Shade matching for indirect restorations using a remote laboratory

By Barry F. McArdle, DMD

Ideally, shade matching for indirect restorations would occur with a laboratory technician in the dental operatory performing this function directly. Yet, in reality, according to the most recent statistics on the subject published by the American Dental Association in July of 2009, less than 5 percent of all dental offices in the United States have an in-house dental laboratory.1

The reality dictates that the vast majority of the more than 40 million indirect restorations placed each year in this country are fabricated at remote dental laboratories and because an exceedingly high percentage of those are tooth colored, shade matching becomes a critical challenge for the dentist in these situations.

There are four key areas involved with accurately accomplishing a shade match for an indirect restoration: the quality of the clinical preparation, the restorative material used, the skills of the lab technician involved, and the quality of the clinical records provided to that technici

This article will explore the last consideration as it is very often the most demanding of the four and to my mind the least well elucidated.

Color
What is shade matching? Shade matching is all about color and so a review of the Munsell color system would be a good place to start. Color is described as the energy of visible light (at varying wavelengths) reflected off a surface as expressed in the elements of that system: hue, chroma and value.

Hue is what the layman calls “color,” and it corresponds to the particular wavelengths (expressed in nanometers) at which light is visibly reflected. The visible spectrum of light energy is from about 580 nanometers (shorter, violet spectrum light) to about 750 nanometers (longer, red spectrum light). The hues of natural tooth shades fall between the mid 570s to about the mid 580s (Fig. 1).

Chroma refers to the depth or strength of the hue. The higher the chroma, the more intense the hue (color), while a low chroma results in a more diluted hue (Fig. 2).

Value is the concentration of gray (lack of light energy an object reflects (Fig. 3). Dental patients are notably more sensitive to the value parameter of the Munsell color system rather than hue and chroma in how they perceive a dental restoration’s shade.2 Thus, the answers to those questions can be very bit as important as the routine health history questions posed. Not only will the patients’ stress levels go down, so too will the dentist’s.

Many anxious or phobic patients feel more comfortable in the dental chair and this can be particularly traumatic. Helping them to feel that they have some control is critical. The most common approach is to establish a signaling system in which the dentist will stop working if patients raise a hand for any reason—including to ask a question or because they might want to rinse. The key is to ease their fears by emphasizing they have more control of their circumstances.

In addition, it is vital that team members are sensitized to the special needs of this type of patient. Putting the patient at ease the moment he/she walks in the door will go a long way in improving the entire experience. Dental teams should tune into the patient’s body language such as breathing rates, perspiration, and not if the patient is unusually quiet or particularly enthusiastic.

How is the patient holding his/her body? Is he/she gripping his/her hands? Do you see muscle tension? Dentists and dental teams that take the time to get to know and understand fearful patients often find that they become the most loyal patients, your biggest fans and a fantastic source for patient referrals.

Subtle messages have a big impact
Watch your timing. Neither the patient nor the dental team appreciates it when staff runs behind schedule. It’s essential that the scheduling coordinator fully understand how much time is required for procedures.

Additionally, consider checking hygiene patients when it is convenient for you, the dentist, not at the end of the hygiene appointment. This requires a little adjustment at first, but can significantly improve efficiency.

In addition, pay attention to the subtle messages that the employees send to patients, specifically, their smiles. If your assistant can smile with confidence and tell the patient that Dr. GoodDoc is her dentist and he is absolutely the best, this has a huge positive impact chairside in selling treatment. Moreover, it will make the team member feel good about working for your practice.

Most importantly, make it easy for your patients to pursue treatment. They like you. They like your team. They trust your recommendations, but they are afraid of the price tag. Provide financial options. Offer 10 percent off if they pay with cash or check. Consider 5 percent off if they use a credit card and pay at the time of service.

Provide outside financing options as well. The 12-months interest-free financing through CareCredit is my personal favorite. All you have to say to the patient is, “How does 12-months interest-free financing sound to you?” and he/she is usually thrilled to pursue your recommended care.

Finally, don’t disappear for six months. Keep your name in front of your patients. Send birthday cards, articles, magnets, electronic newsletters, recipes, etc.

About the author
Sally McKenzie is a nationally known lecturer and author. She is CEO of McKenzie Management, which provides highly successful and proven management services to dentistry and has since 1980. McKenzie Management offers a full line of educational and management products, which are available on its website, www.mckenziemgmt.com. In addition, the company offers a vast array of business operations programs and team training.

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it is crucially important to match the value of adjacent teeth in shade selection of an indirect restoration as this is of the greatest significance in its acceptability to the patient.

