Artifact Biography: A Variable Colour Mixer

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Abstract

Among the artifacts representing the founding of psychological research at the University of Toronto is a variable colour mixer, a precisely machined steel instrument of German manufacture. Such instruments were widely disseminated over the late nineteenth and early twentieth centuries as universities around the world adopted the tools and practices of experimental psychology. This new science embodied the much-admired German research-based model of university education.

The biography of this instrument opens onto a largely forgotten research program into colour perception that depended heavily on colour mixer-type instruments. Through uncovering regularities underlying the human perception of beauty, this program promised a renewal of the fundamental language of aesthetics. The artifact may be viewed as both a means towards, and an embodiment of, this aesthetic vision.

Key words: Experimental Psychology, Toronto, Colour, Aesthetics, Biography,

A storage room in the basement of a university building in downtown Toronto contains an odd assembly of objects. Unmatched shelves line the walls, holding scientific instruments, parts of apparatus, and other research-related objects. An orphaned lens from a twentieth century slide projector sits near an as-yet-unidentified piece of locally-made brass apparatus from the late nineteenth century. A large event recorder from the 1970s sits forgotten in the shadows at the back of the narrow room. Through some quirk of the building's ventilation system, the space is perpetually hot and very dusty.

On a large upper shelf sits an unfamiliar steel instrument, roughly the size of a kitchen stand mixer, which gives an immediate impression of both precision and solidity. It is in good condition, its surface only slightly tinged by oxidation. It is unusual; certain aspects, like the classical mouldings on its stem and the cursive engraving of its maker's mark, recall a traditional form of artisanal instrument manufacture. The precision machining of its steel components suggests modernity. The engraving shows that it was made by the E. Zimmermann workshop in Leipzig. Further research places its manufacture around the first decade of the twentieth century.[1]

This is a purely mechanical instrument; its working mechanism of machined bearings, dovetail slides, rotating shafts, and adjusting screws, is exposed to view. A sturdy stem, mounted on a cast tripod base, supports a horizontal frame at its centre. The frame provides a mount for an axle—in fact two concentric, nested axles, though this isn't immediately obvious. A pulley at the rear of the axels shows that they are driven by an electric motor and belt. The front ends of the axels terminate in a shallow circular frame-like assembly.

At the back of the instrument is an adjusting wheel. Turning it actuates a mechanism that rotates the outer axle relative to the inner. The mechanism's basic operation reveals itself: An electric motor will spin both axles as one, but turn the adjusting wheel while they are spinning, and their axial orientation will shift. This is made possible by a spiral guide that translates the horizontal push of the adjusting wheel into an axial twist of the outer assembly. An arrangement of nested bearings transmits that horizontal push while permitting the mechanism to spin freely.

Fig. 1 The Zimmermann Colour Mixer

Wheels of Colour

The instrument is a variable colour mixer, a specialized example of an early psychological technology known as the colour wheel or colour mixer. The basic concept behind this technology is not complicated. Colours are arranged as sectors of a circular disk. When the disk is spun with sufficient speed, the colours will appear to merge into a seamless field that is perceived as a blend of the component colours. This phenomenon provided an important early tool for exploring the human visual system.

Exploration of this technology invites anachronism. To understand its significance is to explore our culture before international scientific committees standardized colour and illumination, before the widespread availability of calibrated and durable pigments, before the array of technologies that now make it possible to summon vivid and accurate colours at will.

The technology of colour was then in a liminal state. Through care and labour, researchers could produce scientifically accurate colour stimuli. The arrangement of coloured segments on a wheel provided a means to produce a broad range of colours. Illumination, whether from natural, gas, or electric sources, required careful correction for colour and intensity. Reflected light from a mixer or other source could be adjusted to within a narrow spectral band using

filters and coloured gels. Measuring instruments such as spectrometers and photometers were essential for calibration.

