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.

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 technician.

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 380 nanometers (shorter, violet spectrum light) to about 700 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 or black in the hue (color) and is directly correlated with the amount 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. Thus, 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 credit card and pay at the time of service.

Provide outside financing options as well. The 12-months interest-free financing option with 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.mckenzie mgmt.com. In addition, the company offers a vast array of business operations programs and team training.

Mckenzie is the editor of the e-Management newsletter and The Dentist’s Network newsletter sent complimentary to practices nationwide. To subscribe, visit www.mckenziemgmt.com and www.thedentists network.net. She is also the Publisher of the New Dentist™ magazine, www.thenewdentist.net. McKenzie welcomes specific practice questions and can be reached toll-free at (877) 777-6151 or at sallymck@ mckenziemgmt.com.
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, A.5.5 and B.5 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 I know are more critical of the final results than their patients, “close enough” plainly is not adequate anymore.3

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 Pensler4 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 reddish-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.5 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 by using a shade map on the illustrations of anterior teeth included on the prescription.

Any unusual characteristics 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.

Any unusual characterizations present would also be shown in the pictures, making it easier for the laboratory technician to replicate them in the definitive restoration. As a result, I have been using digital photography for this purpose and to document my cases ever since.

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 Easyslide 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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can be downloaded and analyzed by
via a USB port so that the shade data
its docking station after the reading,
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 labora-
tory.

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

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 supe-
rior shade matches that left little to be
desired (Fig. 17). My laboratory also
appreciates receiving shade informa-

tion 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 con-

sistency 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 suf-

cient 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
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nology made me faster and better at
shade matching while erasing some of
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nician 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.8

Though not strictly a part of shade
matching, opalescence (the optical
property of scattering the shorter
wavelengths of visible light exhib-
ited by natural teeth) and translucen-
cy (creating the appearance of light’s
diffusion through enamel in ceramics) are also important factors in
producing lifelike porcelain restora-
tions. 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 real-
ism 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 labo-

ratory 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 match-
ing.

However, in the hands of the most
skilled laboratory technician, superior materials can produce vir-
tually flawless results when effec-
tively imparting shade information to a remote laboratory. In the real
world of nearly all dentists, this is
the goal.9

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

About the author
Barry F. McCardle, DMD, graduate
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McCardle is also an alumnus of The Pankey Institute. He co-
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and his lecture series, Seacoast Dental Seminars, in 2005.

Fig. 15: The shade matcher’s soft-
ware gives an average hue from the
reading that is useful in selecting the
shade for provisionals fabricated
chairside.

Fig. 16: Precise transitioning of dif-
ferent porcelain blends from region
to region on the restoration is pos-
sible with exact shade mapping.

Fig. 17: Using digital shade matching can produce virtu-
ally flawless results.

Fig. 18: Varying surface textures reflect light
differently.

Fig. 19 (above), 20 (below): Supplemental use of digi-
tal photography to capture unusual characterizations
texture cues is the last piece of the shade-matching
puzzle.