'Who is going to do the work? Is it to be the lighting engineers; the architect (if there is one; often there is not on factories); the welfare officer; or an independent colour-consultant?'[62] With demands for experts in factory colouring reported to be increasing, the architect Mark Hartland Thomas was two years later urging architects to take on this new field of activity: 'It is unfortunate that this topic should not have evoked more interest among architects than it has done. Here is something at the present time in which architects could render a special service to the nation.'[63]

However, factory colouring had already been claimed since the first decades of this century by many other professions and occupations, from doctors,

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111 (1950), 93-94.

[59] Note No. B33, 'The Use of Colour in Factories', p. 9.

[60] See for example, Note No. B33, 'The Use of Colour in Factories', p. 9: 'From what has been said it is obvious that we have some definite guidance for the colour treatment of two controlling features in factories, the areas around the work and those near the light source.'

[61] 'Colour in the Factory', Times Review of Industry, 1 (1947), 9-10 (p. 10).

[62] Allen, 'Colour in Buildings', p. 286.

psychologists, welfare workers, managers, and industrialists, to lighting, paint and industrial finishing specialists, designers and decorators, as well as representatives of the paint industry.[64] Architects were to borrow extensively from the theory of factory colouring in elaborating their own scientific theory of architectural colour. Yet, it was not in relation to factories but in the development of a range of colours said to conform to scientific criteria and geared especially at schools, that architects first set out to make their mark in the competitive field of colour in buildings.

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[63] Hartland Thomas, 'Influence of Technical Research on Design', p. 189.
[64] For reports of growing interest in factory colouring, see 'Colour in the Factory', Times Review of Industry, p. 9; Hartland Thomas, 'Influence of Technical Research on Design', p. 189; contributions of Hartland Thomas and Robert F. Wilson, 'Monday, 17th September, 1951', in Building Research Congress 1951: Record of Discussion (London: Building Research Congress, 1951), pp. 142-46 (pp. 143, 144).

Fig. 1 Two examples (including the famous Brynmawr factory) of factory colour schemes centred on the principle of better illumination. (H. L. Gloag, Colouring in Factories, Factory Building Studies No. 8 (London: HMSO, 1961), plates 1-2)

CHAPTER II

SCIENTIFIC COLOUR, MODERNISM AND DECORATION

The subject of colour in architecture does not strike us today as particularly scientific. It seems to be a matter of taste, convention, of fashion and of artistic choices. Yet British architects for some two decades after the second world war claimed to have developed a scientific approach to colour which differed radically from the previously arbitrary, decorative use of colour in buildings. How can this curious episode of British architectural modernism be explained? In this chapter, I shall begin to argue that colour was in fact only given the appearance of science, and that the significance of scientific colour was, in part, rooted in the architects' ambivalent responses to the emergence of a dominant ideology of science after the war.

Shortly after the war, Allen had called for a conference 'in which all the various colour interests, scientific, technical and aesthetic' would meet.[65] In 1948, a three-day course on 'Colour and Lighting in Factories and on Machines' was held at the RIBA, jointly organized by the Council of Industrial Design and the British Colour Council. Improved factory conditions, including colour and light, were seen to play a crucial role in the struggle for increased industrial productivity in the economically precarious post-war period, and the conference aimed to fulfil the growing demand for colour and lighting experts by taking stock of scientific and practical knowledge on these subjects. The range of the organizations and occupations present at the conference offers a good picture of the interest generated by colour in buildings in the late forties.

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[65] W. A. Allen, 'Colour in Buildings', RIBAJ, 53 (1946), 282-88 (p. 288).

Among the speakers and participants were a doctor, a former president of the Illuminating Engineering Society, the Chief Inspector of Factories, the chairman of the Parliamentary Sub-Committee on Industrial Efficiency, the Chief Architect at the Ministry of Works, the Art Director of the British Colour Council, as well as representatives of the BRS, the Paint Research Station, the Lighting Service Bureau and the Council of Industrial Design. The topics covered included workers' welfare through better lighting and colour, the new approaches to colour and light centred on improved vision, the physical and chemical properties of paint, and the standardization of colour terminology. Several papers dealt with the principles and rules of applications of colour in factories.

Contributing a different perspective to the proceedings, the architect David Medd described the use of colour within the Hertfordshire primary schools. Adopting similar principles to that advocated by practitioners of factory colouring, Medd claimed that the selection and application of colour in the schools had been determined by the needs and activities of children, by the lighting requirements, and by the modules of the structural system. The Hertfordshire schools' claim to fame, notwithstanding their industrial system of construction, stemmed from their brightly coloured interiors. However, another equally innovative approach to colour in the schools has gone largely unnoticed by historians. This was the idea that standardization, held up as central to the schools programme, should be applied to colour. Medd summarized the principles involved: 'standardisation of small numbers for production giving a wide freedom in application.'[66] Medd complained in his

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[66] David Medd, 'The Application of Colour in Building (With Particular Reference to Primary Schools in Hertfordshire)', in 'Colour and Lighting in Factories and on Machines: Report of Course' (unpublished

paper to the conference that 'manufacturers standards are necessarily based on sale, and consequently are scientifically and aesthetically arbitrary.'[67] Architects' special needs were not fulfilled by commercial ranges. He proposed that, following the Ostwald system, five basic colours, with black and white, be mixed to produce an extensive range of colours. In fact, by 1948, Medd and his colleagues at the Herts Architects Department had devised their own limited range of colours based on the Ostwald system. With the help of the architect Bill Gloag at the BRS, this range was reorganized according to the American Munsell system of colour classification, which was judged to be more objective and flexible than the Ostwald system. In 1953, a revised and extended range entitled Archrome was published in the Ministry of Education's Building Bulletin No 9, on colour in schools. In 1956, the British Standards Institution issued the British Standard 2660, 'Colours for Building and Decorative Paints', which incorporated some of the colours of the Archrome range. A high point in the post-war history of architectural colour in Britain, the BS 2660 was presented by architects as a first 'architectural' standard range of one hundred and one systematically classified colours, specifically for use in buildings.

1. NEW ATTITUDES TO COLOUR

One of the architects most closely involved with the development of standard ranges, David Medd looked upon Amédée Ozenfant, the French painter and founder with Le Corbusier of the Purist movement, as a crucial influence on his thinking on colour. On coming in London in 1937, Ozenfant had published a

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typescript, November 1948), pp. 24-28 (p. 25).
[67] Medd, 'Application of Colour in Building', p. 24.

series of articles on the subject, in which he criticized the lack of method and precision in the choice of colours in buildings:

> The architect receives in the schools a serious and methodical course on the art of planning, materials, strength calculations. All these studies on which his art depends are the subjects of methods, laws, tables. But colour is left entirely to the architect's sensibility. It is all completely empiric. It is all haphazard. [...] We must try to find some method of arriving at some sort of order-one that will at least enable us to escape from this vagueness in the design of colour.[68]

To Ozenfant, the solution was standardization, with Great Britain leading the way: 'I believe that an immense service would be done to architects, decorators, house-painters, etc., if a chart especially adapted to their particular requirement were established. This chart might contain about a hundred hues. [...] The initiative could, of course, be undertaken by the Standards Office.'[69] The proposed 'architectural' colour range was to be based and improve on the classification and notation system developed in the 1920s by the German physical chemist Wilhelm Ostwald.[70]

The vagueness of the theory and practice of colour had already been commented upon by some architects in the 1920s. 'In spite of much talk in recent years and a certain amount of research work, colour decoration is still in a somewhat nebulous state', observed L. H. Bucknell, a teacher at the AA School.[71] 'There are many reds, blues and yellows,' wrote George Drysdale, the director of the school of architecture in Birmingham, 'many more than the trade is aware of. Many of us specify red or blue, as the case may be, and leave it at that [...]. I wonder if we always realise that we cannot talk about

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[68] Amédée Ozenfant, 'Colour: The English Tradition', AR, 81 (1937), 41-44 (p. 44).
[69] Amédée Ozenfant, 'Colour: Experiments, Rules, Facts', AR, 81 (1937), 195-98 (p. 196).
[70] Ozenfant, 'Colour: Experiments', p. 196.
[71] L. H. Bucknell, 'Modern Architectural Colour', RIBAJ, 32 (1925), 281-83 (p. 281) (repr. 'Foreword', in John M. Holmes, Colour in Interior Decoration (London: Architectural Press; New York: Charles

colour accurately.'[72] The disorderly, anarchic nature of ready-mixed colour ranges offered by industry to decorators and architects was pointed out by John Holmes, a lecturer in decoration at the AA School of architecture, in his manual Colour in Interior Decoration. 'A plea is made here', wrote his colleague Bucknell in the foreword, 'for a reasonable standardization and classification of manufactured colours to obviate the present confused variety in sample books.'[73]

However, unlike Ozenfant, Holmes and Bucknell devoted only a few lines to the subject of standardization. In fact, such a discussion of standardization was uncommon between the two world wars. Like other writers on colour decoration of the period, Holmes's main concern was with theories of colour relationships and their application to the production of colour schemes.[74] Largely inspired by the many nineteenth-century studies on the subject, these theories promulgated laws according to which colours could be harmoniously combined or juxtaposed.[75] Thus the ordering system for colour sample books proposed by Holmes did not seek precise colour designation, or the reduction of the number of colours available to architects and decorators, but aimed to achieve 'good colour relationships'.[76] On the whole, consideration of colour in an architectural context was limited to general, unsubstantiated comments on

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Scribner's, 1931)).

[72] George Drysdale, 'Architect and Artist', RIBAJ, 81 (1924), 534-36 (p. 535).

[73] John M. Holmes, Colour in Interior Decoration (London: Architectural Press; New York: Charles Scribner's, 1931), p. 76; Bucknell, 'Foreword', p. 10. See also 'Colour Names Standardised', ABN, 125 (1931), 230: 'One could wish that standardised names could be established for paint colours. It is quite impossible to visualise a scheme of colour decoration from a written description.'; 'Book Review: Colour in Interior Decoration', ABN, 128 (1931), 267: 'Colour is a fascinating if somewhat baffling subject, the principal stumbling block being the entire lack of any standard of values in pigments. Until pigments are standardised as rigidly as drugs in the British Pharmacopoeia, decorators will find considerable difficulty in specifying colour schemes that will produce what they want without a great deal of revision on the job.'

[74] Holmes, Colour in Interior Decoration, p. 18; H. Barrett Carpenter, Colour: A Manual of its Theory and Practice, 3rd edn (London: B. T. Batsford, 1933).

the importance of colour, on its relation to form, structure, proportion and light and to occasional historical studies of the application of colour in past architecture, a relic of the nineteenth-century scholarship which had fed the stylistic revivals.[77]

If in the late thirties, the idea of colour standardization in architecture was a novelty, by the early fifties it had gained widespread acceptance among architects. What had once been a decorative concern, a matter of subjective, incommensurable aesthetic judgement, was increasingly presented as a science, a seemingly objective part of architecture. Andrew Saint has emphasized the commitment of public architects to the development of a national standard of architectural colour from its modest beginnings within the Herts County Council Architect's Department:

> Here was another example of how public architecture in this period filled a want which private practice could never conceivably supply. Without charge, patent or restriction, the fruits of local experiment and experience were fed into the pattern of national building for others to take advantage from.[78]

Although such a view informs us on the architects' motivations and rationales, it fails to give an account of the astonishing scientization of colour which underlined the making of the standard. Indeed, why did many British post-war architects so keenly embrace a scientific approach to architectural colour? Why was the particular field of colour, traditionally associated with subjectivity and art, scientized by architects?

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[75] See for example, Michel-Eugène Chevreul, The Principles of Harmony and Contrast of Colours, trans. by Charles Martel, 2nd edn (London: Longman, 1854); Wilhelm von Bezold, The Theory of Colour, trans. by S. R. Koehler (Boston: Prang, 1876); Ogden Rood, Modern Chromatics (London: Kegan Paul, 1879).
[76] Holmes, Colour in Interior Decoration, pp. 39-40, 76-77.
[77] Edward Maufe, 'Present Day Architecture', AAJ, 47 (1932), 156-60 (p. 159); Bucknell, 'Foreword', Colour in Interior Decoration, p. 9; Howard Robertson, Architecture Explained (London: Ernest Benn, 1926), p. 155; William Harvey, 'Colour in Architecture', RIBAJ, 29 (1922), 485-501.
[78] Andrew Saint, Towards a Social Architecture: The Role of School Building in Post-War England (New

One crucial reason for these new attitudes to colour was the British state's scientific ideology and modern architects responding to that ideology by successfully recasting themselves as scientific experts. Another, closely related reason were the attempts by architects to rehabilitate and redefine decoration in face of the modern movement's traditional aversion to decoration, and within the context of the post-war scientization of building.

Scientific Experts

From the second world war on, the British state committed itself to the scientization of building, for some two decades actively promoting standardization, prefabrication and the use of innovative building technologies. This scientific revolution in building was viewed as crucial to the realization of the massive building programmes set up after the war as a response to the housing shortage and to reforms in health and education. Indeed, faced with difficult economic and political conditions which threatened its programmes, the state seized on the current belief in science and technology as a panacea for society's ills. The inspiration for this strategy came in part from the doctrine of the modern movement, according to which scientifically-based mass-production of architecture was a means to rapidly available, abundant and low-cost building for all. As Brian Finnimore argues, a scientized architecture, with its promise of social justice and harmony, played an important ideological role in sustaining the belief that the state was able to fulfil the needs of the working class and, so the state hoped, in securing the loyalty of its citizens.[79] Many architects, whose status within a highly

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Haven and London: Yale University Press, 1987), p. 90.

[79] Brian Finnimore, Houses From the Factory (London: Rivers Oram Press, 1989), pp. 127-29, 234.

competitive building industry had up until the second world war rested mainly on their design skills, felt at first threatened by these state-induced changes. To protect their professional interests, architects soon willingly colluded with the government's scientific aims. Espousing the doctrine of the modern movement, they evolved a new professional identity, posing as scientific and technological experts devoted to the fulfillment of human needs. As one architect put it:

> Let him recognize that the age of empirical formulae is gone, and that of rational calculation firmly established, for only by accepting this rather unpalatable truth and equipping himself with the necessary means to deal with it, can the architect hope to maintain his position as a competent leader of the building team.[80]

However, at the same time as modernism triumphed, and as the scientization of building was relentlessly pursued, a revision of pre-war modernism was taking place. As Joan Ockman points out, this was in part due to a reassessment of the belief in science as guarantee of material and social progress, following the use of science to destructive ends during the war. Among the new directions given to modernism were a rapprochement of functionalism with humanist issues such as aesthetic expression, and a return to topics previously barred from modernism, namely, decoration.[81] In Britain, the perception that architecture had become overly scientific and inhuman was indeed shared by a section of the profession. Centred on the journal Architectural Review, this revisionist movement was designated by the name of

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[80] K. R. Herbert, 'Letters', AJ, 115 (1952), 36.
[81] Architecture Culture 1943-1968: A Documentary Anthology, ed. by Joan Ockman with Edward Eigen (New York: Columbia University Graduate School of Architecture, Planning and Preservation; Rizzoli, 1993), p. 13.

New Empiricism, or New Humanism, by contributors of the journal.[82] Their views were brilliantly summarized by Gordon Cullen in 1950:

> Everyone is aware nowadays of the danger of architecture, having absorbed so much of the scientific vocabulary and outlook, losing all contact with the humanity which is its reason for existence. An architecture which cannot retain qualities that the ordinary individual can welcome and apprehend, will never achieve widespread popular support and therefore never fulfil its proper social role.[83]

This charge against modernism instigated similar calls for a change in the professional role of architects. 'And for a true understanding of our fellows', Sven Backström wrote in the Architectural Review, 'both the feeling and the knowledge of the artist are essential conditions. It is not sufficient for the architect to be an engineer; he must also be an artist.'[84] The humanist revision of modernism allowed many architects to mitigate what they perceived as an excessively technocratic image, and to present themselves as capable of artistic expression, of communion with their fellow human beings.

Decoration, we have seen, was viewed as one means of humanizing modern architecture, of reestablishing contact with the people. However, there were two important obstacles to this return to decoration. One was the modern movement's long-standing hostility to the subject, another was the necessity for architects to appear as scientific and objective professionals. The scientization of the decorative practice of colour by architects aimed in part at making colour acceptable within modernism, and tolerable to the political

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[82] See Sigfried Giedion, 'Alvar Aalto', AR, 107 (1950), 77-84; A. D. B. Sylvester, 'Architecture in Modern Painting', AR, 109 (1951), 81-88 (p. 88): 'Architectural theorists to-day feel a need for a less austere and puritanical approach than that of the Bauhaus tradition and functionalism in general, a revulsion against both rigid geometry of design and bareness of surface, a desire for a more organic style.'

[83] Gordon Cullen, 'Trees Incorporated', AR, 108 (1950), 233-248 (p. 235).

[84] Sven Backström, 'A Swede Looks at Sweden', in Architecture Culture 1943-1968: A Documentary Anthology, ed. by Joan Ockman with Edward Eigen (New York: Columbia University Graduate School of Architecture, Planning and Preservation; Rizzoli, 1993), pp. 43-46 (p. 45).

establishment by demonstrating that the architects' command of science also extended to aesthetic matters.

Modernism and Decoration

Until about the time of the second world war, colour had unequivocally been considered as decoration, defined as the embellishment of architectural surfaces, and primarily a matter of expression and aesthetics, of experience and taste. H. S. Goodhart-Rendel in a lecture entitled 'Some Opinions upon Architecture and Decoration' affirmed that colour was more important than form for 'emotional comfort', adding with confidence that such a statement stemmed entirely from 'personal experience'.[85] In the Architectural Association School of Architecture's prospectuses, and in the RIBA prescribed reading lists issued between the wars, works on colour were classified under the headings of decoration and aesthetics.[86] Likewise, colour in architectural journals was frequently discussed as part of the decorative aspect of the building. For example, the description of the interior of a cinema published in the early 1930s read:

> The colour scheme of the decoration is based on the consideration of the flood-lighting colours-red, blue, and green, and is nothing more than a background to obtain the maximum effect for the changing coloured light. Buff, and matt silver surfaces predominate, accentuated by orange, peacock blue, and silver leaf portions to give point where necessary to the decorative form.[87]

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[85] H. S. Goodhart-Rendel, 'Some Opinions upon Architecture and Decoration', ABN, 128 (1931), 100-101 (p. 100).

[86] See James Ward, Colour Decoration of Architecture (London: Chapman & Hall, 1913); Holmes, Colour in Interior Decoration, a book intended for AA students. In the AA School of Architecture prospectus for the year 1930-31, the theory of colour is said to be a preliminary to the study of decoration.

[87] 'Sheen Cinema' (Leathart & Granger), ABN, 125 (1931), 6-11, 13 (p. 8); see also 'A Factory Office' (Aiton & Scott), ABN, 128 (1931), 15-17.

Yet, after the second world war, architects seemed to downplay the decorative role of colour. 'We claim that colour has an effect on the character of buildings to a greater and more fundamental degree than is yet generally realised and we wish to advance a plea at this point that architectural colouring should take a recognised place in the syllabus of all schools of architecture as an integral part of design, not as a mere embellishment.'[88] For David Medd, what he described as the 'decorative' approach to colour was best avoided:

The commonest sign of this approach is the exaggeration of detail, picking out lines, or the super-imposition of a pattern foreign to the surface on which it is being applied. It would be a mistake to condemn this approach, but treated as a method it is almost bound to be taken too far and lead to some form of decadence.'[89]

This change of view towards colour was in part a consequence of the introduction of modern movement ideas into mainstream British architecture from the second world war on. Indeed, a key feature of the theory and, at face value, of the practice of the modern movement from the time of its emergence in the late nineteenth century had been its rejection of decoration. As Reyner Banham remarked: 'Everyone knows that Modern Architecture is undecorated. This concept is the layman's recognition check: flat roof, big windows, no decoration. It is also one of the great seminal half-truths that have now become rules of design morality.'[90]

The conceptual source of this rule lies in late eighteenth and early nineteenth century German philosophical aesthetics, namely in the writings of Immanuel Kant, which asserted that aesthetics was independent from utility, and that architecture, being predominantly practical, was thus of limited

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[88] H. L. Gloag, D. L. Medd, 'Colour in Buildings', RIBAJ, 63 (1956), 334-45 (p. 334).
[89] David Medd, 'Colour in Buildings: A Scale for Use in Schools', Builder, 176 (1949), 251-52 (p. 251).
[90] Reyner Banham, 'Ornament and Crime', AR, 121 (1957), 85-88 (p. 85).

aesthetic value.[91] In view of that Kantian separation of aesthetics from utility, was architecture to be considered as an art or as an utilitarian pursuit? This was the question which throughout the nineteenth century underscored the debate on decoration in architecture.[92]

In one view, it was assumed that architecture was an art, primarily concerned with ideas and meanings, and therefore that decoration, whose task it was to convey meaning, was the only purely aesthetic part of architecture. Subscribing to such a view was the British critic John Ruskin, who dismissed the utilitarian in architecture, and equated architecture with decoration, that which was useless and beautiful in architecture. In The Seven Lamps of Architecture, he noted that 'ornament is an extravagant and inessential thing' and reflecting on the progression of his ideas on architecture, he wrote: 'it gradually became manifest to me that the sculpture and painting were, in fact, the all in all of the thing to be done; that these, which I had long been in the careless habit of thinking subordinate to the architecture, were in fact the entire masters of the architecture'.[93]

Likewise, although from an entirely different perspective, the German architect and historian Gottfried Semper also considered decoration to be the most meaningful and thus most important part of architecture. Semper has been misinterpreted as a functionalist, yet he refuted the argument that materials and structure were at the origin of architectural form. On the contrary, he traced the origins of architecture to four elements or essential

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[91] Immanuel Kant, Critique of Judgement, trans., introduction and notes by J. H. Bernard, 2nd rev. edn (London: Macmillan, 1914), Book 1, §15, 44, 45; Book 2, § 51.
[92] See for example Otto Wagner's criticism of Semper. H. F. Mallgrave, 'Introduction', in Modern Architecture, introduction and trans. by Harry Francis Mallgrave (Santa Monica, CA: Getty Center for the History of Art and the Humanities, 1988), p. 33.
[93] The Works of John Ruskin, ed. by E. T. Cook and Alexander Wedderburn, 39 vols (London: George Allen, 1903-1912), VII, pp. 10, 83.

ideas, the hearth, the roof, the enclosure and the mound, which had received a first material existence by means of crafts techniques, such as ceramics, carpentry, masonry and weaving. Thus the idea of space enclosure was first embodied in the weaving of plants and later of carpets hung vertically as walls. Even as in time more solid materials were needed, and as primitive techniques were abandoned, the motifs they had generated were transposed and metamorphosed as decoration. And it was decoration which symbolised the essence of architecture, which reminded us of the original idea in its primitive embodiment, and at the same time acted as mask to the material reality of architecture, the conditions, for Semper, of true art.[94]

Gaining momentum however was another movement which in the last decades of the nineteenth century appeared to turn against the Semperian emphasis on decoration. Concerned like most architects of the period with the quest for a style truly of their own epoch, the instigators of this counter-movement advocated emancipation from historical references as a path towards a modern style, and sought new repositories of aesthetic meaning in architecture. Among the new sources of aesthetic meaning for modern architecture, these rebellious architects gave primary importance to the concepts of form and space. Of Kantian extraction, these concepts were subsequently developed by late nineteenth-century aestheticians such as Robert Vischer, Adolf Hildebrand and August Schmarsow, before being taken up by architectural theoreticians and architects. Harry Francis Mallgrave points

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[94] Michael Podro, The Critical Historians of Art (New Haven and London: Yale University Press, 1982), pp. 45, 48; Harry Francis Mallgrave, 'Introduction', in Gottfried Semper, The Four Elements of Architecture and Other Writings, trans. by Harry Francis Mallgrave and Wolfgang Herrmann (Cambridge: Cambridge University Press, 1989), pp. 24-25, 39; Gottfried Semper, The Four Elements of Architecture: A Contribution to the Comparative Study of Architecture (1851), pp. 102-03; Style in the Technical and Tectonic Arts or Practical Aesthetics: A Handbook for Technicians, Artists, and Patrons of Art (1860), pp. 255, 257.

out how the writings of Heinrich Wölfflin and Adolf Göller brought these aesthetic researches, (largely based on the physiology and psychology of perception) to the attention of architects, and by emphasising the aesthetic value of abstract, pure forms, contributed to the demise of historical forms in modernist theory and practice.[95] It was also in the last decades of the nineteenth century, and under the influence of, amongst others, French structural rationalism, A. W. N. Pugin's own version of French rationalism and the material interpretation of Semper's theory of architecture, that other aspects of architecture such as function, construction and materials came to be regarded by architects as sources of aesthetic meaning in a new modern architecture. This awareness of the aesthetic possibilities of materials, structures or construction, and of the beauty of abstract forms, helped bring about the rejection of historically-inspired decorative detailing. These novel tendencies were cleverly brought together in the architect Otto Wagner's influential book Modern Architecture, first published in 1896. Wagner believed utility to be the dominant principle of architecture, and asserted that from the truthful construction and use of materials, later vested with artistic ideals, would emerge new architectural forms, whose main characteristics were simplicity and restraint in decoration.[96] Wagner wrote: 'there is in the new style a merging (convergence) of tectonic and sculptural form, a minimal use of sculptural decoration in general, an objection to the arrangement of portrait statues as tectonic building elements, a clarity of ornamental form, and so many other things.'[97] At the turn of the century, in the wake of Wagner's

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[95] Empathy, Form, and Space: Problems in German Aesthetics, 1873-1893, introduction and trans. by Harry Francis Mallgrave and Eleftherios Ikonomou (Santa Monica, CA: Getty Center for the History of Art and the Humanities, 1994), p. 3; Wagner, Modern Architecture, pp. 23-25.
[96] Wagner, Modern Architecture, pp. 33, 39, 40.
[97] Wagner, Modern Architecture, p. 85.

manifesto, the theorists of European modernism adopted an increasingly hardening attitude towards decoration. Thus in 1901, Henry van de Velde designated form itself as the new ornament, while the following year, in his book Stilarchitektur und Baukunst, Hermann Muthesius called for an architecture entirely devoid of decoration. Looking upon contemporary developments such as railway stations, new bridges and bicycles as embodying the principles of a new modern style, Muthesius affirmed: 'Here we notice a rigorous, one might say scientific objectivity [Sachlichkeit], an abstention from all superficial forms of decoration, a design strictly following the purpose that the work should serve.'[98]

It was however the Austrian architect Adolf Loos which provided the most radical formulation of this modernist banishment of decoration. In his influential essays 'Ornament and Crime' (1908), and in 'Architecture' (1910), Loos posited the incompatibility of modern architecture and decoration. His argument was a reworking of the Kantian idea of aesthetics which, in a sense, he brought to its 'logical' conclusion: as architecture was concerned solely with practicality, it was therefore not an art and should not carry any artistic or decorative features.[99] Loos' iconoclastic comments soon caught the attention of the French avant-garde. After a first translation in French in 1913, 'Ornement et Crime' was published in L'Esprit nouveau, the Purist magazine founded by Le Corbusier and Amédée Ozenfant in 1920.[100] Le Corbusier found Loos' views most useful in elaborating his own theory of modern design and

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[98] Hermann Muthesius, Style-Architecture and Building-Art, introduction and trans. by Stanford Anderson (Santa Monica, CA: Getty Center for the History of Art and the Humanities, 1994), p. 79; Wagner, Modern Architecture, pp. 43-45.

[99] Adolf Loos, 'Architecture' (1910), in Tim Benton, Charlotte Benton, with Dennis Sharp, Form and Function (London: Crosby Lockwood Staples and Open University Press, 1975), pp. 41-45 (p. 45).

[100] Adolphe Loos, 'Ornement et crime', in L'Esprit nouveau: revue internationale d'esthétique, no. 2 [1920] (repr. New York: Da Capo Press, 1968)), pp. 159-68.

architecture. Loos' uncompromising equation of ornament and crime was combined to other sources of inspiration such as social Darwinism, German Sachlichkeit, and a productivist approach to architecture and design. Sharing in the national enthusiasm for industrial efficiency, this last stance eulogized American scientific management, mass production, prefabrication and standardization.[101] Thus in the 1920s, Le Corbusier expounded his belief that modern objects and architecture, like machines, tended to perfect, standard shapes geared to the satisfaction of human needs and devoid of unnecessary decoration. In The Decorative Arts of Today (1925), a modernist classic against ornament, Le Corbusier wrote in his enigmatic prose: 'There is no mystery in the crisis of the decorative art; the miracle can occur of an architecture that will be, the day when decorative art ceases to be.'[102]

In the 1920s and 1930s, Le Corbusier's writings and images were for British architects one of the main sources of information on the modern movement in mainland Europe.[103] It was thus through them that Adolf Loos' strong views on decoration, and the echoes of the nineteenth-century debates on the place of decoration in architecture, were absorbed into British modernism.

Closer to home, the Arts and Crafts movement undoubtedly prepared the ground for the modernist anti-decorative stance in Britain. In the last decades of the nineteenth century its leading architects instigated a style only loosely based on historical precedents and making a sparse use of decoration. It was however William Richard Lethaby who through his writings and teachings

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[101] See Mary McLeod, '"Architecture or Revolution": Taylorism, Technocracy, and Social Change', Art Journal (Summer 1983), 132-47 (p. 135).
[102] Le Corbusier, The Decorative Art of Today, trans. and introduction by James I. Dunnett (London: Architectural Press, 1987), p. 181.
[103] See for example in Alan Powers, In the Line of Development: F. R. S. Yorke, E. Rosenberg and C. S.

effectively modernised the Arts and Crafts doctrine and most explicitly attacked ornament in architecture. Around the time of the first world war, Lethaby came to reject, under the influence of Muthesius, his previous beliefs in a craft basis for architecture.[104] He envisioned instead a new architecture stemming from science and industrial methods, from functional requirements and human needs. He viewed the nineteenth century quest for a modern style as futile and advocated the restrained use and even elimination of historicist ornament. In 1920 he wrote:

> To go on building houses in the cocked-hat and brass-candlestick style is not only rather imbecile play-acting, but it destroys rational growth. We have to put an efficiency style in the place of this trivial, sketchy picturesqueness. Even leaving out the style trimmings would be something. If you cut away disease and surplusage, you strengthen and consolidate.[105]

Lethaby's attacks on style and decoration were used by the architect F. R. S. Yorke, (later of the post-war practice Yorke Rosenberg Mardall), to support the budding cause of British modernism in the 1930s. Indeed, a long passage, including the extract quoted above, was used as a foreword to Yorke's The Modern House in England, published in 1937.[106] As Alan Powers has indicated, Yorke was familiar with Lethaby and the Arts and Crafts tradition, partly through his architect father's Arts and Crafts practice, and through his training at the Birmingham School of Art in the late 1920s, where he met other future modernists such as Frederick Gibberd and Frank Gollins. Similarly, Charles Holden, a generation older, was no stranger to the Arts and Crafts doctrine.

Mardall to YRM, 1930-1992 (Exhibition Catalogue, RIBA Heinz Gallery, 1992), pp. 17, 18.

[104] W. R. Lethaby, 'Modern German Architecture and What We May Learn From It', in Form in Civilization, 2nd edn (London: Oxford University Press, 1957), pp. 78-85 (p. 81); Muthesius, Style-Architecture and Building-Art, p. 28.

[105] W. R. Lethaby, 'Housing and Furnishing', in Form in Civilization, 2nd edn (London: Oxford University Press, 1957), pp. 29-37 (p. 30).

[106] F. R. S. Yorke, The Modern House in England (London: Architectural Press, 1937), pp. 11-12.

Although best known for his modern classical designs of the 1930s, Holden trained with C. R. Ashbee, and his early practice at the turn of the century included projects and buildings in the pared down, dehistoricised Arts and Crafts style.[107] In The Modern House, first published in 1934, Yorke himself looked upon the Arts and Crafts architects as precursors of the modern movement. He also reiterated the Lethabian and modernist edicts against ornament: 'The modern architect does not force upon the house a symmetry or a geometric scheme if neither symmetry nor geometry is necessary to the purpose of his project. He does not cover it with decorations borrowed from the "styles" or with modernistic ornaments invented by catchpenny commercial fashion makers.'[108]

In Britain as on the continent, the rejection of decoration was held as a formative principle of the modern movement. This canonical assumption has however been challenged by Mark Wigley in his book on the meaning of the ubiquitous white wall in modern architecture.[109] Modern architecture, he notes, has long been closely identified with white walls. These are habitually interpreted as neutral, as signalling a complete absence of decoration. Yet, in re-examining the seminal texts and buildings of the modern movement before the second world war, Wigley concludes that architects did not in fact reject decoration but developed their own 'sophisticated theory of the surface'. He argues that, contrary to received knowledge, modernists perpetuated the nineteenth-century Semperian view of architecture as clothing. Thus, it was not that historical styles and decoration had been stripped away to reveal a

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[107] Powers, In the Line of Development, pp. 9-10; Peter Davey, Arts and Crafts Architecture (London: Phaidon Press, 1995), p. 144.
[108] F. R. S. Yorke, The Modern House, (London: Architectural Press, 1944), pp. 24, 14.
[109] Mark Wigley, White Walls, Designer Dresses: The Fashioning of Modern Architecture (Cambridge, MA and London: MIT Press, 1995).

pure, cleansed, transparent modern architecture. Rather, a change of dress had taken place, old clothes replaced by new ones. The smooth, white surface was the modernized dress of architecture. It was the new decorative surface, suspended and stretched like the textiles of Semper's primordial architecture. As with Semper, the surface was a crucial element of architecture, and that which defined space.

But as Wigley reminds us, modern buildings were not only painted white. Indeed, at the same time as the equation of white and modern was being established, architects such as Le Corbusier and Bruno Taut were making extensive use of colour which, Wigley argues, was conceived and construed as a 'multi-coloured outfit'. Yet, this new decorative practice has gone virtually unrecorded by the major historians of modern architecture. According to Wigley, this strange silence stemmed from the obsessive hostility amongst modern architects and historians. not only towards decoration but most crucially towards fashion. Modern architecture was sold as the final, ahistorical, eternal style. The powerful image of modern architecture as white, which was thought to encapsulate this monolithic and static vision of modern architecture, was painstakingly crafted through a long process of selection and censorship, in which historians had a leading role. To have recognized modern polychromy would have been to recognize the incontrovertible phenomenon of fashion, of which, as Wigley shows, the modern movement was part and parcel. It would have threatened the white, immutable image of modern architecture. Wigley's intense arguments have many interesting implications for the study of British post-war colour. His detailed interpretation of the persistence of a decorative practice in modernism as, in part, a continuation of the nineteenth-century clothing

metaphor, offers one useful understanding of post-war architects' conception of decoration and of colour. Another implication of Wigley's work is to alert us to the complexity and inconsistencies within the issue of decoration, and to the obstacles, prohibitions and controls faced from within the modern movement by architects attempting to reinstate a decorative practice of colour.

2. COLOUR AND DECORATION IN BRITISH MODERNISM

The contradictions and ambiguities of the modern debate on decoration inevitably constrained and shaped the efforts of those among British architects who sought to humanize modern architecture after the war. Indeed, a central problem for those architects was to find a form of decoration which would satisfy modernist criteria, as well as be acceptable to their political masters. Gordon Cullen underlined the humanist's quandary:

> The problem is how to encourage modern architecture to develop sympathetic human qualities without driving it in a backward direction or a direction of false sentimentality. In the old days this was achieved by humanistic embellishments-such as the classical order (now culturally irrelevant)-and by carving and other hand-worked enrichment (now, [...], largely incompatible with the spirit of architecture). [...] there are, or should be, many other methods of enriching or embellishing the diagram building without applying decoration in the traditional sense of pilaster or crocket.[110]

Past forms of decoration having been rejected, new, modern practices had to be found. However, many British modernists were fiercely opposed to decoration. A form of decorative policing was instituted in part through historical and critical writings, which pounced on any breach to the anti-decorative canon. This is well demonstrated by Reyner Banham's hostile reaction to the Neoliberty style in Italy, whose proponents were scandalously

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[110] Gordon Cullen, 'Trees Incorporated', AR, 108 (1950), 233-48 (p. 235-36).

unburdened by decorative inhibitions. Modernism, argued Banham, had achieved a welcomed break with the past. Neoliberty, which harked back to Italian Art Nouveau, betrayed the modernist ideals of 'formal architectural purity' and represented a retreat from the modern movement. 'To revive it', Banham concluded, 'is thus to abdicate from the Twentieth Century'.[111] In a paper given in 1941, John Summerson perceptively discussed this modernist fear of ornament, which he ascribed to an undiscriminating espousal of Loos' puritanical views, and to an anxiety about lapsing into stylistic revivals. In fact, he believed that modernists had failed to understand the nature of ornament and pointed to an alternative decorative theory and practice appropriate to modern architecture. He argued that there were two kinds of ornament, on the one hand what he called the 'subjunctive architecture', a historical, imitative, reprehensible form of ornament, and on the other hand, the abstract, valid 'problem of surface', to do with patterns and 'decorative revetements'.[112]

However, even some of these decorative practices hinted at by Summerson were unsympathetically received by British modernists. A vivid illustration of this is the reaction to Berthold Lubetkin's facades of his public housing schemes in the 1940s and 1950s. John Allan recounts that modern architecture was not to Lubetkin solely about functional planning or advanced building technology. It was more importantly about aesthetic expression and impressions, the communication of an egalitarian ideology to the onlooker. As Lubetkin saw it, the problem was to reconcile in a single aesthetic pronouncement the boundless repetition of the urban facade which standard

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[111] Reyner Banham, 'Neoliberty: The Italian Retreat from Modern Architecture', AR, 125 (1959), 231-35 (pp. 231, 235).

dwelling units were thought to make inevitable, with the modernist concern with human values. His solution for the elevations, consisting of a checker pattern surrounded by borders, was almost unanimously condemned by his contemporaries as an excessive preoccupation with aesthetics. In their view, the forms of a building were derived from its function and plan and should not be arbitrarily camouflaged and subverted by decorative patterns.[113] This characteristically modernist point of view is apparent in Cullen's somewhat extreme suggestion that trees were a natural way to embellish and humanize while leaving intact the abstract appearance of modern architecture.[114] (Fig. 2) The same view was expressed by David Medd whose use of euphemisms convey his efforts to bypass the modernist taboo on decoration:

'Decoration or 'interest value' can be achieved in 2 ways-one by using materials of inherent decorative value-or by applying decoration on the surface. The first is a simpler process and is a matter of material selection and formal control-the stock in trade of architectural design-the second requires more creative and artistic ability and offers more pitfalls for the [unskilful.] [...] Again the first rule, [...] is that decoration should not destroy form.'[115]

Science of Colour Decoration

Architects thus posited new 'methods' of decoration which could be seen as modern and would escape the wrath of the decorative police. In part because of its unobtrusiveness, its flatness and surface-hugging minimalism, and inasmuch as it was seen not to subvert, but enhance architectural forms, colour was regarded by many as an acceptable form of decoration in modern buildings. However, attempting to talk about decoration, about the problem of

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[112] John Summerson, 'The Mischievous Analogy' in Heavenly Mansions and Other Essays on Architecture (London: Cresset Press, 1949), pp. 195-218 (pp. 214-17).
[113] John Allan, Berthold Lubetkin: Architecture and the Tradition of Progress, (London: RIBA Publications, 1992), pp. 386, 390.
[114] Cullen, 'Trees Incorporated', p. 236.
[115] David Medd, 'Ideas on Decoration' (unpublished typescript, December 1951) p. 1.

the treatment and meaning of the surfaces of buildings, against the established rules of the modern movement, was one factor which led architects to maintain an ambivalent and shifting discourse on the subject. Thus, out of fear of being perceived as unmodern, many architects would not admit to colour being decorative and attached a suitably pejorative meaning to the word. In an article on the Hertfordshire schools, Richard Llewelyn Davies and John Weeks declared: 'Colour is always used in an architectural rather than in a decorative manner.'[116] For the authors, the word 'architectural' stood for the exact opposite of their view of what was decorative: colour in these most modern of buildings was not applied, unessential embellishment, but served to differentiate interior planes and emphasize the modular construction system of the schools. For another commentator, writing in 1956, it was harsh economic circumstances which made colour an ideal replacement for past forms of decoration: 'But rich colour is all that the twentieth-century can offer now that texture, sculpture, decoration and bold three-dimensional modelling is too expensive for present-day facades and surfaces.'[117]

There was in fact a tradition in the modern movement of considering colour as a modern alternative to historical decoration. In Style-Architecture and Building-Art (1902), Hermann Muthesius had regarded colour as integral to the simple and functional architecture he called for. Inspired by the example of the late nineteenth-century English free style, Muthesius set the goals which a new German domestic architecture should achieve: 'to renounce every architectural trinket on and in our house; and to introduce a sense of spatial warmth, color, natural lay-out, and sensible configuration instead of continuing

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[116] Richard Llewelyn Davies, John R. Weeks, 'The Hertfordshire Achievement', AR, 111 (1952), 367-87 (p. 385).

to be restrained by the chains of formalistic and academic architecture-mongering.'[118] For Lethaby, colour was also a particularly modern form of decoration: 'Ample materials for ornamentation exist which are universal and modern without our calling for more hundreds of miles of "egg and tongue" or more acres of "vermiculation." These are such methods as the introduction of precious materials, and changes of colour, plaitings and frets of lines.'[119]

But for colour to appear as a modern antithesis to stylistic, applied ornament, it had, most crucially, to be grounded in science. In his study of Lubetkin, John Allan has shown that, if thought to stray away from rationalist or functionalist justifications, a decorative practice was likely to meet with suspicion. The designs of Mies van der Rohe or Le Corbusier, however, because they appeared to derive from structural or constructional elements, were more warmly received by British critics.[120] Even for those architects who had expressed doubts over the state of modernism and had proposed new, more human ways for architecture, science, albeit subdued, was thought to be central to modern architecture and human progress.[121] Why was science still held in such high esteem by architects? And why did they insist on looking upon colour decoration as a science? The professional prestige of architects within the British state after the second world war stemmed to a large extent from their claims to possess a unique expertise in science and technology. This gave rise to the paradox that to humanize modern architecture, to introduce the

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[117] Astragal, AJ, 123 (1956), 402.
[118] Muthesius, Style-Architecture and Building-Art, p. 97.
[119] W. R. Lethaby, Architecture, rev. ed. (London: Thornton Butterworth, 1929), p. 240 (quoted in Robert McLeod, Style and Society (London: RIBA Publications, 1971), p. 65, n. 25); see also 'Book Review: Colour in Interior Decoration, by John M. Holmes', ABN, 128 (1931), 267: 'At the present day, it [colour in interior decoration] is of even greater importance than in the past, since modern developments tend to rely for decoration mainly on colour by day and on colour in combination with light for decorative effect at night.'
[120] Allan, Berthold Lubetkin, pp. 390-91.
[121] See J. M. Richards, 'The Next Step?', AR, 107 (1950), 165-81 (p. 181).

decorative practice of colour in modern architecture, architects could not but make colour appear as a science. Colour, they claimed, was not the mere frivolity it had been in the past, but was an integral part of the new scientific architecture. Conversely, scientizing colour helped to maintain and reinforce the belief that architects commanded a scientific expertise which even encompassed and revolutionized traditional aesthetic concerns. In an article on colour in schools published in 1953, David Medd noted the recent shifts in British modernism and the need for a rational basis for modern decoration: 'there are signs that designers are realising that architecture is starved of visual interest, and that a form of decoration and enrichment must be established which springs naturally from present-day materials, techniques and economy.'[122] The standardization of colour and the development of a body of seemingly objective principles and rules of application were the means by which architects attempted to construct a science of colour decoration.[123]

Colour Science and Ambivalence

In 1951, the American colour consultant Birren bluntly declared: 'That functional colour is a unique science, little related to art or interior decoration, is now well understood.'[124] Yet, the confidence expressed by colour experts in achieving objectivity in colour was accompanied by strong doubts

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[122] David Medd, 'Colour in Schools', Transactions of the Illuminating Engineering Society, 18 (1953), 123-36 (p. 125).