Most importantly, the relative area of the segments on a colour wheel provided a mathematical measure of the final colour. Shifting these variables provided a way to test the thresholds of human visual perception. At what size did a sector of saturated red become perceptible against a field of colourless grey? How did this compare to other colours, and was this phenomenon affected by varying illumination? How did these factors vary among experimental subjects? Colour wheels enabled scientists to quantify human vision, to study its defects, and to approach its physiological underpinnings.

The variable mixer was a valuable refinement of this technology because it permitted the experimenter to vary the colour mix while the disk was in motion, that is, without interrupting the experience of the observer. The colour mix shifted as separate segments of a disk fixed to either axel changed their relative orientation. As they did, part of one segment was occluded behind the other as a new part was exposed. This refinement made it easier to study psychological phenomena such as sensory thresholds.

German Science in Toronto

The variable colour mixer (*Farbenkreisel zur beliebigen Verstellung der Sektoren während der Rotation*) was a product of the nineteenth century German research university, specifically the emergence of experimental psychology under Wilhelm Wundt (1832-1920). Trained in physiology at Tübingen, Heidelberg, and Berlin in the mid-nineteenth century, Wundt published seminal texts that codified the initial practices and tools of the new field. In 1879, he established the first dedicated psychological laboratory at the University of Leipzig. Over subsequent decades, this laboratory trained numerous graduate students who spread the experimental practices to newly founded laboratories around the world (Titchener 1901: 5-9).

Wundt's instruments were manufactured by the Zimmerman workshop in Leipzig. Zimmermann's catalogues listed a number of wheel-type instruments. These included the variable colour wheel, beginning with an early version developed by Karl Marbe (1869-1953) of the University of Würzburg around 1894. This was supplemented after the turn of the century by an instrument featuring a more robust mechanism that had been introduced by O. Lummer and E. Brodhun in 1896. This is the instrument encountered in our basement room.

Experimental psychology arrived at the University of Toronto during a period of enthusiasm surrounding the research-oriented German university system.[2] In 1889 a professorship opened at the Department of Philosophy. After much controversy, in which a prominent nativist contingent sought to promote a Canadian to the post, the position went to James Mark Baldwin (1861-1934), an American well versed in experimental psychology who had toured German laboratories.[3]

Baldwin established a laboratory at the University of Toronto in 1891, but left for a position at Princeton in 1893. His role was filled by August Kirshmann (1860-1932), a German, whom Baldwin had hired as a laboratory assistant. Kirschmann had studied under Wundt and worked as an assistant in his lab. He could operate and calibrate the essential instruments of the psychological laboratory.

Kirschmann's expertise was in vision, particularly in colour perception. He had a considerable knowledge of colour mixer-type instruments, incorporated them in his experimental apparatus, instructed his peers in their construction, even developed new instruments of this kind, one of which was manufactured and sold by Zimmermann (Weidenhammer 2015: 9-14).

The researched carried out under Kirschmann is summarized primarily in two volumes of the *University of Toronto Studies: Psychology Series*. These feature the experimental work carried out in the lab, as well as essays on aesthetics by Kirschmann and Oswald Külpe (1862-1915), another of Wundt's former students. The variable colour mixer makes two appearances within the second volume, which covers the period from 1900 to 1908. The first is an experimental study of the eye's varying sensitivity to different colours under different levels of illumination (the Purkinje effect), the second measures the intensity of commercial pigmented cardboards sold as sets of complementary colours (Wilson 1907: 52-53; MacGregor and Dix 1907: 105-106).

Kirschmann was not well treated in Toronto. Though his teaching and research contributions far exceeded those of his native-born colleagues, he struggled for several years before obtaining a comparable professor's salary. He returned to Germany in 1908 on a research visit to several psychological laboratories. There, he suffered a bout of serious illness and never returned to Toronto, moving eventually to Switzerland. In 1915, in the midst of the First World War, a local newspaper cast him as a German national cynically collecting Canadian money from his European residence. His salary and university affiliation were ended later that year (Slater 2005: 181-187).

