Jean-François Lasserre

Fusion

Art and Nature in Ceramic Restorations

QUINTESSENCE PUBLISHING

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Berlin | Chicago | Tokyo
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Born in 1960 in Bordeaux, Jean-François Lasserre, PhD., DDS, graduated from the University of Bordeaux 2 in 1983. Following his DEA in anthropology, in 1994 he became an associate professor in the Prosthetic department of the Dental faculty of the University of Bordeaux. In 2003 he defended his University Doctoral Thesis on the topic of dental wear in modern and historical population, developing and introducing a chewing simulator device to study the in vitro wear of novel ceramic and composite dental materials.

For more than 15 years, he has been teaching Occlusion, to later dedicate himself to research and teaching of dental esthetics and ceramic restorations. He has authored numerous articles in national and international magazines and has frequently presented lectures in France and abroad, dedicated to esthetic ceramic restorations. Jean-François Lasserre practices at the University Dental Hospital Center but also owns a private clinic in Bordeaux specializing in dental esthetics, implantology, and prosthetics. He is a founder of the research and educational group for dental esthetics named “Symbiose.”

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Art and Nature
in Ceramic Restorations

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DEDICATION

To my wife Christine, for her patience, her encouragement, and her unconditional support.
In memoriam to my father, Guy, and his mother, Simone, both teachers, who have transmitted to me their passion for hard work and travel.
To my daughters, Camille, Romane, and Solène, for developing their talents.

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FOREWORD

Johann Wolfgang Goethe once said: "There is no such thing as patriotic art or patriotic science. Both belong, like all good things, to the whole world, and can be fostered only by untrammeled intercourse among all contemporaries, continually bearing in mind what we have inherited from the past."

For this reason, it is a great pleasure for me to write this foreword. It is gratifying to know that everyday professionals of excellence, as Dr. Jean Lasserre, worry about the quality of their work and seek through their publications to share their knowledge. Contemporaries who, in the universe of the knowledge, have crossed a path close to mine, which is based on a new vision of beauty that uses the nature to obtain a result of superior quality. Dentistry is renewed every day, creating new techniques, treatments, and ways of seeing the world. Now, it ceases to be just mathematical calculations and art. The contemporary professional seeks the most perfect techniques for all esthetic requirements, achieving the patient's complete satisfaction. Now, the artificial is no longer desired. What is expected is a rehabilitation that promotes the perfect integration of the patient structures and the restorations, copying nature into its shape, texture, and function.

This title, *The Fusion of Art and Art and Nature Within Ceramic Restorations* depicts, with illustrations, clinical cases of units and extensions rehabilitation, in which a minimally invasive method is used to restore dental elements.

The philosophy described in the following pages pursues the art through the nature without leaving aside the science. Prosthetic treatments that result in excellence and characteristics that escape artificiality.

Dr. Jean François Lasserre and collaborators demonstrate techniques to increase the vertical dimension and ceramic stratification with a focus on mimicking the natural esthetics.

In addition, it covers concepts such as color, shape, asymmetries, and facial analysis. A complete book that also describes the action of psychological and physical factors on the oral structures, such as aging itself. The concepts discussed in this book are extremely useful to oral health professionals. Each page contributes as a reference for a new dentistry based on nature and enriches the reader's knowledge.

Paulo Kano

PREFACE BY ALAIN PERCEVAL

It is an immense pleasure and a great honor for me to produce the preface for the book written by my friend, Jean-François Lasserre. An exceptional clinical practitioner, passionate about painting, butterflies and Asia – in fact, passionate about everything – Jean-François is a true artist. So often over-used to describe somebody who demonstrates brilliance in their work, in this case the term "artist" encapsulates the man perfectly. But it must be acknowledged that it is sometimes difficult for an artist to transmit his talent and know-how to others.

There are many talented practitioners whose meticulous and precise work is based on solid scientific knowledge and who are capable of applying their talents to clinical practice. There are also many excellent teachers who are able to successfully transmit their knowledge in a precise and instructive manner. However, not many people manage to combine the two qualities. Jean-François is one of those people. This book is a labor of love, completed with the same level of perfectionism he puts into everything he does. It is the fruit of lengthy, intensive preparatory work to collate and organize information and clinical case histories gathered over a period of years. These are not "Sunday best cases" picked out especially for the book, but examples taken from the everyday life of a dental practice. Jean- François has surrounded himself with the very best people, with the skills required to support the various chapters. Whether ceramic experts, clinicians, dental technicians, or researchers, they have all contributed their perspectives, complementing Jean-François' own expertise.

As you will see, FUSION is hinged around three main themes: the fundamentals, the laboratory and clinical practice. A learning philosophy based initially on seeing and knowing, understanding, and only then reproducing. Seeing and knowing are the essential foundations underpinning any understanding and it is these fundamentals that are covered in the first nine chapters of the book. The merry-go-round depicted on the cover of this first volume gives it an additional symbolic dimension, reminding us that every treatment is an eternal new beginning in which these same esthetic fundamentals need to be kept in mind.

I think it was Pascal Magne who said: "the three most important things when carrying out esthetic restorations are: form, form ... and form." So it comes as no surprise that Jean-François Lasserre has begun the fundamentals in his book with an analysis of form, via an exhaustive exploration of the understanding that each dentist and each dental technician has of the morphology of human teeth, so important to the esthetic and functional quality of our restorations. Observation of natural teeth teaches us the function and harmony of the forms integral to the periodontium, the smile and the face, more generally. This observation will be taken to its logical conclusion in a study conducted with Jean-Pierre ABal on mapping of enamel thicknesses in the anterior sector, aimed at examining ceramic bonding, and minimally invasive dentistry practices more broadly, on the basis of the thicknesses available before preparation.