[123] DSIR, BRS, Note No. B33, 'The Use of Colour in Factories', by W. A. Allen (unpublished typescript, July 1948), p. 17: 'This, as we see it, is the essence of the problem at the moment, -to establish a sound basis and tradition of colour practice in which the logical elements are directed into channels of cheerful good taste.'; Medd, 'Colour in Schools', p. 123: 'If we can establish some principles, a methodical approach, or a sort of child's guide to colour design that does not set down rules or recipes, we shall be doing enormous good.'; see also H. L. Gloag, M. J. Keyte, 'Colour Co-ordination for the Manufacturer and User', Design (March 1959), 34-40 (p. 40): 'With the aid of research, the use of colour in decoration and furnishing is becoming better understood, and less subject to arbitrary whims.'

[124] Faber Birren, 'The Functional Use of Colour', in Building Research Congress 1951: Papers Presented in Division 3 (London: Building Research Congress, 1951), pp. 176-80 (p. 176).

about the claims made. This problem, which plagued the theory of colour in buildings, had already been recognized between the wars. Little progress seemed to have been done when, in a BRS Note published in 1948, Allen cautiously concluded:

> The Station has provided this review of colour practice for industry because it believed it to be the case that managements wish to know to what extent colour usage can be founded upon certain knowledge. · It cannot be denied that the knowledge is much less certain than could be desired, nor can it be said that there is proof positive of solid economic returns for the investment.[125]

For the American physician and prolific writer on light and colour Matthew Luckiesh, colour played no more than a modest role in the improvement of lighting and vision:

> Color is generally a secondary aspect of visibility and seeing which is superposed upon the more basic world of brightness. It is very generally of far less importance in critical seeing than brightness which in its various aspects is the backbone of visibility. [...] Whereas low visibility and poor seeing conditions are generally due to indifference to or our ignorance of brightness-factors, color and spectral quality of light seem to be open doors for over-emphasis of their importance even to and beyond the borderline of quackery.[126]

In contrast, J. T. W. Walsh saw the role of colour in achieving better lighting and vision as the only one on which there was some certainty. Beyond this limited scope, speculation was inevitable, and Walsh warned his audience at the 1951 Building Research Congress against too ambitious a view of the scientific analysis of colour:

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[125] Note No. B33, 'The Use of Colour in Factories', p. 16; see also p. 1: 'It seems, in fact, that the use of colour in factories is not yet on a very reliable basis.'; see also W. A. Allen, 'Colour in Buildings', RIBAJ, 53 (1946), 282-88 (p. 283), on the conflicting evidence on the effect of colour on the size of rooms: 'In this matter we find ourselves again faced with widely held opinions which conflict among themselves and with what little evidence there is.'; Paint Research Station, Research Memorandum No. 122, 'The Painting of Factories: Colour and Psychology', (unpublished typescript, November 1945), p. 1: 'Research has revealed the complexity and variety of the facts, without as yet yielding generally accepted explanations.'

[126] Matthew Luckiesh, Light, Vision and Seeing: A Simplified Presentation of Their Relationships and Their Importance in Human Efficiency and Welfare (New York: Van Nostrand, 1945), p. 242.

The use of colour in its more general applications is, however, a matter on which opinions will almost certainly differ. This was well brought out in the report, quoted by Mr. Faber Birren, where reference was made to the difficulty involved in measuring the effects of a service as intangible as colour, and Mr. Gloag said frankly that we still lacked an understood basis for colour treatment. [...] Once again caution is needed lest what may well make a valuable contribution to human comfort should be discredited by the uncritical acceptance of every statement made by well-meaning enthusiasts.[127]

The assessment of the effects of colour to which Walsh referred in his address was certainly a problematic issue for those seeking to establish a science of colour after the second world war. Reporting seemingly positive results to the repainting of a calculating machine at the BRS, Allen noted: 'We can obtain the opinions of operators but a more exact proof would provide some very desirable evidence in support of the whole principle of using colour to help work.'[128] The hope was that reliable measurements of the effects of colour would help dispel doubts about the unscientificity of colour, and justify continuing financial support for this new field of research. At the conference on 'Colour and Lighting in Factories and on Machines', W. D. Wright, reader in colour vision at the Imperial College of Science, pointed out the lack of scientific basis for colour:

I think we shall find during this course that the principles on the use of Colour in Factories which are most firmly established and which have proved most successful have been reached empirically by trial and error. It is perhaps

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[127] J. W. T. Walsh, 'Review of Part III', in Building Research Congress 1951: Record of Discussion (London: Building Research Congress, 1951), pp. 144-46 (p. 145).
[128] DSIR, BRS, Note No. D68, 'Appraising the Results of Functional Colouring', by W. A. Allen (unpublished typescript, March 1949), p. 2. See also contribution of Mr. H. D. Murray of the Paint Research Station, 'Open Discussion Forum', in 'Colour and Lighting in Factories and on Machines: Report of Course' (unpublished typescript, November 1948), pp. 67-87 (p. 85): 'There is one point that occurs to me, [...], on how far scientific experiments have been made upon the successful result of changes in decorative schemes. [...] It is very difficult when you have completed a scheme to know whether it is, in fact, successful. The test of the success of the scheme is not whether it pleases you or the managing director, but whether it has improved conditions for the people working in the factory - a question that can probably be settled quite definitely by a man who is skilled in the methods of applied psychology.'

dissappointing (sic) to find that so much reliance has had to be placed on experience and so little on our knowledge of the facts of colour vision.[129]

He judged that certain aspects of the physiology of vision, as well as colorimetry, the science of colour measurement, constituted the fundamental and reduced body of scientific facts on colour, and that there was no valid scientific assessment of the psychology and aesthetic of colour. 'Hence although the assessment of the aesthetic and visual merits of a colour scheme may involve a number of rather intangible factors, the description of the colours themselves is not a factor that need give rise to any ambiguity or uncertainty.'[130]

No reliable methods of measurement or conclusive evidence were ever produced to support the wider claims of improved health, greater productivity and happiness through a science of colour. The authors of the Building Bulletin No 9 on colour in schools acknowledged as much but nonetheless typically persisted in claiming some beneficial effects for colour:

It is obviously impossible to give any exact proof of the effect on children and teachers of this new approach to colour, but there has been sufficient experience to provide both educators and architects with some evidence that daily work can be made more enjoyable when the colour scheme is a positive rather than a neutral element in the environment.[131]

This is not to deny that colour in buildings pleased onlookers and improved their lives in some way, but simply that such effects were not ascertainable in scientific terms. If anything, the architects' appeals for methods of measurements seem to make the paucity of scientific support more evident.

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[129] W. D. Wright, 'Fundamentals of Colour Vision', in 'Colour and Lighting in Factories and on Machines: Report of Course' (unpublished typescript, November 1948), pp. 12-18 (pp. 12).
[130] Wright, 'Fundamentals of Colour Vision', pp. 18, 16-17.
[131] Ministry of Education, BB9, Colour in School Buildings, 2nd edn (London: HMSO, 1956), p. 3.

But most of all what threw into doubt not only this quest for measurements, but also the scientific premises of, as Gloag put it, 'the controlled use of colour', were the studies such as those of Elton Mayo or T. N. Whitehead in the United States, which suggested that in themselves, improvements in the environment had no proven impact on workers' output.[132] It was not physical changes in the factory that were likely to raise productivity, but rather that such changes were seen to be done, that employers seemed eager to involve their employees in factory decisions. At the Building Research Congress, a Mr. A. L. Brentwood had criticized Birren's view of functional colour as being too narrowly concerned with the improvement of vision:

> In Australia experience had been that the growing interest of factory and office managements in the use of colour was due less to the effects that colour had on seeing, than the realization that it could have a profound effect on a worker's reaction to his work and to his work plane. Good colour could turn a dingy and depressing environment into a cheerful one, [...], engendered pride among employees in their work, and led to improved relations between men and management.[133]

Ultimately, colour in the factory was meant to induce a cooperative rather than an adversarial attitude to management on the part of workers.

Colour Science and Colour Sense

A number of architects realized that there was little to corroborate a so-called science of colour in architecture. Curiously, this did not prevent them from

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[132] H. L. Gloag, 'The Development of the Use of Colour in British Factories', in Building Research Congress 1951: Papers Presented in Division 3 (London: Building Research Congress, 1951), pp. 181-83 (p. 181); Reinhard Bendix, Work and Authority in Industry: Ideologies of Management in the Course of Industrialization (Berkeley, LA, and London: University of California Press, 1974), p. 310. Elton Mayo was a pioneer of the 'human relations' school of management in the United States between the wars.

[133] Contribution of A. L. Brentwood, 'Monday, 17th September, 1951', in Building Research Congress 1951: Record of Discussion (London: Building Research Congress, 1951), pp. 142-46 (p. 142); see also J. W. T. Walsh, 'Review of Part III', p. 145: 'For instance we may [...] try to assess the effect of a new colour scheme by something measurable such as output or absenteeism. The psychologist, however, will tell us that it is well recognized that any change (unless definitely for the worse) may, just because it is a change,

expressing undiminished confidence in the value of a scientific colour practice, and from insisting that proof for the effects of colour, albeit of a more empirical type, was at hand. As pointed out by Walsh at the Building Research Congress, Birren had recognized that a number of manufacturers thought that the effects of colour were too difficult to measure. Yet Birren went on to extract other, seemingly more favourable data from the report, not noting the perhaps rather loose terms in which that data was couched: '64.7% of the companies stated that colour had improved lighting. 27.9% reported production increases. [...] 19.1% commented favourably on reduced eyestrain and fatigue. 14.7% credited colour for reduced absenteeism.'[134] Likewise, Allen was undeterred in his optimistic pronouncements on colour by the absence of scientific validation:

> There is adequate evidence from experience with production studies under different lighting conditions to show that when work is seen well it can be done more rapidly and with less error than under poor conditions, and although the Station has not yet obtained figures to show what improvements can be had by colour treatments, there is no reason to doubt that some useful effect will be established. [...] It is impossible to say whether the effort and materials involved are more than justified by results, but again the Station has confidence that the sound use of colour will show a nett gain.[135]

We might ask ourselves why many modern architects so casually overlook the lack of scientific evidence for their claims on colour? Why did they persist, despite it being unsubstantiated, in the belief that there was such a thing as an ascertainable science of colour?

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be regarded as an improvement and give, temporarily, a positive effect.' (p. 145)

[134] Birren, 'Functional Use of Colour', p. 178. Birren quotes from a study by the National Industrial Conference Board on colour in industry: 'It was found, however, that many "companies were unprepared to evaluate their programmes primarily because of the difficulty involved in measuring the effects of a service as intangible as colour." '

[135] Note No. B33, 'The Use of Colour in Factories', pp. 16-17.

One simple answer to these questions was that it was in the architects' interest to do so. Indeed, architects have time and again been torn between the project to systematize and codify architectural knowledge and the danger that such knowledge would become available to all and then cease to be their exclusive preserve.[136] Architects after the war faced precisely this dilemma of how to make their practice appear scientific and objective without loosing control over it. Robert Thorne has noted that 'all professions like to imbue their expertise with a certain air of mystery, to encourage dependence on their skills by not revealing too much about their subject.'[137] While at pains to emphasize the scienticity of architectural colour, architects attempted to preserve the mystery, to remain in control of their practice, by invoking their unique, innate and intuitive taste, experience and imagination, their 'sound aesthetic judgement', which pre-empted and could overrule scientific objectivity. The power and prevalence of this strategy is made clear in the physicist Ralph Hopkinson's obligingly modest account of his long working association with the Hertfordshire schools' architects:

> With hindsight, the most significant help we were able to give them was the scientific backing which they felt they needed for their reliance upon natural light in their school designs. I believe that they would have done what they did anyway, because their observation, architectural knowledge and instinct told them that they were right. We may have led them to refinements of their design, [...], but they knew where they were going before we came onto the scene.[138]

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[136] A notorious example of this dilemma early on in the modern movement was the debate within the German Werkbund between the Muthesius camp who advocated standardisation and the Van de Velde camp who opposed it partly on the grounds that it quelled creativity. Leonardo Benevolo, History of Modern Architecture: The Modern Movement, 2 vols (Cambridge, MA: MIT Press, 1971), II, pp. 274-76; Reyner Banham, Theory and Design in the First Machine Age (Cambridge, MA: MIT Press, 1980), pp. 75-78.

[137] Robert Thorne, 'Using the RIBA Archive: A Historian's View', in Angela Mace, The RIBA: A Guide to its Archive and History (London and New York: Mansell, 1986), pp. xxix-xxxix (p. xxix).

[138] Saint, Towards a Social Architecture, p. 90.

Thus, one further and crucial reason for architects proclaiming a new science of architectural colour at the same time as casting a blind eye on the dearth of scientific evidence, and most importantly, for their attraction to the subject of colour, was that in colour they had found a field which could appear scientific, but in which ultimately, their taste and subjective judgement reigned supreme. In a sense, one could say that the threat posed to the architects' expertise by the scientization of their knowledge was couched in terms of a threat to their artistic integrity. At a discussion on colour, William Allen queried:

> He [Medd] spoke of being analytical and methodical about colour (which is interesting when you consider what an artist he is), and it makes me think of the way in which we are moving now with the aid and outlook of science to make colour more teachable and communicable. But now that we are getting the matter tied down in this way does this add or detract from the power of the artist?[139]

Throughout the post-war, architects gave a typically ambivalent answer to this question. Describing the method developed for the application of colour in the new Hertfordshire schools, David Medd declared:

> All surfaces to be painted are subject to certain natural and functional conditions, such as the degree of daylight falling upon these surfaces, their orientation, and most important, the functions for which these surfaces are forming a background. It is necessary to analyse these conditions in a building before selecting colours. But although these factors go a long way to determine the nature of the colour, the actual colour cannot, of course, be achieved by mere analysis, but must be left to the creative ability of the architect. I suggest, however, that the resulting colour scheme should be able to stand up to rational analysis.[140]

Elsewhere, asked the extent to which colours in the Hertfordshire schools had been chosen 'by taste of by a system', Medd answered:

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[139] Medd, 'Colour in Schools', p. 131.
[140] Medd, 'Colour in Buildings: A Scale', pp. 251-52.

> They are chosen entirely by taste, aided by the system. The system merely helps one to analyse the situation and to define in what portion of the scale you are going to select your colour, but as to the actual selection, it must, so to speak, remain the creative act of architects.[141]

In an introductory paragraph for an article by H. L. Gloag and Michael Keyte, it was noted that 'in choosing the title "Rational aspects of colouring in building interiors" they do not wish it to be thought that colour can be dealt with entirely by rational argument.' Gloag and Keyte elaborated:

> In each case we follow the same pattern of analysis and development as in the [rational] approach, but it should be noted that this is done for the sake of clarity in setting down the arguments; not because we are proposing that the sequence should always be rigidly followed, like a recipe or formula, at the expense of imagination. [...] Far from being stifled, imagination should become more effective and purposeful if it is harnessed to definite objectives.[142]

Thus, architects were on the one hand keen to assert their scientific expertise, and insisted on the rationality of their practice of colour, and on the other, beating a partial retreat from science, and reserving part of colour as art. This is further illustrated by the report of the conference on Colour and Lighting in Factories and on Machines, published in the RIBA Journal in 1949, which began: 'Some scientific thought in recent years has been devoted to the use of colour in buildings, [...]. Practice, of course, remains an art, and the scientists themselves insist most vigorously upon this; but it is an art in which technical skill plays an exceptional part.' It concluded, on the same lines, that 'the designer, the man of taste and skill, retains the central position; [...]. Colour

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[141] Contribution of David Medd, 'Open Discussion Forum', in 'Colour and Lighting in Factories and on Machines: Report of Course' (unpublished typescript, November 1948), pp. 67-87 (pp. 73-74).
[142] H. L. Gloag, M. J. Keyte, 'Rational Aspects of Colouring in Building Interiors: 1', AJ, 125 (1957), 399-402 (p. 399); 'Rational Aspects of Colouring in Building Interiors: 2', 443-48 (p. 443). See also 'RIBA: Colour in Schools', AJ, 117 (1953), 365: David Medd is reported as saying that 'the systematic approach is not a substitute for the imagination; on the contrary, it provides a more accurate basis for creative design and frees it from false restrictions.'

in factories, like colour elsewhere, is best handled by people with sound aesthetic judgment, provided they have the requisite special technical skill.'[143] The architects' desire to have the best of both worlds is further demonstrated in a review in the Architectural Journal of an article by American authors Parry Moon and D. E. Spencer, 'Aesthetic Measure Applied to Colour Harmony':

> 'The history of attempts to measure aesthetic satisfaction is unexpectedly long, reaching well back into the nineteenth century and including the names of some very fine experimenters. Almost certainly the first reaction of the artist to studies of aesthetic measure would be to say, "it is impossible to measure aesthetic satisfaction; and in any case the artist must rely on intuition." [...] In a period of aesthetic revolution one is bound to seek a foundation somewhere in science. One would probably not visualize ever using such an analytical method for purposes of design, but undoubtedly the method of thinking could provide first-class intellectual discipline.'[144]

The considerable amount of attention devoted to colour for more than two decades after the second world war is a unique episode in the history of twentieth-century British architecture. Not since the mid-nineteenth century passion for polychromy had colour been the object of such an elaborate discourse, of such an abundant body of literature and research. During that period, colour appeared to have been transformed into a science. The main reason for that intense interest in a seemingly scientific colour was that architects, while embracing the dominant scientific ideology to raise their professional status within post-war society, simultaneously sought to resist the perceived threat to their exclusive claims over architectural practice posed by scientization, in part by reviving decorative practices within modernism. Among the other aspects of architectural aesthetics, colour was the one which best lent itself to 'scientific' treatment, to classification and systematization,

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143 'Colour and Lighting in Factories and on Machines: Report of a Conference', RIBAJ, 56 (1949), 136-37.
144 'Aesthetic Colour Evaluation', AJ, 100 (1944), 335.

the one which could be most easily grafted onto a wide variety of hard scientific disciplines.[145] And unlike many other scientized aspects of architecture, such as the science of materials or building construction, colour still touched upon one of the core features of architecture, the exercise of artistic skills. Colour was a field where architects could both consolidate their scientific identity and hold on to their intuitive and innate creativity. Because it highlights the ambivalent attitudes of architects towards science, the study of colour is particularly relevant to exploring the meaning of science in architecture. Architects, it tells us, did not after all wholeheartedly embrace the scientific ideology as their confident statements would have us believe. It shows science to be not the professed objective means to efficient building and social progress but to a large extent, a discourse which paradoxically eased a return to aesthetic issues within modernism, and was geared to ensure the professional survival of architects in a changing post-war Britain. First and foremost, science had an ideological and instrumental value for architects. In this light, and that of its eventual decline in the late sixties, the scientization of architectural colour after the war emerges as one more episode in the long history of colour which, the historian John Gage has shown, consisted of endless and ultimately unsuccessful attempts to systematize colour.[146] These failures, Gage argues, stemmed from ideas and practices of colour having little to do with scientific objectivity. They are, rather, deeply rooted in changing cultural values, not least the crucial cultural value of science in our century.

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[145] Another example is architectural proportion. See Eva-Marie Neumann, 'Architectural Proportion in Britain 1945-1957', Architectural History, 39 (1996), 197-221.
[146] John Gage, Colour and Culture: Practice and Meaning from Antiquity to Abstraction (London: Thames and Hudson, 1993).

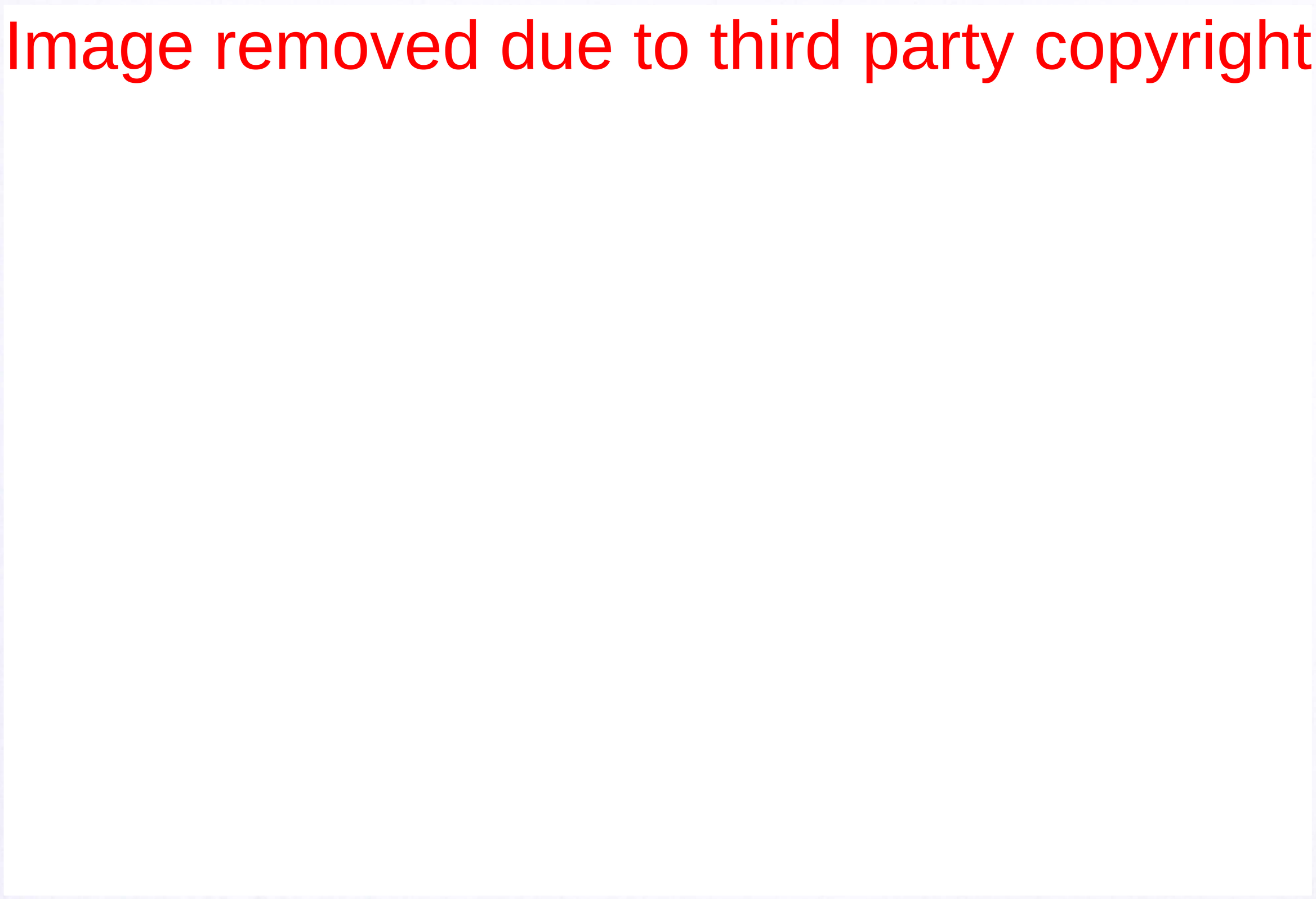

Fig. 2 'Before' and 'after': the banishment of applied decoration from modern architecture. Gordon Cullen's solution to the problem of decoration in modernism: decoration is kept at a safe distance from the 'abstract', 'impersonal' surfaces of modern architecture. Like most modernists, Cullen interpreted as an absence of decoration, the minimalist and repetitive grid patterns and the smooth glass surfaces which so successfully expressed the idea of the rejection of ornament. (Gordon Cullen, 'Trees Incorporated', AR, 108 (1950), p. 237)

CHAPTER III

THE STANDARDIZATION OF ARCHITECTURAL COLOUR

Contemporary literature from the 1950s as well as more recent historical accounts all point to the offices of the Hertfordshire County Council as the birthplace of the new scientific and systematic approach to colour in post-war British architecture.[147] As those directly involved and their followers liked to claim, it was there that a rational method of application of colour in buildings and a standardized architectural range were first developed. On two of the greatest achievements to come out of the Hertfordshire experiments, the Ministry of Education's Building Bulletin No. 9 (BB9) and the accompanying Archrome (Munsell) range, published in 1953, one editor wrote ecstatically:

> The rationalization of design of colour schemes is part of the development of a science of aesthetics. Aided by our new knowledge of applied psychology, the time will surely come when other aspects of visual art will be as scientifically analysed as the art of colour design (in schools) has been analysed in the latest of the MOE's excellent Building Bulletins.[148]

1. RATIONAL COLOUR AND STANDARD RANGES

The greater part of the BB9 presented a new rational and analytical approach to colour-which underlay the choice of each colour of the Archrome range-and resulting principles and suggestions for the design of a scheme. 'The aim', one

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[147] Derek Poole, 'Colour in Buildings: The Development of a Rational Approach', BM, 26 (1966), 57-62 (p. 60); Andrew Saint, Towards a Social Architecture: The Role of School Building in Post-War England (New Haven and London: Yale University Press, 1987), p. 90; H. L. Gloag, David Medd, 'Colour in Buildings', RIBAJ, 63 (1956), 334-45 (p. 334); H. L. Gloag, Mary J. Gold, Colour Co-ordination Handbook (London: HMSO, 1978), p. 19;Nuffield Provincial Hospitals Trust, Studies in the Functions and Design of Hospitals (London: Oxford University Press, 1955), pp. 109-11; T. W. A. Whitfield, M. O'Connor, T. J. Wiltshire, 'The British Building-Colour Standards: A Model for International Application', Color, 11 (1986), 215-22 (pp. 215-16).

critic wrote, 'is to depart as far as possible from purely arbitrary criteria of design.'[149] This analytical method, based on work by the Architects and Building Branch of the Ministry of Education, the Hertfordshire and London County Council, and on the research on colour, light and vision at the BRS, took account of three factors.

A first one was the 'character' of a building, that intangible quality which was closely related to the needs and activities of the occupants. Helping to express the 'character' of a school was the colour scheme which echoed and impressed the naive and energetic, boisterous nature of children, and provided a 'restful', 'stimulating' or 'domestic' background, according to the function of a particular space. Classrooms, where most attention was required from children and most of their time was spent, demanded light, reflecting colours for good vision, with smaller areas of strong, contrasting colours at child's height, which helped to created a 'feeling of intimacy and friendliness' and enliven the scheme.[150] (Fig. 3) At the other extreme were the circulation spaces, lively, noisy and only fleetingly occupied. Here was the place for large areas of bold, bright colours, for murals and 'stencils patterning'. (Figs. 4, 5) In assembly halls, a feeling of 'gaiety and homeliness' was called for, and in dining spaces, of 'spaciousness and dignity'.[151] In both the architect could use bright colours in small areas balanced by large expanses of light or neutral colours.

In creating a colour scheme, the architect also had to take account of lighting requirements, and of those for 'comfortable and efficient' vision.

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[148] 'Colour in Schools', AJ, 117 (1953), 437-41 (p. 437).
[149] 'RIBA: Colour in Schools', AJ, 117 (1953), 365.
[150] Ministry of Education, BB9, Colour in School Buildings, 2nd edn (London: HMSO, 1956), pp. 6-7, 17-18.
[151] BB9, pp. 6, 18.

Colour, the authors of the Bulletin stressed, could not be considered in isolation from lighting, as both were crucial factors in enabling good vision. Quantity as well as quality of lighting were important, and colour had a role to play in each. How light a colour was determined the quantity of light it reflected back to other surfaces, and therefore its contribution to the total quantity of lighting in the room. Regulations by the Ministry of Education required a minimum of 2 per cent daylight factor in classrooms.[152] The daylight factor was 'the total indoor illumination on a horizontal plane, expressed as a percentage of that simultaneously obtained out of doors, under a completely unobstructed hemisphere of sky', and took into account indirect light reflected from walls, ceilings and floors. The Building Bulletin prescribed a high 'average reflection factor' or pale colours for the surfaces of a room, to make the most of the light available. Quality of light was conditioned by the quite different criterion of the 'pattern of contrast between light and dark'. Blinded vision from glare, which was caused by excessive contrasts of brightnesses, usually between windows and their surroundings, affected the quality of light. Painting mullions, reveals, and all surfaces nearest to windows in colours of high reflection value could resolve this problem.[153] (Fig. 6)

Colour could also help visual concentration in the classroom, as in the case of 'chalkboards'. Two principles applied: first, that contrast between chalkboard and wall be strong enough to capture children's attention, and second, that sufficient contrast existed between chalk and chalkboard to insure greatest 'visual acuity'. The term chalkboard made a necessary distinction with the traditional blackboard, which architects thought contrasted too much with

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[152] See W. A. Allen, J. B. Bickerdike, 'The Daylighting of Classrooms Under the New Regulations', RIBAJ, 53 (1946), 492-95 (p. 492).

and could not be easily graded into the background wall. They recommended instead coloured chalkboards of Munsell value of 3 or 4, and chromas ranging from 4 and 6. A table in the BB9 listed the Archrome number, Munsell reference and approximate reflection factor of the colours which could be used.[154]

If too much contrast was bad, too little was sure to lead to 'dull' and 'soporific' interiors. Crucial to quality of lighting were stimulating and varied contrasts of light and shade, which colour could mirror and emphasize. (Fig. 7)

A third and last factor affecting the selection of colours was the 'constructional elements and surfaces in the building.' The architect had to bring together all these elements, beams and pilasters, walls, windows, doors and pipes, so as to achieve good, tidy 'proportions and relationships', and the role of colour was to mirror and articulate this successful design. Colour, the authors of the Building Bulletin noted, could express, emphasize, obscure, or even destroy the composition of a space or building. Having identified two types of elements or surfaces in a building, 'extensive' and 'linear', the authors concluded that by reason of their greater visual presence, emphasis had to be placed on 'extensive' elements or surfaces and strictly avoided on 'linear' ones. On walls, which belonged to the 'extensive' type of elements and surfaces, the treatment could vary from a single strong colour on large, prominently placed surfaces, to different colours applied on smaller surfaces appearing in the same field of vision, with the aim of expressing their relationship and creating visual interest.[155]

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[153] BB9, pp. 49, 7.
[154] BB9, p. 30. See R. G. Hopkinson, 'The Selection of Suitable Chalkboard Colours', RIBAJ, 59 (1952), 377.
[155] BB9, pp. 6, 8, 10.

Of utmost importance to a successful colour scheme was the framing or containment of colour planes. Two colours, the BB9 stated, could not simply and arbitrarily meet on the same surface plane, but had to be clearly separated by such devices as corners or pilasters. As a rule, early and careful thought had to be given to the composition of walls, to provide well-defined and proportioned areas in which to apply colour. Good wall compositions arose naturally in schools where the structural system of beams and stanchions were left apparent, producing a series a framed coloured panels. Frames however, like beams, stanchions, surrounds or pipes, were 'linear', subservient elements which did not deserve emphasis, and were consequently always to be painted in white or neutral colours. 'Linear elements should be looked upon as providing a frame round the colour picture', the authors noted. The Bulletin also had advice on ceilings, another 'extensive' element of building, advocating that they be painted white, with the exception of high spaces where more freedom of colour was allowed.[156]

The development of an analytical method of colouring buildings by Medd and his colleagues was paralleled by attempts to standardize the production and referencing of colour paints. These efforts, Medd explained, were a further application of the principle of standardization which underpinned the whole of the Hertfordshire schools' building programme.[157] In 1946, when seeking to decorate their first schools, Medd and his colleagues had been appalled by the randomly arranged and unattractive colour samples offered by paint representatives.[158] (Figs. 8, 9) As Medd still noted in 1949, 'the average shade card of manufacturers standard colours is a very limited affair, consisting

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[156] BB9, p. 10.
[157] David Medd, 'Colour in Buildings: A Scale for Use in Schools', Builder, 176 (1949), 251-52 (p. 251).

of 80% of various creamy light stones, buffs and the rest a number of greens that all look alike, the odd blue and red, and of course a few browns.'[159] Essendon and Burleigh, the prototype schools, were painted white with a few accents of 'primary' or strong colours.

For the subsequent schools, architects set out, with some difficulty, to obtain the colours of their choice from the manufacturers. They also adopted the Ostwald colour system or 'scale' to choose and specify their colour. Apparently based on scientific researches, this colour system was the brainchild of German physical chemist Wilhelm Ostwald. To represent his system, Ostwald devised a three-dimensional colour solid in the shape of a double cone. (Figs. 10, 11) This double cone was formed of twenty-four triangles hinged on an achromatic axis. At the equator of the double cone were found the twenty-four 'standardized' colours, then the strongest colours that could be produced. Each triangle of the colour solid was formed of an established number of combinations of black and white with one hue. The Ostwald system of notation consisted of the number of the full colour, followed by two letters, the first one indicating the percentage of white, the second the percentage of black.[160] For example, '2 na', a strong colour, referred to the 'second yellow', with 5.6 percent of white, 11 percent of black, and 83.4 percent of full yellow hue. (Fig. 12) It was based on a reduced achromatic scale, called by Ostwald 'practical Grey Scale', of eight equidistant shades from white to black, a, c, e, g, i, l, n

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[158] Gloag, Gold, Handbook, p. 19.

[159] David Medd, 'Colour Lecture to Messrs. Gays' (unpublished typescript, 7 November 1949), p. 1; David Medd, 'Derby Lecture' (unpublished typescript, 12 March 1951), p. 4: 'In other words the colour cards which we are shown are controlled in the main by persons of very low artistic discrimination, and practically no knowledge of the principles underlying the choice of colours in building. We are all familiar with the shade cards containing large numbers of "creams" and "stones" and "straws" and "Buffs" based on yellow ochre, and greens based on Brunswick Green, with a few browns, and the odd red and blue thrown in.'

[160] BB9, p. 43; J. Scott Taylor, A Simple Explanation of the Ostwald Colour System (London: Winsor & Newton, 1936), p. 44.

and p. Each letter stood for a certain percentage of white and black respectively: 'a': 89% and 11%; 'c': 56% and 44%; 'e': 35% and 65%; 'g': 22% and 78%: 'i': 14% and 86%; 'l': 8.9% and 91.1%; 'n': 5.6% and 94.4%; and 'p': 3.5% and 96.5%. Fired with enthusiasm for the Ostwald system and the idea of standardization, and seeking new, strong colours for their schools, the architects experimented with mixing their samples from pots of paint matching the Ostwald circle of full hues, and called upon the paint manufacturers to provide samples of the twelve colours from the Ostwald 'na' circle.[161] However, this last initiative was not successful as manufacturers were unable to produce colours as bright as those shown in the Ostwald manuals. Moreover, it was found that, partly because of the molecular construction of different pigments, the Ostwald system could not be used as a paint mixing system. Many of these 'na' colours could not be mixed together, while others, when intermixed or reduced with black and white according to the proportions determined by Ostwald, would not give the expected results.[162]

David Medd and Oliver Cox next persuaded two manufacturers, R. Gay and Company and Docker Brothers, to provide them with pure stainers to produce their colour samples.[163] Stainers, being the basic colouring in paints, gave architects not only the strong colours they so desired but also the freedom to create their own colours. 'There is urgent necessity', Medd wrote in 1949, 'for research into how [...] a small number of basic reliable colours can be

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[161] The 'na' circle represented the most saturated colours which could be produced on paper for educational purposes. Taylor, A Simple Explanation,p. 45.

[162] Oliver Cox, 'Report on Colour Work at Hertfordshire on Primary School Programme Up to July 1950' (unpublished typescript, 14 June 1950), pp. 1, 3, 4; see Medd, 'Colour in Buildings: A Scale', p. 251: (on Ostwald system) 'The method of achieving each colour by pre-determined proportions of black, white and full colour constituents is not practical at the present time. Manufacturers should be free to mix each colour in the most economical way to give the highest possible degree of fastness.'

[163] Eight stainers were used: 'crimson, scarlet, orange, yellow, lemon, prussian, ultramarine, vandyke, white and black'. Cox, 'Report', p. 1.

selected so that, when intermixed, they can provide a comprehensive colour scale.'[164] But architects soon found having to continually mix their own colour samples cumbersome, and the different colours they specified for each school was objected to by manufacturers who had to produce many special paints in small quantities.

By this time, the work on colour was attracting considerable interest and the opportunity arose to expand its scope beyond the Herts schools. To resolve difficulties inherent in previous approaches to colour, a new reduced range was developed in collaboration with the BRS, the Ministry of Education, the London County Council, and paint firms Gay and Docker Brothers. Chiefly based on Oliver Cox's work, the range consisted of nine 'standard pure pigments' and fifty (later sixty-six) 'supplementary' colours said to be produced from nine of the basic pigments.[165] To facilitate selection from this standardized range, a 'loose chip' colour chart was produced, from which each samples could be detached and manipulated. With some exceptions, the nine basic pigments had been chosen according to specific criteria. They were of the fullest hues available, they could be mixed with each other and produce any other colour, they were light fast, inexpensive and commonly available to all manufacturers.[166] The fifty supplementary colours aimed to reduce the need for the mixing of samples by architects, encouraging them to choose their colours from a limited range and use the same colours in different schools.

Fewer small quantities of special paints were then required from the

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[164] David Medd, 'Colour In Schools', in Robert Townsend, 'Towards an Architecture: Post-War Schools in Britain', AR, 106 (1949), 153-68 (p. 166).
[165] The basic standard colours were 'crimson, red, orange, yellow, lemon, blue, umber, venetian, ochre'. Cox, 'Report', pp. 1, 4. According to Cox, the supplementary range was produced from six basic pigments. Cox left the H.C.C. in 1950, but continued to work on a standard range for the schools.
[166] Cox, 'Report', p. 4; Medd, 'Derby Lecture', p. 4.

manufacturers who could then 'stock up bulk supplies of popular colours.'[167] To save manufacturers from having to produce and stock too many versions of the range, efforts were made to rationalize finishes and types of paints, for example by limiting the number of colours available in gloss, eggshell, or flat oil.

