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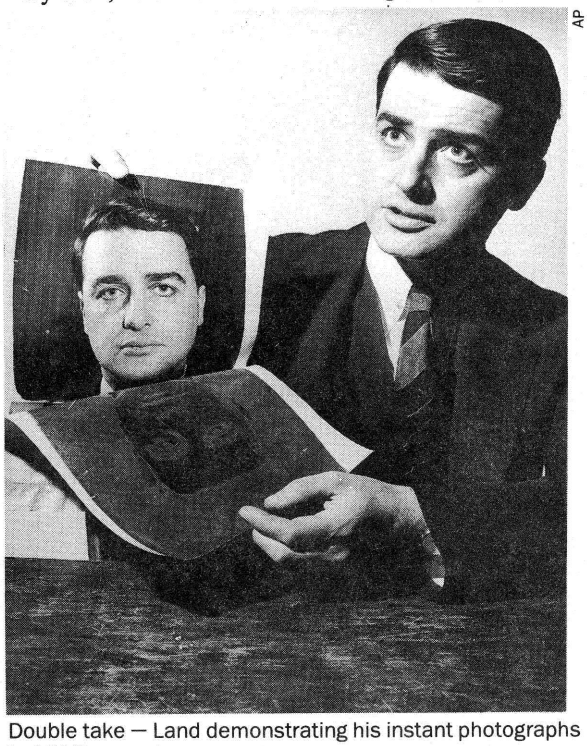
OBITUARY

Edwin Herbert Land (1909-1991)

In 1957, Harvard University awarded an honorary doctorate to a man who dropped out of its freshman physics class of 1926. After leaving Harvard, he had continued his education in the New York Public Library and had become one of the great American scientific entrepreneurs, to be counted alongside Edison and Bell. Such was Edwin Land, who died on 1 March.

By 1932, Land had succeeded in aligning submicroscopic crystals of iodoquinine sulphate and embedding them in a sheet of plastic, so as to yield large sheets of artificial polarizer. With his Harvard physics instructor, George Wheelwright, he set up the Land–Wheelwright Laboratories in 1932; and he established the Polaroid Corporation in 1937. Polaroid filters, for visible and infrared light, were soon being used in cameras and sunglasses, and in wartime rangefinders and night-adaptation goggles.



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Double take — Land demonstrating his instant photographs in 1947.

Land's first instant camera, yielding a picture in 60 seconds, was demonstrated to the Optical Society of America in 1947. By Christmas of 1948, it was on sale to the public. An instant colour camera was marketed in 1963. It was a classic case of giving away the razor and making the money on the blades. Land and his company became very rich. But an instant movie system, placed on the market just as domestic video systems were becoming available, proved commercially disastrous; and Land retired from the Polaroid Corporation in 1982.

Much less known than his cameras, but probably of more significance, was Land's secret work on high-altitude optical surveillance systems. In the 1950s, he led the team that designed the high-resolution camera for the U2 spy plane — the forerunner of later systems mounted in satellites.

For the last 35 years of his life, Land's main scientific obsession was colour vision, a subject that has been a seductive and passion-provoking mistress to so many physicists. His writings and lectures attracted (thoroughly justified) hostility from established colour scientists, but he was able to leave generations of undergraduates with the notion that he had refuted existing theory.

It was in the late 1950s that he captured public imagination with his two-colour demonstrations. A black-and-white photograph of a scene is taken through, say, a red filter, and a second is taken of the same scene through a green filter. A positive transparency is prepared from each of the two negatives. The first transparency is then projected on a screen through a red filter; the second is projected in register, but with unfiltered white light. We might expect to see an array of reds, pinks and whites — reds where the first transparency was light and the second dark, pinks where the transparencies had similar density, and whites where the second was the lighter. In fact, the image on the screen exhibits a much richer gamut of colours, which includes blues and greens.

The two-colour demonstration shows that there is no fixed relation between the spectral composition of light and the hue that we perceive at a local point in the scene. Rather, we judge colours by the company they keep. Land took his finding to contradict what he held to be the classical colour theory of Young and of Helmholtz.

The less insightful of his critics complained that his effects, apart from being rediscoveries, were all a matter of colour contrast. Those who thought more deeply, such as M. Woolfson (*IBM Journal* 3, 313, 1959) and D. Judd (*J. opt. Soc. Am.* 50, 254; 1960) grasped that the Land effects, like several other contrast phenomena, were by-products of the visual mechanism that gives us colour constancy — our ability to recognize the permanent colours of objects despite large changes in the spectral composition of the illumination. In the example given above, the illumination will be regarded as pink, and patches that reflect less long-wave light (those illuminated mainly by the second transparency) will be interpreted as greenish or bluish objects.

Rather more slowly than Woolfson and Judd, Land himself realized the relationship between his two-colour demonstrations and colour constancy, and during the next two decades he developed a second series of demonstrations, the 'Mondrian' demonstrations. These were grand (but increasingly laboured) demonstrations of colour constancy. Land always eschewed the term 'colour constancy' and declined to relate his demonstrations to a long-established tradition in colour science. Yet Young himself wrote in 1807 ". . .when a room is illuminated either by the yellow light of a candle, or by the red light of a fire, a sheet of writing paper still appears to retain its whiteness". And in fact Land's death coincides with the bicentennial of the masterly paper by Monge, in which that great mathematician relates coloured shadows to colour constancy and draws Land's conclusion — that we respond not to the absolute properties of the stimuli that strike our retinae but to their ratios.

It must nevertheless be said that Land's attentions revived a quiescent field. And his theory of colour constancy was important. The idea was that each of the three cone systems extracts the spatial pattern of light and dark as seen by those cones, scaling each local signal according to the total range of illuminations that it finds over a larger region. Later, a comparison is made of the three separate lightness signals for a given local area, and this comparison gives the colour of the corresponding surface. This 'retinex' theory was an early example of a computational model of how the brain might accomplish a particular task.

In public manner, Land was at once shy and imperious. Like many in his position, he gained the reputation of a recluse. In 1980 he saw the potential of a vacant lot beside the Charles River, and built there his Rowland Institute. It was a cross between an art gallery and the private laboratory of a nineteenth-century gentleman scientist — with perhaps just a touch of Hearst Castle.

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