In other words, whereas the restorative dentist may have some small latitude when it comes to matching hue and chroma in the porcelain, his/her leeway when it comes to value is almost zero for the typical dental patient. Therefore, when selecting hues for shade down to the closest alternatives, A5.5 and B3 are often the finalists (Fig. 4) as their value levels are nearly indistinguishable.

For instance, when looking at a basic Vita shade guide, it is divided into four sections signified by different letters (A through D), and each division is further subdivided by number (1 through 4). The letter designations specify different hues, while the ascending numbers represent degrees of chroma and value.

The vast majority of individuals perceive these changes primarily as they relate to value and much less so in regard to chroma. Those who are color blind, while they probably cannot perceive any significant differences between the guide’s letters, will almost certainly do so between its numbers.

As another example, consider the crown shown on tooth #11 (Figs. 5, 6). This longstanding patient in my practice, whom I had always deemed to be somewhat difficult over the years, regarded the crown as “excellent” on insertion. Obviously, this was not true. While checking the photo in Figure 5 for a PowerPoint presentation I was putting together, I accidentally changed it to an eight-bit grayscale image as shown in Figure 6.

As it happened, the cause of our different perceptions of this same restoration was that this patient was actually quite colorblind. Since the value of both tooth #10 and the crown’s shade were very close, this patient saw no shade inconsistency here and so the hue disparity between the two was immaterial for him.

The process

When I graduated from dental school in 1985, single shade tabs were still being used in the clinic to match the porcelain for crowns to my patients’ adjacent natural teeth. While this method may rarely produce an accurate result (Fig. 7), under most circumstances it is just a case of “close enough” (Fig. 8).

Today, with the newer crown and bridge materials available on the market and the higher sums being charged for their use in fee-for-service dentistry, this obsolete approach to shade selection is no longer the standard of care. Although most dentists know are more critical of the final results than their patients, “close enough” plainly is not adequate anymore.

After my first few years out of school, having experienced several remarks because of shade concerns, I began taking multiple shades for each unit with the basic Vita shade guide. I reasoned that while I sometimes might match one or two of the three sections (gingival, body and incisal) on a natural tooth with one shade tab, I would very rarely match all three.

In assigning different shades to the three regions of a tooth for each crown, as I had thought, only rarely did I select the same tab for all. Now I was coming much closer on a consistent basis to the natural teeth I was trying to match, but there was still room for improvement (Fig. 9). Remember that this method takes more time intraorally and dessication of the teeth can occur, which will distort the match. Teeth should always be wet with saliva when shade taking.

Not too long after that, I read an article by a Dr. Alvin Pensler that caused me to think about other factors involved with shade taking that included lighting and background. Lipstick and heavy makeup should be removed before placing shade tabs, while loudly colored clothing should be hidden under a bib. Light blue works best for this as its value is rather neutral, its chroma will not overly bias your evaluation and its hue does not fall within the wavelengths of visible light reflected by enamel or cementum.

The hues of natural teeth are red-dish brown (A shades), reddish yellow (B shades), gray (C shades) and reddish gray (D shades), which are equivalent to the wavelengths of light noted previously. Color-corrected fluorescent operatory lights are also important to the three-tab method of shade selection. Their impact on shade matching when using such tabs cannot be overrated. Your dental supply representative should be able to help you with such lighting.

Shade mapping

Another important point I gleaned from Pensler’s article was the use of “shade mapping” on the laboratory slip (Fig. 10). Instead of having the laboratory technician guess at where the three different shade regions on the restoration should be transitioned, I was marking them on the prescription along with a shade map on the illustrations of anterior teeth included on the prescription.

Any unusual characterizations that would further add to the restoration’s natural vitality were also indicated on...
the map. These refinements in my process produced additional improvements in my results (Fig. 11), but some subtle discrepancies continued that I was sure I could resolve.

Digital pictures
The next advancement in my shade matching approach came on the advice of my dental laboratory manager. He suggested that I take digital pictures of the shade tabs as I tried them in the mouth, a practice well documented in the literature.6

In this way, any subtle deviation in values from standard porcelain parameters could be adjusted for by comparing the shade tab to the natural tooth in the mouth through the pictures.

I saw this next step in my shade matching produce considerably better results and I knew I could not go without digital imaging again (Fig. 12). My only disappointment with this new path was that I found it to be somewhat inconsistent (Fig. 13).

Shade mapping equipment
Now that I was able to by and large achieve near perfect outcomes, I was looking to do this on a more predictable basis. In talking with the laboratory manager I regularly worked with about this, he told me about his experiences with digital shade matching equipment.

He had tried units from several different manufacturers (VITA Easyshade by Vident, ShadeScan by Cynovad, SpectroShade Micro by MHT, etc.) and settled on Shade-Vision (X-Rite Corp.) as being the most effective combination of both user friendliness and accuracy on both sides of the dentist/CDT interface.