Yet, Cox also argued that the system of basics and supplementaries, of 'wet mixing' of each supplementary according to a 'mixing formula' of standard basic colours, was particularly suited to economical production of small, rather than large, quantities of paint. Moreover, the system of 'basic standards' gave architects the freedom, if dissatisfied with the available range, to mix their own colours on site or as samples for the production of small quantities, according to the manufacturers' instructions.[168] As Cox acknowledged, this 'escape route' served to break down the architects' resistance to the rationalization of what they saw as the essentially creative and subjective field of colour:

> In practice it has been found that the possibility of using a colour outside the range of standards, where it is particularly required by the site architect, has answered a psychological resentment against the system for a means of expression which is basically decided emotionally. It has resulted in architects adhering to the system without the resentment which would have been felt had this possibility not existed.[169]

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[167] Cox, 'Report', pp. 1, 5.
[168] Cox, 'Report', pp. 4, 5,; Docker Brothers, Colour With a Purpose ([1950s]), p. 11.
[169] Cox, 'Report', p. 5. See also Medd, 'Derby Lecture', p. 5: 'It is hoped that the range will be sufficient for most normal requirements in schools, [...] but it is realised that there will always be a psychological resentment against the publication of what purports to be a standard range. It has therefore been arranged that if an architect wants a particular colour not on the range he can mix it from any of the basic nine pigments which can be made available in small quantities either for office mixing, or site tinting. The architect therefore has the freedom to go outside the range, provided he keeps within the limitation of the nine basis (sic). Experience, I think, shows that a standard is more readily accepted if there is the possibility of departing from it.'

Thus, ultimately, the arrangement of basics and supplementaries enabled architects to look upon colour both as amenable to rationalization and also as a matter of personal preference and aesthetic skills.

In late 1949, at the same time as establishing their restricted range, the Herts team was converting to the Munsell system of colour classification. Medd had often emphasized the 'need for a nationally adopted colour standard reference and terminology system of which all smaller or selective standards formed by various bodies should conform.'[170] Throughout their early work on colour, he and his colleagues had looked upon the Ostwald system as this future 'National Master Scale'. However, research on colour systems at the BRS concluded that the Munsell arrangement and coding, being more 'scientific' and 'objective', was altogether better suited for this role.[171] The BRS had been involved early on with the Herts school building programme, contributing technical knowledge on matters of structure, heating, ventilation and lighting. In 1948, a group concerned with scientific research on colour was set up within the Physics Division by the architects H. L. Gloag and William Allen, then deputy head of the Division.[172] Their study of colour systems judged the more popular Ostwald arrangement of colours within a symmetrical solid, and its colour references based on letters rather than numbers, as a closed, unflexible system. By contrast, the Munsell numerical notation made possible unlimited subdivision and expansion of the system, allowing in particular for the development of stronger pigments. Any surface colour could thus be positioned

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[170] David Medd, 'Notes on Talk on Colour Given to Schools Group on 14th February 1949' (unpublished typescript), p. 10.
[171] Cox, Report, pp. 1, 3, 6; David Medd, 'Rough Notes for Talk to Colour Group' (unpublished typescript, 15 February 1950), p. 3: 'I recommend that a mutually agreed interpretation of the Munsell system should be adopted as the National Master Scale.'.
[172] Edward Mills, W. A. Allen, 'Men of the Year: Edward Mills and William Allen', AJ, 121 (1955), 74-75 (p. 75).

in the Munsell three-dimensional colour solid according to three subjectively perceptible, practical properties: hue, value, and chroma. Hues were disposed on a horizontal circle of five main and five intermediary hue groups designated by their initials, and arranged in spectral order. Chroma, or strength of a colour, was graded on radii extending from the axis of greys towards maximum purity. Value, or lightness, was represented on a vertical, scientifically-established scale of nine neutrals. This property of value was seen by architects as amongst the greatest advantage of Munsell over Ostwald for each value step corresponded to a specific reflection factor, establishing a direct link between the selection of colour and the design of lighting. A Munsell specification, 5.0 Y 8/2 for example (a greyish yellow), was therefore composed of three parts. First, one of four established decimal positions and initials of the hue group, followed by value and chroma. Value was represented by a number from 1 to 9, from very dark to very light, while for chroma, the higher the number, the purer the colour.[173] (Figs. 13, 14)

In 1951, after much research and reworking of the original restricted range of basics and standards, a range of forty-seven colours for use in the Herts schools was finalized.[174] (Figs. 15, 16) It was published under the name of Archrome (Munsell) range in the Ministry of Education's BB9, devoted to colour in schools.[175]

The range was presented as a table of two Munsell co-ordinates, with hues and neutrals on horizontal rows and values disposed in eight columns, allowing colours of similar reflection factors to be easily selected. Colours were identified not by evocative and imprecise names, such as 'mushroom

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[173] BB9, p. 44.
[174] Medd, 'Derby Lecture', p. 4;

pink' or 'clover', but by their Archrome serial number and approximate Munsell reference.[176] In the BB9, it was noted:

> From time to time certain fashions set in, particular colours become popular and certain combinations of colour gain a common currency. [...] If there is any criticism which can be fairly levelled at this tendency, it is that it induces a passive attitude to colour which in the end prevents it from doing much of the work of which it is capable.[177]

All forty-seven colours of the range, however, were said to be systematically selected from the many possible combinations of the nine basic standards for their usefulness in schools.[178] Thus, in contrast to its arbitrary and chaotic commercial counterparts, the range included colours from each hue group, and within those groups, colours of both strong and weak chromas and from high to low values. Neutrals or greys, also neglected by manufacturers of decorative paints, were well represented. The only gaps within the range were purples, omitted entirely for their lack of light fastness, and greens, which were 'difficult to use', and of which there was only one representative.[179] (Fig. 17) David Medd, one of the authors of the Bulletin, gave in a talk to lighting engineers a break down of the different categories of colours available in the range, and of some of their uses:

> There are alternative colours of high value and low chroma (value 9 and chroma 2) for the pale wall colour category; there are alternative colours of lower value and low chroma (values 6, 7 and 8 [and] chromas 2 and 4) for the background wall category; there are alternative colours of middle value and middle chroma (values 5 and 6 and chromas 6, 8 and 10) for small wall areas and the panel accents category; there are alternative colours of low value and low chroma (values 3 and 4 and chromas 2 and 4) for chalkboard and heavy

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[175] Ministry of Education, BB9, Colour in School Buildings (London: HMSO, 1953).
[176] BB9, (1956), p. 11.
[177] BB9, p. 3.
[178] BB9,(1953), p. 10: 'since there are literally millions of colours discernible by the human eye, some selection has to be made from them and that this selection should be systematic and not arbitrary.'; see also Medd, 'Rough Notes', p. 2.
[179] BB9, (1956), p. 12.

colour category; and finally there are a range of very high chroma colours centrally chosen in each important hue group (i.e., yellow, orange, red, blue and green).[180]

But while it offered many alternatives to the designer, the range was nonetheless considered 'small enough' to be easily memorized and economically manufactured.

National Range

'Here was the beginning of a large programme of school building', Medd recalled in 1953, 'and although I was aware of the enormous opportunities, I was appalled not only at the lack of guidance on the subject of colour scheme design but also at the absence of suitable colour ranges'. The BB9 and the Archrome range, he hoped, met those urgent needs.[181] But Medd's hopes were soon to be more than fulfilled, if judging only by the triumphant accounts of later events in contemporary and in the more recent professional literature.

In 1951, the Paint Manufacturers' Co-operative Committee set up the Paint Industry Colour Ranges Committee (PICRC) to compile a single national standard range of building paints. Geared at government, local authorities and similar large organizations, the range was to replace all others and include only a limited number of colours, fifty or sixty at the most.[182] The Committee argued that the growing demand for 'special' colours in small quantities, and the multiplication of customized ranges, not only unduly burdened the paint industry who had to produce an ever-increasing number of colours, but also

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[180] David Medd, 'Colour in Schools', Transactions of the Illuminating Engineering Society, 18 (1953), 123-36 (p. 129).
[181] Medd, 'Colour in Schools' (1953), p. 123.
[182] The PICRC was made up of the National Paint Federation, the Society of British Paint Manufacturers, and the Paint Manufacturers and Allied Trades Asociation. BSI, BS 2660: Colours for Building and Decorative Paints (London: BSI, 1955).

threatened the nation's economy. In particular, it led to 'a relatively large amount of available capital and scarce raw materials to be locked up in unnecessary stocks of paints and colours that are very near duplicates.'[183] The paint industry's initiative had been largely inspired by two influential reports on 'Simplification in Industry' published in 1949 and 1950 by the Anglo-American Council on Productivity. Looking to the American model, both reports preached the reduction in variety of manufactured products to achieve higher productivity and lower costs, and the urgent application of this principle to all sectors of British industry.[184] The PICRC thus set out to study a number of commercial and institutional ranges, such as those issued by the Ministry of Works and the Air Ministry, the British Standards 381C Colours for Ready-Mixed Paints and BS 1572 'Colours for Flat Finishes for Wall Decoration', and the Archrome, Festival, and Coronation ranges. (Figs. 18, 19) With advice from the British Standard Institution, the Paint Research Association and the British Colour Council, seventy six to eighty colours were chosen from the 320 or so collected. Comments and suggestions were then solicited from the RIBA and various other groups and organizations on this prototype range. Two representatives of the RIBA were promptly dispatched to a PICRC meeting. There it was decided that the Royal Institute and other groups would prepare a draft range, by eliminating fifty colours out of one hundred and six which

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[183]'Paint Colour Ranges', Transcript of letter from Claude E. Bridges, Secretary of the PICRC, to Secretary, RIBA, 19 February 1952, RIBA Science Committee Minutes 1951-1959, 6 March 1952, Inset C.

[184] Anglo-American Council on Productivity, Simplification in Industry (1949), frontispiece: The Anglo-American Council on Productivity was formed in the autumn of 1948 on the initiative of Sir Stafford Cripps, the Chancellor of the Exchequer in Britain, and Mr. Paul Hoffman, the Economic Co-operation Administrator in the U.S.A. [...] composed of representatives of management and Labour both in the [U.K.] and [U.S.A.]. In the UK section the constituent bodies are the Federation of British Industries, the British Employers' Confederation and the Trades Union Congress. The purpose of the Council is to promote economic well-being by a free exchange of knowledge in the realm of industrial organisation, method and technique and thereby to assist British industry to raise the level of its productivity.'; Simplification in British Industry (1950); Brian Finnimore, Houses From the Factory (London: Rivers Oram Press, 1989), p. 42: the Council was a 'product of British interest in American industrial organisation.'

included, in addition to the PICRC range, a number of colours from the Archrome range chosen by LCC architects. In July 1952, the RIBA formed a special ad-hoc Committee to perform this task, and 'to advise and offer guidance to this [PICRC] Committee on the modern trend in the use of colours by architects'.[185] Made up of six members, including representatives of the BRS, the Ministry of Education, the LCC, the Ministry of Works and of one art school, the new RIBA Committee spent twenty-six months analysizing ranges and studying trends and uses of colour with the technical support of the BRS, finally arriving at a range of ninety-nine colours. In October 1954, the range was sanctioned by the RIBA Council, and after final adjustments, was apparently agreed by all concerned.[186] The RIBA range was then submitted to the British Standards Institution and in early 1956, was published as the BS 2660 'Colours for Building and Decorative Paints'.

As was emphasized in the accompanying propaganda articles and documents, the BS 2660 was not 'just another range to choose from', but 'a new and significant instrument of design for architectural colouring.'[187] The Munsell system was instrumental in the development of this tool of design.[188] The colours of the range, it was claimed, had been systematically and rationally selected and arranged according to the three Munsell co-ordinates of hue, value and chroma. Thus, in its final form, the range included 101 colours distributed on ten cards numbered from 0 to 9, and divided into groups of

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[185] Transcript of letter from Claude E. Bridges, Secretary of the PICRC, to Secretary, RIBA, 19 February 1952, RIBA Science Committee Minutes 1951-1959, 6 March 1952, Inset C; 1 May 1952; 29 May 1952; 16 July 1952. The chairman of the RIBA ad-hoc Committee was S. Rowland-Pierce.

[186] 'New Range of Colours for Building', RIBAJ, 62 (1955), 174; DSIR, BRB, 'Paint Colours' (unpublished typescript, May 1953).

[187] Michael J. Keyte, 'The New British Standard Colour Range of Building and Decorative Paints', AJ, 123 (1956), 212-17 (pp. 212, 216).

[188] Gloag, Gold, Handbook, p. 19; Keyte, 'New British Standard', pp. 214, 216.

similar chroma, hue and value.[189] Four broad divisions of chroma were established in the range. On card 0 were assembled fourteen colours of the strongest chroma technically available in each hue group. (Fig. 20) The last card, number 9, showed a selection of colours of least chroma, including 'neutrals', greys and lightly tinted colours. Cards 1 to 8 assembled colours of 'weak' and 'fairly strong' chroma arranged, with some exceptions, on the left-hand and right-hand columns of each card respectively.[190] Within those cards, colours were also classified according to their Munsell hue group. As research demonstrated, the value or lightness of a coloured surface directly affected the quantity and quality of lighting, and was therefore crucial to the development of any colour scheme. In the BS 2660, colours were displayed in decreasing order of value from top to bottom of each card. (Fig. 21) With the help of the Munsell notation, which indicated the colour's position on the achromatic scale, and the lining up of similar values on the same horizontal rows throughout the ten colour cards, architects were free to choose, for a particular value level, between alternatives of hue and chroma. The BS 2660 also provided a formula, V(V-1), for the conversion of a Munsell value (V) into an approximation of the reflection factor, in percentage, of a colour. This allowed a more accurate estimate of the total amount of light in a room and, moreover, drew a direct parallel between the design of colour and lighting engineering.[191] Finally, in addition to its British Standard serial number, an approximate Munsell notation was assigned to every colour, avoiding the ambiguity and confusion of traditional names such as 'primrose' or 'crimson', and helping designers to

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[189] H. L. Gloag, M. J. Keyte, 'Colour Co-ordination for the Manufacturer and User', Design (March 1959), 34-40 (p. 40).
[190] Gloag, Gold, Handbook, pp. 19, 22.
[191] Keyte, 'New British Standard', p. 216; BS 2660, Appendix A.

understand more precisely what differentiated one colour from another.[192] Visual comparison was also made easier by printing of the colour patches along the vertical edges of the colour cards.

The BS 2660 was presented as an 'instrument of design' for architects not only by virtue of its systematic arrangement of colours but also because both this arrangement and the choice of which colours would be included in the range was made according to 'uses in practice'.[193] A BRS Digest on the BS 2660 stated that:

> The main object in developing it was to agree a range that would meet most of the demands of architects and other paint users. It is not based on manufacturers' sales data, or on an arbitrary narrowing down of existing ranges, but on a thorough re-assessment of requirements.[194]

Thus, in addition to technical considerations such as limits of pigmentation, permanence, or costs and technology of production, all 101 colours of the Standard were said to have been selected to serve a particular purpose in architectural design. The majority of colours in the range was devoted to the 'soft and recessive background treatment' of large interior surfaces.[195] This included colours of low and medium chroma on cards 1 to 8, colours of value of 6 and over, and several of the neutrals and greys on card number 9. Next were colours of 'strong' and 'fairly strong' chroma on card 0 and left-hand columns of the cards. Architects claimed that, as these were used in smaller surfaces and in smaller quantities, they had been under-represented in commercial

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[192] Gloag, Keyte, 'Colour Co-ordination', p. 40: 'To aid in detecting the more detailed differences and similarities within categories, the approximate Munsell reference is given against each colour'; BRS, BRS Digest 101, The B.S. 2660 Range of Colours (Garston: HMSO, 1957), p. 4: 'Although the introduction of Munsell references may seem at first sight to be complicating matters, it is really only making for a more conscious and precise distinction between the properties of colour which a designer must and does think about already.'

[193] Keyte, 'New British Standard', p. 214; DSIR, BRB, 'Paint Colours', p. 3.

[194] BRS Digest 101, p. 2.

ranges. Yet they were essential in providing contrast to wider expanses of lighter colours and in creating 'decorative effects', 'richness' and 'variety'.[196] Neutrals and lightly tinted greys had another function in buildings. Nearly or entirely devoid of hue and chroma, they were ideal on trims, frames and columns, to separate and define boldly coloured surfaces.[197] Other categories of colours were destined to even more specific purposes. For example, colours of low hue and low chroma were deemed particularly suitable for chalkboards, machinery and external surfaces.

Harmonious relationships between colours had also been an important principle in the composition of the BS 2660 as a 'tool of design'. Existing British Standard and commercial ranges were criticized by architects involved with the 2660 for being no more than arbitary, ill-assorted, motley collection of colours whose effect when combined, juxtaposed had been completely ignored.[198] However, as architects themselves admitted, traditional theories, which posited for colour the same mathematical laws of harmony as in proportion or music, remained unproven, leaving the issue of colour harmony largely unresolved.[199] Architects nonetheless formulated some general principles which ensured harmony of colours in the range. For example, colours of the same hue were believed to form 'pleasant and harmonious combinations'.[200] The BS 2660 therefore offered families of colours of identical hue and chroma but decreasing steps of value, the longest series being in the 10 YR group (yellow-reds) on card 3, and in the 5 Y group (yellows) on card 4.

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[195] Keyte, 'New British Standard', p. 215.
[196] H. L. Gloag, 'The Colouring of Building Interiors', AD, 25 (1955), 296-97 (p. 297); Keyte, 'New British Standard', pp. 213, 215.
[197] Keyte, 'New British Standard', pp. 215; Gloag, Keyte, 'Rational Aspects of Colouring in Building Interiors', p. 443.
[198] Gloag, Keyte, 'Colour Co-ordination', p. 39; Gloag, 'Colouring of Building Interiors', p. 296.
[199] Keyte, 'New British Standard', p. 215;

There were sets of colours of same hue but of different chroma, which aimed to harmonize the strong colours with those of weaker chroma in the range. Also thought to combine agreeably and included in the range were colours of different hues but similar 'weight', that is, of broadly similar value and chroma. According to the architects, a further means of achieving harmony was to exclude colours which did not fulfil any of the prescribed functions or were similar to an already selected colour, and were therefore not useful.

With only 101 colours to choose from, BS 2660 imposed a sometimes unwelcome discipline upon architects.[201] In the eye of its devotees, this was more than outweighed by the systematic nature of the range, its flexibility and comprehensiveness, and the balanced distribution and harmony of its colours. The BS 2660 was the 'living embodiment of a designer's range', specifically conceived for use in all building types, and as such, by far superior to the jumbled, confused offerings of paint manufacturers.[202] Even before becoming an official British Standard, the new range had been adopted by Government Departments in March 1955, and was thereafter declared a resounding success among architects and paint manufacturers.[203] (Figs. 22, 23)

The Road to Colour Co-ordination

In 1959, at a conference on colour co-ordination held jointly by the RIBA and BRS, the BS 2660 was formally launched as a 'master-range', a 'common source of colour' from which smaller ranges for paints and industrialized buildings

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[200] Keyte, 'New British Standard', pp. 214, 215.
[201] BRS Digest 101, p. 3; Keyte, 'New British Standard', p. 212.
[202] Keyte, 'New British Standard', p. 216.
[203] David Medd, 'The Coordination of Building Colours: The Road to DD17', BSI News (January 1972), 12-13 (p. 13); H. L. Gloag, 'Munsell and B.S. 2660', BM, 26 (1966), 73-74 (p. 73).

products would be derived to achieve overall harmony of colour in a building.[204] Architects argued that the BS 2660, although conceived initially for paint colours, was large enough to accommodate a variety of needs, and most importantly, had been systematically designed according to users' needs and technical considerations. Some manufacturers and designers were already selecting BS colours for a variety of building products such as rubber flooring, 'linoleum, plastics, ceramics, furniture finishes and textiles.'[205] From the start, architects had conceived the BS 2660 as a master-range. Yet the way the range was collated throws some doubts on its supposed rational basis. For example, thirty-six out of the 101 colours of the BS2660 were unceremoniously lifted from the forty-seven colours of the original Archrome range published in 1953.[206] Somewhat curiously, in these circumstances, the first use of the BS 2660 as a master range was for a revised and expanded Archrome range, published in 1956 and containing fifty-four colours selected from the 2660.[207] Moreover, although thirty-six of the first Archrome range could be found in the BS 2660, only twenty-seven of these were retained in the 'Archrome 2 Range', all apparently chosen on grounds of their greater popularity among architects.[208]

Popularity can hardly be considered as a rational criterion of colour selection. Yet architects forwarded at the 1959 conference on colour co-ordination, the idea of a master range and of a 'systematic' method to create satellite ranges. In the months prior to the conference, the BRS had carried out research on colour ranges for industrialized building products which

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[204] RIBA Industry Note 2, Co-ordinated Colour Ranges for Buildings (June 1959); 'Colour: Co-Ordinated Ranges for Building', Building Centre Forum 3 (London: Building Centre, 1961).
[205] Medd, 'DD 17', p. 13; BRS Digest 101, pp. 5-6.
[206] BB9, p. 12.
[207] Medd, 'DD 17', p. 13; BRS Digest 101, p. 5; BB9, p. 13.

concluded that most were unsystematic, took no account of architects needs and were unrelated to each other and to the BS 2660.[209] While 'sales appeal' and technical and economical constraints were recognized as important factors in shaping a colour range, the 'systematic' method of colour co-ordination was centred on architects' needs. These were apparently for colours answering the 'functional requirements' of a particular building product, and which harmonized with each other and the colours of the BS 2660.[210]

A small range for studded rubber tiles developed by the Ministry of Education's Architects and Building Branch, the BRS and the manufacturer Rubberware Ltd, was published to explain the functioning of this rational approach to colour co-ordination. A first consideration had been the 'functional requirements' of floors, which consisted mainly of the efficient redistribution of light from windows and lighting. This led to a basic range of light colours of approximately Munsell value seven. Curiously, considerations of 'harmony and attractiveness' were also important to architects. Thus, darker colours of approximately value four were selected with the sole aim of providing contrasts with the basic colours. The range was to have a balanced and appropriate representation of colours in all four subcategories of grey, soft, middle and strong chroma, the grey and soft being in most demand, the middle and strong to complement basic colours. However, preference was given to warmer hues over cooler ones, with only three representatives, black, grey and blue, in the latter category. Closer match of the resulting selection with BS 2660 colours, the marbling of certain tiles 'for decorative effect and to

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[208] BB9, p. 13.
[209] Building Centre Forum 3; W. A. Allen, 'Influences of Research on Building Design: 1. Functionalism and Science', Builder, 197 (1959), 610-12 (pp. 611-12); 'Proposed Conference on Colour for Building Products (Other than Paints)', Report of the Industry Liaison Sub-committee of the Science Committee, RIBA Science Committee Minutes 1951-1959, 25 March 1959.

mask dirt', and such factors as Rubberware's 'sales experience' and limits of pigmentation, gave the range its final appearance. The last stage of the systematic approach had been to devise a useful and logical presentation of the range, with boxed samples accompanied by an information sheet giving for each colour a strictly descriptive name, approximate Munsell value and the link with a BS 2660 card.[211] Thus, in the opinion of two of its designers, Bill Gloag and Michael Keyte, no other than strictly pragmatic, functional concerns had entered into the making of this range: 'The Rubberware range illustrates how the approach [...] has led to a compact set of colours, each owing its place to specific practical needs.'[212] (Fig. 24)

In 1959, more than twenty firms were reported to have adopted the new method of colour co-ordination and the BS 2660 master range. Over the next ten years, architects could boast of having converted such firms and organisations as the Vitreous Enamel Development Council, manufacturers of melamine plastics Arborite and Formica, Nairn the makers of linoleum and plastics, Richards and Carters for ceramic tiles, and the Carpet Manufacturing Company, to the cause of colour co-ordination.[213] (Fig. 25)

Yet within a few years of having been declared the master range for colour co-ordination, the BS 2660 had already fallen from grace in the eyes of its promoters at the BRS and the RIBA. In 1962, the newly formed RIBA Colour Panel, chaired by Bill Gloag, with the BRS Colour Section and the BSI, set out to

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[210] RIBA Industry Note 2; Allen, 'Influences of Research: 1', p. 612.
[211] H. L. Gloag, M. J. Keyte, 'Colour Co-ordinating a Range', Design (September 1959), 33-37 (p. 37); RIBA Industry Note 2.
[212] Gloag, Keyte, 'Colour Co-ordinating', p. 37.
[213] Allen, 'Influences of Research: 1', p. 612; 'RIBA Colour Panel', RIBAJ, 71 (1964), 326; 'Colour Co-ordination: Proposals for a New British Standard', AJ, 150 (1969), 705-08 (p. 705); A letter from H. L. Gloag to William Allen, then at the AA (19 July 1962) mentions that four out of six 'major ceramic tile firms' intending to produce B.S. colours, and that the firm Storeys of Lancaster was producing 'fabric-backed sheet vynal' (sic) for interior walls, in about twenty-four B.S. colours.

revise the BS 2660.[214] Aiming at first for a modest revision and extension of the range, they were calling by the mid-sixties for the development of a whole new framework for colour co-ordination.[215] The opinion now on the BS 2660 was that it contained too few colours to serve the needs of a wider range of materials, having originally been designed for paints, that its structure was unsystematic and its colours did not combine harmoniously.[216] Moreover, the period of five years after which a standard was open to revision had already elapsed.

According to research at the BRS, part of the problem with the BS 2660 was with the Munsell system of classification itself.[217] Indeed, researchers objected to the three Munsell attributes as basis of colour classification and co-ordination on the grounds that they failed to provide sets of similarly looking or 'perceptually equivalent' colours.[218] For example, they argued that colours of equal Munsell value and chroma often did not, as could be expected, appear related to each other. (Fig. 26) Lacking in the BS 2660, 'direct equivalents' were thought to be useful within a limited standard range, for they offered the designer a choice of different hues of same 'character' appropriate to a particular location and function.[219] The problem of how to achieve sets of colours which were 'equivalent' or of 'similar character', and according to

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[214] The original members of the RIBA Colour Panel, which answered to the Technical Standards Committee, were chairman Bill Gloag, Alex C. Hardy, Mary de Saulles, Michael J. Keyte, David L. Medd, Godfrey Samuel, Rex Savidge (From Society of Industrial Artists), J.A. Wells Thorpe, Anthony Williams. RIBA Colour Panel Minutes 1962-1969, 9 January 1963; 'RIBA Colour Panel', p. 326.

[215] Gloag, Gold, Handbook, p. 20; H. L. Gloag, 'Colour Co-ordination Applied to Materials', Design (November 1967), 39-42 (p. 40).

[216] 'Colour Co-ordination: Proposals', pp. 705, 706; H. L. Gloag, A. C. Hardy, 'Progress Toward Colour Co-ordination', RIBAJ, 76 (1969), 491; Gloag, Gold, Handbook, pp. 20, 30; BRS, BRS Information, Colours for Building ([1969]).

[217] 'Colour Co-ordination: Proposals', p. 705, 706; Gloag, Gold, Handbook, p. 25.

[218] 'Colour Co-ordination: Proposals', p. 706; Gloag, Hardy, 'Progress', p. 491.

[219] The example forwarded by Gloag and colleagues to demonstrate the disadvantage of having no 'direct equivalents' was the extensive use of BS 2660 number 9-098 ('very dark bluish grey') for external cladding, which they suggested was probably due to no other choice of hue being available in the desired

which parameters, was closely investigated at the BRS, leading to the adoption of a set of new attributes.[220]

Researchers first proceeded to select twelve specific hues on the Munsell circle. These replaced the ten Munsell hue bands originally used for the BS 2660 which were now judged too wide, allowing too many different colours to be selected within each band, and therefore offering few alternatives of value and chroma within one hue. By choosing specific hues, it was possible to develop 'complete ranges' of colours of 'consistent' hue and 'appropriate' value and chroma.[221] The twelve chosen hues were very carefully selected following three criteria: they had to be representative of the whole hue circle, be distinct from other hues at any steps of value and chroma, and for the most part, combine harmoniously with each other.[222]

The concept of colour harmony adopted by the BRS was based on its own special survey of this controversial subject, concentrating on the work of those perceived as its most rigorous theoreticians such as Chevreul, Wilhelm von Bezold, Munsell, Ostwald, and Moon and Spencer. However, the theories of the American team of Parry Moon and Domina Eberle Spencer appeared to BRS researchers to be the most 'detailed and systematic' on offer.[223]

Moon and Spencer defined harmony as the result of unambiguous relationships between colours, and disharmony as that of confusing, uncertain relationships between such colours. But BRS researchers were definitively most impressed by Moon and Spencer's representation of these relationships on the Munsell hue circle, as zones of harmony and disharmony defined according to

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'dark, subdued' colours. Gloag, Gold, Handbook, p. 25.

[220] Gloag, Gold, Handbook, p. 29; BRE, BRE Digest 149, The Co-ordination of Building Colours (Garston: HMSO, 1973), p. 1.

[221] BRS Information, Colours for Building, p. 2.

[222] Gloag, Gold, Handbook, p. 23.

fixed numerical intervals.[224] Thus, on a Munsell hue circle of forty steps, a colour of a given hue was said to be harmonious with all colours of identical hue, with colours distant by between three to five hue steps, and by between eleven to twenty hue steps. Conversely, it was deemed disharmonious with colours of between three to five, and eleven to twenty hue steps away. Each of the twelve hues for the new standard framework was thoroughly tested against Moon and Spencer's regions of harmony and disharmony and, as BRS researchers proudly pointed out, related harmoniously with a minimum of seven of the other selected hues.[225] (Fig. 27) This was achieved with the help of the 'BRS Colour Harmony Selector', an 'instrument' developed in 1970 to predict colour harmonies and ambiguities and based on the work of Moon and Spencer. The basic 'Selector', which ascertained the relationship between two colours, consisted of two superposed discs showing on one disc forty Munsell hue positions, and on the other, sectors of harmony and disharmony. The designer simply aligned the reference arrow against a designated hue, to have all harmonious hues instantly indicated along the darkened zones on the circumference of the disc. To these two Selector could be added more discs for harmonizing three, four, and five colours at once. (Fig. 28)

Architects at the BRS had wanted twelve sets of colours of same hue in the framework in the hope that controlled variations of value and chroma in these sets would finally yield 'direct equivalents', that is, sets of colours similar in every respect but in hue.[226] However, as we have seen, BRS research

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[223] Gloag, Gold, Handbook, p. 25.
[224] Gloag, Gold, Handbook, p. 41; Parry Moon, D. E. Spencer, 'Geometric Formulation of Classical Color Harmony', Journal of the Optical Society of America, 34 (1944), 46-59; 'Area in Color Harmony', 93-103; 'Aesthetic Measure Applied to Color Harmony', 234-42. Parry Moon was from the Massachusetts Institute of Technology.
[225] BRE Digest 149, p. 3.
[226] BRE Digest 149, pp. 3, 4;

for the new co-ordination range showed that sets of colours which varied in hue but remained of constant value and chroma did not in fact unfailingly appear 'perceptually equivalent'. With the help of a recent American study on 'Variables of Perceived Color', these puzzling differences between colours of equal value and chroma were eventually identified as differences in 'greyness'.[227] All colours, according to BRS researchers, fell into two groups: colours with and colours without a grey content. The point at which, on the chroma scale, each hue of the Munsell solid passed from grey to clear was recorded at every value level by a small group of observers. The grey zone of each hue was further subdivided in four practical steps, from A for maximum greyness to D for minimum greyness, and E designating the 'clear' state. From this 'systematic data', contours of greyness were traced on sections of the Munsell solid at every value level, showing colours of similar greyness. To BRS researchers, the 'deviation' between contours of greyness and the regular steps of chroma on the charts was unequivocal proof of the inadequacy of chroma steps in achieving direct equivalents in different hues.[228] (Fig. 29)

Still, in a small number of cases, the combined attributes of greyness and value failed to deliver the desired sets of equivalent colours. Researchers observed that in sets of hues in categories of least and zero greyness (groups D and E), yellows in particular looked 'heavier' in comparison to the other hues. The reason for this disparity, it was suggested, was the so-called 'natural order' of colours, whereby different colours (such as yellow) were inherently lighter than others at maximum chroma. In order to make the yellows appear equivalent, their value had therefore to be raised, in what was called an

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[227] Ralph M. Evans, 'Variables of Perceived Color', Journal of the Optical Society of America, 54 (1964), 1457-74.

adjustment for 'equal weight'. (Fig. 30) Hence, for the architects and researchers involved, with the twelve sets of constant hue, and the combined new co-ordinates of equal greyness and equal weight, the problem of finding direct equivalents through the hues was resolved at last.[229]

Opposition and Compromises

In late 1968, after consultation with members of the profession, the CoID (Council of Industrial Design) and the Illuminating Engineering Society, the BRS submitted a final draft of the basic colour co-ordination range for upgrade into a standard to a specially-formed technical committee at the BSI, 'Colours for use in building'. The committee was chaired by David Medd, who had been active, as a member of the RIBA Colour Panel, in developing the range.[230] However, architects faced strong opposition to their proposals for a new co-ordination range from industry. Paint manufacturers, fearing that architects would ask for all 180 colours or so to be produced and available in stock, pressed for only the 'satellite' ranges to be published as standards. Architects sought, in vain, to alleviate their doubts by emphasizing that the range was not for specification purposes but strictly a 'systematic stock of colours' from which smaller standards for specific building products would derive.[231] Even stauncher opposition came from the National Council of Building Materials Producers, whose representative at the first BSI meeting on the master range was reported to say that 'so far as manufactured products was concerned, no

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[228] Gloag, Gold, Handbook, pp. 26-27; 'Colour Co-ordination: Proposals', p. 706.
[229] Gloag, Gold, Handbook, p. 29; 'Colour Co-ordination: Proposals', p. 706.
[230] Members of BSI Committee B/117 'Colours for use in building' included Leonard Manasseh and Alexander Hardy as RIBA representatives, Gloag as BRS representative, Rex Savidge for the Society of Industrial Artists, Medd as chairman, and representatives of the CoID, BCC, Ministry of Health, Plastics Industry, Paint Makers, and of National Council of Building Materials Producers. H. L. Gloag, 'Proposed New British Standard for Building Colours', RIBA Colour Panel Minutes 1962-1969, 22 May 1968.

colour standardisation was necessary or wanted.'[232] As Medd acknowledged a few years later: 'However clear this concept [of master range] was to those who proposed it, agreement to it yielded the most difficult negotiations yet experienced in colour range work.'[233]

A compromise between reticent manufacturers and persistent architects was finally reached with the publication in January 1972 of a BSI 'Draft for Development' (DD17), 'Basic Range for the Co-ordination of Colours for Building Purposes'.[234] The publication of the co-ordination range as a Draft for Development imposed a two-year 'waiting' period before upgrading to full British Standard status. Although this delay was presented by architects as a deliberately chosen, self-imposed period for 'constructive' comment, for testing and improving the range, it was effectively a setback, giving only provisional status to the range.[235]

For architects, a co-ordination standard was greatly needed, not so much for reasons of economy as to improve the mismatched and incoherent colouring endemic within an increasingly industrialized architecture.[236] Such a standard would bring all building products into 'systematic colour relationship' and, as William Allen put it in 1959, help to create a 'complete and unified environment'.[237] Termed a 'new tool for the co-ordination of colour in the building industry', the DD17 was indeed intended, most ambitiously, as a source of new and revised standards covering all colour needs, from those of

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[231] BRS Information, Colours for Building, pp. 1, 7.
[232] 'Colour Co-ordination: Proposals', pp. 708; on resistance of manufacturers to propositions for a new standard, see Cassandra Bhatia, professional services, RIBA, Circular to all Regional Secretaries (RIBA), RIBA Colour Panel Minutes 1962-1969, 27 August 1969.
[233] Medd, 'The Road to DD17', p. 13.
[234] DD17 was launched at a BSI/Modular Society Forum, chaired by Sir Paul Reilly. Anthony Williams, 'Master Range of Colours', Building, 222 (1972), 71.
[235] BSI, DD 17: Draft for Development for Basic Range for the Co-ordination of Colours for Building Purposes (London: BSI, 1972), p. 1.
[236] 'Rational Colour Co-ordination', AJ, 163 (1976), 1262-63 (p. 1262).

building materials, components and finishes for interior and exterior use, to furniture and textiles.[238] Architects argued that, being derived from the same range in which all colours had a 'known relationship to each other', the different specification standards would all interrelate harmoniously and, used together, would ensure a colour co-ordinated environment.[239]

The DD17 had been restricted to 182 colours, organized according to the three revised Munsell co-ordinates of hue, greyness and weight.[240] On A4 size folding cards, colours were disposed in twelve lines of constant hue identified by even numbers from 2 to 24, above a row of neutrals numbered 00. Colours were further divided into five groups of greyness from maximum (A) to zero greyness (E), each of these groups containing vertical columns of direct equivalents bearing odd numbers from 1 to 55, and arranged in decreasing steps of value from left to right. Specification was by a new code composed of the hue row number, the letter of the greyness category, and weight column number, putting an end to the use of Munsell notation system which was now to be used strictly for reference.

The first specification standard to be extracted from this provisional master range was the BS 4800, 'Paint Colours for Building Purposes'. It replaced the BS 2660 which, after almost eighteen years of service, was to be withdrawn in January 1973. Three principles were said to have shaped the new paint range: colours been selected from all hue, greyness, and weight categories of the DD17; they answered technical requirements regarding in particular finishes and fastness; and the final number of colours in the range

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[237] 'Colour Co-ordination: Proposals', p. 708: Allen, 'Influences of Research: 1', p. 612.
[238] Gloag, Gold, Handbook , p. 35; DD17, p. 1; BRE Digest 149, p. 1: 'paints, ceramics, wall and floor coverings, etc.'
[239] DD17, p. 1; Gloag, Gold, Handbook, p. 35.
[240] DD17, p. 1.

took account of the different finishes and can formats required for 'marketing' purposes. The eighty-eight paint colours, fifteen less than the defunct BS 2660, were presented as a definite improvement on its predecessor: 'they are better balanced in the different colour categories and are far more orderly', Gloag claimed.[241] Curiously, although the range was meant to appear as new and improved, more than a third of its colours were taken from the BS 2660, as a table in the standard itself made clear. Presentation of the colours on eight cards with samples printed on the edges for easy comparison, was also similar to the BS 2660. However, the structure of the range was broadly that of the DD17, with throughout the cards, horizontal rows of hues, groups of greyness and columns of equivalent colours. (Figs. 31, 32) Several manufacturers were soon producing the range, but to the disappointment of the architects involved in its design, they were adding their own 'house' or 'supplementary' colours. Worse still, they often modified or altogether ignored the 'systematic' arrangement which architects considered so crucial. 'Although these colours have the status of 'British Standard Colours'', architects acknowledged, 'there is, of course, no compulsion to use them exclusively, and most paint manufacturers are continuing to produce other shades as well.'[242] (Figs. 33, 34)

In the event, the DD17 only received full British Standard status in 1976, as BS 5252: Framework for Colour Co-ordination for Building Purposes. The new master range included, with a few modifications, the whole of DD17, and was similarly organized. But while the DD17 had contained 182 colours, a number thought amply sufficient for the task of colour co-ordination, the BS 5252 now contained many more, a total of 237 colours. This increase was apparently due

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241 Gloag, Gold, Handbook, p. 35.
242 'British Standard Colours', BM, 33 (1973), 13.

to added weight columns, following BRS recommendations. However, the 237 colours of the BS 5252, architects insisted, had been selected within an expanded framework of 490 possible colours, according to 'a thorough reassessment of practical requirements and constraints.'[243] In a manual on colour co-ordination published in 1978, Gloag and Mary Gold gave a detailed description of the framework's greyness categories. Group A included a set of multi-purposed neutrals on row 00, an off-white and two off-blacks in the first and last columns as alternatives to the 'clear' black and white in group E, and four rows of tinted greys as alternatives to the neutrals which often appeared bluish when seen with other colours. In group B were more 'subdued' colours appropriate for large surfaces like walls and panels. Departing somewhat from their rational approach, Gloag and Gold stated popular preference as the reason for including more 'warm' than 'cool' colours in this group. Moreover, it was seemingly to prevent ambiguity between certain colours of high grey content that three out of the twelve hues adopted for the range were exceptionally modified. Thus, a more yellowish red (10R) replaced the red hue (7.5R) which in this greyness group could not be clearly distinguished from the purples, and the two different yellow-red hues (5YR and 10YR), which produced nearly similar sets of colours at low chroma, were replaced by a single hue (8.75YR). In group C, the hues emerged from greyness and well differentiated sets of each of the twelve hues were now available. The first two and last columns of apparent equal weight in this group, and their counterparts in group B, were designated by the authors as the main supply of light and very dark colours in the master range. Group D contained colours of minimum greyness described in the manual as 'strong accent colours' to be applied with

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[243] Gloag, Gold, Handbook, pp. 31, 30.

moderation. The only hue missing from the regular set of twelve were the purples, the reason for this exclusion, Gloag and Gold contended, being their harshness at these high levels of chroma. The clearest, most saturated colours were in Group E, namely in column 53 and in column 55, which was not in this case a distinct equivalent weight column. Clear black and white were considered as clear colours, and although they logically belonged at either end of the series of weight columns, they were, for reasons of space, placed at the bottom row of group E. (Figs. 35, 36)

Thus, the BS 5252 was not as systematic and rational as Gloag and Gold would have wished it to be. Already mentioned were the 'departure' from the established sets of hues in greyness group B, and column 55 in group E which was not of distinct weight but a continuation of column 53. Another flaw was the irregular numbering of weight columns, architects having been forced to keep the DD17 numbering because of the premature publication of BS 4800, under pressure from paint manufacturers, as a derived range from DD17.[244] A further compromise to the alleged systematic order of the BS 5252 was the adjustments of Munsell references in favour of BS 2660 colours, within what should have been columns of same apparent weight, in order to preserve some continuity between the ranges.