From our historical vantage point, we see a tension running through this early laboratory. Emerging within a polyglot and cosmopolitan network sharing instruments and practices, its history is coloured by parochialism and xenophobia. We might speculate that, if not for the wars, the laboratory's early instruments might have become emblems of an early blossoming of local research culture, rather than being hidden away and forgotten.

Colour and the basis of aesthetics

From his position within the Department of Philosophy, Kirschmann lectured on aesthetics. Under his direction, the laboratory emphasized investigation into which colours and colour combinations were considered pleasant. These investigations, and the insight that they promised into viewer's taste and artist's craft, led him to advocate a renovation of art criticism based on the products of psychological experimentation (See Kirschmann 1900b).

Properly calibrated colour was essential to this program. For instance, the widespread assumption that complementary colours provide the most aesthetically appealing combinations could be tested by presenting subjects with matched complementary pigments under controlled lighting, then comparing the results statistically (Chown 1904: 188-190). Such investigative rigour might eventually reveal the mechanisms through which the mind experienced beauty.

Kirschmann's ideas were nuanced, but some of their character is captured in his description of a picture as '…a surface (a part of our field of view) consisting of smaller surfaces which differ in space-relation (extension, shape, arrangement), light-quality (colour-tone and saturation) and light-intensity.' Consequently, 'Any alleged physical or aesthetical characteristic of the picture, which cannot thus be unambiguously defined in terms of these elements is not a property of the picture at all.' Traditional art critics were purveyors of 'sham-knowledge', 'deception', and 'fraud' (Kirschmann 1900b: 190).

This rationalization of language and practice existed comfortably alongside certainties about racial and ethnic difference. Kirschmann maintained that: 'The ideas of human, architectonic, and ornamental beauty differ widely in a European, a Chinese, a Hindoo, and a Negro, even if they have all reached the highest standard of education' (Kirschmann 1900b: 186). Investigations into pleasing colour combinations took place in the presumably macabre setting of the university's sky-lit ethnological museum: a comparative collection of human skulls (Kirschmann 1900a: II).

Kirschmann's program redefined art (or aspects of art) as measurable matter. In a sense, his instruments embody his understanding of art as the precisely calibrated and expertly conceived. Rembrandt, in Kirschmann's understanding, was a master of representing light's intensity because he understood that 'the yellow and orange side of colour manifoldness… admits of the greatest number of intervals between full saturation and the darkest shade' (Kirschmann 1900b: 198).

As a piece of art, the variable mixer reflects a different sort of material precision, albeit one similarly emblematic of Germanic prestige. Just as it had surpassed France in the production of scientific instruments, Germany led Europe in the development of high-speed machine tools by the beginning of the twentieth century (Rolt 1986: 225, 235; Pantalony 2009: 13, 138-139). The variable mixer is, essentially, a belt-driven rotary tool – a material echo of the mills and lathes used to make it.

The variable mixer brought together eye and machine, recalling the culture of blood and iron from which it emerged. In its provenance, its material inflexibility, and its embodied precision, we can glimpse the superb military engineering of a united Germany, or the technology employed to detect defective vision within a growing army of machine operators.

It is a tool for unpicking the mind, for instrumentalizing life and labor. It belongs to an earlier stage in the process of surveying ourselves, and subjecting our newly exposed patterns to management. It is passive, its purpose explicit, bounded, and discernable, in striking contrast to the technological systems that influence us now through screens of effortless colour.

Received: 15 August 2019
Finally Accepted: 18 November 2019

Notes

1 See the digitized catalogues at the online Virtual Laboratory of Max Planck Institute for the History of Science, Berlin. https://vlp.mpiwg-berlin.mpg.de/library/tradecatalogues.html (accessed 20 June 2019).

2 See several essays extoling the German University in early issues of *The University of Toronto Monthly*, especially those by U of T President James Loudon (1900 1 [2], 1902 2 [9], 1903 4 [2]), and Professor A. H. Young (1904 4 [7]).

3 For a detailed account of the circumstances surrounding the hiring of James Mark Baldwin, see: Green 2004, 130-153.

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