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Matthew Adby

More than skin deep

Advanced colour measurement makes selection of customized cosmetics practical

Cosmetic manufacturers are harnessing some of today's advanced technology to obtain baseline measurements of colour and appearance of customers' skin

Handheld spectrophotometers are used more frequently in R & D of new skin care products and formulation of customized cosmetics

MATTHEW ADBY

X-Rite Incorporated 17 Hellath Wen, Nantwich Cheshire, CW5 7BB, United Kingdom

Skin is the visual calendar by which a person's age is measured, and virtually everyone wants to use cosmetics to flip the pages of that calendar forward or backward at will.

Teenagers embrace more sophisticated eye shadows and blushes to look older, and senior citizens reach for creams to regain the glow that their skin had when they were young. In a more compelling sense, individuals who suffer disfigurement from accidental burns or disease want to turn back the clock to when their skin was more attractive. Regardless of the reason, new technologies in the measurement of colour and appearance is making it possible for people to customize how they look using cosmetics more than ever before.

Skin is the largest organ of the human body that protects against invasion by microorganisms, the sun's rays, weather and chemicals (1). Experts are just beginning to fully understand the complex workings of skin and how those processes leave clues about a person's origin, age, living habits and current state of health - and how those appearances can be changed with cosmetics.

RESEARCH ON HOW AGING AFFECTS SKIN APPEARANCE

There is a significant amount of work being conducted into the colour and reflective properties of skin because, aside from medical applications, enhancing those skin characteristics is a growing business segment. IBISWorld, a Santa Monica, Calif.-based industry research company, recently reported that "colour cosmetics and skin-care products are presently thought to be two of the fastest growing product categories (in the toiletries and personal care industries) as evidenced by the staggering number of new product introductions. A number of these new products (both mass market as well as super-premium products) are thought to promote specific ingredients or target particular consumer concerns such as aging" (2).

The report went on to say that global retail sales of anti-aging skin care products are expected to continue to grow through 2014, on the heels of a 7 percent increase in retail sales in 2010 (3). Overall, the cosmetics industry spent an estimated \$10 billion last year on research and development of new products, a good portion of which are associated with skin care.

A significant amount of research work already has been done on more obvious age-dependent skin imperfections such as pronounced wrinkles, roughness and age spots, and researchers now are addressing more subtle differences that have to do with colour and appearance, such as changes in the optical reflectance characteristics of skin comparing the young and the aged (4).

For instance, scientists have brought the latest advances in colour measurement and optics to bear on the challenge of defining colours of cosmetics that mimic what one would normally associate with individuals with younger skin. As part of their toolboxes, researchers have used devices such as handheld spectrophotometers, digital cameras equipped with liquid polarizing filters and whole-face image-capture and analysis systems.



On a general level, "colorimetric measurements show that elderly skin is darker than young skin even in areas not exposed to the sun" (5). But similar to complex coatings and paints, the reflection of light from the human skin is complicated by its multilayer structure (6). The stratum corneum, the outermost layer of the epidermis, reflects some light, but allows most to penetrate deeper into the skin before it is reflected. Researchers have found that there are a number of age-dependent differences between these surface and subsurface reflections - which accounts for the skin glow often associated with youth.

In a study of 83 Japanese females ranging in age from 20 to 49, researchers at the Procter & Gamble Kobe Innovation Centre in Kobe, Japan reported significant differences in the evenness of the surface reflection and intensity of the subsurface reflections between younger and older individuals. Younger individuals had a more even surface reflection and a greater subsurface reflectivity than older individuals (7).

The skin colour of fair, white-skinned individuals who are healthy is strongly influenced by the presence of two main light absorbants, hemoglobin and melanin (8). Hemoglobin is a red-coloured protein that carries oxygen in blood, and melanin is a brown-coloured pigment that also occurs in hair and the iris of the eye. Researchers who conducted the Kobe P & G study used a handheld spectrophotometer to determine the melanin and hemoglobin indices used in their analysis (9).

A MORE WIDESPREAD USE OF SPECTROS TO MEASURE SKIN COLOUR

Cosmetic companies are taking a keen interest in the latest instrumentation used to accurately measure the colour and appearance of skin, both from research and retail perspectives. Without question, handheld spectrophotometers that are much more precise and versatile than colourimeters have dropped in price to where their widespread application in the colour measurement of skin has become feasible.

Upscale department stores may soon adopt this measurement technique by having beauty advisors at cosmetic counters take colour measurements of their customers' skin with handheld, easy-to-use spectros to determine the most appropriate products for their needs.

For instance, a palm-sized spectrophotometer that is now commercially available can accurately measure colours of test surfaces of varying textures and compare the results with an internal library of more than 45,000 colours, with just the click of a button. Further, the instrument called CAPSURE can suggest colours that harmonize with the main measured colour to fit a customer's ensemble. New colour libraries can be downloaded into the instrument through the internet, so new product offerings of the latest fashions can be easily updated.