From this imperfect framework were nevertheless derived three 'co-ordinated' standards ranges: BS 4900: Vitreous Enamel Colours for Building Purposes, BS 4901: Plastics Colours for Building Purposes, BS 4902: Sheet and Tile Flooring Colours for Building Purposes. (Fig. 37) Several other standard specification ranges were derived from or revised in line with the DD17 or BS 5252, including BS 4904: External Cladding for Building Purposes, BS 1710:

Identification of Pipelines; BS 3030: School Furniture: Part 3: Pupils' Chairs and Tables; BS 4514: Unplasticized PVC Soil and Ventilating Pipe, Fittings and Accessories, BS 1319: Medical Gas Cylinders and Anaesthetic Apparatus, and BS 5081: Sterile Hypodermic Syringes and Needles for Single Use'.[245]

Some of the applications of the co-ordination standard might have strayed, strictly speaking, from the sphere of building, and the range itself might have been flawed, but our small group of architects hailed the derived ranges and the BS 5252 as the culmination of their efforts over thirty years to bring reason, harmony and taste into architectural colour.

'I think that due to faults in our education', Medd had written in 1951,

> we are given no guidance on what analytical process we might adopt to help us to determine the general nature of a colour scheme. I think the process must be taken out of the realms of guesswork and arbitrary selection and a more rational procedure substituted for it.[246]

On the publication of the BS 5252, one anonymous ally enthused: 'British architects have dreamed about a rational system of colour co-ordination ever since the impact of the influential Ministry of Education Building Bulletin 9 [...], and the Hertfordshire schools, in the early fifties. Now, at long last, they have it.'[247] Indeed, stemming from research on building colour classification, the BS 5252 provided architects with what they apparently needed most: sets of colours which were systematically and harmoniously related to each other. Pointing to what was in their opinion pioneering advances from the earliest work at Hertfordshire to the BS 5252, Gloag and his colleagues presented

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[244] Gloag, Gold, Handbook, p. 31.
[245] Gloag, Gold, Handbook, p. 35.
[246] Medd, 'Derby Lecture', p. 1.
[247] 'Rational Colour Co-ordination', p. 1262.

Britain as a world leader in colour standards.[248] However, as we shall see, the new co-ordination range did not have much impact on the profession or on manufacturers of building products. Far from a triumph, the publication of BS 5252 was in fact the last episode in this history of attempts by British architects to develop a scientific approach to colour.

2. THE IDEOLOGY OF STANDARDIZATION

From its beginnings in the Hertfordshire schools until its demise as a co-ordination range, scientific colour in architecture was closely linked to issues of industrial production and to the modernization of the building industry. The Archrome range and the 'methodical' approach to colour, Medd claimed, stemmed from the same philosophy of standardization which had presided to the success of the Hertfordshire schools.[249] The BS 2660 had not seen the light of day only to provide architects with 'functional' colours, but also was to help modernize by means of 'simplification' British industry in general and the paint industry in particular. And colour co-ordination drew legitimacy in part from its association with the movement of flexible standardization through modular co-ordination. Medd wrote in 1972: 'Dimensional coordination and colour coordination are part of the same process - that of research workers and designers trying to heave the building industry into the 20th century.'[250]

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[248] See Whitfield, O'Connor, Wiltshire, 'The British Building-Colour Standards: A Model for International Application', pp. 215, 216 ; 'Rational Colour Co-ordination', p. 1262; see Gloag, Gold, Handbook: the introduction was translated in French, German, Russian and Spanish; Williams, 'Master Range of Colours', p. 71: [on developments from DD17] 'Not least international standardisation is bound to follow. No country in the world has a rational framework for colour co-ordination and many are watching the UK's pioneering work with interest and enthusiasm.'

[249] Medd, 'Colour in Buildings: A Scale', p. 251.

[250] Medd, 'Can Colour Coordination Work?', p. 71; BRS Information, Colours for Building, p. 1: 'The need for dimensional co-ordination of these components is now widely recognised and the sizing of products within an agreed dimensional framework is an essential part of the metric change programme. The need for an agreed system for co-ordinating building colours is equally apparent.'

The standardization of colour was for architects one means to rationalize colour, to separate it from its traditional links with decoration, with personal preferences and fashion, and make it acceptable to the profession, industry, and to their main clients, the science-conscious local authorities and government departments. But why did architects choose to 'standardize' colour to give it a rational appearance, rather than, say, simply producing their own system of classification, or only developing a rational method of application? Why was 'standardization' considered the appropriate mode of scientization?

A closer, more critical look at the architects' account of standards will show how the apparently trivial subject of scientization of colour in architecture was steeped in the economic circumstances of the post-war period and in contemporary debates on industrial production, modernism, and aesthetics.

Colour and Mass-production

David Medd and Bill Gloag looked upon Amédée Ozenfant's call for colour standardization in 1937 as one source of inspiration for the development of the Archrome range and of the BS 2660.[251] They were also surely influenced by existing British Standards dealing with colour, such as the BS 381C 'Colours for Ready-Mixed Paints' and even by institutional and commercial ranges and reference ranges such as those issued by the British Colour Council.[252] The BS 381C was used by the BRS team in several experiments in factory colour during the war and the late forties, most famously in the Brynmawr rubber factory in

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[251] Medd, 'The Road to DD 17', p. 12; Gloag, Medd, 'Colour in Buildings', pp. 334-35.

Wales.[253] However, these ranges were both models and foils: architects criticized them for being ill-assorted selections of colours which did not serve their needs. In their view, these standards had never been conceived as 'ranges', as sets of colours planned to go well with each other. They were mainly a collection of 'corporate' or 'identification' colours in use by different government departments and services. The BS 381C, for example, contained the post-office red. It is most probable that architects used and advertized their use of such colours, before the advent of the Archrome and the BS 2660, for the sake of using a standard range, for being seen to apply a colour that could be called 'standard'.

We have seen that in the early days of the Herts colour work, Medd presented the development of 'standard' ranges as a natural and unproblematic application of the discipline of standardization which was central to the school building programme.[254] Medd explained in a talk on colour in schools:

> I should like to say a few words about my Department's general attitude to the technical problems of building in order to emphasise how we have tried to bring a consistent approach to bear on every aspect of the work. We believe that technical progress lies in standardisation for production to give flexibility in application. Moreover, the wider the application, the greater will be the resulting economy. [...] I hope to show that what I have said can bear some relationship to colour.[255]

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[252] BSI, BS 381C: Colours for Ready-Mixed Paints (London: BSI, 1948); British Colour Council, Dictionary of Colours for Interior Decoration, 3 vols (London: British Colour Council, 1949); British Colour Council, Dictionary of Colour Standards, 2 vols (London: British Colour Council, 1934).
[253] R. Furneaux Jordan, 'Brynmawr', AR, 11 (1952), 143-64 (pp. 161-62).
[254] Ezra D. Ehrenkrantz, John D. Kay, 'Flexibility Through Standardization: Part 1: The Hertfordshire Prefab Schools', Progressive Architecture, 39 (1957), 105-11 (p. 106); Richard Llewelyn Davies, John R. Weeks, 'The Hertfordshire Achievement', AR, 111 (1952), 367-87 (p. 368).
[255] Medd, 'Colour in Buildings: A Scale', p. 251. See also Medd, 'Colour Lecture to Messrs. Gays', p. 2: 'We as architects spend much time in attempts to rationalise building construction and methods to meet the new conditions being created by the gradual disappearance of craftsmanship from the building industry, and it is now time to make similar efforts in the field of paint.'

Non-traditional approaches to building, including standardization and prefabrication, were seen as the key to the social, architectural, financial and logistical success of the Herts and the Ministry of Education's schools. The school building programme appeared to have realized the modern movement's dream of mass-produced architecture serving social ends, and seem to be this long-awaited, truly British form of modern architecture.[256] Widely publicized, the new methods of construction brought international acclaim for British schools, crowned by a special grand prize at the 1960 Milan Triennale to the Nottinghamshire architect's department and CLASP system building for an unassuming prefabricated school.[257]

The Herts passion for standardization was part of a wider belief among architects, encouraged by the state, in an imminent and necessary revolution in the building industry through the application of the industrial methods of mass-production. Standardization was assumed to be the sine qua non of efficient and economic mass-production.[258] Bruce Martin wrote in 1957: 'It should be recognized in the first place that the development of standardization is inevitable; it is part of the inexorable evolution of industrial progress, the flow of which has taken on a momentum of its own that no single individual or group of individuals can attempt to stem.'[259] Standardization, in the minds of architects, industrialists and politicians, was hardly distinguishable from the popular idea of simplification, the reduction of variety in industry, which was

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[256] Guy Oddie, 'The New English Humanism: Prefabrication in its Social Context', AR, 134 (1963), 180-82 (pp. 180, 182); krantz, Kay, 'Flexibility Through Standardization : Part 1', pp. 105-111; Saint, Towards a Social Architecture, ix; Bruce Martin, School Buildings 1945-1951 (London: Crosby Lockwood, 1952).

[257] Reyner Banham, Guide to Modern Architecture (London: Architectural Press, 1962), pp. 142-46.

[258] Finnimore, Houses From the Factory, pp. 244-45; Ehrenkrantz, Kay, 'Flexibility Through Standardization: Part 1', p. 105.

[259] Bruce Martin, 'The Nature of Standardization', in Architects' Year Book 8 (London: Elek Books, 1957), pp. 187-98, (p. 197); see also Bruce Martin, Standards and Building (London: RIBA Publications, 1971), p. 92.

thought to raise productivity and lower costs.[260] Industry, in alliance with the state, also looked to the application of simplification and standardization as panacea to the post-war economic crisis of Britain, as illustrated by the report on Simplification in British Industry by the Anglo-American Council on Productivity. This report, and the earlier Simplification in Industry, aimed to encourage British manufacturers to emulate the apparent success of American methods of production.[261] Part of the fascination for all things American after the war, it prompted a section of the paint industry to call for a national paint colour standards which, in the firm hands of the architects, was to lead to the BS 2660. In the building industry, Brian Finnimore has argued, it was the rapid advances in industry and in particular the success of munitions factories, the difficult economic conditions of the early post-war period, and the influence of the European Modern Movement and Taylorism which to a great extent contributed to the prominence of system building in state policies in the post-war period.

But Finnimore also points out how system building did not achieve the substantial economies promised, and underlines the ideological function of the use and promotion of new methods of construction for the British state: helping to ensure the consent and social cohesion of the working class. As Finnimore also notes, some contemporary critics were aware that there was, in the end, little evidence to support the claims that mass-production brought 'miraculous' economies.[262]

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[260] See Martin, 'The Nature of Standardization', pp. 190, 194, 195; Simplification in British Industry, pp. 1, 4; RIBA, The Industrialisation of Building (1965), p. 19.

Flexibility vs Simplification

The revisionist history of the 'principles' of industrial change proposed by economic historians Charles Sabel and Jonathan Zeitlin seem to confirm these doubts. They argue that the emergence and prevalence, for the greater part of the twentieth century, of the Fordist model of mass-production, 'the manufacture of standardised products in huge volumes using special-purpose machinery and unskilled labour', was not primarily due to its being the best technological solution, or the most efficient and economic form of industrialization.[263] This is shown in part by the emergence and persistence from the eighteenth century onwards, of alternatives to mass-production, namely what Zeitlin and his colleagues call 'flexible specialization'. In different regions and economic sectors, small and large firms using skilled labour and innovative and flexible technology manufactured a wide range of products. The emergence in the 1980s of small to medium enterprises employing highly flexible forms of production, such as the textile industry in Nothern Italy, also called into question the assumption that Fordist mass-production was the only path to economic and technological development. According to Zeitlin and his colleagues, the decline of flexible forms of production which began after the second world war and the dominance of mass-production until the 1980s had less to do with the search for efficiency than with 'accidents of historical timing' and political and social struggles over 'visionary ideas of machine design'. Thus, among the different promising technologies and forms of industrial organization available at any one time, state support, large human and financial commitments, the desire to follow

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[261] Finnimore, Houses From the Factory, p. 42.
[262] Finnimore, Houses From the Factory, pp. 133, 244, 245.

trends, and the power of utopian images, tend to favour one option and discourage other potentially viable ones.[264]

This interpretation of the prominent place occupied by mass-production in twentieth-century industrial culture, where politics and coincidence play a greater role than productivity and technological superiority, casts doubt on the architects' and the paint manufacturers' whole endeavour to standardize colour. It also helps us to understand, in part, why colour was standardized.

Both architects and manufacturers claimed that variety, including 'specials', the production on demand of small quantities of customized products, was time-wasting, expensive and inefficient. Mass-production and standardization, which inexorably transformed all sectors of industry, demanded that a small number of colours be produced in large quantities for economies of scale and increased productivity.[265] But were architects and manufacturers right in vilifying variety? Was the main purpose of colour standards for architects really economy of production through the elimination of specials? Did the spread of mass-production, and the imminent industrialization of building exemplified by the Herts schools, as architects implied, make the standardization of colour inevitable?

If and to what extent the principles of mass-production were applied in the paint industry, if they brought the promised economy and efficiency, and if specials were really bad for economy, and more expensive and difficult to

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[263] Steven Tolliday, Jonathan Zeitlin, 'Between Fordism and Flexibility: The Automobile Industry and its Workers: Past, Present and Future', Archiv für Sozialgeschichte, 28 (1988), 153-171 (p. 153).
[264] Jonathan Zeitlin, Charles Sabel, 'Historical Alternatives to Mass Production: Politics, Markets and Technology in Nineteenth-Century Industrialization', Past and Present (August 1985), 133-176 (pp. 134, 170, 171).
[265] Transcript of letter from Claude E. Bridges, Secretary of the PICRC, to Secretary, RIBA, 19 February 1952, RIBA Science Committee Minutes 1951-1959, 6 March 1952, Inset C; 'Comment: The Problem of Shades', PT, 16 (1951), 237-38; Martin, 'The Nature of Standardization', p. 196: 'Moreover, in these times the manufacturer can no longer afford to produce small runs of specials, because of high production costs, but must mass-produce in a response to a steady uniform demand.'; BB9, pp. 12.

obtain after the second world war, these are not questions to which straightforward answers are possible. Unlike the more seductive subject of the car industry, paint production has not attracted the attention of critical and original historians.[266] However, there is some evidence, as Zeitlin's compelling understanding of mass-production suggests in relation to industrial production as a whole, and to the car industry in particular, that the manufacturers' and the architects' enthusiasm for simplification and standardization in paint colour was largely ideological, in a sense that it was based on ideas of the superiority of those approaches to industrial production rather than substantial evidence of their success, relevance or actual efficiency.

The report Simplification in British Industry, published in 1950, stated that it was 'common practice' for British firms to produce a wide range of products. Regarding the paint industry, it believed that there was 'a good deal of scope for eliminating needless variety', suggesting that firms were able and willing to provide a variety of colours, within the boundaries of current fashion.[267] As colour cards from the 1940s and 1950s show, decorative 'ready-mixed' paints were available from manufacturers in a relatively small number of colours, on average between fifteen to forty, and in a similarly small number of finishes, to keep stocks of paints to a minimum.[268] (Figs. 38, 39) But special ranges and colours, in small and large quantities, were also produced to order. For example, the Paints Division of ICI, one of the largest paint firm in Britain, was reported in 1953 to produce large batches, as well as smaller ones of up to

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[266] To the best of my knowledge, there is no critical history of the methods of production and technologies in the modern paint industry similar, for example to that of Zeitlin and Tolliday, 'Between Fordism and Flexibility', on the automobile industry.

[267] Simplification in British Industry, pp. 5, 11; 'The Problems of Shades', p. 237.

[268] Small ranges might have reflected the practice of the 'painter craftsman' before the war, who tinted and mixed his own colours from paint in white paste and stainers. 'Comment: Colour and Fashion', PT, 23 (1959), 195-97 (p. 197).

fifty gallons in a separate department which also served to test new products.[269] (Fig. 40) One critic's dismissal of the Archrome range, published in 1953, suggests not only that specials in a wide variety of shades could still be had, but also that, for those unconcerned or unaware about the need for standardization and the elimination of specials, these were a perfectly acceptable option for architects: 'I am not clear why the Bulletin should emphasize that the [Archrome] colours given are commercially available as from experience there has never been difficulty in obtaining any shade desired by architects.'[270]

Emerging like all industries from the war effort, paint manufacturers had to surmount many difficulties while establishing new markets for their products. Among the difficulties they had to face were the low quality of paint, a legacy of war-time austerity, and the rationing and recurring shortages of raw materials.[271] Their eagerness to find new markets and their flexibility in responding to new clients is illustrated by the collaboration of a number of paint manufacturers with Hertfordshire architects in their early successive attempts to produce colours for schools.[272] In this context, one can look at the

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[269] 'Varnish and Paint Production at the I.C.I. Slough Works', PM, 23 (1953), 376-78 (p. 378); see also 'Comment: More Royal Colours', PM, 22 (1952), 44: 'H.R.H. Princess Elizabeth has agreed to sponsor a number of colours for the benefit of the textile and allied trades in connection with the forthcoming tour of Australia, [...]. This time four colours have been chosen, and named Tudor cream, Pacific Yellow, Edinburgh rose, and Wildflower blue. The British Colour Council, which is responsible for this sponsorship, has described Edinburgh rose as a flower-fresh pink and Tudor cream as having the soft glow of a creamy rose. [...] It is expected that these four colours will prove particularly popular in Australia and New Zealand this summer, and it is hoped that manufacturers will also benefit.'

[270] 'Colour in Schools', ABN, 203 (1953), 471-72 (p. 471); 'A New Paint System: 999 Colours from 16', ABN, 203 (1953), 182: 'In the years since the war an increasing number of paint manufacturers in this country have mixed paints to order in the Munsel (sic) range of colours.'; 'Colour Co-ordination: Proposals', (1969), p. 708: 'The need for co-ordination in the colours of manufactured components is much more pressing than it is for paints, for with paints it is always open to the architect who has the necessary understanding to choose colours or have them made specially if necessary, to ensure paint co-ordination.'

[271] Simplification in British Industry, p. 11; 'Colour in the Factory', Times Review of Industry, 1 (1947), 9-10: 1802-1952: 150 Years of Paint and Varnish Manufacturing (Thos. Parsons and Sons, [1952]), pp. 54-55.

[272] R. Gay & Co., Docker Brothers, Jenson & Nicholson, Hadfields, Gerald Carter collaborated with Herts architects, although some paints came from pre-war stocks. Medd, 'Notes on Talk on Colour', pp. 9, 10;

call by a section of the paint industry for a 'national standard', at the decision to denigrate their current flexible practices, as motivated in part by the genuine hope, stirred by the reports on simplification and accompanying propaganda barrage, that the concentration of resources and demand through standardization would improve their situation and reduce unit costs of the product. (Fig. 41) But it makes no doubt that in pressing for a national standard, manufacturers' minds were firmly set on the massive government building programme and corresponding paint sales. Industry might have hinted at the range being only the start of a wider simplification of paint colour ranges. Architects might have dreamed of their national standard as destined to all consumers of paint. But this national, 'simplified' range of colours had never been seriously intended for paint production as a whole, but aimed to eliminate the many ranges then in use within large organizations and government departments.[273]

As for architects, many of whom were state employees, in seizing upon the campaign for simplification and diverting to their own purposes the initiative of the paint industry, they were perhaps less concerned with economic production than, in part, fearful of having a range thrust on them by industry and unenlightened civil servants, and losing control over what they saw as an essential part of architectural practice. The growing prestige of the

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Gloag, Keyte, 'Colour Co-ordination', p. 39.

[273] See transcript of letter from Claude E. Bridges, Secretary of the PICRC, to Secretary, RIBA, 19 February 1952, RIBA Science Committee Minutes 1951-1959, 6 March 1952, Inset C: '[The reports of the Anglo-American Council on Productivity] have been considered by the Paint Industry with a view to action being taken, for the Industry recognises its duty to provide a positive lead towards the simplifcation of colour ranges for decorative paints. Acting through the Paint Manufacturers' Co-operation Committee, it has established the Paint Industry Colour Ranges Committee, and that committee has instructed me to tell you that, [...], a single co-ordinated range of colours is being compiled which, it is hoped, will be acceptable to Government Departments, Local Authorities and bodies of similar standing.' Architects at the RIBA had definitive hopes that the range would have a wider impact: 'This friendly collaboration brought the work to successful completion and has resulted in the production of a range of 101 colours for building, commendable to the industry, the R.I.B.A. and important users of paint including, it is hoped, the public at

profession within the state's building programme no doubt led paint manufacturers to accept, rather reluctantly, its requests for 101 colours for the BS 2660, which was many more than the fifty or sixty originally intended by industry. Ironically, architects argued in a BRS Digest that no less than these 101 colours were needed if demands for specials were to be reduced![274] However, among the many firms who took on the BS 2660 range, not all provided the 101 colours, and none restricted their production of decorative paints to the standard. One reason for this was that manufacturers had apparently legitimate doubts about the commercial attractiveness of certain of the colours selected by architects. In part to avoid taking up storage space and tying up capital in slow-moving stocks, manufacturers seemed to favour smaller, more popular ranges for ready-mixed paints.[275] Moreover, with the BS 2660, paint firms found themselves in the curious situation of producing the same colours, of having, in a sense; part of their production nationalized. The report on simplification of 1949 mentioned how in the USA, consumers had not seen their choice of colours reduced, as each individual firm, although producing a simplified range, offered different colours from its rivals.[276] Similarly, to retain their competitive advantage, British firms gave their own names to colours, in addition to the Munsell code, and complemented BS colours with their own, more popular, 'house' colours. Thus, it could be said

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large. 'New Range of Colours for Building', p. 174.

[274] BRS Digest 101, p. 3; H. L. Gloag, 'Notes on Mrs. de Saulles' Proposals (Revision of BS 2660)' (unpublished typescript, 21 February 1963), p. 1: 'paint industry visualised 50-60 and got 101 colours! but even so there was reduction of about 1/3 of colours contained in various ranges then in circulation'.

[275] BRS Digest 101, p. 5; S. A. Wood (I.C.I. Colour Advisory Department) in Gloag, Medd, 'Colour in Buildings', p. 344: 'I think that there are [...] up and down the country many architects who have not quite the use for what we describe, for want of a better term, as the aesthetics in this range .'; 'Comment: Colour Coordination', BM, 33 (1973), 7: 'It is now nearly 18 years since BS 2660 [...] was published. In that time it can hardly be said to have achieved very much for the industries it was supposed to benefit, not least because there proved to be little demand for a considerable number of the shades specified.' For views on factors leading to good range, Eric P. Danger, Using Colour to Sell (London: Gower Press, 1968), p. 172.

[276] Simplification in Industry, p. 7.

that from the start, manufacturers betrayed the goals of the national standard.[277] In fact, from the fifties onwards, manufacturers saw themselves more as sellers of colour rather than merely of protective finish, and offered an increased range of colours both for trade and domestic consumers. This new consciousness of colour was partly due to the growth of the Do-It-Yourself market, the development of home decoration as a mass leisure activity, and as Penny Sparke has argued, to the greater choice and personalization which the increasing importance of women in the purchase of consumer goods was thought to demand.[278]

Bill Gloag complained: 'Paint manufacturers originally pressed through their committee for a reduction in demand. Having been given a tight range of 101 colours, accepted by most architects at the beginning, they presumably add to these in the hope of gaining advantage among themselves!'[279] Thus, while manufacturers were unhappy about the larger number of standard colours and some of the selection imposed by architects, they, in turn, condemned the manufacturers' practice of adding more colours which, they were well aware, threatened the claimed universality of the range and more dangerously, one of its main justification, the reduction in number of colours in use.

Moreover, there were many competing colour ranges such as the one first launched in 1951 by the House & Garden magazine which were geared to decorators and the Do-It-Yourself market. Taken up by firms of furnishing

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[277] See Danger, Using Colour to Sell, pp. 114-15, 174; 'Comment: Colour and Fashion', p. 196; 'Colour Cards', AR, 130 (1961), 70, 72: [On Manders 'Architects Range and Supplementary Colours] 'The range comprises the B.S.S. 2660 range plus 28 supplementary colours for which presumably they have found sufficient demand to add to the standard colours.'; BRS Digest 101, pp. 4, 5.

[278] Penny Sparke, As Long as It's Pink: The Sexual Politics of Taste (London: Pandora, 1995), p. 194. For paint industry as a seller of colour, see 'Comment: Colour and Paint', PT, 23 (1959), 5; 'Comment: Colour and Fashion', p. 195. The reasons for the emergence of the Do-It-Yourself movement are many and complex, one of them, suggested in a contemporary article, was that while low income families had always been amateur decorators, the rising costs of hiring decorators firms led more middle-class households to decorate their homes themselves. See 'Comment: Amateur Decoration Trends', PM, 22 (1952), 83.

fabrics, floor coverings, paint and wall paper such as Nairn's, Conran, Race, and Heals, these ranges show that industry believed that at least for the emerging Do-It-Yourself market and for decorators, variety offered a distinct commercial advantage.[280]

The introduction of tinting systems, in the same years leading to the publication of BS 2660, is more evidence of how misguided were the industry's and the architects' stance against variety, as uneconomical and inefficient. Here was a new development in paint technology which favoured flexibility, allowing an unprecedented variety of colours to be produced and offered to the consumer. First devised in the USA, tinting systems consisted generally of two bulk-produced bases to which one or more universal colourants were added in different proportions and combinations, with systems such as the 'Colourdex' yielding 2011 colours, the 'Colour Toners' 1600 colours, and the 'Colorizer' providing 1322 colours. One observer of these latest American developments noted:

> All the firms seem to be agreed on certain matters, viz that the public must have more colour to choose from, must be able to choose it themselves, and must mix the paint themselves as far as they can be persuaded so to do.[281]

In 1953, a version of the 'Colorizer' was introduced in Britain by the firm of Jenson and Nicholson, based on a white and grey base and sixteen colourants packed in flexible tubes, and offering a total of 999 colours. (Figs. 42, 43) Greater accuracy in the production and reproduction of colours of tinting systems was achieved with manual and automatic tinting machines, first introduced in the United States in 1953. The American 'Spectro-matic' manual

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279 Gloag, 'Notes on Mrs. de Saulles' Proposals (Revision of BS 2660)', p. 2.
280 'Colour', House & Garden, 8 (1953), 38-42.

dispenser, whose distributing rights were bought in the late fifties by Walter Carson and Sons Ltd., made one thousand colours available to the customer, including the twenty-three colours of the Carsons' matching range and an intermediary range of 320 colours.[282] (Figs. 44) By contrast, a smaller range of 250 colours could be obtained from the 'Matchmaker' paint tinting machine, which was introduced in 1960 by the Paints Division of ICI. It is interesting to note that at the same time as launching the 'Matchmaker', the Division announced that their 1961 'retail' range for ready-mixed paints had been 'streamlined and simplified.'[283] (Fig. 45)

When first introduced in Britain, tinting systems were viewed by one observer as beneficial to all sides of the building industry. For manufacturers and retailers, tinting systems fulfilled consumer demand for more colours without the need to increase storage space. For contractors, small quantities were quickly and easily available. According to the same observer, visibly unaware or indifferent to the modernist edicts against variety in matters of colour, the advantage of tinting systems for architects lay in the greater choice of colours.[284] In practice, however, the new technology was largely aimed at paint retailers servicing the rapidly expanding Do-It-Yourself market.[285] Due to the limit on the concentration of colourants in the base paint, mostly lighter shades were produced by tinting systems. Until the mid-seventies, partly because they compared unfavourably with factory produced ready-mixed paints in terms of quality and opacity, paints from tinting systems were not in wide

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[281] L. A. Jordan, 'Colour Control by the Customer', PT, 16 (1951), 537-38 (p. 537).
[282] 'Mechanical Colour Dispensing', PT, 23 (1959), 202, 210 (p. 202).
[283] 'Now I.C.I', Paint, Oil and Colour Journal, 18 (1960), 1165.
[284] 'A New Paint System: 999 Colours from 16', p. 182.
[285] 'Now I.C.I.', p. 1165; Jordan, 'Colour Control by the Customer', p. 538; Don Mason, Lecture (unpublished typescript, 1996); Frank Armitage, The British Paint Industry (Oxford: Pergamon Press, 1967), pp. 112-13; Frank Armitage, 'A Century of Paints and their Application in the UK', Polymers Paint

use in the building industry.[286] And although welcoming the new technology, architects heading the standardization movement remained firmly opposed, on principle, to the wider choice of colours it promised, thinking it more appropriate to the uneducated, inexpert homeowner dabbling in decoration. In fact, the flexibility of tinting systems was an embarrassing contradiction to the 'Fordist' interpretation of colour standardization adopted by architects in the fifties. Michael Keyte, one of those who worked on the BS 2660, wrote in 1956:

> The fact that the paint industry is increasingly turning to mass production and is becoming less able, taken as a whole, to deal economically with orders for small quantities of "special" colours is not the whole of the other side of the story. If it were, then architects would have every reason to encourage a method, recently introduced, whereby the pigment and the bulk paint are supplied separately, the pigment being added by the user in pre-determined proportions to produce a very wide selection of light and very light colours. This new technical development may very well foreshadow more precise and economical methods of manufacture inside the paint factories and it may be of advantage to the domestic user buying his paint at the counter, but it must not be assumed that the practising architect's real need is for the largest possible number of colours. In fact, there are strong arguments in favour of a limited range of colours from consideration of design alone, quite apart from questions of economical manufacture.[287]

From Gropius to Ford

That besides paint, other materials provided colour in buildings, that the perception of a particular colour was in a building affected by light, shadow and texture, making several closely related colours irrelevant, that with the aid of the three Munsell categories only the most representative and useful colours could now be selected, these were some of the architects' 'strong arguments' for discipline in colour. A smaller but 'balanced' and 'comprehensive' range

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and Colour Journal, 169 (1979), 474, 477-78 (p. 478)

[286] In 1987, only 10% of coloured paint sold in Britain came from paint tinting systems, the majority of sales coming from relatively limited ranges of popular colours in ready-mixed paints. Paint and Surface Coatings: Theory and Practice, ed. by R. Lambourne (Chichester: Ellis Horwood, 1987); 'Berger Breakthrough', PM, 47 (1977), 21, 23 (p. 21).

[287] Keyte, 'New British Standard', p. 213.

was also said to save time in selection and raise the aesthetic standards of colours schemes, as well as simplify the administration of paint stocks for a local authority or government department. Mention was also made, in relation to BS 2660, of problems involved in expanding a range by mixing, as a combination of the same colours in different types of paints did not necessarily produce the same results.[288]

But architects had not always equated standardization with a curtailed choice of colours, as their changing approaches to the concept reveals. We saw earlier on that Herts architects had first envisaged a standardization 'of means, not ends', 'of small numbers for production, giving a wide freedom in application'.[289] This 'flexible' approach to standardization was of course a leitmotiv of the schools programme, modelled on ideas championed by Walter Gropius since between the wars. To the Fordist uniformisation of end products, Gropius opposed the small number of standardized, interchangeable components yielding any shape of building desired.[290] The American architect Ezra Ehrenkrantz wrote in 1957 about the earlier Herts schools: 'Flexibility and variety in planning were valued highly, [...]. Hence, while the component parts could be standardized, the whole building should not.'[291] This philosophy also pertained to the interest for the theme of 'flexibility', within the wider

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[288] BRS Digest 101, pp. 2, 3; Keyte, 'New British Standard', p. 213; ; BB9, pp. 11-13.

[289] Medd, 'Colour in Schools' (1949), p. 166: [on schools by HCC] 'A high degree of component standardization is involved-standardization of means, not ends. [...] There is urgent necessity for research into how [...] a small number of basic reliable colours can be selected so that, when intermixed, they can provide a comprehensive colour scale.'; Medd, 'Colour in Buildings: A Scale', p. 251.

[290] Saint, Towards a Social Architecture, p. 27; Walter Gropius, The New Architecture and the Bauhaus, trans. by P. Morton Shand (London: Faber & Faber, 1935), pp. 29-30:'We are approaching a state of technical proficiency when it will become possible to rationalize buildings and mass-produce them in factories by resolving their structure into a number of components parts. Like boxes of toy bricks, these will be assembled in various formal compositions in a dry state [...] The repetition of standardized parts, and the use of identical materials in different building, will have the same sort of coordinating and sobering effect on the aspect of our towns as uniformity of type in modern attire has in social life. But that will in no sense restrict the architect's freedom of design. [...] The net result should be a happy architectonic combination of maximum standardization and maximum variety.'

revision of modernism which took place after the war, towards the integration of, amongst others, humanist and aesthetic issues.[292] A reworking as well as continuation of the concept of functionalism, 'flexibility' accommodated the eventuality of change of function in a building or space, for a component or even a colour.[293]

Until the late 1940s, when it was replaced by the Munsell system, the Ostwald colour system was for the Herts architects the embodiment, in the field of colour, of the ideal of 'flexible standardization'.[294] From only five coal tar dyes Ostwald had obtained his twenty-four standardized colours, each mixed in varying combinations with an established number of steps on the grey or achromatic scale, to form his colour solid: for eight steps on the grey scale there were 680 colours, five steps yielding 245 colours in total.[295] But this model had more theoretical than practical value, as it was found that the colours could not be mixed by manufacturers according to the Ostwald recipes. The Ostwald system was seen as a universal reference range from which other ranges could be derived, but no suggestion had as yet been made that the number of colours for these ranges should be kept to a minimum. In fact, in 1949, Medd still found quite shocking the idea of standardizing colours themselves:

> We at H.C.C. have been concerned with trying to standardise the means and not the ends, by standardising the basic five primary colours which gives freedom of choice by means of inter-mixture. On the other hand, the British

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[291] Ehrenkrantz, Kay, 'Flexibility Through Standardization: Part 1', p. 106.
[292] Architecture Culture 1943-1968: A Documentary Anthology, ed. by Joan Ockman with Edward Eigen (New York: Columbia University Graduate School of Architecture, Planning and Preservation; Rizzoli, 1993), p. 13; see Matthew Nowicki, 'Origins and Trends in Modern Architecture', in Architecture Culture, pp. 150-56 (pp. 154, 156); for interest in flexibility see also Reyner Banham, Guide to Modern Architecture, p. 145.
[293] Thank you to Adrian Forty for this view on flexibility.
[294] This expression is used by Ezra Ehrenkrantz in 'Flexibility Through Standardization : Part 1', p. 107.
[295] Medd, 'Colour in Buildings: A Scale', p. 251; Taylor, A Simple Explanation, p. 31.

Standard Institution are now setting up a Committee at the request of the Ministry of Works, to standardise 24 distempers for use in classrooms! It is this kind of thing which we want to try and restrict.[296]

The next and equally doomed attempt at colour standardization involved architects mixing their own samples, for firms to produce, from a dozen or so pure stainers. Still no restriction on the number of colours were envisaged, so much so that paint firms, which up till then had happily supplied architects with special colours, apparently protested at the many different colours requested. Apparently to help reduce wet-mixing by architects and therefore the demand for special colours in small quantities, architects, in collaboration with the paint manufacturer Docker Brothers, developed a system of nine basic, intermixable tints, with black and white, from which was derived a supplementary range of fifty colours.[297] Each supplementary was obtainable following a mixing formula indicating the required volume of the basic ingredients. This system of basics and supplementaries, Oliver Cox noted in a report on colour in the Hertfordshire schools, was particularly appropriate to the economical manufacturing of small quantities of paint. The technique was apparently even spreading to other sectors of the paint industry, such as the 'coach works trade.'[298] Basics also gave architects the freedom to mix their own colours, thus helping to gain acceptance for the limited range of supplementaries. Cox recommended that all manufacturers should therefore list the mixing properties of standard basics, and mixing recipes for the supplementary range, a recommendation which was closely followed in the

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[296] Medd, 'Notes on Talk on Colour', p. 11.
[297] Cox, 'Report', p. 1.
[298] Cox, 'Report', pp. 4-5; p. 6: 'the supply of small quantities of paint selected from a wide range of hues is made possible by the wet mixing by the manufacturers of standard basic colours.'

explanatory booklet on the new Archrome range published by Docker Brothers,

and anonymously written by Medd:

> In cases where this colour selection [Ministry of Education range] does not contain the precise shade required, the use of the basic tinters should give satisfaction and we offer two alternatives for this purpose:
>
> (1) Where a colour is required in a small quantity on a comparatively small area, then undoubtedly, the quickest method is to mix it up on the site from the appropriate basic tinters.
>
> (2) Where larger quantities, unsuitable for site mixing are involved, then a small sample of the required colour should be made up from the basic tinters and the manufacturers can readily match this pattern in bulk.[299]

Much emphasis had been laid, in the Herts schools programme, on minimizing specials in the design of prefabricated components, to help achieve the economies offered by standardization. Yet Andrew Saint, in his history of post-war schools, notes that specials were a much more frequent occurrence than was openly admitted.[300] Similarly, despite the talk of decline of craftsmanship in the building industry, despite the exhortations to reduce specials, it is obvious that architects made extensive use of specials at least throughout the first years of the schools programme, and that mixing on site, not only of samples but of small quantities of paints, was still common practice for architects and painters.[301] At this point, the architects' concept of standardization was imbued with a culture of flexibility and variety which had not yet been silenced.

However, in 1951, the number of colours for the future Archrome range developed by Herts and Ministry of Education architects was fixed at forty-seven colours. If from then on architects continued to be allowed specials, as

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[299] Docker Brothers, Colour With a Purpose ([1953]), pp. 11-14 (p. 11); David Medd, 'Dictated Draft: Comment on Dockers Pamphlet "Colour With A Purpose"' (unpublished typescript, [1953]).

[300] Saint, Towards a Social Architecture, p. 94.

[301] Architects' experiments with paint colours at Herts show that clearly. See also 'A New Paint System: 999 Colours from 16', p. 182.

was no doubt the case, this ceased to be openly acknowledged. This turnabout on previous approaches can be related, in part, to the desire to conform more closely to the well-publicized reports on simplification.[302] In the first (1953) edition of the BB9 on Colour in Schools, there is still mention of the principle of 'flexible standardization' which originally underlay the Archrome range:

> In this case, in order to obtain a harmonious range and to ensure sympathy between all the colours, it was decided to assume the use of as few pigments as possible. The intermixture of these pigments in various combinations could produce a large number of colours. The 47 selected colours were chosen because they were each known to be useful for educational buildings.[303]

But the principle of limiting the number of pigments takes on again a rhetorical character, as architects acknowledged that any number of pigments might be used, the manufacturer being free to use the methods of his choice to arrive at particular colours. And in the second edition published in 1956 of the BB9, no mention at all is made of the basic pigments. From that same year, another clue to the tightening of the view of standardization is Keyte's statement, quoted above, dismissing the usefulness of tinting systems for architects. Yet, one cannot but note how tinting systems such as the Colorizer, with their colourants and mixing recipes, and which at first also involved mixing by the user, were similar in their principles to the system of basics and supplementaries promoted by architects only a few years earlier.[304]

With the new BS 2660 launched in 1955, the ban on specials and variety is unequivocal, as expressed in the BRS Digest 101: 'Was extension of the range

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[302] Some evidence that at least the most prominent modernists within the profession were acquainted with the reports on simplification can be found in the fact that the Architect to the London County Council, Robert H. Matthew, was part of the delegation sent to the United States to compile the report on Building. Anglo-American Council on Productivity, Building: Report of a Visit to the USA in 1949 of a Productivity Team (1950).

[303] BB9, (1953), p. 12..