Because we have had a very successful working relationship over the years, I decided to purchase one of the ShadeVision machines (Fig. 14) and started using it along with my shade tabs and digital photography. I quickly learned that this tech-
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nology made me faster and better at shade matching while erasing some of the difficulties that I had previously encountered. This device is basically a color analyzer that generates its own corrected light source and takes a reading of the natural tooth to be matched. Operatory lighting is thus not critical here. A cone mounted on the unit that focuses the light beam is positioned on the tooth involved and then a measurement is taken. The cone also acts as a barrier to reflected ambient light, so clothing color and makeup are no longer factors.

The apparatus is then seated in its docking station after the reading, which is connected to your computer via a USB port so that the shade data can be downloaded and analyzed by ShadeVision’s proprietary software. A file is then created that can be sent as an e-mail attachment to your laboratory.

This file contains information such as relevant hue and mapping boundaries along with the relative parameters of the other Munsell color system factors as they relate to the different porcelain components of your definitive restoration or processed acrylic of your laboratory-fabricated provisional (Figs. 15, 16). I also use the average hue given by the analysis as a guide in selecting the acrylic for provisionals.

The learning curve in using the ShadeVision system as it concerns angling the cone to the tooth that will be measured can be mastered in a few readings. Once I had acquired a good degree of competence with the unit, I was able to attain reliably superior shade matches that I felt were to be desired (Fig. 17). My laboratory also appreciates receiving shade information in this manner more than any other means.

Other considerations

The only other aspect of shade matching that I thought still had to be resolved was surface texture. Surface texture has a substantial effect on shade parameters in the way that it alters patterns of light reflection. This is obvious under dry conditions (Fig. 18), but may be more subtle under conditions of oral moisture. The consistency of natural teeth affect their perceived shade and if that texture is absent in the definitive restoration, a difference will exist.

I had found, however, that both the adjacent teeth of the master cast and the ShadeVision system could be unreliable in communicating surface texture to the laboratory. The real image produced by my ShadeVision is approximately equivalent to the less than two mega pixel resolution of first generation digital cameras. That degree of precision, though sufficient for relaying shade information, is inadequate to impart texture and unique characterizations necessary for vital replication in the porcelain of definitive restorations.

About two years after I initiated the ShadeVision system in my practice, I heard a speaker who also used it, but advocated supplementing the process with the use of digital photography as well. He believed that certain details, such as surface texture and especially unusual characterizations, would be best conveyed to the laboratory technician using digital photography.

In fact, the ShadeVision system allows for the inclusion of digital photos into the work orders sent to your laboratory. On the same subject, the use of a silver paint pen by your laboratory (available at most hobby shops) to coat the labial surfaces of proximal teeth on the model will aid the technician in realizing the surface textures to be imitated in the final restoration.

Though not strictly a part of shade matching, opalescence (the optical property of scattering the shorter wavelengths of visible light exhibited by natural teeth) and translucency (creating the appearance of light’s diffusion through enamel in ceramics) are also important factors in producing lifelike porcelain restorations. When considering a crown and bridge laboratory, be sure to discuss with the ceramist how he or she achieves these effects in his/her work and assess the credibility of the response.

I regard these refinements as the last steps that I was looking for in my shade matching armamentarium. I have now been able to predictably accomplish cases with shade matches that I deem to be the best possible using a remote laboratory (Figs. 19, 20), such that I can now recommend single anterior indirect restorations to my patients with complete confidence in their satisfaction at the result.

Conclusion

In summary, shade taking is almost surely the most complicated aspect of fabricating indirect restorations to correctly share with a remote dental laboratory. While many other issues (e.g., technician ability and material choice) contribute to the overall realism of the shade attained, they are normally less challenging than the delivery of effective shade matching information.

My education on this matter in dental school was wholly inadequate, and I think many of my colleagues feel the same way. My professional development in this area progressed through conversations with my fellow dentists, the suggestions of sage laboratory people, knowledge acquired from industry representatives along with a lot of trial and error.

The process has led me to believe that there is no nothing like having an in-house laboratory when it comes to perfection in porcelain shade matching.

However, in the hands of the most skilled laboratory technician, superior materials can produce virtually flawless results when effectively imparting shade information to a remote laboratory. In the real world of nearly all dentists, this is the goal.

A complete list of footnoted references is available from the publisher.

About the author

Barry F. McArdle, DMD, graduated from Tufts in 1985 and maintains a private practice in Portsmouth, N.H.

An expert reviewer for JADA, he has written numerous articles in the peer-reviewed literature. McArdle is also an alumnus of The Pankey Institute. He co-founded the Seacoast Esthetic Dentistry Association in 2000 and his lecture series, Seacoast Dental Seminars, in 2005.