While this electronic wizardry may make the trips to cosmetic retailers convenient and fun for consumers, accurate measurement of the colour of skin is imperative for companies such as Microskin International Pty Ltd. and Spectromatch Ltd. that use different types of spectrophotometers to customize camouflage products or create silicone prosthetics for individuals based on their skin colours.

Microskin, a business based in Brisbane, Australia that uses handheld spectros to measure the skin colour of individuals who use specialized cover-ups to camouflage their burn scar tissue or unsightly skin conditions. Spectromatch, a London -based developer and marketer of systems to colour silicone and cosmetic creams for maxillofacial and other prosthetics, has been using spectrophotometers during the past five years to measure and match skin tones for individuals of ethnicities worldwide.

Microskin Executive Chairman Barry Amor said it is possible to conduct that exacting work without a spectrophotometer, but a technician matching colours by eye may take a number of hours - possibly days - trying to determine what the instrument can define in minutes.

"Also a person's ability to match colours varies enormously with their eyesight, health and age" Amor said.

Charlie Carroll, technical director of Spectromatch and a partner in the company, said use of a spectrophotometer in measuring skin colour solves the appearance problems caused by metamerism, an optical phenomenon where a pair of colours might appear equal under one light source, but different under another light source.

Humans perceive the colour of an object differently depending on the strength of each colour of the visible spectrum that combined make the white light they observe. An apple appears red to humans because its skin absorbs all the colours of the visible spectrum except for the colour red. So an apple may appear a vibrant red under a white light source that is rich in red light, but dull red under a white light source that is deficient of red light.

"Metamerism should not be underestimated on the psychological well-being of patients and their acceptance of their prosthesis" Carroll said. One Spectromatch patient recently told technicians that his confidence was somewhat shaken when he received a prosthesis at a clinic that matched his skin colour well under the room lights, but looked quite artificial when he viewed it in his bathroom mirror. Using a spectrophotometer and proprietary software for mixing a palette of special colourants, Spectromatch was able to make the





prosthesis match under various lighting conditions. "It had a marked positive effect on the patient's self-confidence" Carroll said.

"But we also have found that recreating skin colour is not just a case of taking a measurement" he added and continued: "It is how we interpret that data to recreate the skin tone in whatever material, whether it is silicone prostheses or cosmetic creams". Spectromatch's system seeks to reproduce the texture of a person's skin with a combination of pigments and fine fibres, as well as faithfully reproducing its colour.

Technicians traditionally have colour matched prosthetics to their patients' skins using a number of colour swatches, according to a report given at the MyoElectric Controls/Powered Prosthetics Symposium in Fredericton, Canada

(10). "This approach has three potential weaknesses" a study found. "The number of swatches (up to 50) limits the range of colours available; the colour selection is based on the practitioner's judgment of the colour which can vary considerably; and the colour perceived is affected by the ambient light in the area where the matching is being done".

Spectrophotometry eliminates all three of these weaknesses, the researchers said. Measurements taken with a portable spectrophotometer "have 5 times greater resolution than the colour swatch approach" (11). Further, spectros can hold thousands of colours in their internal memories, many times the number of swatches that a technician would use.

In response to potential metamerism, cosmetic manufacturers use highly calibrated and/or certified light sources in light booths to compare samples during a production run with a colour standard. The booths also are used to evaluate precisely how consumers will perceive the colour and appearance of cosmetics under fluorescent store lighting, in daylight and at home under incandescent lighting. In general terms, cosmetic manufacturers often choose a standard illuminant that best represents the source of light under which their products will be sold.

MORE THAN SKIN DEEP

Microskin performs a sophisticated analysis of data to formulate the cosmetics for its customers, certainly at a higher level than what one may expect occurring at the cosmetics counter of a department store selling a standardized line of products. "We use a spectrophotometer to obtain the colour spectra of the good and affected skin, and then feed the spectra into a computer model that calculates a target colour" Amor said and continued: "When the target colour is applied to the affected area, it results in a spectra equivalent to the good skin, which effectively conceals the affected area".

Not defined as a makeup, Microskin is a camouflage product in the form of a liquidised, simulated second skin that binds to the epidermis, yet allows the skin to breathe. Users can bathe, swim, and play sports with Microskin products because they are waterproof, flexible and durable enough to last several days between applications.

Well formulated cosmetics from a colour standpoint appear to have a beneficial effect for accident victims. Psychological research of children and adolescents in Australia and New Zealand with burn scarring indicates that they experience lower health-related quality of life and increased behavioural problems than their healthy counterparts. Jessica James-Chadwick, clinical researcher with the Centre for Children's Burns and Trauma Research in Queensland who worked on the study, said that after eight weeks of using the Microskin cosmetic camouflage, health-related quality of life had increased to be more aligned with healthy children.

So on both the product R & D and customer sales fronts, it's likely that handheld spectrophotometers and other advanced methods of colour measurement will play a greater role in determining the baseline of skin colour of individuals with the intent of altering their outward appearance.

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