[304] See for example A. E. Hammond, 'Collapsible Tubes for Paints', PM, 24 (1954), 22-24 (p. 23).

by mixing visualized? No. The range was intended to be a self-sufficient unit.'[305] It could be said that architects came closest here to realising a Fordist conception of colour standardization, a standardization of 'ends' not 'means', in a sense of a reduced and fixed range of products to be manufactured in large quantities for economies of scale. But although the Archrome and BS 2660 were officially 'closed', finite ranges, architects were keen to reassure their colleagues that that their choice of colours had not been fundamentally reduced. Indeed, rather than a few colours yielding many, as in the standardization 'of means, not ends', variety was now deemed to be integral to these standards, a careful and scientific selection of colours eliminating unnecessary variety and ensuring 'balance', 'comprehensiveness', and 'flexibility' within such limited ranges.[306] The fact that reassurance was offered shows that the narrowing down of the ranges wasn't generally seen in the most positive of lights, and it was crucial for the acceptance of the range among the architectural profession that aesthetic freedom, a most important part of its identity, be seen to have been preserved.

Somewhat in contravention to the principle of simplification, architects were in 1955 expanding the Archrome from forty-seven to fifty-four colours, now all selected from BS 2660, the new master range. In 1959, BS 2660 was officially chosen, partly because of its larger size, as a co-ordination range. Yet ten years later, it was judged too small by architects in charge of its

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[305] BRS Digest 101, p. 3.

[306] BRS Digest 101, p. 2: [on BS 2660] 'The chief needs were [...] to have a palette moderate in size but capable nevertheless of a generous gamut of architectural expression. [...] it is hoped that this Digest will help to make its flexibility and other advantages clear.'; DSIR, BRS, Note No. E603, 'A Systematic Range of Paint Colours for Buildings', by H. L. Gloag (unpublished typescript, May 1955), p. 1: 'The final range contains 101 colours and conforms to a size which experience has shown can be sufficiently comprehensive for most design purposes.'

revision, and not to offer enough variety for the purpose of co-ordination.[307] BS 2660 had been launched in 1955 with the purpose of reducing specials and stocks of paints, but architects now argued it could not, with so few colours, achieve this goal for other coloured building materials! Moreover, it seems architects were prepared to accommodate manufacturers' requirement for a larger reference standard from which to choose their specification ranges. Increasingly since the war, manufacturers had indeed become aware of colour and choice of colour as an instrument for raising sales and profits. As one architect (no doubt Gloag or Keyte) explained, in relation to the revision of the BS 2660 as a co-ordination range: 'Marketing of these self-finished components differs from that of paints and manufacturers who might agree to the principle of colour standardisation became restive when they found that the options were so few.'[308] However, although the new co-ordination framework based on the attributes of hue, greyness and weight contained some 500 colours, the need for 'economies' had apparently restricted the number of colours to 182 for the new but provisional co-ordination range, Draft for Development (DD) 17, which was published in 1972.[309] Architects' first proposals in the late sixties for a co-ordination range of 180 colours or so had been opposed by a section of the paint industry who suspected architects might require all colours to be produced and stocked as a paint range. The first range to be derived from the DD 17 was BS 4800, the new paint colours standard of eighty-eight colours, fifteen colours less than BS 2660 which it replaced. Yet manufacturers still found fault with the standard. In the months preceding its first revision in 1981, one observer wrote: 'Since BS 4800 was introduced in 1972 it has been

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[307] RIBA Industry Note 2; BRS Information, Colours for Building, p. 2; Gloag, Gold, Handbook, pp. 20, 30; 'Colour Co-ordination: Proposals', p. 705.

extensively criticised - by the manufacturers for being too wide and by the specifiers for being too restrictive.'[310] Compounding the industry's discontent was the fact that many colours in the range had not been commercial successes. In 1981, BS 4800 was extended to hundred colours including black and white, but to accommodate manufacturers, was divided into a 'basic selection' of the thirty-two colours for which it was thought there was the most demand and which were to be readily available, and two 'supplementary selections' in different finishes, containing a total of sixty-eight, presumably less popular colours. As was noted in the next revision of the standard in 1989: 'The selection of colours in the basic and supplementary categories has been revised to reflect market demands.'[311] That in the end, manufacturers viewed the range simply as a part of their widening selection of colour is demonstrated by their continuing practice of offering, no doubt following 'market demands', many other colours besides the standard range, and by the availability, for example from Carsons, of 'near equivalents' of many BS 4800 colours through Carsons' machine tinting system.[312]

Meanwhile, a definitive and expanded successor to the provisional DD 17 had been published in 1976, along with a string of further 'satellite ranges'. From the 237 colours included in the new co-ordination range BS 5252, BS 4802 for plastics colours had derived 124 colours, BS 4902 for sheet and tile flooring 143, and BS 4900 for vitreous enamel 199 colours. For this last standard, Gloag

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[308] Colour Co-ordination: Proposals', p. 705.
[309] BRE Digest 149, p. 6.
[310] 'Pressures in the Decorative Market: Changes in the Offing', PM, 50 (1980), 10; 'The State of Standards', PM, 48 (1978), 2.
[311] 'Paint Colours for Building Purposes: Colour Coordination for the Building Industry', BSI News (October 1981), 9-10 (p. 9); BSI, BS 4800: Paint Colours for Building Purposes (London: BSI, 1972); 'Foreword'.
[312] 'Carsons Colours BS 4800' colour card (n.d. 1972): 'Many near equivalents to BS4800 colours can be produced from the Carsons machine tinting system.';'Crown Paints: BS 4800 and Trade Colour Range' colour card (n.d. 1972): there were thirty 'Crown Standard Colours Additional to BS 4800 range'.

and Gold felt compelled to explain that, at the manufacturers' request, the usual restraint in numbers had been set aside and that 'marketing considerations' had momentarily taken over functional ones, on the grounds that being offered more choice, architects were more likely to select from the range to colour their buildings.[313]

One stated purpose of co-ordination was 'to combine economy in the number of colours used with sufficient flexibility for meeting design and technical requirements.'[314] This was obviously an echo of the old 'flexible standardization' theme, but it could also be seen as exemplifying the conflict, tension, in the architects' mind, between 'Fordism' and 'flexibility', between their continuing allegiance to the increasingly irrelevant Fordist principle of simplification, and having to recognize and accommodate the variety now offered by the paint and the building industry.[315] Thus by the 1970s, while the ideal of Fordism had a persistent grip on architects' imagination, in order to reassure manufacturers and make their proposition appear attractive to them, architects had to present their BS ranges as one product among many:

> The derived standards are not intended to cover all demands for colours, but to deal with basic and recurring needs. There remains ample scope for colour variety outside the coordination scheme.[316]

What is more, issues of simplification, of reduction of specials and stocks gradually receded into the background as the pursuit of harmony emerged as the main justification for colour co-ordination standards.

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313 Gloag, Gold, Handbook, p. 32-33, 35.
314 BSI, BS 5252: Framework for Colour Co-ordination for Building Purposes (London: BSI, 1976).
315 Such a tension between Fordism and flexibility, both as ideological models and as actual production methods, was noted by Jonathan Zeitlin and Steven Tolliday in their study of the European and American car industry. 'Between Fordism and Flexibility', p. 158.
316 'British Standard Colours', p. 13.

Using standards might well have saved time for architects. However, the recurrent references in the literature of colour standardization to economy of time or money, had less to do with concern for manufacturers' than to show how their professional competence in the application of standardization might reduce costs in state building programmes and assist recovery from the post-war economic crisis.

Architects often hailed standard ranges as the result of joint and harmonious efforts of the profession and industry, as the modernist ideal of the union of architecture and industry come true. At a lecture on BS 2660 soon after its publication, S. A. W. Johnson-Marshall observed that Gropius, who had visited only a short time earlier,

> might have been rather pleased to listen to at least one aspect of this talk this evening, that is the complete accord between members of our profession, working on behalf of the Institute and their clients, on the one side, and industry on the other. I feel that it was a momentous achievement for the R.I.B.A. to take the initiative in this matter, with the gallant support of the organisations that have been mentioned, and I do hope that this will be followed in every other sphere of our work.[321]

Although architects and some section of the paint and building industry might have at one point agreed on the need for colour standards, they were most of the time at loggerheads on the number and choice of colours, and ultimately, on the meanings and aims of such standards.

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prices for non-standard products because they are anxious to give a good service to customers. Paint manufacturers complain that architects demand special colours which require extra time in production, but are not prepared to add the extra costs involved to their prices. [...] The fact that special components are being subsidised in this way is an obvious limitation to the spread of standardisation.'; Simplification in British Industry, p. 5.

[321] Gloag, Medd, 'Colour in Buildings', p. 344; see also W. A. Allen, 'Influences of Research on Building Design: 1. Functionalism and Science', Builder, 197 (1959), 610-12 (p. 611).

I asked in this chapter why colour standards were developed after the war, or more precisely, why standardization, among other possibilities, seemed to architects a good way to make colour appear rational, modern and scientific. Why did architects not stop at using the Munsell system, or simply require what colours they deemed functional and modern from manufacturers without raising the whole issue of standard ranges? More to the point, why standardization, if it was not for economies in production?

Until at least the 1960s, the theories of mass-production and standardization were at the heart of strategies of industrial production, of state social and economic policies and of architectural modernism. Standardizing colour, discussing pigments, specials and costs, allowed architects to associate colour to the serious business of industry, and to the trendiest of theories of industrial production. It allowed architects to attach colour to the urgent mission and technical prowess of state building programmes, as against the vain commercialism of the paint industry. Finally, it helped to modernize colour, to align it with the aesthetic, technological and social principles of modernism. Standardization was quite overtly for architects a path to official approbation and respectability for colour. The BRS had been from the beginning closely associated to the development of the ranges, as architects often emphasized, and with BS 2660, they could also share in the institutional prestige of the BSI. Founded in 1901, receiving its Royal Charter in 1929, BSI had a reputation for objective and disinterested (because voluntary) service to 'British Industrial Progress'.[322] Thus Medd insisted in 1950: 'I should like to close by saying how important it is and how helpful it would be if a

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[322] British Standards Institution, Fifty Years of British Standards 1901-1951 (London: HMSO, 1951), pp. 30.

Master Scale could be agreed on and recognised at an official level such as the B.S.I.'[323] Much as they would have denied that view, standardization was also the means by which architects attempted to impose a particular choice of colour, what they saw as a modern and rational aesthetic, to industry and the profession. In the competitive world of colour ranges, their seemingly systematic make-up, their BSI seal of approval were distinctive selling points for the architects' standards, unique features which it was hoped, would encourage their use and bring commercial success.[324]

Architects held throughout the first decades of the post-war period, and sometimes simultaneously, very different views of colour standardization. Whether the flexible, 'Gropian' concept offering variety, choice and aesthetic freedom or the closed, restricted Fordist concept demanding control and discipline from architects, they were seized upon by architects as principles of seemingly systematic theories of colour. But these fluctuating and contradictory concepts show how arbitrary and tentative was the architects' project to standardize colour, how complicated it was to adapt ideas of standardization taken from industry and building to the field of colour. Particularly in the shift, in the early fifties, from the Gropian to the Fordist view of colour standardization, one sees the influence of the ideology of simplification, and how important it was for architects to appear wedded to the trendiest, most up-to-date theories of industrial production. This is not to say that architects were totally unconcerned with production. Despite much

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[323] Medd, 'Rough Notes', p. 3; Medd, 'The Road to DD17', p. 12: 'Thus in nine years the work of the pioneers had achieved, through government recognition, British Standard specification status, which is the only status from which design experience can be properly fed into the building industry.'

[324] Letter from H. L. Gloag to William Allen, 19 July 1962, concerning a new range of Shell Plastics Researched Colours, 'Shades of Shell', with thirteen out of forty-six colours closely related to BS 2660: 'If the 13 they list as close to 2660 colours are acceptable, it would be a good thing if they added this data in their advertising.'; Building Centre Forum 3.

evidence to the contrary, many architects no doubt genuinely subscribed to the belief that standardization and simplification had real economic benefits for paint producers and consumers. Moreover, architects showed real curiosity for the process of paint production when attempting to apply their 'means, not ends' approach to colour standardization. It could be argued that architects and manufacturers had more in common than at any other time in this story, the desire for variety and freedom of choice of the one coinciding with the ability to produce variety of the other. The decision to create restricted ranges, to reject customization as pre-industrial, enabled architects to align colour with the puritanical, minimalist aesthetic of modernism in a more visible way than the Gropian standards could. However much variety was now in offer, it was dismissed as incompatible with modern industrial production and modernism itself. But the amount of reassurance that had to be offered in defence of restricted ranges makes plain that these were perceived as threatening by many architects who remained attached to variety and choice. The project of standardization was not about production but about creating and defending a new scientific aesthetic of colour, towards which architects were themselves so ambivalent

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Fig. 3 Classroom, Aboyne Lodge Infants School, St Albans, Hertfordshire County Council (1949-1950). Generous daylighting and brightly coloured, child-height cupboards, to create a friendly atmosphere. Photograph from 1977. (David Medd)

Fig. 4 A figurative departure from monochrome walls: a mural by Fred Millet, 'Summer', in circulation space, St Crispin's Secondary Modern School, Wokingham, Ministry of Education Development Group with Berkshire County Council (1951-53). (Oliver Cox)

Fig. 5 Architects sometimes indulged in rather unmodern forms of decoration, but their theory of functional colour restricted their use to certain categories of spaces. These stencilled patterns of stylized pots, pitchers and plants, doors and arched windows was designed and painted (with some help) by Oliver Cox for the dining hall of St Albans Secondary School, Wokingham (1950-51). (Oliver Cox)

Fig. 6 Diagram from the BB9 with indications for an appropriate colour scheme in a classroom lit from one side only, closely related to the lighting scheme. (Ministry of Education, BB9, Colour in School Buildings, 4th edn (London: HMSO, 1968), p. 27, diagram 4)

Fig. 7 Variety and contrast in lighting and colour in St Crispin's School, Wokingham. Arresting overhead lighting for the 'Autumn' mural by Fred Millet. (David Medd)

Image removed due to third party copyright

Fig. 8 War-time colours: Nobel Camouflage Colours, standard range of colours approved by the Air Ministry. (ICI Paints)

Fig. 9 The scorn of architects, a typical manufacturer's colour card from the early 1950s. Mander's Durable Gloss Paint colour card. (Decorators Materials List No. 60 (Bristol: Cotterell Brothers, 1950), p. 79) (Patrick Baty)

Fig. 10 The Ostwald colour solid, from a booklet coming with a set of twenty-four Ostwald colour cards acquired by David Medd in 1937, with a total of 680 colours. (24 Farbentafeln (Großbothen: Unesma Verlag, [n. d.]), pp. 10-11, fig. 3) (David Medd)

Fig. 11 Ostwald colour circle of twenty-four 'standardized' colours and achromatic scale. (J. Scott Taylor, A Simple Explanation of the Ostwald Colour System (London: Winsor & Newton, 1936), frontispiece) (British Library)

Fig. 12 A beautiful educational game: colour card 14, 2nd Ultramarine Blue, of the Ostwald colour triangle, with eight-step achromatic scale, and transparent notation overlay. (24 Farbentafeln (Großbothen: Unesma Verlag, [n. d.]) (David Medd)

Fig. 13 Munsell Student Chart, belonging to David Medd. This plate shows the vertical scale of nine steps of value, horizontal scale of chroma, and circle of ten strongest hues. (Munsell Student Chart (Baltimore, MD: Munsell Color Company, [n.d.]) (David Medd)

Fig. 14 An attractive, ordered display of colours in the Munsell Student Chart. Plates for 5.0 PB and 5.0 Y, two 'complementary' colours. In the Munsell system, colours reach their maximum chroma at different values, hence an irregular colour solid. (Munsell Student Chart (Baltimore, MD: Munsell Color Company, [n.d.]) (David Medd)

Fig. 15 The first Archrome Range of forty-seven colours, hand-made by Oliver Cox in 1951, with removable patches. (Oliver Cox)

Fig. 16 Cover of the first edition of the Ministry of Education's Building Bulletin No. 9 (BB9), Colour in School Buildings. The Bulletin became a best-selling manual of colour among British architects and was re-edited in 1956, 1963, and 1968. (Ministry of Education, BB9, Colour in School Buildings (London: HMSO, 1953)) (British Architectural Library, RIBA)

Fig. 17 A visually interesting and scientific-looking draft diagram of the proposed distribution of the Archrome range colours, plotted on a clever combination of the Munsell hue circle, value and chroma scales, 5 February 1951. A final version was published in the first 1953 edition of the BB9 on colour in schools. This diagram surely helped to convey the architects' rational approach to colour selection. (Oliver Cox)

Fig. 18 A British Standard range, BS 381C from 1948, one of the many ranges studied by the PICRC to produce a national standard range. The BS 381 included many 'institutional' and state 'corporate' colours, including the post office red. (BSI, BS 381C: Colours for Ready-Mixed Paints (London: BSI, 1948))

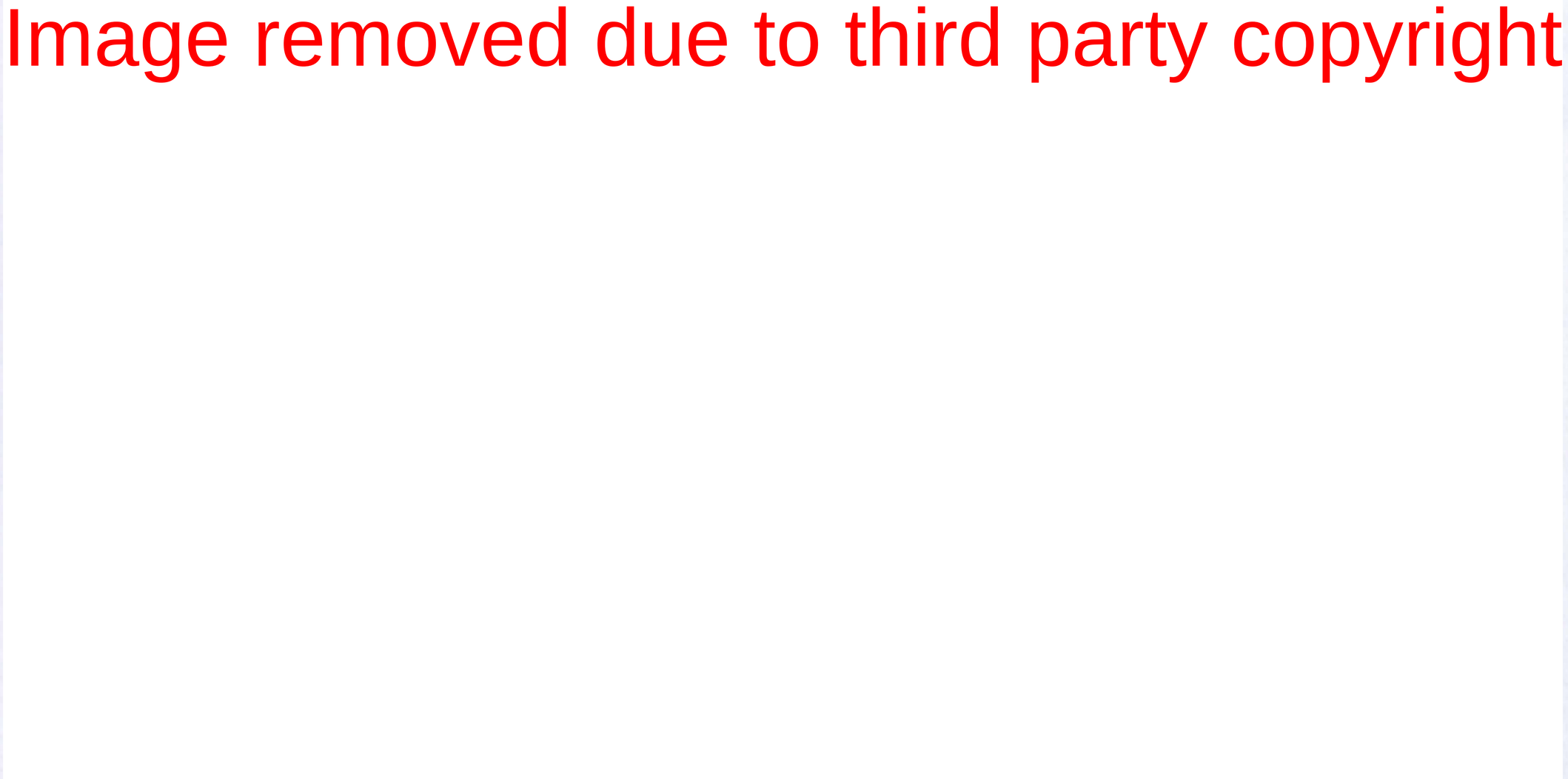

Fig. 19 Another of the ranges examined by the PICRC, Coronation Colours 1953 for Decoration, Advertising, Packaging and Display, fan of twenty-seven colours published by the British Colour Council in 1952. (ICI Paints)

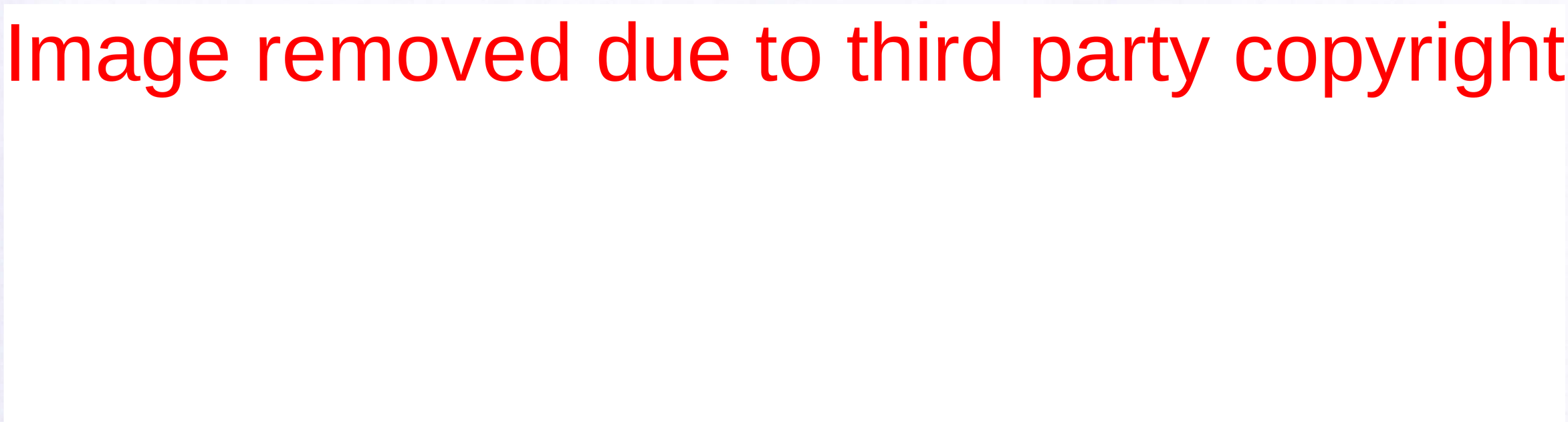

Fig. 20 The BS 2660 in its original packaging, showing part of card 0 with colours of strongest chroma. (BSI, BS 2660: Colours for Building and Decorative Paints (London: BSI, 1955))

Fig. 21 Cards 2 and 3 of BS 2660 displaying a selection of colours in the category of 'weak chroma', with many browns and red-browns. Colours on all cards are arranged in decreasing order of value. (BSI, BS 2660: Colours for Building and Decorative Paints (London: BSI, 1955))

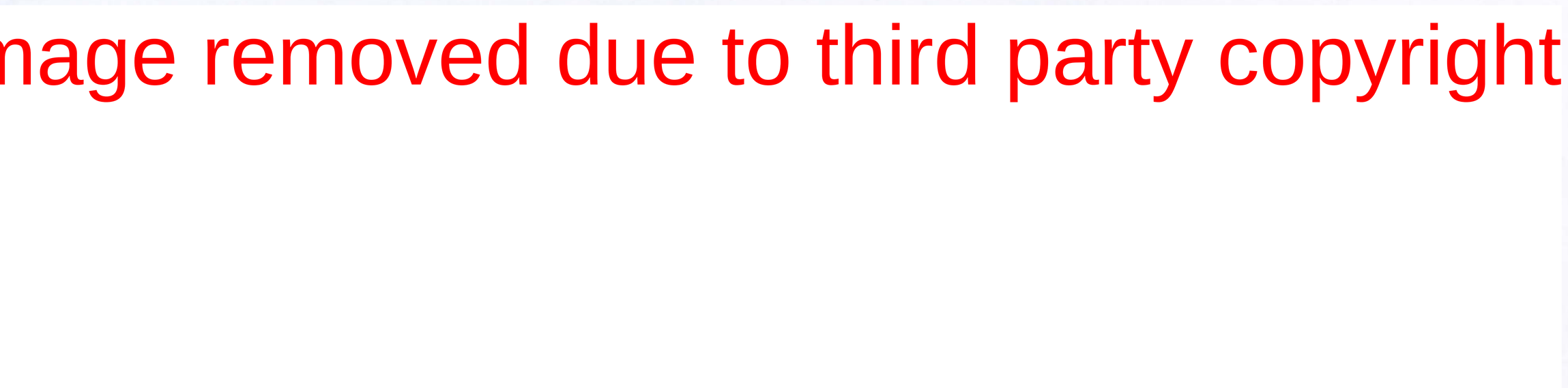

Fig. 22 BS 2660 colour fan published by Walpamur, with BS serial numbers and Munsell references on the back. Walpamur was one of many paint manufacturers who produced all or part of BS colour range. (Ronald Binns)

Fig. 23 The serious business of colour selection. Cover of ICI Dulux colour card for the 101 colours of BS 2660 (1968). (ICI Paints)

Fig. 24 A range of colours for studded rubber tiles, related to BS 2660 and developed on similar rational principles. The smaller diagrams on the left emphasize the systematic nature of the range. One shows the distribution of 'warm' and 'cool' colours in the range (with a bias toward warmer colours), the other illustrates the principle of a balanced distribution of colours in the four broad categories of chroma and within the Munsell value scale. (Gloag, Keyte, 'Colour Co-ordinating a Range', Design (September 1959), pp. 34-35)

Fig. 25 A display of colour co-ordinated building products, meant to demonstrate the success of 'colour co-ordination', from an article published by Gloag in 1967. Although not perfectly matched, all products belong to the 'light grey' chroma category. Below, a card by Nairn Floors showing a range of coloured building materials and finishes developed especially for schools. (Gloag, 'Colour Co-ordination Applied to Materials', Design (November 1967), p. 41, figs. 4-5)

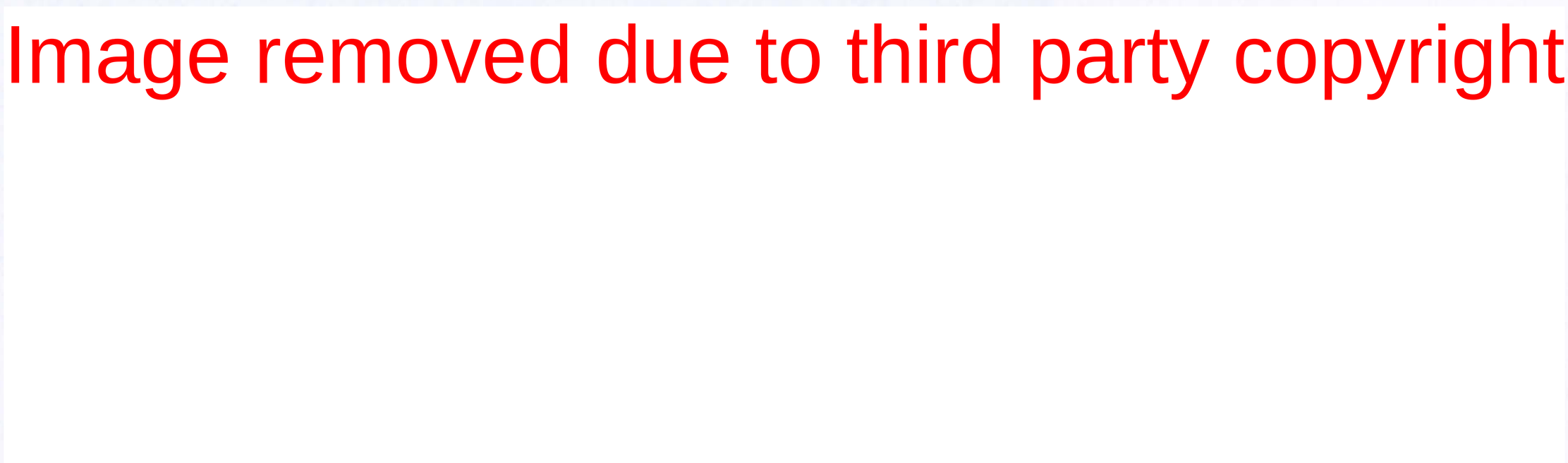

Fig. 26 One image used by Gloag and his colleagues to illustrate the concept of 'equivalent' colours. With the same blue, colours of same value and chroma but of different 'character' in upper row, adjusted to produce a set of 'equivalent' colours, on lower row. (BRE, BRE Digest 149, The Co-ordination of Building Colours (Garston: HMSO, 1973), p. 4, fig. 3)

Fig. 27 Illustrations from the Colour Co-ordination Handbook showing the position of the twelve hues selected for the framework in a forty-step Munsell hue circle, and below, zones of harmony and disharmony, according to Moon and Spencer's theories. (Gloag, Gold, Colour Co-ordination Handbook (London: HMSO, 1978), p. 24, figs. 10-11)

Fig. 28 Illustration in the Colour Co-ordination Handbook of the 'BRS Colour Harmony Selector', for two, three and four-hue combinations. (Gloag, Gold, Colour Co-ordination Handbook (London: HMSO, 1978), p. 43, figs. 22-23-24)

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Fig. 29 More scientific-looking diagrams showing contours of greyness on a horizontal section of the Munsell solid at value 6, and on a vertical section through Munsell hues 7.5R and 7.5BG. The D contour represents the boundary line between grey and clear colours. Below the irregular greyness contours can be seen the regularly-spaced Munsell chroma steps, graphic proof, Gloag argued, of the inadequacy of the attribute of chroma in achieving equivalent colours. (Gloag, Gold, Colour Co-ordination Handbook (London: HMSO, 1978), p. 28, figs. 13-14)

Fig. 30 An image from one of the articles published to promote colour co-ordination, explaining the 'adjustment for equal weight'. It shows the column of twelve equivalent colours for value 5 in greyness groups B to E. In greyness group E, the value of the colour of Munsell hue Y has had to be raised to 8.5 to appear equivalent to other colours. ('Colour Co-ordination: Proposals for a New British Standard', AJ, 150 (1969), p. 707, fig. 3)

Fig. 31 Cards 1 to 4 of BS 4800, with colours in greyness groups A to C. The arrangement of the range is less systematic than claimed. For example, not each hue has its own row, and not all columns contain equivalent colours. (BSI, BS 4800: Paint Colours for Building Purposes (London: BSI, 1972)) (British Architectural Library, RIBA)

Fig. 32 Cards 5 to 8 of BS 4800, with colours in greyness groups C to E (one colour patch missing). (BSI, BS 4800: Paint Colours for Building Purposes (London: BSI, 1972)) (British Architectural Library, RIBA)

Fig. 33 Brolac 4800, colour card from Berger Paints. The original classification has not been retained. Colours are grouped by hue but there is no column of equivalent colours. (David Medd)

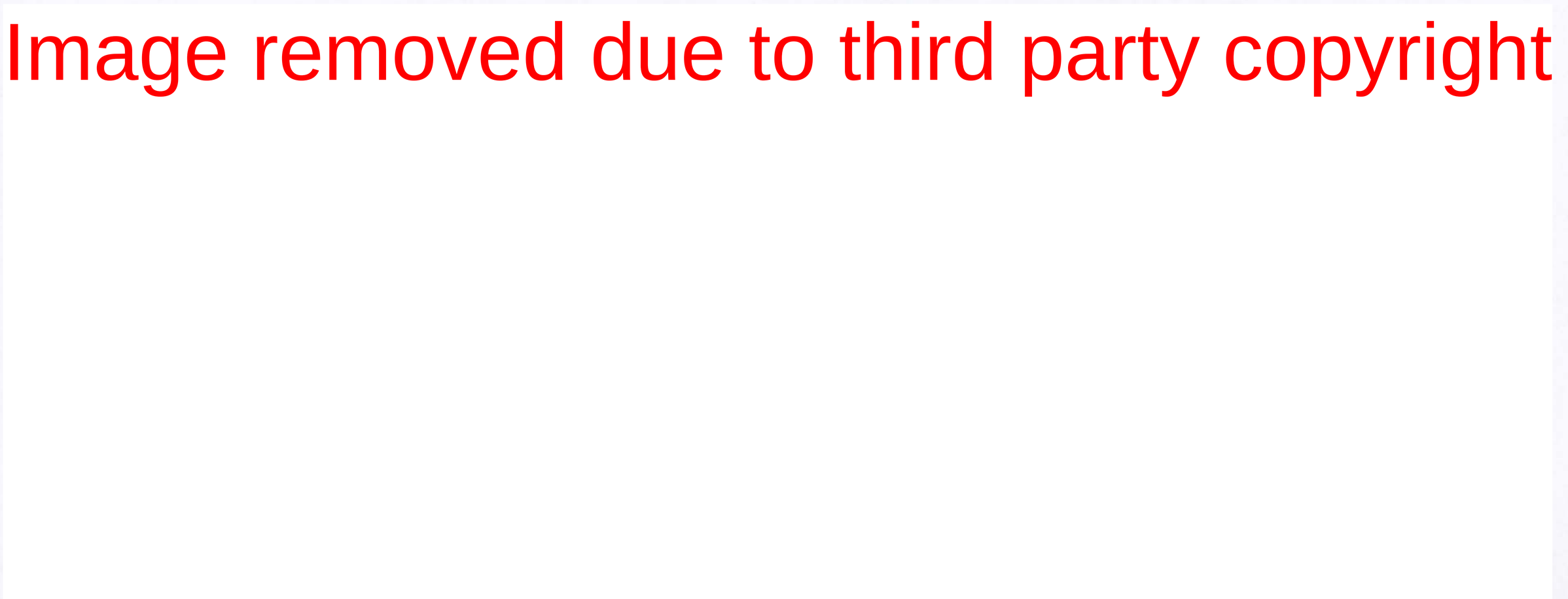

Fig. 34 BS 4800 and Trade Colour Range card from Crown Paints (1972). Greyness groups are shown but the order of the colours is not the exact same as in BS 4800. The manufacturer has given 'trade' names to colours, and added his own 'house' range of 'Crown Standard Colours'. (David Medd)

Fig. 35 The BS 5252: Framework for Colour Co-ordination for Building Purposes. The overall structure was that of the DD17: twelve rows of selected Munsell hues, five groups of greyness, and columns of equal weight in each greyness group, in decreasing order of value from left to right. (BSI, BS 5252: Framework for Colour Co-ordination for Building Purposes (London: BSI, 1976)) (David Medd)

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Fig. 36 BS 5252, four columns of equivalent colours in group D, 'strong acccent colours'. (BSI, BS 5252: Framework for Colour Co-ordination for Building Purposes (London: BSI, 1976)) (David Medd)

Fig. 37 Three ranges derived from the co-ordination framework, from top to bottom, BS 4900: Vitreous Enamel Colours for Building Purposes, BS 4901: Plastics Colours for Building Purposes, BS 4902: Sheet and Tile Flooring Colours for Building Purposes, shown over an outline of BS 5252 framework. (Gloag, Gold, Colour Co-ordination Handbook (London: HMSO, 1978), p. 33, fig. 15)

Fig. 38 Keyolin Enamel Paint colour card, published in 1950, sixteen colours shown, white and ten other colours also in the range. (Decorators Materials List No. 60 (Bristol: Cotterell Brothers, 1950), p. 69) (Patrick Baty)

Fig. 39 Walpamur Water Paint colour card, published in 1950, sixteen colours shown, black, white, and three other colours in the range. (Decorators Materials List No. 60 (Bristol: Cotterell Brothers, 1950), p. 91) (Patrick Baty)

Fig. 40 Small batches of paint produced in portable mixers. Photograph from ICI Paints Division, from late 1950s or 1960s. (ICI Library, ICHO/PH0/3949))

Fig. 41 Caricature illustrating a 1951 article on the problems of specials for paint manufacturers. ('Comment: The Problem of Shades', PT, 16 (1951), p. 237)

Fig. 42 Robbialac Colorizer Paints, catalogue of colour samples, published after 1953. Due to technological limitations, only lighter shades could be obtained. (Patrick Baty)

Fig. 43 'Deep Strikes', a range by Robbialac Colorizer, aiming at compensating for the lighter shades offered by the dispensing machines. (Patrick Baty)

Fig. 44 The 'Spectro-matic' tinting machine. ('Mechanical Colour Dispensing', PT, 23 (1959), p. 202)

Fig. 45 The tinting machine from Crown, launched in 1962, could produce a range of 250 colours as well as forty-three colours from BS 2660. ('The 'Dulux' Matchmaker', Decorator News (January 1962), p. 11)

CHAPTER IV

SCIENCE AND SENSIBILITY IN ARCHITECTURAL COLOUR

British architects between the wars looked upon colour as decoration, and decoration as an integral part of architecture. Post-war architects, by contrast, saw colour as a scientific, quantifiable aspect of architecture, and least of all, it seemed, as decoration. Faber Birren, the American colour specialist, wrote in 1951: 'For colour, as a science rather than as an art, can accomplish many wonders, and can add real efficiency, comfort and security to human life.'[325] This shift from a decorative to a scientific approach to colour, this scientization of colour was in part, we have seen earlier, an attempt to maintain and legitimate a theory and practice of colour in the context of a pervasive ideology of science and of the aversion for decoration in the prevalent modernist dogma. In this chapter I want to consider some of the ways in which architectural colour was made to look scientific, predictable, and not decorative. Standardization, the subject of the previous chapter, was certainly one important means of giving colour a scientific allure. Here I shall examine the methods and principles, and particularly the 'functional' principles which, architects claimed, determined the selection of colours: the quantification, through light reflection factors and the Munsell attribute of value, of this hitherto emotional field; the promotion of the Munsell classification and coding system as rational and scientific and as the very basis of their new, modern approach to colour; and lastly, the development of colour co-ordination as a scientific theory of colour harmony. Although a science of architectural colour cannot be dismissed as an entirely irrational and fantasist

proposition, the evidence points to architectural colour having little to do with science, a contradiction which, as we shall see, did not entirely displease architects.

1. FUNCTIONAL COLOUR

In 1959, A. Douglas Jones, the director of the Birmingham School of Architecture, gave tribute to Medd and Gloag: 'I think that these two have guided thought in the world of colour since the war as much as anybody else, and probably they have also done as much as anybody else to codify colour.'[326] Indeed, with a handful of colleagues, Gloag and Medd signed many papers, articles, and booklets expounding what they variously called an 'analytical', 'systematic' or 'rational' approach to architectural colour. In part, this approach was based on the idea that colours were not merely a matter of taste but served specific functions or needs in buildings, which could be fulfilled methodically, and even scientifically. Inspired to some extent by theories of factory colouring, the development of 'functional' criteria and principles for the choice of colour was at least until the late fifties, one of the most important strategy used by architects in their attempts to scientize colour.[327]

Medd and his colleagues often acknowledged the influence of Amédée Ozenfant's views on colour which were publicized in the Architectural Review in 1937. Interestingly, what mattered most to Ozenfant was less what the rules

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[325] Faber Birren, 'The Functional Use of Colour', Building Research Congress 1951: Papers Presented in Division 3 (London: Building Research Congress, 1951), pp. 176-80 (p. 179).
[326] H. L. Gloag, D. Medd, 'Colour in Buildings', RIBAJ, 63 (1956), 334-45 (p. 344).
[327] See for example, Ministry of Education, BB9 ,Colour in School Buildings, 2nd edn (London: HMSO, 1956), pp. 3-4: 'It was found that mistakes could be avoided and satisfying results achieved if the different uses to which colour could be put were clearly appreciated and something was known of the behaviour and effect of different colours.'; see also p. 5: 'If colours are to be chosen purposefully, architects, [...], must in practice consider systematically the functions which colour can be made to perform and the particular effects which it is desired to achieve.'

were, their content, than the fact that there were rules to be followed in the first place, and that colour could not then be seen as arbitrary. 'We have talked of rules, first because without rules there is chaos; even when a rule is completely inverted that is better than total absence of method: art is not a game of chance.'[328] Moreover, he also posited three as the ideal number of rules in a theory of colour. He explained:

> What we learn chiefly from the rule of Rubens is, first, the necessity of method, and, secondly, the "rule of three." Consider this for a moment: if you are classifying any phenomenon whatever (art included) at least three categories will be found necessary. Two will not be enough (more than three will often be clumsy): where will you put the luke-warm if you have only two categories, in that of the hot or that of the cold? Where would the respectable man go, if there were only the lower regions of criminals and the paradise of saints? Always we must have the two categories of extremes and the one of mediums.'[329]

This esoteric belief in the superior value of the triad, a recurrent feature of the theory of colour throughout its history, was adopted by those very post-war architects who sought to rationalize colour, providing more evidence of the arbitrariness of their 'scientific' theory of colour. Thus, architects posited three main functions for colour, namely, that it should express character, express the building elements, and aid vision.[330]

Character

Because colour is, I feel, perhaps the most important single factor in determining the character of a building, the more care and money should be

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[328] Amédée Ozenfant, 'Colour: Experiments, Rules, Facts', AR, 81 (1937), 195-98 (p. 197).
[329] Ozenfant, 'Colour: Experiments', p. 195.
[330] There were slightly different versions of the theory of functional colour. In one of their articles on colour, Gloag and Keyte list 'appropriate colour stimulus', 'to assist good lighting and vision', and expression of form as the three functions of colour, all of them constituting colour's contribution to character. H. L. Gloag, M. J. Keyte, 'Rational Aspects of Colouring in Building Interiors: 1', AJ, 125 (1957), 399-402 (p. 399).

spent on it than is normally the case, for by colour alone can the true values of a building be expressed, or the failings mitigated.[331]

As these enthusiastic words by David Medd show, imparting character to a building or space was considered a perfectly legitimate objective for a rational theory of architectural colour. Yet character was, and had been throughout its history within architectural discourse, a notably confused and woolly concept.[332] Not only did it have several meanings at any one time, but architects themselves were not precise or systematic in their use of the term. Moreover, the words to describe character, such as 'stimulating' or 'depressing' and 'suffused' or 'dramatic', architects themselves admitted, lacked precision.[333] Thus, character might be used in one of its more traditional meaning of making clear the specific purpose of a building or space. As Medd emphasized: 'A Primary School's character should be separated from all other types of school, and the colour must reflect the difference in the same way as a good plan does.'[334] The term might also refer to a space's unique personality, or simply to a particular atmosphere. Moreover, character could apply indifferently to a building, to its occupants or to colour itself.[335] The authors of the Building Bulletin on colour in schools observed: 'The character of a building is one of its most intangible, but nevertheless most impressive, qualities.'[336]

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[331] David Medd, 'The Application of Colour in Building (With Particular Reference to Primary Schools in Hertfordshire)', in 'Colour and Lighting in Factories and on Machines: Report of Course' (unpublished typescript, November 1948), pp. 24-28 (p. 28).
[332] See Colin Rowe, 'Character and Composition', in The Mathematics of The Ideal Villa and Other Essays (London: MIT Press, 1976), pp. 59-87 (pp. 62, 66).
[333] Gloag, Medd, 'Colour in Buildings', p. 334.
[334] Medd, 'Notes on Talk on Colour Given to Schools Group on 14th February 1949', (unpublished typescript), p. 6.
[335] See for example, H. L. Gloag, Colouring in Factories, Factory Building Studies No. 8 (London: HMSO, 1961), p. 3; BB9, p. 6.
[336] BB9, p. 6.

The notion of character and the view that it was an important quality of architecture was familiar to any architect who like Medd and Gloag, had trained before or immediately after the second world war, and had absorbed the precepts of inter-war architectural theory. Books in vogue at that period, such as A. Trystan Edwards' Good and Bad Manners in Architecture, Howard Robertson's Principles of Architectural Composition, Geoffrey Scott's Architecture of Humanism and John Holmes' Colour in Interior Decoration, to name but a few, all discussed character as an indispensable quality of architecture.[337]

Medd and his colleagues had apparently no qualms in introducing a term which belonged to another age of architecture into their modern, rational theory of colour. To Colin Rowe however, writing in the early 1950s, character did not even qualify as a modern concept. He noted that while character had enjoyed a successful career within British architectural theory since the late eighteenth century, it had now, he believed, fallen into disrepute. Rowe argued that this 'critical embargo' stemmed in part from the incompatibility between modern architecture, all system, standard, abstraction, and anonymity, and character, which sought out 'the particular, the personal, and the curious'.[338]

Character and colour's contribution to character, our architects had once acknowledged, was difficult to define precisely. Yet at the same time, perhaps aware of its illicitness in the eyes of a section of the profession, and as

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[337] A. Trystan Edwards, Good and Bad Manners in Architecture: An Essay on the Social Aspects of Civic Design (London: John Tiranti, 1944); Robertson, The Principles of Architectural Composition (London: Architectural Press, 1924); Scott, The Architecture of Humanism (London: Constable, 1914); Holmes, Colour in Interior Decoration (London: Architectural Press, 1931). The last three books were listed in the AA School of Architecture prospectuses in the thirties. See for example, Architectural Association School of Architecture: Prospectuses 1930-31, 1937-38. See also Rowe, 'Character and Composition', pp. 62, 67.

[338] Rowe, 'Character and Composition', pp. 80, 62.

part of their efforts to rationalize colour, architects tried (rather unsuccessfully) to present character as an ascertainable, objective quality of architecture. Thus, in one instance, character was assimilated to a set of measurable and modifiable variables objectively perceived through the purely physiological sense of vision. Character was 'the collective effect of visual qualities', 'the visual impressions in a building', 'the sum effect of the parts under the control of the architect, including lighting, colour, form, pattern and texture'.[339] Elsewhere, it was the ubiquitous modernist myth of 'users' requirements' which was called upon to develop a scientific version of character. Gloag and Medd wrote: 'The pursuit of an appropriate character therefore brings us to particulars about human requirements and the means of satisfying them in buildings. It is here that science and systematic studies come to our aid.' They added:

> The basis for our approach is observation and subjective studies-quite distinct from studies confined to one particular science, [...]. The concept of character, [...], arises from subjective studies and represents a line of thought which we believe can serve to draw together the lessons not only from the various relevant sciences but from past architectural successes as well, [...].[340]

The expression of correct character by means of colour was assumed to be directly related to the scientifically determined needs and activities of the inhabitants of a building. And what character was appropriate to which inhabitants or activities could be determined scientifically. But this 'science', these subjective studies from which, Gloag and Medd claimed, their conception of character stemmed, the objective data from which a "diffused", "restrained" or "stimulating" character could be rationally produced, were in

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[339] Gloag, Medd, 'Colour in Buildings', p. 334; H. L. Gloag, M. J. Keyte, 'Rational Aspects: 1', p. 399. R. G. Hopkinson defined character as 'an integrated effect, what the psychologist would call a Gestalt.'

fact no more than an amalgam of principles of functional colouring, of improvement of vision, and of light measurement and distribution. As Hopkinson recognized, no scientific approach to character had as yet been developed, although he optimistically added, such a breakthrough was within reach.[341]

Links with a rather contentious aspect of the psychology of colour was another means by which architects attempted to scientize character. Spaces with different functions, they argued, each demanded their own character, mood, or 'degree of stimulus'. In turn, certain colours or groups of colours were deemed to provide a particular stimulus or evoke a certain mood. The BB9 recommended:

> The colour treatment will, therefore, differ according to the degree of stimulation, concentration, gaiety, repose, etc., which is appropriate in any one space. The properties of colour are able to match these needs; they can stimulate and excite; they can be restful; they can encourage concentration and close attention. On the other hand, they can be distracting and irritating; or they can merely be boring.[342]

The giving of symbolic meaning to colours, the linking of colours with particular values and emotions, has a very long and complex history. Johann Wolfgang von Goethe can rightly be regarded as the father of a cruder kind of colour psychology, of a modern folklore of colour.[343] In his Theory of Colours, published in 1810, he devoted a whole chapter to the moral associations of colours, finding that, for example, yellow 'has a serene, gay, softly exciting character', red evoked 'gravity and dignity', 'grace and attractiveness', while surrounded by green, 'The beholder has neither the wish nor the power to

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Architectural Physics: Lighting (London: HMSO, 1960), p. 113.
[340] Gloag, Medd, 'Colour in Buildings', pp. 334, 345.
[341] Hopkinson, Architectural Physics, p. 113.
[342] BB9, p. 6.

imagine a state beyond it.'[344] Countless variations on these correspondence schemes have appeared and still appear to this day as unchallenged assumptions in numerous popular and professional publications on colour and interior decoration.[345] Our post-war architects were not immune from launching into their own version of colour psychology, although, as Gloag and Keyte momentarily conceded, there was little evidence to support such schemes:

> The problem in practice is to determine what degree of stimulus is appropriate, and this in turn will be suggested by the purposes for which the environment is being designed. It is here, incidentally, that evidence about emotional reactions to colours* would be useful, but firm data so far available is very scarce compared with the quantity of speculation on this subject. We have to rely on experience and observation, for the time being. (*Often referred to as "psychological" reactions)[346]

One can argue that post-war architects were justified in remaining attached, despite its bad reputation, to a pre-modern notion of character, which to a large extent had to do with the conjuring of moods, of atmosphere and of theatrical effects. 'The character of a large space such as an assembly hall,' the BB9 prescribed, 'which is the focus and common meeting place for the whole school, needs to be expressed in a way that will capture the imagination when one enters, and give a feeling of dignity and spaciousness.'[347]

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[343] John Gage, Colour and Culture (London: Thames and Hudson, 1993), p. 204.
[344] Goethe, Theory of Colours, trans. by Charles Lock Eastlake (1840) (Cambridge, MA and London: MIT Press, 1970), pp. 307, 314, 316.
[345] See for example, L. H. Bucknell, 'Modern Architectural Colour', RIBAJ, 32 (1925), 281-83 (pp. 282-83); Holmes, Colour in Interior Decoration, pp. 27-29; Derek Patmore, Colour Schemes and Modern Furnishing (New York and London: The Studio, 1945), pp. 13-14; Deborah T. Sharpe, The Psychology of Color and Design (Totowa, NJ: Littlefield, Adams, 1974).
[346] Gloag, Keyte, 'Rational Aspects: 1', p. 400.
[347] BB9, p. 17. William Allen also took the concept of mood seriously, but here relied on more elaborate psychological and physiological explanations: 'The emphasis throughout is on the argument that the sensory system is an important influence upon architectural design. This is especially true of the sense of vision through which much of the architectural environment of people is received and appreciated. Apart from comfort and discomfort, moods and feelings can be induced which are important functions of

(Fig. 46) It can also be argued that their view that colour had an important role to play in creating such moods and effects was valid. Rowe was wrong. He had declared character and modern architecture mutually exclusive, perhaps only to defend a narrow, dogmatic view of modernism. Yet the ban was more theoretical than practical, as the atmospheric interiors of, for example, some of the Herts schools, or of a Lubetkin or Goldfinger suggest. It was perhaps only their explicit but rather feeble attempts to bring into the scientific fold such a useful and evocative notion which was misguided.

Building Elements

Another 'function' of colour was that it should 'articulate the architectural form of the building', that it 'should follow naturally from, and be an expression of the constructional elements and surfaces in the building'.[348] Like the expression of appropriate character, these propositions were presented as part of a rational theory of colour. But was the expression of the building elements, as architects implied, really that rational? Hardly so.

In the Herts schools, the theory translated generally to the practice of painting different walls in different colours, and into a formulaic colour-coding (light colours for structural members and stronger colours on in-fill panels). As architects pointed out, those techniques had been inspired to a large extent by the paintings of Mondrian, and the teachings of Ozenfant and Le Corbusier. (Fig. 47) Research at the BRS, together with the experiments at the Herts schools, had seemingly vindicated the work of those 'pioneers' of modern

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architecture.' 'Windows and Glass Walls: 1. The Analysis of Experience', Builder, 201 (1961), 13-14 (p. 13).

[348] BB9, pp. 37, 6.

colour.[349] Yet, this supposedly 'scientific' research consisted of no more than a few rather loose principles of good lighting and vision which concealed distinctly aesthetic motives. Gloag and Keyte for example, invoked 'lighting' and 'visual requirements' to legitimate the application of different colours on different walls in a same space, an interesting technique which Ozenfant favoured. But this technique of 'articulation' was also, in the same sentence, posited as an excellent means to achieve much less quantifiable 'spatial effects'.[350]

For the painting of stanchions and beams in white or grey and in-fill panels in bright colours (when 'functionally' appropriate), architects had yet more explanations. One centred on the concepts of visual and spatial importance. It stated that 'spatially minor elements' (such as structure, door and window surrounds, pipes etc.) should never be decorative and attract attention to themselves. They should only act as subservient frames to the 'visually and spatially more significant' and thus more strongly coloured building elements such as walls. Elsewhere, it was the inherent lightness of the structural system (Presweld beams and stanchions) which justified the prescribed whites or greys.[351] (Fig. 48)

Images by the painter Mondrian had a very direct influence on the schools architects' theory of expression of form and on their colour schemes in general. A reproduction of Mondrian's 'Composition with red, blue and yellow' of 1935 twice served to illustrate articles on colour, showing how keen architects were to advertise these particular sources of their designs, and to

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[349] Gloag, Keyte, 'Rational Aspects: 1', p. 400; H. L. Gloag, M. J. Keyte, 'Colour Co-ordination for the Manufacturer and User', Design, 123 (1957), 34-40 (pp. 35-36, 39).
[350] Gloag, Keyte, 'Rational Aspects: 1', p. 401.
[351] BB9, pp. 9-10, 32, 35; Oliver Cox, 'Report on Colour Work at Hertfordshire on Primary School Programme Up to July 1950' (unpublished typescript, 14 June 1950), p. 7.

signal their own and the schools' modernity.[352] (Fig. 49) Mondrian certainly looked upon his abstract pictures, in part, as sharing the universality and objectivity of science and mathematics.[353] However, what knowledge and understanding the schools' architects had of Mondrian's and De Stijl's original theories is difficult to establish precisely. What is certain is that for architects, the 'abstract linear pattern', the simplicity and exactitude of the geometric grids which they might have interpreted as signs of rationality, the 'pure', standardized red, blue and yellow squares and rectangles of the Dutch artist's paintings provided an ideal, ready-made model for the decoration of the new schools and their industrial aesthetic. Mondrian's black dividing lines were however not taken up by architects, no doubt because they went against their view that the schools' apparent structure should be unobtrusive, undecorated and subordinate to the coloured panels.[354] Far from rational or scientific, the whites and greys on the light columns and beam structure, and the different colours which adorned the internal walls were thus, in part, a transposition in three dimensions of Mondrian's paintings, a perhaps derivative essay in De Stijl aesthetic, shored by a seemingly scientific rhetoric. (Fig. 50) As Medd stated in 1949:

> There are the internal partitions which are panels between the stanchions about 8' x 8' which are a restful and equilibrated shape for receiving any (included the strongest) colour treatment [...]. These aesthetics of square or rectangular panels between structural members is one which imparts a natural discipline to the interiors and one which cannot be ignored when the colour is being applied.[355]

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[352] Gloag, Keyte, 'Colour Co-ordination', p. 35, fig. 1; Gloag, Keyte, 'Rational Aspects: 1', p. 399, fig. 1.
[353] Piet Mondrian, 'Neoplasticism in Painting: The New Plastic as 'Abstract-Real Painting': The Plastic Means and Composition', in De Stijl, ed. by Hans L. C. Jaffé (London: Thames and Hudson, 1970), p. 54; Jaffé, De Stijl, p. 18; Leonardo Benevolo, History of Modern Architecture: The Modern Movement, 2 vols (Cambridge, MA: MIT Press, 1971), II, p. 409.
[354] Gloag, Keyte, 'Rational Aspects: 1', pp. 399, 400. Gloag, Medd, 'Colour in Buildings', p. 343.

The theory of 'expression of form' through colour was also concerned with 'tidy' and 'untidy arrangements', with 'proportions' and 'pleasing composition', not exactly rational or scientific preoccupations.

One aim of the architects, I have argued, was to create framed monochrome planes à la Mondrian, (a task made easier, as they themselves pointed out, by the structural system adopted for the new Herts schools), and what they meant by 'satisfactory composition', 'tidy arrangements', '"comfortable" shapes', was closely related to the attainment of that particular aesthetic aim.[356] The BB9 ruled:

In a framed construction where the members are expressed internally, the columns and beams impose a regular discipline which simplifies the internal proportions of the building. The pattern of the walls will then become a series of panels in which different colours can easily be placed, and the neutral or near-neutral pilasters or columns will enhance their brilliance.[357]

Moreover, the BB9 stated that two different colours could not simply meet on the same wall but always had to be clearly separated by a stanchion or other element, or a change in wall direction. Dadoes, which in their view constituted an arbitrary change of colour, and broke the integrity of the wall plane, were particularly frowned upon. (Fig. 51) Architects also warned of the danger of 'broken', badly composed and proportioned surfaces, because strong colours, which would only emphasize such mistakes, were then more difficult to use. [358]

But perhaps the real danger in the eyes of our architects of so-called badly composed surfaces was that, not being pure squares or rectangles, they would spoil the desired Mondrianesque effect.

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[355] Medd, 'Notes on Talk on Colour', p. 2
[356] See Gloag, Keyte, 'Rational Aspects: 1', p. 402; BB9, pp. 9, 32, 34, 38.
[357] BB9, p. 32.
[358] BB9, pp. 32, 34-35.

The architects' preoccupation with 'tidy arrangements' and 'composition' in their theory of colour can also be traced to rather less avant-garde sources. Indeed, Howard Robertson's The Principles of Architectural Composition, Arthur Trystan Edwards' The Things Which Are Seen or Architectural Style, were just some of the many works published between the wars which viewed composition as a crucial issue in architectural theory and design, and which were well known to architects trained until, at least, up to the late forties.[359] After the war, the term 'proportion' continued to prosper, but 'composition' suffered the same fate as 'character', and was banished from modern architectural vocabulary. Colin Rowe has argued that for modern architects, 'composition' became a taboo word because it evoked abstract, arbitrary rules of design, an undue attention to aesthetics and appearance which went against their idea of the new architecture as entirely based on function and reason.[360] Yet, our architects went on talking about 'composition' in their theory of colour. What were the reasons for this defiance? Perhaps were they encouraged by the titles of Mondrian's paintings, (Composition in Red, Blue and Yellow, Composition with Yellow and Double Line, etc.), and indeed, as Rowe points out, one exceptionally tolerated usage of the word was 'in its esoteric sense, as a reference to a composition within the post-Cubist tradition'.[361] Perhaps they did not really grasp the fundamentals of architectural modernism, or rather, although embracing it, they did not

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[359] Robertson, Principles of Architectural Composition; A. Trystan Edwards, The Things Which Are Seen: A Revaluation of the Visual Arts (London: Philip Allan, 1921); Architectural Style (London: Faber and Gwyer, 1926); see also Holmes, Colour in Interior Decoration, p. 9: 'There is one matter out of many in the use of colour which is all important. The question of "Distribution" or proportion. Architects are familiar with "proportion", the relation of the parts and the harmony of the whole. With colour it is similarly important. However perfect a selection of colours may be if they are ill-proportioned or badly disposed the result will be disastrous. This "disposition" is the most difficult of all the problems in colour and only constant practice will bring success.'

[360] Rowe, 'Character and Composition', pp. 60, 61.

[361] Rowe, p. 61.

entirely approve of its apparently functionalist, utilitarian vision. Indeed, although not upholding the particular principles of composition propounded by pre-war theorists, they certainly shared their view that 'composition' involved the application of certain aesthetic principles for the successful arrangement of the parts of a building, which were largely independent from functional requirements.[362] In their attention to well-divided wall surfaces, to the delimitation of planes of colour, contrary to that part of modernism which admitted only of utility as determining the appearance of a building, our architects did cultivate definite aesthetic intentions (however thinly veiled, to make them more tolerable, in functionalist rhetoric). The continued use of the term 'composition' in their theory of colour thus shows how they needed words, even ones outdated and banned, to describe these intentions, and to develop what was in the end a modernized theory of decoration, neither rational nor scientific. (Fig. 52)

Lighting and Vision

Of the three main functions architects assigned to colour, the improvement of lighting and vision was the one which surely made colour look the most rigorous and rational. In the first theories of the late forties, colour was simply to emphasize, by means of variations of value, the patterns of natural light and shadow produced by the arrangement of windows and ceiling openings.[363] From the early fifties, however, influenced in part by theories of factory design and developments in the field of illuminating engineering, architects posited colour as one with lighting design in achieving efficient and healthy vision, and its

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[362] Rowe, pp. 61-62; Robert Atkinson, 'Foreword', in Robertson, Principles of Architectural Composition, p. vi.

contribution to lighting and the worthwhile purpose of improved vision, as precisely measurable.[364] Indeed, architects made much in their literature on colour of 'recent scientific research into lighting and vision', of the instruments, such as the 'sky factor protractors', and the methods and tables to help predict total daylight and fulfil the Ministry of Education's requirements of a minimum 2 per cent total daylight factor.[365] 'At this stage', Medd wrote:

> the contribution of the B. R. S. was to link these early individual efforts [colouring of Herts schools] to the whole body of lighting research being undertaken at the Station and consequently to begin to elevate the subject of colour from an arbitrary hit and miss affair to something far more authoritative.[366]

Most recent methods devised at the BRS of calculating the quantity of total daylight in a room took account both of direct and indirect or reflected light. Many elements had to be considered in the calculation of the indirect component of daylight factor, in particular reflection factors, a measure in percentage of the light reflected off a surface, as well as the glass area, the dimensions and shape of the room, and the location within the room.[367] The colour of a surface, the BB9 purposefully emphasized, played an important role in achieving the required quantity of light in a room, because the level of lightness or the value of the colour directly affected the amount of reflected light.[368] Thanks to the formula R=V(V-1), it was possible to convert the Munsell value (V) of a colour into an approximate reflection factor (R), allowing

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[363] Cox, 'Report', p. 8; Medd, 'Notes on Talk on Colour', p. 3.
[364] BB9, pp. 2, 5, 7; Gloag, Medd, 'Colour in Buildings', pp. 334, 338; Hopkinson, Architectural Physics, p. 109: 'Colour adds an attribute to the visual environment which light alone cannot supply. This attribute is capable of physical measurement as is light. In some of its other aspects colour must be assessed on a psycho-physical basis.'
[365] BB9, pp. 3, 20-22; 'Development in School Design', AD, 21 (1951), p. 93; W. A. Allen, 'Lighting of Buildings: Part II', RIBAJ, 58 (1951), 272-278 (p. 274).
[366] David Medd, 'Colour in Buildings' (Press Handout, unpublished typescript, 17 April 1956).
[367] BB9, pp. 20-21.
[368] BB9, pp. 8, 20.

architects to select a colour to meet lighting requirements.[369] This formula, and in particular reflection factors, became an ubiquitous feature of post-war literature on colour and lighting. They were used by architects to draw colour closer to what was seen as the prestigious technicalities of lighting engineering, and to support their claims that far from being woolly and strictly subjective, colour could on the contrary be handled with mathematical and scientific certainty.[370]

The Munsell system was undoubtedly adopted and promoted by architects in the early fifties to a great extent because it made possible this quantification of colour. As was often emphasized, the great advantage of the Munsell system over the Ostwald system, based on a mixture of black, white and saturated colour, was the Munsell attribute of value which linked colour and lighting.[371] The three Munsell attributes of hue, chroma and value, architects claimed, were the basis of their analytical approach to colour, where the choice of a particular setting of hue, of chroma and of value was deemed to fulfil a particular functional need.[372] In fact, not all attributes were equal. Hue was generally seen as the last attribute to be considered in this analytical approach, but the one which allowed architects some aesthetic freedom. With chroma, hue could nevertheless fulfil such requirements as expressing the

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[369] BB9, pp. 15, 26; see J. Longmore, P. Petherbridge, 'Munsell Value/Surface Reflectance Relationships', Journal of the Optical Society of America, 51 (1961), 370-71. This article shows that there had been many attempts by researchers since the publication of the Munsell system to establish a relationship between the Munsell value and 'corresponding relative surface reflectance'. The reasons for the adoption of the R=V(V-1) formula in relation to architectural colour was that it could be remembered easily, calculations could be made mentally, and the relative accuracy of the results were judged to be appropriate to architectural work.

[370] BSI, BS 2660: Colours for Building and Decorative Paints (London: BSI, 1955), Appendix A; H. L. Gloag, Mary J. Gold, Colour Co-ordination Handbook (London: HMSO, 1978), p. 34; Hopkinson, Architectural Physics, p. 110.

[371] BB9, p. 44; Cox, 'Report', pp. 2-3.

[372] BRS, BRS Digest 101, The B.S. 2660 Range of Colours (Garston: HMSO, 1957), pp. 2, 4; 'Colour: Co-Ordinated Ranges for Building', Building Centre Forum 3 (London: Building Centre, 1961), p. 1; Gloag, Keyte, 'Rational Aspects: 1', p. 399; Gloag, Colouring in Factories, p. 6.

function or character of a space, or making concentration easier.[373] But value was the attribute which visibly imported most to architects. The architect Michael Keyte, for example, saw the selection of values as the foremost decision in the development of a colour scheme: 'The lightness of colours has in fact such an important effect that it is possible for an initial approach to be made to a particular design solely in these terms.'[374] In 1946, Allen and Bickerdike had judged reflected light a negligible factor in the calculation of total daylight in a room.[375] A few years later, opinions had changed. The following sentences are from the BB9:

> To summarise, once it is possible to calculate with reasonable accuracy the indirect component, the element of guess-work is removed and the architect can make a deliberate choice of reflectances which can be immediately translated into terms of colour by the conversion to Munsell references. It is hoped that this approach will encourage further the realisation that the colour scheme is one of the many variables, such as ceiling heights and window sizes and positions, to be considered at the early design stage; is closely related to the lighting scheme and should, in fact, be designed as an essential part of it.[376]

It is evident that one of the main reasons for this about-turn, and for the great importance subsequently accorded to Munsell value, to reflected light, and reflection factors in the theories of architectural colour, even before simpler and more reliable methods were actually developed to predict indirect light,

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[373] Cox, 'Report', p. 7; H. L. Gloag, 'The Colouring of Building Interiors', AD 25 (1955), 296-97 (p. 297).

[374] Michael J. Keyte, 'The New British Standard Colour Range of Building and Decorative Paints', AJ, 123 (1956), 212-17 (p. 216); BB9, p. 28; Hopkinson, Architectural Physics, p. 110. See also Gloag, Keyte, 'Rational Aspects: 1', p. 401: 'The function of colour in answering requirements of good lighting and vision is controlled chiefly through the Value of the colours [...].'; see also H. L. Gloag, M. J. Keyte, 'Rational Aspects of Colouring in Building Interiors: 2', AJ, 125 (1957), 443-48 (p. 448): 'The main issue left open for decision is the Hues for these colours and here the argument becomes less systematic and more speculative, [...].'; Gloag, Medd, 'Colour in Buildings', pp. 340-41 (p. 341): 'We have discussed the visual character of interiors in terms of a pattern of light and dark, and have attempted to show that the functions of colour in modifying the pattern for purposes of comfort and quantity depend chiefly on its lightness as distinct from its strength or hue. We have also said that decisions about lightness (Value) leave the choice of strength (Chroma) partly open and the choice of Hue entirely so.'

[375] W. A. Allen, J. B. Bickerdike, 'The Daylighting of Classrooms Under the New Regulations', RIBAJ, 53 (1946), 492-95 (p. 492).

was that for architects, the link with light was such an efficient and convincing way of making the use of colour seem more precise and objective.[377]

'Comfortable and efficient' vision, architects insisted, depended not only on the quantity of light, on measurements, but also on its quality.[378] Largely a matter of subjective perceptions, quality of lighting had been until recently overlooked by scientific research. But a field of lighting studies now claimed to deal more scientifically with the problem of quality of lighting. These new studies, which sought to establish the conditions for optimum visual comfort, focused on brightness contrasts, designated as the main factor in quality of lighting, and on excessive brightness contrasts leading to glare.[379] (Fig. 53) Architects made these studies and ensuing practical advice an integral part of their theories of colour, emphasizing the role of colour, again by virtue of its lightness, in increasing or reducing brightness contrasts. Like lighting computation methods, work on the more 'subjective' aspects of lighting thus helped architects to develop a seemingly more scientific approach to colour.

Drawing on both quantitative and qualitative branches of lighting and vision research, model studies and chalkboard studies are good examples of how our architects exploited the new approach to lighting. Among the design problems investigated with the help of models were classrooms with windows on only one side which in the 1950s, due to economic constraints, had succeeded to the high ceilings and generous lighting arrangements of the first

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[376] BB9, p. 26.

[377] G. Pleijel, 'Reflected Daylight and Model Studies', Building Research Congress 1951: Papers Presented in Division 3 (London: Building Research Congress, 1951), pp. 167-71 (p. 167). Pleijel notes in 1951 that there is no convenient method to calculate reflected light, something the BB9 admitted in its first 1953 edition. Not until 1956, in its second edition, did the Bulletin report the new techniques devised at the BRS.

[378] BB9, pp. 6.

[379] Building Research Board, Post-War Building Studies No. 12, The Lighting of Buildings (London: HMSO, 1944), pp. 7, 74; R. G. Hopkinson, Lighting and Seeing (London: William Heinemann, 1969), p. x, ch. 5, 'Lighting and Vision'.

post-war schools. More compact and deeper hospital ward designs were also studied extensively by the Division for Architectural Studies of the Nuffield Foundation by means of models. In both cases, the goal was to obtain, by measurements and calculations, good daylight distribution in the room, but also that observers and users found the lighting and colour schemes 'subjectively satisfactory'.[380] Such use of scale models was of great benefit to building design, architects explained, because they allowed different ideas to be tried out and discussed and the results to be 'tested'.[381] But as these last arguments suggest, in describing and displaying photographs and drawings of model studies in their literature on colour, architects sought to assimilate them to methods of scientific research. Model studies thus stood in their eyes as laboratory experiments, as scientific observations in controlled conditions, as systematic testing of hypotheses, which would sanction their final decorative scheme as a proven and irrefutable conclusion. The fact that these techniques were part of the usual arsenal of lighting engineering research and the newer subjective lighting studies which now encompassed colour, and moreover, that they were used at the BRS, surely helped to pass them as part of a 'rational' approach to colour.[382] But although they did not lack a certain internal logic and common sense, the schemes supposedly arrived at by these studies were not, as implied, objective and irrefutable, but were the product of certain rather arbitrary ideas about what colour should be in modern architecture. As the electrical

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[380] BB9, p. 23; Nuffield Provincial Hospitals Trust, Studies in the Functions and Design of Hospitals (London: Oxford University Press, 1955), p. 99.

[381] BB9, p. 23; R. G. Hopkinson, The Evaluation of the Built Environment (London: H. K. Lewis, 1966), p. 20.

[382] BB9, pp. 23-25, 36; A. C. Hardy, 'Colour in Architecture: Introductory Article', BM, 26 (1966), 43-44 (p. 43); Gloag, Medd, 'Colour in Buildings', pp. 338, 341; Functions and Design of Hospitals, pp. 93-99, 111; Hopkinson, Architectural Physics, pp. 42-46; DSIR, BRS, Note No. C233, 'Daylighting Studies in a Model School Classroom: Part II: The Effect of Reflection Factors of Interior Surfaces on the Daylighting in a Side-Lit Classroom' (unpublished typescript, July 1952); see also Pleijel, 'Reflected Daylight and Model Studies'.

engineer R. G. Hopkinson noted about model studies in 1965: 'At this stage, however, the subjective element is uppermost. Certainly the scale model building can be used to check physical standards, but its real purpose is to enable the client and architect to discuss other values which might reasonably be called aesthetic values.'[383] A kind of doll's house game for adult men, model studies allowed detailed work on decoration to be carried out under scientific cover, and represented another facet of the architects' efforts to make a science out of decoration, of lighting and colour design. (Figs. 54, 55, 56, 57)

Like model studies, chalkboard studies helped architects to show colour as a subject which could be approached scientifically. The study of what R. G. Hopkinson termed the 'chalkboard problem' was part of the movement of research on lighting and particularly on the visual performance of children.[384] Which conditions help attract and keep children's attention to the classroom chalkboard? Which colours of chalk and board enabled children to see most easily and clearly? A substantial section in the BB9 was devoted to answering these questions. Seemingly on the basis of the research on lighting and vision, it posited principles of brightness contrasts, namely between chalk and background and chalkboard and surrounding walls, it gave upper and lower limits of value and chroma levels, and provided lists of approved colours. These principles as well as specific colours (chosen from BS 2660) were even enshrined in the British Standard Specification for School Furniture, part 4 on chalkboards, issued in 1959. Yet, the replacement of the term blackboard with 'chalkboard' indicates that researchers and architects were concerned here

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[383] Hopkinson, Evaluation, p. 20.

with more than just visual performance. Chalkboards, the argument went, were better than blackboards for 'reasons connected with vision'. Under good lighting conditions, they were less tiring for the eyes because they did not present an excessive contrast between chalk and board.[385] Yet Hopkinson and his colleagues clearly looked upon blackboards more as an unchallenged traditional practice than as actually harmful to children's vision. Hopkinson noted that earlier examination of the research literature had not uncovered any proof of the superiority of coloured chalks and boards over white chalk on blackboard. He continued:

> But the increasing use of colour in classrooms as an essential feature of the design did lead to the conclusion that serious consideration should be given to the use of white chalk with coloured chalkboards, the colour of the chalkboard being an integral part of the colour treatment in the classroom.[386]

Although many of the colours selected as suitable for chalkboards seem hardly distinguishable from the dreaded deep black, to Hopkinson, they introduced 'colourfulness and pleasantness' in the classroom.[387] The rejection of black as a colour for chalkboards was thus, to a great extent, an aesthetic decision, a consequence of the desire to apply new decorative trends. (Fig. 58)

Our architects liked to present the alliance of architectural colour with lighting and vision studies as something of a scientific revolution. There is no doubt that colour and lighting interact with each other and that in certain conditions one can see better than in others. No doubt also that ways could be found to measure some aspects of the complex relationships between colour, lighting and vision. However there is no evidence either that there were

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[384] BB9, pp. 28-30; R. G. Hopkinson, 'The Selection of Suitable Chalkboard Colours', RIBAJ, 59 (1952) 377 (repr. in R. G. Hopkinson, Architectural Physics, pp. 294-95).
[385] BSI, BS 3030: Part 4: Chalkboards (London: BSI, 1959), p. 6.
[386] Hopkinson, 'Selection of Suitable Chalkboard Colours', p. 377.

improvements in the vision of children educated in the new classrooms, or that improvements, if any, resulted indeed from the subjective studies, the calculations, and attached practical advice. In the BB9 on colour, it was made clear that the instruments and elaborate calculation 'techniques' to establish the levels of lighting were to be used by architects only in exceptional cases. Moreover, the formula to convert Munsell value into a reflection factor only gave approximate results, and the Munsell value of a colour was never determined exactly but rounded off to a whole number.[388] Lighting calculations and the rest of this seemingly scientific paraphernalia were thus tagged onto colour theory largely for cosmetic effect, helping to create an impression of precision and control but having only an indirect impact on the practice of colour. 'Intuition', rules of thumb and the search for dramatic and arresting aesthetic effects was what in the end, really most often guided architects in matters of colour, lighting and vision.[389]

Not only was the colour, light and vision theory put forward by architects much less scientific in practice than in theory, but it was also much less original than claimed. Several pre-war works on colour decoration had already dealt, minus the calculations, with lighting. These works, as well as the ideas put forward by the factory reform movement between the two wars, were

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[387] Evaluation, p. 10.
[388] BB9, p. 20; Longmore, Petherbridge, 'Munsell Value/Surface Reflectance Relationships', p. 370.
[389] See David Medd, 'Colour in Schools', Transactions of the Illuminating Engineering Society, 18 (1953), 123-36 (pp. 124-27). The 'intuitive' approach of architects to lighting and colour was nonetheless seen to anticipate and confirm scientific work on these subjects. See Andrew Saint, Towards a Social Architecture: The Role of School Building in Post-War England (New Haven and London: Yale University Press, 1987), pp. 90-91; R. G. Hopkinson, 'The Brightness of the Environment and its Influence on Visual Comfort and Efficiency', in Building Research Congress 1951: Papers Presented in Division 3 (London: Building Research Congress, 1951), pp. 133-38 (p. 138): 'Much of the design data which is emerging from the experimental work [on lighting] is found to be a systematisation of the qualitative experience built up over the long period of development of the architectural tradition.'

formative influences on post-war theories of architectural colour.[390] Nor were architects alone in exploiting this theme after the war. They followed a trend shared by all interested in colour, from decorators and a thriving home decoration press, to illumination engineers and the British Colour Council.[391]

In the end, the theory of light and colour might not have been very new or scientific, but it helped at once to camouflage the persistent fascination of architects for the aesthetic pleasures of colour, and, it was also hoped, to transform this taste for the games of colour into a rational and predictable part of architecture.

2. THE MUNSELL SYSTEM

British theorists of architectural colour between the wars were either unaware of or had no use for the Munsell or the Ostwald colour classification systems, although both were already in existence and at least the Ostwald system was known to artists' and art teachers' circles.[392] The enthusiastic espousal and ceaseless promotion of the Munsell system by Medd, Gloag and their entourage after the war can be directly linked to the crucial role assigned to it in the development of a science of colour. We saw in an earlier chapter how the Munsell system help to structure and impart objectivity to the colour ranges

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[390] See for example, John Gloag, Colour & Comfort (London: Duckworth, 1924), p.53. H. Barrett Carpenter, Colour: A Manual of its Theory and Practice, 3rd edn (London: B. T. Batsford, 1933), pp. 53-63; Amédée Ozenfant, 'Colour and Method', AR, 81 (1937), 89-92; for Ozenfant's influence, as perceived by architects, see Gloag, Medd, 'Colour in Buildings', p. 334.

[391] British Colour Council, Colour and Lighting in Factories and Offices, 2nd edn (London: British Colour Council, 1956); Elaine Denby, Colour at Home: An Illustrated Guide to Interior Decoration (London: Industrial Paints, 1958), p. 4; Colour as Applied to the Decoration of Factories and Offices (Hounslow: Deeds (Builders), 1949); E. J. Ward, 'Lighting and Decoration in a Windowless Factory', Light and Lighting, 41 (1948) 257-59.

[392] Wilhelm Ostwald, Colour Science: Part I: Colour Theory and Standards of Colour, trans. by J. Scott Taylor (London: Winsor & Newton: 1931); J. Scott Taylor, A Simple Explanation of the Ostwald Colour System (London: Winsor & Newton, 1936); Jan Gordon, An Elementary Introduction to the Ostwald Colour System (London: Reeves & Sons, 1938).

and standards.[393] We have also just seen how the correspondence established between sets of Munsell 'variables' and functional purposes, and particularly the link between value and reflectance, underlay and gave scientific credibility to the theory of functional colour. But there were other ways in which the Munsell system was made to contribute to a science of colour.

For a start, the Munsell itself was often described by architects as rational and objective. Oliver Cox wrote favourably on the choice of the Munsell for colour work in the Hertfordshire schools: 'The Munsell coding system seems to be the most scientific and objective system so far devised and Hertford have taken the first step to popularize the coding system amonst (sic) paint manufacturers.'[394] This claim rested, in part, on Ostwald's and Munsell's own pronouncements on the scienticity of their systems.[395] The many modern scientific and industrial applications of the Munsell system were also invoked by architects as further evidence of its rational nature.[396] Indeed one can say that architects shrewdly shared in the post-war prestige of the Munsell system, held as an objective representation of the innate and universal structure of human colour perception, a prestige it enjoyed not only in science, business and industry but also in leading disciplines of the human sciences.[397]

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[393] See Gloag, Gold, Handbook, pp. 19-29; Gloag, Colouring in Factories, p. 2: 'The Munsell Atlas was used as the means of systematizing the design of B.S. 2660 [...].'.

[394] 'Report', p. 6. See also BB9, p. 44; Docker Brothers, Colour With a Purpose ([1950s]), p. 14; contribution of Norbert Dutton (designer), 'Open Discussion Forum', in 'Colour and Lighting in Factories and on Machines: Report of Course' (unpublished typescript, November 1948), pp. 67-87 (p. 76).

[395] For example, according to Munsell, his scale of value had been elaborated with the aid of an instrument called photometer, and was supposedly based on 'the simple facts of vision': 'Since this VALUE SCALE underlies all color work, it needs accurate adjustment by scientific means, as in scales of sound, of length, of weight, or of temperature.' Albert Henry Munsell, A Color Notation, 3rd edn (Boston: Geo. H. Ellis, 1913), p. 38, see also pp. 39-40. In his classic work on colour unequivocally titled Colour Science, Ostwald, a physical chemist, makes many references to colour and to his own approach to the subject as belonging to the realm of science; Gage, Colour and Culture, p. 247.

[396] BRS Digest 101, p. 3: 'The Munsell system has been established for many years. It is used by scientists and technologists in many parts of the world for many different purposes varying from the grading of silk-yarn or tomatoes to the classification of sub-soils in geological work.'; Gloag, Keyte, 'Colour Co-ordination', p. 36.

[397] Barbara Saunders, 'The Ignis Fatuus of Colour', Art History, 17 (1994), 494-504 (p. 495).

The adoption of the Ostwald, then of the Munsell classification system was also undoubtedly construed by architects as the application of scientific method to architectural colour decoration. Gloag and Keyte wrote: 'Munsell's system has come to hold a pivotal position in these efforts to tidy up selections and ranges. [...] Without such a system is like being without a clock for time, a thermometer for temperature, or a foot scale for sizes.'[398] The Archrome and succeeding standards were modelled on the Munsell system, with the same or variants of its co-ordinates, and derived their visual arrangements from it. The creation of more divisions and subdivisions, beyond those of the Munsell system, for example, the four categories of 'grey', 'weak', 'medium', and 'strong' chroma in BS 2660, or BS 5252's five categories of 'greyness' (a new attribute of classification partly based on the Munsell ones), was seen by architects as a typically scientific gesture.[399]

The design of the architects' colour cards based on the Munsell, and the many images of the Munsell system published in the architectural and technical press, also served to create and reinforce the architects' vision of architectural colour. Indeed, the colour ranges had carefully thought out presentations and layout which expressed all the work of classification, and the sophisticated drawings of sections and diagrams of the Munsell were evidently meant to recall the abstraction and objectivity of scientific illustration. (Figs. 59, 60, 61)

The technical-sounding language, the evocative terms such as 'system', 'colour solid' and 'atlas', which were used in the descriptions of the system were

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[398] Gloag, Keyte, 'Colour Co-ordination', pp. 36, 38. Interestingly, John Gage points out that the usefulness of colour to the task of classification in the natural sciences led to the development of many colour systems in the eighteenth and nineteenth centuries. Colour and Culture, pp. 169, 170.
[399] Gloag, Gold, Handbook, pp. 19, 23-29; Gloag, Colouring in Factories, pp. 2-3.

equally calculated to convince their audience of the rationality of the Munsell and of the new theory and practice of architectural colour.[400]

The Munsell reference also played its part in producing a scientific effect for colour. Architects had persistently attacked the 'adjectival' nomenclature which paint manufacturers and the fashion world attached to colours. They argued, in part, that terms like 'daffodil', 'primrose', or 'eau-de-nil' were arbitrary descriptions of colours, evoking different meanings to different people. And because they did not refer to the properties of colour, they made precise comparison and classification of colour impossible. By contrast, they continued, Munsell references coded the positions in a colour solid of the three properties of subjectively apparent colour, respectively hue, value and chroma, and thus allowed any colour to be precisely and unambiguously identified.[401]

But perhaps architects took to the Munsell notation also because its unpoetic, abstract sequence of numbers and letters could easily evoke the secret code, the mathematical or chemical compound formula, giving to their colour proposition an appearance of precision, objectivity and expertise, and, it was perhaps hoped, setting it advantageously apart from competing, seemingly less 'rational' views on colour. Thus, colours in the first Archrome (Munsell) range card were primarily identified by their Munsell references, and many examples can be found in the press of architects' colour schemes

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[400] Gloag, Gold, Handbook, p. 13: 'Geometrically it can be represented as a cylindrical solid [...] in which value (lightness) is scaled along the axis from perfect black (value 0) to perfect white (value 10); chroma (saturation) is scaled along the radii from the axis (chroma 0) outwards to maximum perceptible saturation; [...].'. For the influence of the Munsell on the design of the BS 2660, see DSIR, BRS, Note No. E603, 'A Systematic Range of Paint Colours for Buildings', by H. L. Gloag (unpublished typescript, May 1955), p. 2: 'In the preparation of this new range of paint colours, the Munsell Atlas was used as the means of defining the various categories and gradations of colour described, and this systematic basis has been made explicit by the display of the range on ten separate cards and by giving the approximate Munsell reference beside each colour.'; BRS Digest 101, p. 4; Gloag, Medd, 'Colour in Buildings', p. 335.

[401] See for example, Gloag, Colouring in Factories, pp. 2; BB9, pp. 11, 14, 44; Gloag, Keyte, 'Colour Co-ordination', pp. 36, 38; David Medd, 'Derby Lecture' (unpublished typescript, 12 March 1951), p. 5; Hopkinson, Lighting and Seeing, p. 61.

described with Munsell code.[402] After 1956, with the publication of BS 2660, serial numbers (2-032, 9-099) may have accomplished the same scientizing function, although Munsell references were still prominently displayed below each BS 2660 and Archrome colour. The rhetorical effect of the notations can also be admired in the following passage describing the composition of BS 2660:

> They [colours of fairly strong chroma] are selected to form sets within distinctly different hues, with emphasis placed on the red (7.5 R), yellow-red (10 YR), yellow ((5 Y), green-yellow (2.5 GY) and blue (5 B). Hence there are groups which are fairly consistent in hue within themselves, and there are also alternatives of equal weight as in the series 7.5 R 5/8, 7.5 YR 4/10, 5 Y 7/6, 5 GY 5/6, and 10 RP 5/8.[403]

Science and Fiction

Architects strove to create a scientific image for the Munsell system. However, critical examination of these systems shows that these are not objective, but are shaped and invested by the ideas and interests of their authors and users. As T. W. A. Whitfield, M. O'Connor, and T. J. Wiltshire put it, in a 1986 review of British colour standards:

> No doubt a plethora of claims and counterclaims by the devotees of particular systems is to be expected; however, opinion must be distinguished from empirical fact. [...] The particular set of dimensions presumed to be primary, or fundamental, will, it is suggested, reflect the conceptual orientations of those involved in the selection. It is further suggested that one problem within the domain of colour-specification systems is the presumption that colour is a perceptual phenomenon: Clearly, it is also a cognitive phenomenon, with all that entails.[404]

Speaking at the 1948 conference on colour and lighting in factories (to which Medd and William Allen contributed papers), W. D. Wright, reader in colour

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[402] Gloag, Gold, Handbook, p. 19. For Munsell references in architectural press, see for example, Max Lock and Partners, 'Flats in Ashburnham rd, Bedford,' AJ, 122 (1955), 15-24; J. L. Martin, 'Secondary School, off Bellingham rd, Catford, London SE6', AJ, 122 (1955), 249-62.
[403] Keyte, 'New British Standard', p. 215.

vision at the Imperial College of Science, made comments of a similar nature about colour systems. Although recognizing the usefulness of systems of the Munsell type in identifying colours visually, he argued that none of these systems was objective or universally valid, as each only really positioned colours in relation to its own closed, idiosyncratic and arbitrary set of parameters. Thus, a system did not derive its value from being more objective than another but from the purposes it served best. For example, the Munsell and similar systems based on colour atlases were convenient for artistic, architectural or industrial purposes, while the CIE was particularly suited to scientific and industrial ends: 'The merits of one system of spacing compared to another depend very largely on the use to which the system is to be put, but no system can claim to be superior in all respects to the others.'[405]

John Gage's account in Colour and Culture, of the chequered fate of the Ostwald system within a number of architectural and artistic movements, is a good example of how systems are not unchanging givens but that their reception and interpretation varies greatly in relation, amongst other things, to the 'conceptual orientations', the interests and priorities of the groups or individuals concerned.[406]

Gage also traces the historical development of some elements of modern colour systems, revealing how they were often imaginatively derived from colour science, and therefore essentially arbitrary. He shows for instance that the striking phenomenon of the rainbow, as well as Sir Isaac Newton's prismatic spectrum, provided throughout history a model of an assumed universal and

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[404] T. W. A. Whitfield, M. O'Connor, T. J. Wiltshire, 'The British Building-Colour Standards: A Model for International Application', Color, 11 (1986), 215-22 (p. 222).
[405] W. D. Wright, 'Fundamentals of Colour Vision', in 'Colour and Lighting in Factories and on Machines: Report of Course' (unpublished typescript, November 1948), pp. 12-18 (p. 17).
[406] Gage, ch. 14, 'Colour Without Theory: The Role of Abstraction'.

natural order and harmony of the colours. Newton's 'colour wheel', a looped arrangement of his spectrum was the main source of inspiration for modern colour circles.[407] It was based on René Descartes' representation of the 'tempered diatonic octave' in a treatise on music, and perpetuated the practice, going back at least to the middle-ages, of choosing circular diagrams to illustrate ideas and relationships in a variety of fields.[408] (Fig. 62)

But as Gage points out, the exact number, identification, and order of the colours of the rainbow or the prismatic spectrum has been a controversial issue, partly because of the way the bands of spectral colours fade into one another, and of the difficulties in translating these colours of light into surface colours. Moreover, cultural ideals played an important role in the final count: Newton, who had first recorded eleven colours in his spectrum, later only placed seven in his colour circle, apparently to create a correspondence between colours and the musical octave.[409]

Little more consensus was reached on the notion of 'primary' and 'complementary' colours. Primary colours, from which all other hues could be produced, were central to modern colour circles and systems. But Gage shows well that there were many conflicting views, from Aristotle to Mondrian, on the number and identity of these irreducible colours.[410] The belief that there was three primaries, plus black and white, was first proposed by scientists in the sixteenth century and stemmed from painters' experience of colour mixing. Red, yellow and blue was certainly the most enduring triad of primaries in art theory. Yet even this set of primaries was perpetually being challenged,

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[407] Gage, pp. 108, 109, 140, 162; on the first three-dimensional systems, see p. 167; John Gage, 'Colour and Culture', in Colour: Art & Science, ed. by Trevor Lamb and Janine Bourriau (Cambridge: Cambridge University Press, 1995), pp. 175-93 (pp. 181, 184).
[408] Gage, Colour and Culture, pp. 171, 232;
[409] Gage, pp. 93, 108, 168, 232.

notably by the conflicts between painters' practice of colour mixtures and the discoveries in the sciences of optics and light.[411] These conflicts were embodied and partially resolved in the dual theories, set forth in the nineteenth century, of 'subtractive' primaries, based on mixture of pigments, and 'additive' primaries, based on mixture of coloured lights.[412]

Similar problems plagued the notion of 'complementaries'. Theories of art from the eighteenth century onwards defined a 'complementary' colour as the 'opposite' of a given colour. This definition was partially derived from Newton's 'colours of thin plates' experiments, in which he observed contrasting coloured rings appearing on each side of illuminated plates of glass pressed together. His prismatic circle of 1704 which showed pairs of colours facing each other, seemed to illustrate this relationship of opposites and had a lasting legacy on subsequent colour circles. The study of after-images also seemed to many to confirm the notion of complementary colours. This phenomenon is triggered by staring at a bright light or at a coloured shape, whose image then lingers in the field of vision as a negative or highly contrasted colour. Gage notes however that the seduction exercised on nineteenth-century artists and art theorists by the neatly symmetrical circle of three primaries and three secondaries led to green, rather than blue-green, the colour observed as an after-image of red, being most often designated as the complementary of red.[413] Furthermore, the idea that, apart from black and white, there are pairs

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[410] Gage, pp. 34, 36.
[411] Gage, pp. 168, 153, 158.
[412] Gage, pp. 154, 169, 174-75; Martin Kemp, The Science of Art: Optical Themes in Western Art from Brunelleschi to Seurat (New Haven and London: Yale University Press, 1990), p. 262.
[413] Gage, Colour and Culture, pp. 171-72. Interestingly, after-images have been described as made up of several, quickly succeeding phases, as fleeting and changing sensations which depend on the conditions in which they are created (lighting in the field of view, size of colour patch, time of exposition to colour, colour of background etc.). The colour of after-images would thus be constantly changing, making the idea of fixed sets of complementary colours difficult to uphold. Optical Society of America, Committee on Colorimetry, The Science of Color (New York: Crowell, 1953), pp. 115-117; R. J. Hawkes also points to

of 'opposing' colours, has not always been easily grasped or unequivocally accepted, and Gage suggests that the increasing currency of colour diagrams helped to ingrain this idea of 'opposite' colours among scientists and artists. Yet, even then, as he shows in his book, there was no one view as to which pair of colours were complementary contrasts.[414]

Gage's historical evidence shows colour circles and sets of primaries and complementaries to be largely arbitrary conventions trying to rationalize and make sense of the bewildering human experience of colour. The Munsell attributes, which architects posited as 'fundamental' categories in colour perception, seem just as arbitrary. Gloag wrote in 1955:

> Certain distinguishing terms in common use, however, although broad in meaning, indicate fundamental colour differences and cannot be dispensed with. These are such terms as "red," "orange," yellow," [...]; those distinguishing lightness as compared with black or white, [...]; and those distinguishing the strength or intensity of colour, [...]. All these terms, it will be noted, relate solely to the appearance of colours and within their broad limits of descriptive power serve as a universal vocabulary.[415]

Yet research conducted in the early seventies by R. J. Hawkes, a lecturer at the Bartlett School of Environmental Studies who worked with Ralph Hopkinson, suggested that subjective perception of colour did not correspond to the Munsell categories of hue, value and chroma, challenging the assumptions that these are somehow 'universal'.[416] Gage has also emphasized the limitations of

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the elusiveness of after-images, what he calls 'psychological' complementaries. He notes further that 'physical' complementaries, colours which when combined in prescribed proportions produce 'achromatic' grey, have little to do with a 'normal experience of the visual environment'. 'Colour Systems and Colour Scaling', Architectural Research and Teaching, 2 (1971), 16-22 (pp. 20-21)

[414] Gage, Colour and Culture, pp. 171-72, 248; 'Colour and Culture', pp. 187-88.

[415] 'Colouring of Building Interiors', p. 296; see also BB9, pp. 11: '[...] a reference system should: [...] distinguish colours in terms of the characteristics which are significant in practice, namely hue, value and chroma.'; Gloag, 'Systematic Range', p. 2: 'The three subjective attributes of Hue, Value and Chroma conformed with colour differences which are recognised in common experience and which it has proved of value to distinguish in an architectural context.'; F. G. Cooper, Munsell Manual of Color (Baltimore: Munsell Color Company, 1941), p. 9 (acquired by David Medd in 1950).

[416] Hawkes, 'Colour Systems', pp. 20-21.

the Munsell attributes in adequately describing the perception of surface colours, and the importance of other parameters such as texture. He illustrates his point with the 1940s table of colours by English 'non-representational' painter Winifred Nicholson, which included 'mud', 'flame' and 'black coffee' in the orange scale, 'knife blue' and 'midnight' in the indigo scale, and 'lead', 'prune' and 'chocolate' in the violet scale, all evocative names which no doubt would have horrified our architects.[417]

As we saw earlier, Whitfield and his colleagues disputed the idea, underlying the architects' view of colour systems, that colour was strictly a 'perceptual phenomenon', suggesting that it was also a 'cognitive' one, to do with complex and rather subjective issues such as aesthetics and fashion, 'style and identity'.[418] Others have gone further, arguing that colour systems have considerably less to do with physiological and psychological perception than with the cultural and historical circumstances in which they were developed, thus denying any universal claims for colour concepts. In her instructive review of Gage's volume on colour, Barbara Saunders calls for a clear distinction to be made between our perception of reality and that of schemes or depictions of this reality. She argues that 'visual awareness' of the environment around us, and perception of a representation, of 'a surface which specifies something other than what it is' are two very different things. Yet they have repeatedly been confused in art history and in the study of colour, leading namely to a 'depiction' like the Munsell system being interpreted as an objective representation of 'reality', of how we actually see colour.[419] Saunders suggests

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[417] Gage, 'Colour and Culture', pp. 184-85.
[418] Whitfield, O'Connor, Wiltshire, 'British Building-Colour Standards', p. 222; A. Whitfield, T. Wiltshire, 'Colour', in Industrial Design in Engineering: A Marriage of Techniques, ed. by Charles H. Flurscheim (London: The Design Council, 1983), pp. 133-57 (p. 147).
[419] Saunders, 'Ignis Fatuus', pp. 498, 500.

that there are nonetheless good reasons why such a confusion persists. Inspired by Pierre Bourdieu's concept of habitus, and by Martin Kemp's remark on how the influence of images on the way we perceive reality has been ignored in the study of painting, she suggests that theories, concepts, and representations of colour such as classification systems, which somehow stem from and try to explain our 'visual universe', go on in turn to shape the way we perceive and understand colour. Thus we come to interpret what we see, our experience of colour, in terms of these systems, creating an apparent 'snug fit' between daily perceptions and concepts.[420]

Munsell certainly confused perception and representation. He firmly believed his system to be the most exact and truest representation of the world of colour, as implied in the following remark on rival systems: 'Desire to make colors fit a chosen contour, and the absence of measuring instruments, cause these schemes to ignore the facts of color relation. Like ancient maps made to satisfy a conqueror, they amuse by their distortion.'[421]

However, a look at this rather problematic parallel with geographical maps (a popular one in colour theory) puts into doubt Munsell's belief.[422] First, the implied counterpart to the analogy between rival systems and ancient maps, assumed to 'distort' the territory they surveyed, was that Munsell's own system was like a modern map, presumed to be no less than an objective representation of reality. J. B. Harley provides a convincing argument against such sets of comparisons:

> Far from holding up a simple mirror of nature that is true or false, maps redescribe the world-like any other document-in terms of relations of power

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[420] Saunders, 'Ignis Fatuus', pp. 497-98.
[421] Color Notation, pp. 77-78.
[422] See for example, Gloag, Keyte, 'Colour Co-ordination', p. 36; Gloag, 'Colouring of Building Interiors', p. 296.

and of cultural practices, preferences, and priorities. What we read in a map is as much related to an invisible social world and to ideology as it is to phenomena seen and measured in the landscape.[423]

Thus, from this point of view, Munsell's system was not as he claimed objective and 'value-free' but indeed, as all maps, a social and cultural product conveying particular agendas.

A second misleading assumption entailed in Munsell's derisive statement on his rivals was that colour systems, like maps, record and refer (however inaccurately) to some actual, incontrovertible, and demonstrable reality. Yet, there is no innate, immanent colour world for colour systems to depict. Barbara Saunders writes uncompromisingly:

> Space and colour as Gibson [...] might say, are figments of fallacious theories of vision if not schemes of false metaphysics. We should stop trying to extract from the behaviour of pigments, dyes and light something we call colour. There is no single phenomenon to be captured by an all-embracing theory of colour.[424]

Indeed, Saunders notes that the scientific study of light waves or of the physiology of vision, (and other scientific research on which colour systems of the Munsell type claimed to be based), are quite powerless to explain or describe how we 'see' colour.[425] What colour is for human beings, what

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[423] J. B. Harley, 'Text and Contexts in the Interpretation of Early Maps', in From Sea Charts to Satellite Images: Interpreting North American History Through Maps, ed. by David Buisseret (Chicago: University of Chicago Press, 1990), pp. 3-15. Quoted in Kent C. Ryden, Mapping the Invisible Landscape: Folklore, Writing, and the Sense of Place (Iowa City: University of Iowa Press, 1993), p. 298, n. 15.

[424] 'Ignis Fatuus', p. 498. Saunders refers to a book by J. J. Gibson, The Ecological Approach to Visual Perception (New Jersey, 1986).

[425] Saunders, p. 498. See also Wright, 'Fundamentals', pp. 16-17. Wright makes some 45 years earlier similar commments to those of Saunders regarding what he calls the 'psychology and aesthetics of colour': 'Unfortunately our knowledge of this aspect of the problem is too subjective and introspective to be amenable to any very valid scientific analysis. Although we may know that light of a certain wavelength gives rise to a sensation, say, of redness, and although we may be able to derive certain information about the characteristics of the physiological receptors which respond to this kind of light and which initiate nerve signals that ultimately stimulate the cells in the brain and are responsible for the redness in our mental image, yet the quality of redness defies description in these terms. All we know about redness or yellowness or greenness comes from the experience we have when we perceive sensations of these qualities.'

Saunders calls the 'experience of living in a chromatic world' is infinitely more complex, varied, and elusive than the schematic and reductive models and theories purporting to represent it. American journalist Janet Flanner gives us one marvellous and literary example of this, in her reply to a friend who had sent her a black notebook, instead of the red she had asked for:

> At any rate, what you did send and thought was blue, mistakenly I am glad to say, is really black, the next best thing to red always, in fact, usually my substitute much of my life. I have thought "red," felt it, too, while masquerading as it were in conscious black, in dresses; black looked black to others but was to me privately red, the next best thing so often that in their positiveness, their positive oppositeness, they were the same thing, like the two lines aimed at infinity which meet.[426]

Conversely, ethnographers and linguists have encountered societies which simply do not talk about colour, although they most surely experience it.[427]

One of the strong points of Gage's historical research is precisely that it encompasses just such ambiguous and contradictory experiences of colour. As Saunders notes, Gage challenges, at least implicitly, the 'physical, neurophysiological, linguistic and essentialist accounts' which presume to various extents that our physiological and psychological make-up faithfully apprehends the physical reality of colour in innate and universal categories which also naturally emerge in language.[428] For example, he shows that colour words have often been felt to inadequately describe the experience of colour. He also shows that colours and colour names do not in fact inherently correspond to each other, with for instance what for us could appear and be named as 'yellow' having been designated by quite different names and

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[426] Janet Flanner, Darlinghissima: Letters to a Friend, ed. and commentary by Natalia Danesi Murray (London: Pandora, 1985), pp. 269-70.
[427] Saunders, 'Ignis Fatuus', p. 498.

classified within different colour categories, not only in past historical periods but by contemporary observers as well. His historical study of varied subjects such as the interpretations and meanings of the rainbow in colour theory as well as artistic theories and practices from antiquity to the twentieth century, or the fluctuating and complex impact of scientific theories on modern painting suggests moreover that colour concepts are not eternal or universal but change, thrive and wane, in relation to specific social, cultural, aesthetic, and economic contexts.[429] Indeed, as Gage charts in his book, the many claims to the discovery of the 'natural system of colour', of the true 'structure of colour space' have consistently been humbled if not defeated by the multifarious and changing nature of our ideas, practices and experiences of colour. Colour, Saunders concludes, escapes systematization and categorization.[430] The colours we see and think do not ultimately belong to closed, pre-existing categories. On the contrary, as Saunders perceptively puts it, they are 'immanent in the particular', in that idea or theory, in this layer of applied pigments, in this dress or notebook cover, in that moment and place.[431] Thus the Munsell system is a fiction, an imaginative model of an imaginary colour world, always bound up with historical circumstances. John Dean comes to a very similar conclusion in the different yet apposite context of the history of botany:

> To show that <u>our</u> classifications of the natural world have the characteristics of invention is strongly to support the notion that <u>all</u> systems of classification have such a character. To show that systems of natural classification are designed to maintain and serve shared interests and objectives is to suggest that

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[428] Saunders, pp. 496, 498, 499. Saunders summarizes the view of colour underlying the Munsell system from the 1950s onwards: 'Colour was held to be an innately specified, autonomous and mandatory substratum in the brain, automatically issuing perceptuo-linguistic basic categorizations.' (p. 495)

[429] Saunders, pp. 499, 500; Gage, <u>Colour in Culture</u>, p. 10.

[430] Saunders, pp. 495, 497, 501.

[431] Saunders, p. 498.

classification is never a passive and disinterested process of discovery unrelated to social objectives and concerns.[432]

The Uses of the Munsell

Colour classification systems might well be fictional and arbitrary, but as W. D. Wright noted, they do have their uses.[433] Architects themselves appended to the Munsell system such adjectives as 'useful', 'convenient', 'appropriate', 'or 'serviceable'.[434]

In which ways was the Munsell 'convenient' or 'useful' to architects? Along with its obvious practical aspects such as the systematization of the selection and specification of colours, the Munsell system had been an icon and key element of the rational theory of architectural colour. We have already seen how the Munsell allowed and legitimated the profession's interest in such an aesthetic subject as colour, and helped reinforce the scientific image of the profession in the post-war period. Although the system performed this role with some success, it had for architects the paradoxical and added advantage of not being overly scientific. Indeed, had they really wanted a more scientific take on colour, our architects would have turned to colorimetry, the technique of colour measurement. The standard system of colour measurement, first issued by the CIE (Commission Internationale d'Eclairage) in 1931, mathematically defined the colour sensations of a hypothetical observer according to three physical co-ordinates of wavelength, luminance, and purity.

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[432] John Dean, 'Controversy over Classification: A Case Study from the History of Botany', in Natural Order: Historical Studies of Scientific Culture, ed. by Barry Barnes and Steven Chapin (Beverly Hills; London: Sage Publications, 1979), pp. 211-30 (p. 212).
[433] Wright, 'Fundamentals', pp. 17-18.
[434] Gloag, Medd, 'Colour in Buildings', p. 334; W. A. Allen 'Influences of Research on Building Design: 1. Functionalism and Science', Builder, 197 (1959), 610-12 (p. 611); Gloag, Keyte,'Colour Co-ordination', p. 40.

Yet architects preferred the Munsell, partly because the CIE's system required expert knowledge and instruments:

> Attention has already been drawn to the advantages of a reference system which will help directly in the choosing, matching and specifying of colours in terms of their appearance. Such a system is needed in addition to that evolved by the Commission Internationale d'Eclairage by which colours are specified in terms which are obscure to most designers, and not directly related to subjective impressions.[435]

This more suitable system, the Munsell, did rely for the identification and comparison of colours on no more than subjective vision and appearance.[436] Instruments and measurements did not count, what colours looked like to the naked eye did. The Munsell, architects had often argued, had brought precision to the hitherto arbitrary process of colour selection.[437] Yet as they also acknowledged, the subjective basis of the Munsell, as well as other factors such as the incapacity of human vision to detect small colour differences, the technological difficulties in achieving constancy in colour, or the fading of colour samples, all precluded accuracy in matters of colour.[438]

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[435] BB9, p. 39; see also Gloag, Colouring in Factories, p. 2.

[436] Hopkinson, Lighting and Seeing, p. 59: 'These various Hues are arranged around a circle, the Munsell Colour Circle, Munsell's arrangement being entirely on a subjective basis, the attempt being made to ensure that the intervals between any one Hue and the next round the circle would be approximately equal to the eye. In the same way, Munsell selected entirely by subjective assessment a series of greys, in ten steps from white to black, and made these equal to the eye.'; Gloag, 'Systematic Range', p. 2: 'In the study which was made at the Building Research Station into the available systems of surface colours, it was found that the Munsell system had distinct advantages from the point of view of architectural colouring. Its subjective basis was appropriate to problems in which concern must rest ultimately on the appearance of colours rather than on their physical attributes.'; Gloag, Keyte, 'Colour Co-ordination', p. 37; Gloag, Gold, Handbook, p. 12.

[437] Gloag, Medd, 'Colour in Buildings', p. 345; Keyte, 'New British Standard', p. 214.

[438] Gloag, Keyte, 'Colour Co-ordination', p. 38: 'But the Munsell Atlas is designed to help the user to do this [distinguish between three qualities of colour] with reasonable accuracy by its display of over 1,000 colour patches, [...].'; Keyte, 'New British Standard', p. 213:'On the BS colour cards a Munsell reference is given against each colour and a note is included in the text stressing that these references are approximate. Their purpose is not to give precise scientific definitions of the colours, but to aid the eye in picking out the differences and the similarities between all the colours of the range.'; Gloag, 'Systematic Range', p. 2: 'Although it is recognised that the steps of colour as represented in the Munsell Atlas are not strictly accurate, strict accuracy can seldom be realistically considered in a field where so many technical and practical factors affecting the final appearance of the colours must be allowed for.'; BB9, p. 14; Wright, 'Fundamentals', p. 18.

Scientific and subjective, precise and approximate, the Munsell was many things to architects. As for the wider sphere of colour of which the Munsell was a part and which it shaped, the ambiguity and the versatility was what to a great extent compelled architects to pick this particular 'map' of the universe of colour. A symbol of scientific colour, of control over chaos, feelings and tastes, the Munsell system was at the same time for architects another simple and workable means to pursue a thoroughly subjective theory and practice of colour.

3. THE SCIENCE OF COLOUR CO-ORDINATION

The publication of the colour co-ordination frameworks in the 1970s marks a new turn in our architects' protracted attempts to develop a colour science. The DD 17: Draft for Development for Basic Range for the Co-ordination of Colours for Building Purposes, and its definitive version BS 5252: Framework for Colour Co-ordination for Building Purposes, were a collection of 'systematically related' colours from which smaller standard ranges for specific building products would be extracted, thus, architects argued, insuring an harmonious colour environment. In fact, unlike previous standards and ranges, the first stated aim of the co-ordination framework was harmony between colours.

In the Archrome and particularly in BS 2660, harmonious relationships between colours had greatly preoccupied architects, even though both ranges were ostensibly part of a functional approach to colour.[439] However, how harmony could be achieved was the subject of rather nebulous statements:

The second principle, of selection for harmony, was partly met by the decisive spacing of the colours into their various categories, because this helped to

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[439] See for example, David Medd, 'Colour in Schools', p. 129.

avoid the unpleasant or weak effects which occur when colours are neither one thing nor the other-neither the same nor clearly different. As the range was built up, it was usually easy to decide whether a colour 'keyed-in' or not. Nevertheless there is room for some eventual 'smoothing' of the range from this point of view.[440]

By contrast, in the new co-ordination standard framework, not only was the focus decisively on harmony, but for the first time, seemingly firm and 'scientific' principles of colour harmony were on offer. But was science really of much help in the creation of beauty and harmony? And is there really, in the first place, such a thing as harmonious relationships between colours? In answering those questions we shall see once more that forces from an altogether different order than harmony or science shaped the architects' colour ranges and theories.

Underlying the colour co-ordination framework were not one but three, loosely connected strategies to conjure harmony between colours in architecture. The central strategy was the provision of sets of 'equivalent' colours produced by precise control over colour attributes. Another strategy, as we shall see, the only one architects openly recognized as a theory of harmony, centred on harmony of hues, and was based on the controversial studies of two American mathematicians, Parry Moon and D. E. Spencer. Broader in scope, one more strategy implied that any given colour was harmonious with, or at least related to, any other in the framework, simply by virtue of belonging to the same framework and being positioned by means of the same system of co-ordinates.[441]

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[440] BRS Digest 101, p. 2. See also Gloag, Colouring in Factories, p. 6; BB9, p. 7.
[441] Gloag, Gold, Handbook, pp. 1, 35; BSI, DD17: Draft for Development for Basic Range for the Co-ordination of Colours for Building Purposes (London: BSI, 1972), p. 1.

Equivalent Colours

Architects' idea of harmony in colour was complex and not entirely coherent, but centred on the idiosyncratic notion of 'equivalent' colours. According to Gloag and his colleagues at the BRS, equivalent colours were colours of different hues, but which had otherwise a very similar appearance. Series of such colours were to be provided in the new colour co-ordination framework. However, Munsell attributes alone failed to produce the desired sets of equivalent colours. As Gloag and Mary Gold explained, there were still unexpected perceptual differences between colours of equal Munsell value and chroma and which varied only in hue. After lengthy investigations, Gloag and Gold concluded that two more colour attributes were needed to obtain equivalent colours. One was 'apparent greyness', the 'estimated grey content of colours', the other 'apparent weight', nebulously defined as an adjustment of value to obtain colours of same character. Equivalent colours were thus 'colours with the same apparent greyness and same apparent weight'.[442] The new colour co-ordination framework was divided into five groups of colours of same greyness, and in each was offered up to eight sets of these coveted equivalent colours.

The main problem with equivalent colours was that there was absolutely no evidence, nor did architects provide any, that these sets of colours were more harmonious than others. In architects' accounts of colour co-ordination, the particular combination of colours designated as 'equivalent' is simply presented, rather unscientifically, as a self-evident fact. It was assumed, moreover, that colours of 'subjective equality of appearance' were exactly

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[442] Gloag, Gold, Handbook, p. 29.

what designers longed for.[443] The architects' precise definition of equivalent colours, by means of seemingly extensive research on new colour classification, stood nonetheless as some kind of scientific rationale to their special view of colour harmony. We have just seen that equivalent colours were defined as 'colours with the same apparent greyness and same apparent weight'. Yet, the loose definition architects gave of 'weight', 'a subjective term for lightness modified as necessary to produce colours of the same character in different hues', and the use of a 'small number of observers' to determine categories of greyness, (whose boundaries, architects admitted, were only approximate), points to the framework being much less systematic than claimed, and to aesthetic license playing an incontrovertible role in the making of sets of equivalent colours.[444] The new parameters presented to us as a universally valid solution to the perceived decline of the colour environment, had their place only within that particular, idiosyncratic quest for equivalent colours. The challenge of obtaining colours of different hues but of 'same character' was thus a self-imposed one, an aesthetic project born out of a vision of colour as something (at least in part) that could be manipulated and precisely controlled. (Fig. 63)

Harmony of Hues

A column of equivalent colours in the co-ordination framework was doubly harmonious, once because all colours in it were of equal greyness and weight, twice because most hues were harmoniously related to the others, according to

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[443] DD17: Draft for Development, p. 1; Gloag, Gold, Handbook, p. 25.
[444] BSI, BS 5252: Framework for Colour Co-ordination for Building Purposes (London: BSI, 1976); Whitfield, O'Connor, Wiltshire, 'British Building-Colour Standards', p. 220; Gloag, Gold, Handbook, p. 25.

Moon and Spencer's theories. There was however as little evidence for the second proposition as there was for the first.

Parry Moon was an MIT mathematician who had already written several papers in the early forties on lighting, colour and finishing materials.[445] With Domina Eberle Spencer he published in 1944 three papers on scientific colour harmony. According to Moon and Spencer, their theory synthesized the so-called 'classical', nineteenth century theories of harmony, notably those of Eugène Chevreul, Wilhelm von Bezold, and George Field, and presented them on a new scientific basis. The theory's main postulates were that colours were harmonious if separated by unambiguous intervals, and if they formed simple geometric figures when plotted within a three-dimensional 'metric colorspace' derived from the CIE and Munsell systems. The first postulate was based on the apparently 'fundamental' aesthetic principle according to which beauty only arises from clear and unambiguous stimuli. This principle was interpreted within their 'metric colorspace' as three zones of harmony (identity, similarity, and contrast), separated by zones of 'ambiguity', each zone demarcated according to specific numerical intervals. Unlike many previous theorists, Moon and Spencer took account in their calculations of harmony of the effect of the area of colour patches, and of the psychological effect of colour combinations. They also developed a method of rating harmonious colour combinations, as, they believed, not all colour harmonies were equally beautiful. To this end, the two mathematicians applied to colour harmony the formula for aesthetic

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[445] See for example, Parry Moon, 'Optical Reflection Factors of Acoustic Materials', Journal of the Optical Society of America, 31 (1941), 317-24; 'Inter-Reflection in Rooms', Journal of the Optical Society of America, 31 (1941), 374-82; 'Colours of Ceramic Tiles', Journal of the Optical Society of America, 31 (1941), 482-87; 'Wall Materials and Lighting', Journal of the Optical Society of America, 31 (1941), 723-29; 'Reflection Factors of Floor Materials', Journal of the Optical Society of America, 32 (1942), 238-42.

measure, proposed some years earlier by G. D. Birkhoff, M=O/C, where M was aesthetic measure, O was order, and C was complexity.[446]

Of this complicated theory, Gloag and Gold retained only the part dealing with the sectors of harmony and disharmony for hue. This selective reading of Moon and Spencer's work was to a great extent related to their viewing harmony as mostly a matter of hue. This idea was not uncommon, for, as Gage has pointed out, hue has occupied a central place in modern conceptions of colour.[447] Thus, because they did not dwell exclusively on hue, colour equivalence (and colour co-ordination), though clearly aimed at achieving beautiful colour relationships, were never acknowledged by Gloag and Gold as the theories of harmony they patently were. Such a stance allowed our two researchers to conveniently ignore the flagrant contradictions between the hue-centred theory of harmony on the one hand and on the other, the emphasis on the very different attributes of weight and greyness in the theory of colour equivalence.

Moon and Spencer's zones of harmony and disharmony for hue, transposed for convenience on a forty-step Munsell hue circle, were described in some detail in Gloag and Gold's Handbook. 'Numerically', the three sectors of harmony determined by Moon and Spencer (identity, similarity, and contrast) corresponded respectively to colours of same hue, colours apart by three to five hue steps, and by eleven to twenty hue steps. Intermediate zones of

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[446] Parry Moon, D. E. Spencer, 'Geometrical Formulation of Classical Color Harmony, Journal of the Optical Society of America, 34 (1944), 46-59; 'Area in Color Harmony', 93-103; 'Aesthetic Measure Applied to Color Harmony', 234-42.

[447] Gloag, Gold, Handbook, pp. 41-42; Gage, Colour and Culture, p. 11; Gage, 'Colour and Culture', p. 186; Arthur Pope, 'Notes on the Problem of Color Harmony and the Geometry of Color Space', Journal of the Optical Society of America, 34 (1944), 759-65 (p. 760); M. E. Clarkson, O. L. Davies, T. Vickerstaff, 'Colour Harmony', in Colour: A Collection of Papers Describing Investigations in the Fields of Colour Physics and Colour Psychology 1940-48 (Birmingham: Imperial Chemical Industries Dyestuffs Division, 1950), pp. 81-99 (p. 84); Whitfield, Wiltshire, 'Colour', p. 146.

ambiguity or disharmony corresponded to intervals of one and two hue steps, and six to ten hue steps. Gloag and Gold referred to these intervals to insure that the twelve hues for the framework would 'produce as many harmonious combinations as possible', each of the selected hues, as they proudly noted, being harmonious with at least seven other hues.[448] (See Figs. 27, 28)

Yet, Moon and Spencer's numerical intervals which determined zones of harmony and disharmony within the 'metric colorspace' ultimately drew their legitimacy from a dubious analogy with musical theory. More specifically, it was presumed that, as in music, mathematical proportions or intervals determine harmonious relationships between colours. John Gage in his book Colour and Culture offers a useful historical perspective on the troubled attempts to relate colour and music. He indeed places these attempts within a long-running intellectual and practical quest, at times linked to the belief in universal harmony, which has never borne conclusive results. Mathematics was seen as the key to both colour and musical harmony, yet colour proved much more difficult to quantify than music. The advent of more complex and seemingly scientific colour scales and systems in the seventeenth and eighteenth century seemed to announce closer links between colour and music. But the frequent changes in views on colour, on colour harmony and in musical theory have frustrated all attempts to establish coherent and universal correspondences between the two fields, showing the historical rather than absolute nature of these links.[449]

Moon and Spencer, in response to criticisms by Arthur Pope, denied any involvement with musical analogy: 'We agree that analogy between color and

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[448] BS 5252; Gloag, Gold, Handbook, pp. 25, 41-43.

music is fallacious and likely to lead to all sorts of errors. No such analogy is implied in our work.'[450] Although protesting their innocence, they did believe in the existence of a natural and commensurable colour order, accurately represented by their 'metric colorspace'. They believed that colours were perceived to combine harmoniously or disharmoniously according to the numerical intervals separating them or to their relative geometrical position within that colour space. However, we have seen earlier that colour classification systems and their co-ordinates do not represent some immanent colour world, but are rather conventions rooted in history. Without these beliefs about the objective truth of colour systems and colour categories, Moon and Spencer's theory of harmony, Gloag and Gold's theory of equivalent colours and many other theories of chromatic beauty become untenable.

Systematic Relationships

Another of the arguments invoked by architects to garner support for their colour co-ordination project was also based on musical analogy. In the early days of architectural colour standards, David Medd had used the musical analogy to promote the Munsell classification system and standard ranges: 'I feel the present position in colour is as chaotic as music would be without an agreed system of arranging notes and scales and keys.'[451] The harmonic implication of the musical analogy in colour co-ordination was that, being located and identified according to the same system of co-ordinates, colours in

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[449] Gage, Colour and Culture, ch. 13, 'The Sound of Colour'. See also Pope, 'Notes on the Problem of Color Harmony', pp. 760, 761, 762.
[450] Parry Moon, D. E. Spencer, 'Reply to Arthur Pope', Journal of the Optical Society of America, 34 (1944), 765.
[451] 'Rough Notes', p. 2.

the framework all had a 'known relationship' to each other.[452] The Munsell system was evidently seen as this structure which linked all colours. Thus, in the Colour Co-ordination Handbook, it was stated that 'The number and kinds of colours selected from BS 5252 for the different Standards can vary widely to satisfy the practicalities in each case, but co-ordination is assured by the fact that all come from the same framework in which every colour is systematically related to every other.'[453] However, as any colour can be plotted in the Munsell system, this argument, taken to its logical conclusion, meant that the Munsell linked not only the colours in the colour co-ordination framework but all imaginable colours as well, instantly invalidating the co-ordinating claims made for the framework. Moreover, as we have seen, the Munsell system which, Gloag and Gold imagined, insured cohesiveness and harmony in the framework, is a fictional representation never simply related to the complex phenomena and experiences of colour.

Controversies and Motives

Clearly, 'colour co-ordination' was a euphemistic appellation for what was in effect a scientific theory of colour harmony. The choice of this expression, drawn for the fashionable vocabulary of industrialized building, indicates that Gloag and his colleagues were well aware of the contentious nature of colour harmony. Thus the opening lines of the appendix on harmony in the Colour Co-ordination Handbook read: 'Although many attempts have been made over the years to state rules governing these relationships, none has gained firm and lasting acceptance and the subject of colour harmony, though plainly important

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[452] DD17, p. 1
[453] Gloag, Gold, Handbook, p. 1.

in design, remains controversial.'[454] Indeed, there were many who questioned the idea of harmony, and in particular, of scientific harmony. The architect Michael Keyte, writing in 1956, expressed serious reservations towards scientific theories of colour harmony:

> A full understanding of colour harmony does not yet exist. It is true that various rules by which it could be achieved have been suggested in the past, but without exception they rely on the idea that harmony in colour is like harmony in proportion, or music, and that mathematical formulae can be used to produce colour schemes. That such a comparison can be usefully made and that such formulae are valid remains to be proved.[455]

This statement was nonetheless followed by a description of the two principles of harmony which had apparently guided the selection of colours for BS 2660. Despite his scepticism towards dubious analogies, Keyte still believed in the existence of some 'natural' laws of colour harmony. The light and vision expert W. D. Wright had less ambivalent views. At the 1948 conference on colour in factories, he pointed out that no solid evidence could be found for the assumption that, for example, complementary colours went particularly well together, while colours such as pink and red, which were 'close' to each other, did not. On Moon and Spencer's theory, he had not a kind work to say:

> Moon and Spencer, in America, have propounded their theories of colour harmony in very elaborate mathematical form, and I think on quite a mistaken basis. I certainly do not think the laws of colour harmony are yet amenable to the mathematical laws and mathematical treatment such as Moon and Spencer have propounded. A further difficulty is that I cannot understand the mathematics![456]

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[454] Gloag, Gold, Handbook, p. 41. Gloag, Colouring in Factories, p. 3: 'Although a commonly used term and relevant to the pleasant quality required in factory colouring, colour harmony' describes a complex phenomenon not as yet fully understood.'

[455] Keyte, 'New British Standard', p. 215.

[456] Contribution of Wright, 'Open Discussion Forum', in 'Colour and Lighting in Factories and on Machines: Report of Course' (unpublished typescript, November 1948), pp. 67-87 (p. 86); Wright, 'Fundamentals', p. 17.

Likewise, Arthur Pope's comments on their last paper of the series, dealing with aesthetic measure, derided the authors' mathematical approach to harmony: 'Moon and Spencer seem to have accepted Birkhoff as final authority, and it must be suggested that the dazzling effect produced by the ability to put philosophical ideas into mathematical terms is no guarantee of accuracy of thought.'[457] In Pope's view, harmony was the result of too many 'intangible', incommensurable factors, to ever be satisfactorily defined in mathematical terms. Moreover, Moon and Spencer claimed to apply the scientific method to their aesthetic researches, yet they were noticeably silent on the manner in which these experiments were conducted or on their results, a problem which Clarkson and his colleagues noted affected much of the work on colour harmony.[458]

Architects themselves seemed sometimes to retreat from Moon and Spencer's scientific conclusions. The 'hue harmony selector', developed in 1970 by Gloag and Gold, was directly inspired by Moon and Spencer's propositions.[459] Billed in the Handbook as an 'instrument' to predict colour harmonies, it consisted, for two-colour harmonies, of two superposed rotating discs, one marked with the sectors of harmony and disharmony, the other with the forty-step Munsell hue circle. By making a given hue on the Munsell circle coincide with the reference mark, its relationship with every other hue was instantly revealed. (Fig. 64) Yet architects did not always consider the

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[457] Pope, 'Notes on the Problem of Color Harmony', p. 760.

[458] T. W. A. Whitfield, P. E. Slatter, 'Colour Harmony: An Evaluation', British Journal of Aesthetics, 18 (1978), 199-208 (p. 206); Clarkson, Davies, Vickerstaff, 'Colour Harmony', pp. 84, 87: 'So far we have dealt largely with matters of speculation rather than fact, and indeed there is a great lack of experimental data in the field of colour harmony, [...].' (p. 84)

[459] The idea was not a new one. Wilhelm Ostwald, with Franz Illgner, developed a very similar device to determine harmonious colour combinations, based on his own colour circle, and which was published in 1925. Le Corbusier, Polychromie architecturale: Le Corbusier's Color Keyboards from 1931 and 1959, ed. by Arthur Rüegg, 3 vols (Basel, Boston and Berlin: Birkhäuser, 1997), I, pp. 40-41.

selector's scientific answers binding. The selector was not an 'arbiter' of harmony but a 'guide'. Moon and Spencer's sectors were 'neutral and non-committal.'[460] At the same time, architects made the selector's results correspond to the designer's personal taste, one sanctioning the other. In a letter to Gloag and Gold, in thanks for a prototype of the selector, Medd interpreted the device somewhat contradictorily, as a diviner of his own natural intuitions about colour, but also as a safeguard against an unforeseen lapse of intuition, and therefore, as a guarantor of harmony:

> I very much appreciate and indeed was a little surprised to receive the BRS Colour Harmony Selector Mk2 so soon. I shall treasure this autographed device, and am delighted to find already that its use seems to coincide with my instincts, but it will be far more effective for keeping me on the rails.[461]

In the architects' case, the ambivalence towards the selector was not due to a serious questioning of its scientific premises. Rather, there was some genuine belief in its scientific solutions, which was linked to a desire to appear scientifically-minded even in their research on colour. Yet, architects also feared having scientific solutions to aesthetic problems forced on them and sought to preserve their aesthetic expertise.

How important a role 'intuition', arbitrary decisions and other intangibles played in colour co-ordination is also revealed by the many compromises and irregularities within the framework, enumerated somewhat apologetically by its makers. For example, in the B Group of the framework, there were more 'warm' colours than 'cool' ones, 'because the former are more often preferred.' Several colours were not of one of the twelve selected Munsell hue positions, partly because they had been directly transferred from

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[460] Gloag, Gold, Handbook, pp. 25, 42.

BS 2660, to smooth the transition between the old and the new range.[462] Medd himself went some way in disavowing the claimed rationality of the co-ordination framework:

> In choosing 182 colours from the millions which the eye can discriminate, one can select by scientific measurement, or on some symmetrical or geometrical basis such as the Munsell system. Both these methods would have been arbitrary in terms of use. By selecting in terms of practical experience in use, observation, and an appreciation of designers' and industry's requirements, those responsible were exercising personal judgment to a degree. [...] We designed the framework to contain and identify explicitly the three subjective attributes, and quite quickly a vast array of subjective choices began to fall into a systematic arrangement.[463]

The director of the Building Research Establishment (as the BRS is now known) introduced Gloag and Gold's Handbook as 'a contribution to the science of colour co-ordination'.[464] But if the framework was no more than a collection of colours with no demonstrable links between them, if the principles which had guided the selection of its colours were based on a mistaken belief in an immanent, ordered colour world, and on personal preferences, if architects themselves seemed only partly to believe their own claims to scientific colour, then what was the meaning of colour co-ordination?

In part, it was hoped that appearances of rationality and scientific method would help maintain and make less controversial an aesthetic theory and practice of harmony. For architects, these semblances were indeed seen as a distinctive asset in their struggle against a seeming loss of aesthetic control at the hands of industry. Whitfield and his colleagues convey well the architects' arguments: 'The requirements of mass production also had the effect of forcing materials manufacturers to decide upon the colour ranges they

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[461] David Medd, Letter to H. L. Gloag, M. Gold (unpublished typescript, 13 February 1970).
[462] Gloag, Gold, Handbook, pp. 34, 31.

would produce, thus significantly affecting the designer's role in decision making.'[465] More pointedly, the 'science of colour co-ordination' was to halt the perceived decline of taste brought about by commercial interests and put an end to the dominant role of fashion in colour. This rejection of fashion and of what they saw as commercial vulgarity, which since the 1940s underlay the development of 'architectural' colour ranges, was an integral part of modernist dogma. Architectural modernism was indeed partly defined in opposition to a conception of fashion as feminine, superficial, frivolous and ephemeral.[466] It was presented as objective and timeless, not another passing style but a dispassionate, scientific fulfillment of functional needs.

'Colour coordination as meant here,' Gloag once declared, '[...], leaves fashion to look after itself and seeks for the more objective factors.'[467] Others held just the opposite view:

> One of the objects of DD 17 is to provide groups of colours which, when used together, will produce colour harmony or colour coordination to use the modern jargon. Colour harmony, however, is a purely subjective concept and depends on both personal taste and current fashion. It can hardly be considered to lend itself to standardisation. Furthermore, it is obvious that there is a declining interest in colour harmony in the modern world. Many people, and particularly the younger ones, dress and decorate their homes in combinations of colours which would have made their grand-parents shudder. But if a man wants to decorate his dining room in a mixture of clashing psychedelic blues, greens, oranges and reds, there is no reason why he should not do so, and the result may well be as aesthetically pleasing to him as 'colour harmony' was to the Victorians and 'colour coordination' no doubt is to those responsible for DD 17.[468]

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[463] David Medd, 'Can Colour Coordination Work?', Building, 222 (1972), 71-72 (p. 72).
[464] J. B. Dick, Foreword, Handbook, p. iii.
[465] Whitfield, O'Connor, Wiltshire, 'British Building-Colour Standards', p. 215; 'RIBA Colour Panel', RIBAJ, 71 (1964), 326: 'It is regarded as essential that increasing industrialisation should not diminish the architect's influence on the design of products which he will be using.'
[466] Mary McLeod, 'Undressing Architecture: Fashion, Gender, and Modernity', in Architecture: In Fashion, ed. by Deborah Fausch and others (New York: Princeton Architectural Press, 1994), pp. 38-123 (p. 39).
[467] H. L. Gloag, 'Munsell and B.S. 2660', BM, 26 (1966), 73-74 (p. 73).
[468] 'Comment: Colour Coordination', BM, 33 (1973), 7.

Already in 1953, a critic of the BB9 had exposed the Archrome as a fashion, just as the commercial ranges architects so vigorously condemned.[469] As Mark Wigley has pointed out, even seemingly objective propositions cast explicitly against fashion are themselves fashion-to oppose fashion is itself a fashion statement.[470] As a new way to think of and exploit architectural colour, as the product of a series of compromises and arbitrary decisions, of Gloag's particular tastes and vision of colour, the theory and framework of colour co-ordination was itself a new fashion, soon to be a thing of the past.

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[469] 'Colour in Schools', ABN, 203 (1953), 471-72 (p. 471).
[470] Mark Wigley, White Walls, Designer Dresses: The Fashioning of Modern Architecture (Cambridge, MA; London: MIT Press, 1995), pp. xxiii, 161.

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Fig. 46 How to create theatrical effects, according to the BB9. The contrast between a dark, low entrance lobby and a bright and high-ceilinged assembly hall, shown in Diagram 2, was to surprise and impress the children and adults in the school. See also note A, diagram 3. (Ministry of Education, BB9, Colour in School Buildings, 4th edn (London: HMSO, 1968), p. 19, diagrams 2-3)

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Fig. 47 Architects liked to publicize the famous modern works who, they claimed, had inspired their new approach to colour, in part to give it more legitimacy. These included Ben Nicholson, Le Corbusier, and Mondrian. (H. L. Gloag, M. J. Keyte, 'Rational Aspects of Colouring in Building Interiors: 1', AJ, 125 (1957), p. 400)

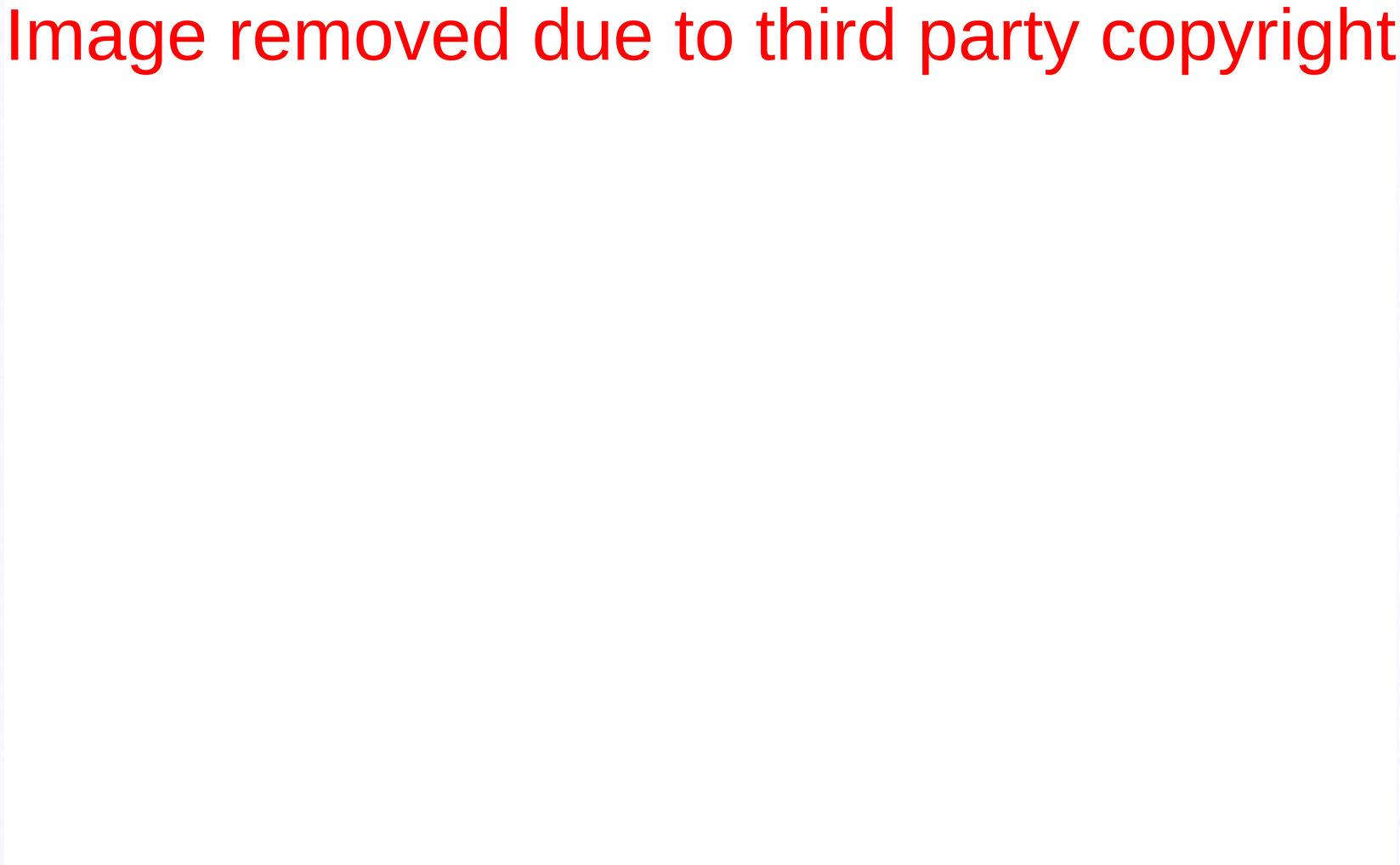

Fig. 48 The creation of a modern form of interior decoration: illustrations from the BB9 of various 'rational' and 'functional' principles of colour application, with overwhelming aesthetic intents. (Ministry of Education, BB9, Colour in School Buildings, 4th edn (London: HMSO, 1968), p. 37, diagrams 9-10)

Fig. 49 Piet Mondrian's painting Composition with Red, Blue and Yellow from 1935, on a page of an article by Gloag and Keyte. (H. L. Gloag, M. J. Keyte, 'Colour Co-ordination for the Manufacturer and User', Design (March 1959), p. 35, fig. 1)

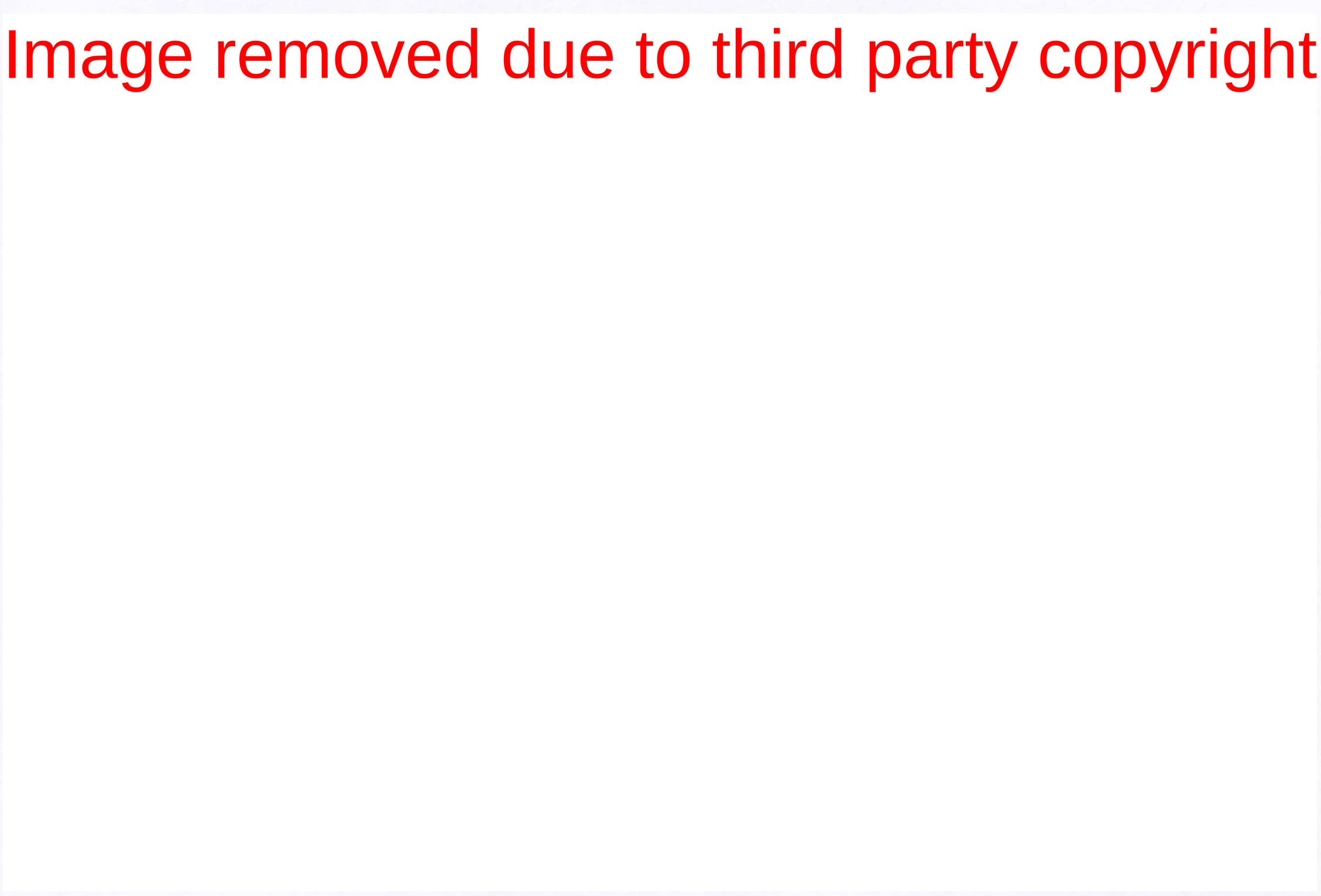

Fig. 50 Mondrianesque aesthetic in Templewood Primary School, Welwyn Garden City, Hertfordshire County Council (1949-1950). (David Medd)

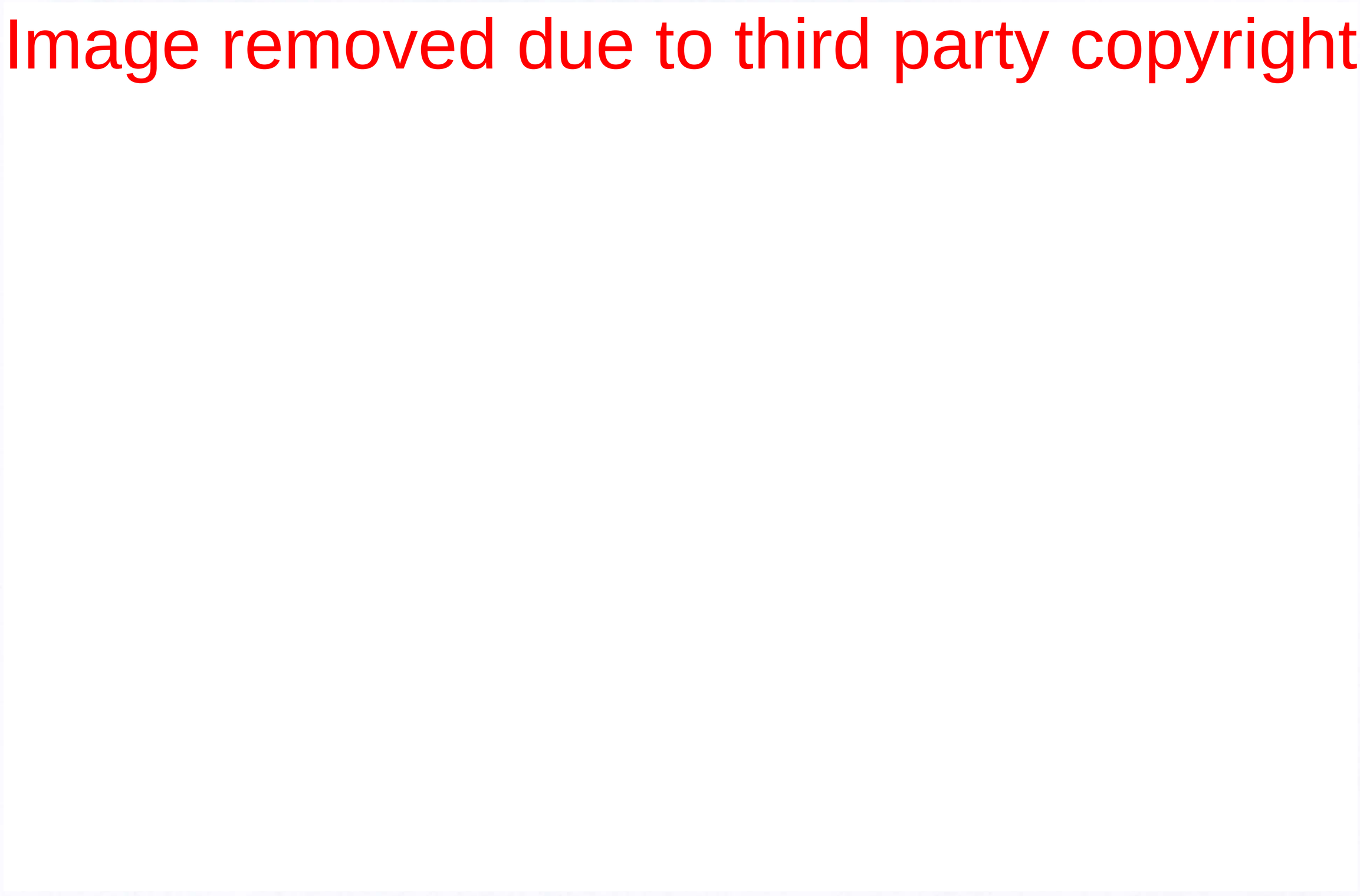

Fig. 51 A foil for a new modern theory of colour: an inter-war card, Standard Colour Schemes for Schools, with dadoes. (ICI Paints)

Fig. 52 The first (and among the few) published colour photographs of the new schools, in a 1949 issue of the Architectural Review. These carefully composed and staged images of Cheshunt and Essendon schools, and the captions giving details of 'scientific' Ostwald notations, were meant to illustrate all the rational principles of modern colouring (character, building elements, lighting and vision). But these early images also show that architects were intensely preoccupied with the appearance and style of the schools, and that they successfully developed a new and striking modernist aesthetic in which colour had a central role. (Robert Townsend, 'Towards an Architecture: Post-War Schools in Britain', AR, 106 (1949), p. 167)

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Fig. 53 Scientific study of subjective impressions: two photographs illustrating the problems caused by glare. (R. G. Hopkinson, Architectural Physics: Lighting (London: HMSO, 1960), p. 23, figs. 3.3-3.4)

Fig. 54 Accounts and images of model studies can be found in key texts of post-war architectural colour. These diagrams from the BB9, complete with authoritative notes, and recommendations on reflection factors and chalkboard colours, described the results of model studies of classrooms lit from only one side. (Ministry of Education, BB9, Colour in School Buildings, 4th edn (London: HMSO, 1968), p. 26, diagram 4)

Fig. 55 Photograph of a detailed BRS model of a classroom lit from one side, showing the effects of a dark-coloured floor on lighting and colour decoration. (David Medd)

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Fig. 56 A page from Studies in the Functions and Design of Hospitals showing the plan of the experimental ward unit at Larkfield Hospital, and a table of colours used in the experimental ward. The annotated plan and the ordered schedule convey an impression of rationality in colour design. The colour scheme of the Larkfield experimental ward unit was said to be based on the results of model studies on the problem of daylighting. These studies recommended that floors and ceilings have light colours because of their crucial contribution, by reflection, to the total amount of light. Reflection factors of walls could not be less than forty-four per cent., yet as model studies showed, bolder, darker colours could be used on some walls, as they did not seriously affect the overall lighting distribution. But lighting was far from the only criteria of colour selection in wards. Emphasis was also laid in the Studies on the right 'atmosphere' and effect through colour, on 'variety' which would distract, cheer and soothe patients, all concerns which no doubt scale models equally helped to explore. (Nuffield Provincial Hospitals Trust, Studies in the Functions and Design of Hospitals (London: Oxford University Press, 1955), p. 112, fig. 99, table 38) (Wellcome Trust)

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Fig. 57 In studies carried out at the BRS, models were used to evaluate the quantitative and qualitative aspects of lighting and decoration. The pictures show how observers could assess the subjective effects of the lighting and colour scheme. Passed over was the fascination of the miniature, the sensation of the giant among a lilliputian world, the pleasure of unimpeded, easy control over an architectural space which must have also animated observers and designers of the model experiments. (R. G. Hopkinson, Architectural Physics: Lighting (London: HMSO, 1960), p. 44, figs. 5.10-5.11)

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Fig. 58 Illustration for the article by R. G. Hopkinson, 'The Selection of Suitable Chalkboard Colours', first published in 1952. The diagram shows, on a horizontal cross-section of the Munsell solid at value 5, the results of a survey of 'psycho-physical' preferences for chalkboard colours. But with this image, architects also deliberately set out to mystify the subject of chalkboard colours. As Hopkinson himself noted, the diagram would seem enigmatic to those unfamiliar with the Munsell system, which in 1952 BRS staff had just begun to promote. The abstract graphics, the outer circle of cryptic numbers and letters, the star-shaped Munsell charts of chroma, and the thick superimposed contour lines, surely made the rather simple information it had to convey seem very complex and scientific. (R. G. Hopkinson, 'The Selection of Suitable Chalkboard Colours', RIBAJ, 59 (1952), 377 (repr. in R. G. Hopkinson, Architectural Physics: Lighting (London: HMSO, 1960), p. 294, fig. V.5)

Fig. 59 Image of the Munsell solid in the first edition of the BB9. (Ministry of Education, BB9, Colour in School Buildings (London: HMSO, 1953), p. 45, diagram 12)

Fig. 60 Scientific imagery: two illustrations detailing the structure of the Ostwald and Munsell colour solid, in the Colour Co-ordination Handbook. (H. L. Gloag, Mary J. Gold, Colour Co-ordination Handbook (London: HMSO, 1978), p. 13, figs. 2-3)

Fig. 61 A calculated juxtaposition of a commercial colour card, a section of BS 381C, and a card from the BS 2660, meant to demonstrate the superiority of the 'systematic layout' of the architects' standard. (H. L. Gloag, Colouring in Factories, Factory Building Studies No. 8 (London: HMSO, 1961), p. 12)

Fig. 62 Newton's rolled-up spectrum, from his Opticks. (Martin Kemp, The Science of Art: Optical Themes in Western Art from Brunelleschi to Seurat (New Haven and London: Yale University Press, 1990), p. 286, fig. 506)

Fig. 63 Three sets of colours from the Colour Co-ordination Handbook illustrating the notion of equivalence. On the left, colours are of same value and chroma but appear 'different in character.' On the right, the same colours after adjustments for equal greyness and weight, now forming a set 'equivalent in appearance'. To the uninitiated observer, the subtle differences between the three columns makes the greater aesthetic value given to equivalent colours that much more difficult to grasp. Why this set and not the other? To some extent, they also bring to light the idiosyncratic and arbitrary character of all aesthetic rules. (H. L. Gloag, Mary J. Gold, Colour Co-ordination Handbook (London: HMSO, 1978), p. 26, fig. 12)

Fig. 64 A draft, hand-made 'BRS Colour Harmony Selector Mark 2', a present to David Medd, signed H. L. Gloag and Mary Gold at the BRS Colour Section, 6 February 1970. The Selector was never published. (David Medd)

CONCLUSION

In 1981, procedures for the revision of BS 5252 were set in motion, with the aim of rearranging the structure of the framework and rectify some of the 'anomalies' in the notations. Members of the BSI committee concerned opposed the renotation of all the colours which this revision implied. BS 5252 has thus remained, against David Medd's wishes, as it was when first published in 1976. Notwithstanding the subsequent publication of a few subsidiary standards, the year 1976 might be seen as neatly closing off a series of events which formally started soon after the second world war in the Hertfordshire County Council.[471]

What had changed? There were many reasons why architects were unsuccessful in pushing through their revision of BS 5252. One was simply that those involved in the making of the ranges were nearing the end of their working lives. Gloag retired in 1979 from the BRS, although he continued to volunteer at the BSI, and died in 1993.

The political clout of the profession, which had allowed architects to transmute their collections of colours into official standard ranges, was much less than it had been in the first two decades of the post-war period. Gloag and his colleagues had held posts in what were then key organizations and institutions of the building industry. Gloag remained at the BRS all his professional life, Keyte (along many other architects) had had a stint at the BRS, Cox and Medd worked for the Hertfordshire County Council, with Cox moving on to the London County Council, and Medd to the Ministry of

Education. William Allen was at the BRS, and became director of the AA school of architecture in 1962. All of them were active members of the RIBA and made their presence felt in the architectural press. By the 1970s, the decline in public employment of architects and of large state building programmes, and the shift to private practice, economic upheavals, and the reaction against architectural modernism affected the prestige of the profession and precipitated an identity crisis. While several paint and building products manufacturers had once been delighted to form alliances with state architects, and adopt and promote their colour theories and ranges, as the profession came to be seen as a less important player in the building industry, manufacturers became much less receptive to its ideas on colour.

Another reason for the decline of the architects' ideas on colour, for the failure to maintain their presence in the field of colour was their misinterpretation and rejection of fashion. Architects argued that theirs was a fixed standard range of colours responding to objective needs. It was geared at architects and designers, at the building industry, at the 'trade' end of the market, and not to the fickle field of DIY and 'home decoration'.[472] In 1955, keen to sell massive quantities of paints to the state and local authorities, and under the spell of the fashion for standardization, manufacturers had given, in the end, their approbation to BS 2660, although its nomenclature, arrangement, presentation, number and choice of colours had largely been determined by architects. This first standard was a victory for architects. From then on, however, architects met with increasing resistance on the part of manufacturers. In the development in the fifties of the Do-It-Yourself

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[471] David Medd, 'H. L. Gloag: An Appreciation' (unpublished typescript, February 1994), p. 4; BSI, Document No. 93/101556, 'Revision BS 5252: 199 (Draft)' (unpublished typescript, 1993); BSI, BS 4800:

movement, and of what Penny Sparke has called the 'golden age' of feminine culture of consumption, succeeded in the sixties by the 'youth revolution' in taste, colour acquired an important economic role in motivating mass-consumption.[473] Contrary to the architects' assumptions, 'trade' markets were not immune to these developments.. Trade ranges of colours for paints and for building materials such as tiles, wall coverings, or 'sanitary ware' inevitably took account of new tendencies in 'home decoration'.[474]

Lesley Jackson's abundantly illustrated book Contemporary deals with home decoration styles from the 1950s, which Sparke identifies as a unique period where the feminine culture of home-making, of 'aesthetic production in the house' was encouraged and celebrated in the commercial design of the day.[475] According to Jackson, two novel features of this 'modified version of Modernism' was the idea of 'mix-and-match' and, Jackson notes, not the co-ordination of 'colour and patterns', but the creation of 'vivid and stimulating contrasts'.[476] If colour contrasts had been important in the days of the Hertfordshire schools, the attention of Gloag and his colleagues had by the late fifties turned to the development of subtle and scientifically 'co-ordinated' colour schemes. Architects argued that colour co-ordination, as they proposed it, was necessary because of the disharmonious relationships between the growing number of factory-coloured building products. We have seen that this stance stemmed in part from the fear of losing aesthetic control over colour selection to manufacturers. But it was also brought about by contempt for the

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Paint Colours for Building Purposes (London: BSI, 1989).

[472] H. L. Gloag, M. Keyte, 'Letters to the Editor', Design (July 1959), 67, 69 (p. 69).

[473] Penny Sparke, As Long as It's Pink: The Sexual Politics of Taste (London: Pandora, 1995), pp. 194, 203.

[474] Eric P. Danger, Using Colour to Sell (London: Gower Press, 1968), p. 113; 'Colour: Co-Ordinated Ranges for Building', Building Centre Forum 3 (London: Building Centre, 1961).

[475] Sparke, p. 184, ch. 9, ''A Kind of Golden Age': Goods and Femininity' (pp. 188-189, 202).

new ways of combining colours, of mix-and-match, which as Sparke points out, allowed women creative lee-way in interior decoration, as well as being a defensive reaction to the further break-down of high modernist rules in the sixties. In other words, our architects firmly refused to follow the latest trends, and in their resistance to fashion, were thoroughly unfashionable.

Among paint manufacturers at least, standards were subscribed to for only a short period in the early to mid-fifties. As can be seen by the long struggle put up by architects to publish their co-ordination framework, the industry's attitudes towards colour standards had shifted by the late sixties and seventies. Colours from these ranges continued to be produced, and the paint standard BS 4800 was revised at regular intervals and still stands today. But these 'architectural' standards were never considered by industry as capable of fulfilling all colour needs, and co-existed with changing and more fashionable ranges. The cumbersome procedures and long delays necessary before standards could be revised, and their built-in resistance to new trends insured that the form architects had chosen to convey their scientific vision of colour was no longer so well tolerated by their partners in industry.[477]

We have seen that although architects rejected fashion, a legacy of modernist dogma, and visibly bristled at the perceived excesses of mainstream, commercial fashions, their own systematic theories of colour and ranges to match were themselves attempts to launch a new fashion. It was by emphasizing the objectivity and rationality of the Archrome, BS 2660, and BS 5252, in comparison to commercial colour cards, that architects hoped to bring the rest of the architectural profession as well as manufacturers round to their

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[476] Lesley Jackson, 'Contemporary': Architecture and Interiors of the 1950s (London: Phaidon Press, 1994), pp. 9, 117.

movement. Architects had wanted to convert the whole of the building industry to their colour philosophy, and dreamt of making their standard ranges international. Like manufacturers, architects promoted their products in numerous articles, pamphlets, books, and lectures. Like manufacturers, they marketed their products and put much thought into their appearance. But this publicity campaign, these marketing strategies, at the same time as expressing a compulsion to participate in the game of fashion, were also motivated by a desire to reform and control taste in colour. From the very first experiments in colour ranges in the late 1940s, bad commercial taste had served as rationale for the making of new 'architectural' ranges. This belief that commercial taste was intrinsically vulgar, not to say morally wrong and had to be uprooted by 'men of taste', belonged to the intellectual tradition of the design reform. As Jules Lubbock has argued, this aspect of post-war architecture concerned with the regulation of taste belongs to a long tradition going back to the early eighteenth century, and was a core dogma of British modernism. Architects had wanted to reform colour taste not only in the building industry and within the profession but also in the schools, where the (principally female) teachers, as well as children, the future generations, would absorb their 'sound' principles of colour. As historians such as Stefan Szszelkun and Penny Sparke have argued, taste is not simply a set of harmless values but is also a powerful instrument of social control. Beyond the fashion for brighter or primary colours among architects during the fifties, for which Gloag and his colleagues could take some but certainly not all the credit for, their particular approach to colour failed to enter as they had hoped the mainstream of fashion in product and interior design. In the long run, the attempts of architects to influence

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[477] Danger, p. 114.

taste were cut short in the fifties, as Sparke has shown, by a frankly decorative alternative to modernism, and in the sixties, by the rise of youth subcultures, free-market consumerism, and an all-out revolt against the 'stuffy good taste' of older modernists.[478]

The declining influence of architects' ideas on colour in the building industry might be related moreover to the attitudes and use of the standards among members of the architectural profession itself. It is difficult to gauge exactly the success and influence of the standards and attendant theories within the profession, not the least because there has been very little research on the subject. What would seem to be the first survey on British architects and their view on colour, carried out in the mid-eighties within a research programme on international colour standardization, arrived at some interesting if speculative conclusions. One was that although colour ranges were presented as 'by and for' the architectural profession, they were in fact not based on actual knowledge of architects' preferences and needs. Another was that the interpretation and use of the standards by architects were not quite that which Gloag and his colleagues had intended. More specifically, the survey showed that architects were in general unaware of the co-ordination framework, the ranges derived from them and their underlying theories. The only derived range with which they were familiar and which a majority of architects used was the paint standard, BS 4800. However, they looked upon this range not as a paint standard, but as THE British Standard for colours, as a 'master-range' from which to specify colours, and as a 'colour identification system', rather than the Munsell system with which they were unfamiliar. The

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[478] Jules Lubbock, The Tyranny of Taste: The Politics of Architecture and Design in Britain 1550-1960 (New Haven and London: Yale University Press, 1995), p. 365; Stefan Szczelkun, The Conspiracy of Good

authors of the survey argued that this misuse of the standards, due in part to information not reaching its target audience, threatened the survival of colour co-ordination standards for building. With little demand for standard colours other than for those in the BS 4800, manufacturers had no continuing interest in maintaining such standards and were reluctant to carry on producing these colours; and indeed, often failed to see the point of standards at all. Whitfield and his colleagues, the authors of the survey, also observed that the profession was not a homogeneous group but was made of different sub-groups with different approaches to colour.[479] It might well be that most architects not only interpreted the ranges in unexpected ways, but that there were within that wider consensus, individual variations and even dissent. Much the same could be argued in relation to the principle of 'rational' colouring, with each architect bringing his or her own touch to the official guidelines.[480]

To have shown the misconceptions underlying the development of a scientific colour and of colour standards, to have revealed the architects' sometimes confused motivations, does not invalidate or ridicule this episode of architectural history. Both Saunders and Gage have shown that concepts and experiences of colour are related to specific historical circumstances, and therefore, that colour concepts and experiences are constantly reinvented. Saunders has sharply (and rightly) criticized the confusion of scientific explanations of colour with how colour is 'seen' by humans.[481] Yet it can be

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Taste (London: Working Press, 1993), p. 117.

[479] T. W. A. Whitfield, M. O'Connor, T. J. Wiltshire, 'Architects' Attitudes to the British Building Colour Standards and Colour Use in Buildings', Die Farbe, 32/33 (1985/1986), 181-95 (pp. 183, 189); T. W. A. Whitfield, M. O'Connor, T. J. Wiltshire, 'A Facet Approach to Architects' Attitudes to Colour', Die Farbe, 32/33 (1985/1986), 196-208 (p. 207).

[480] Letters from Mary de Saulles, Edward Best, Michael Keyte, Ronald Binns, Peter McKay, Jean Macdonald, B. L. Adams, David Jenkin, Kenneth Campbell, Herbert Gilett, George William Dunton, Douglas Cole to author, 1996.

[481] Barbara Saunders, 'The Ignis Fatuus of Colour', Art History, 17 (1994), 494-504 (p. 498).

argued that this belief that scientific research on colour corresponds to our perception of it, although misguided, might nonetheless be regarded as one of these re-inventions of colour. Likewise the architects' own ideas on rational colour and colour standardization, and the standards and coloured buildings themselves, each of these elements were the results of the architects' efforts to make colour as modern and scientific as possible. In doing so, they did succeed in creating a new and unique intellectual discipline and decorative practice of colour.

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AAJ	Architectural Association Journal
ABN	Architect and Building News
AD	Architectural Design
AJ	Architects' Journal
AR	Architectural Review
BM	Building Materials
BRB	Building Research Board
BRE	Building Research Establishment
BRS	Building Research Station
BS	British Standard
BSI	British Standards Institution
DSIR	Department of Scientific and Industrial Research
IW	Industrial Welfare
NPEAC	National Primary Education Archive Collection, Sybthorpe Library Archive, Bishop Grossesteste College, Lincoln
PM	Paint Manufacture
PT	Paint Technology
RIBA	Royal Institute of British Architects
RIBAJ	Journal of the Royal Institute of British Architects

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