"Drawing inspiration from nature rather than destroying it" is therefore the motto for today's dentistry, which, like many other medical specialties, is becoming less invasive and less destructive to remaining issue. Mimicry and bionics underpin these new restorative concepts, based on the study of the biological and biomechanical systems of living things to discover models that can then be applied to technical procedures. But materials and new concepts are not everything. To successfully accomplish any procedure, a fully mastered and standardized technique is required, that is well understood and repetitive. Ceramic bonding – something that barely 25 years ago was a bold treatment offered by just a few exceptional practitioners – is now becoming a predictive technique, confirmed by numerous scientific data, as amply demonstrated in the chapter dedicated to this dentistry technique. The chapter is without any doubt the best I have ever read on the topic, thanks to its clear and precise detailing of these constantly evolving protocols. In this book, the author has achieved the feat of teaching us a working protocol, in an explicit and structured way. Because, as is the case for any practitioner, the challenge is obviously to make sure the treatment is a success, not just once but for every single patient, since technical reproducibility is the key to success in our profession.

To round off, this book will delight all those who are interested in and wish to fully master a modern approach to ceramics because each theme is covered in depth and described in a rigorous, clinical, and instructive manner. That is important not only for practitioners starting out in their careers but also for experienced ones seeking to further improve their clinical protocols. For all these reasons, I would like to thank and congratulate Jean-François once again for having produced this magnificent book and for having passed on his wealth of experience and knowledge to dental professionals.

Alain Perceval

Fig 2-1 Master glassmaker from Murano, Venice
(photographer: Diyana Dimitrova).

How to become an artist in dentistry

Luca Dalloca

Nowadays, the dental surgeon and their technician must be creative and artistic, needing both technical expertise and creative genius. In other words, rationality and creativity must coexist in our abilities. Academic knowledge, skills acquired through clinical practice, and continuous training on new technologies, offer the dental team all the tools for good technical expertise, the one that comes under the rational control of our brain soliciting the left hemisphere or "left brain."

On the other hand, new technologies are standardizing dental work, guided implant surgery, computer-aided design. Manufacturing (CAD/CAM) prosthesis or Digital Smile Design (DSD)[1] previews perfectly illustrate this standardized and mechanistic approach to the smile.

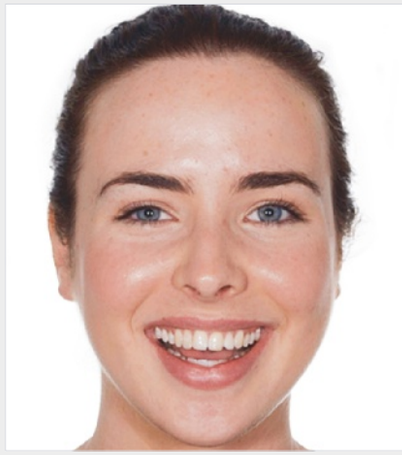
What more can we look for when we have all the knowledge and technological means necessary for our profession?

Artist, craftsman, or creator?

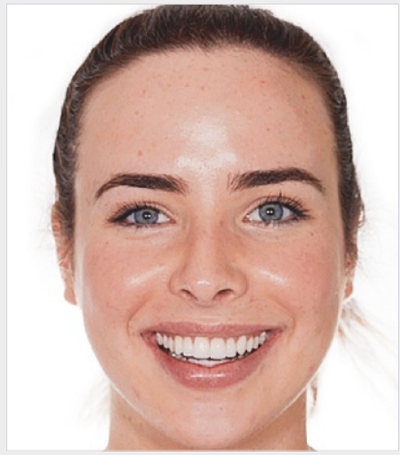
The term artist defines anyone pursuing an artistic practice. It includes the term "artist" in literature from the 14th to the 18th century, along with the terms "author" and "creator." In its earliest origin, the concept of author or of creator encompasses the sense of technical and artisanal expert capable of creating a "Chef d'OEuvre" in its specialty. This definition prevailed until the 18th century and designated painters, sculptors, and architects. Vasari (1568), Baldinucci (1681), and Militia (1797) distinguish between the two terminologies, reserving the term artist to the practice of Fine Arts, whereas the terms author or creator are reserved for technical arts and crafts (Fig 2-1). The concept of the artist evolved during the 19th century toward the romantic vision of creative genius. This is the definition of the artist found in the Treccani encyclopedia[(a)].[2]

In dentistry, knowing the rules and protocols is not enough. Development of our artistic abilities under the control of our creative brain (right hemisphere or right brain) is a necessary complement. The human eye instantly captures the oral sphere because of its strong involvement in verbal and non-verbal communication. Think of the effect of a hand placed in front of the mouth when smiling (eg, in the case of a patient who has a complex): immediately it closes the communication door, our mirror neurons are not activated and empathy is difficult. Now let's imagine the possible consequences of a purely rational approach, for example in a case of an esthetic prosthesis made from a preview by a Digital Smile Design (Fig 2-2).[1] As absurd as it may sound, two people of different age or gender could have the same teeth and smile – or two friends could smile at each other and discover that the other one has the same teeth, which certainly would create discomfort. The smile cannot be industrially manufactured, otherwise it would be symmetrical and stereotyped (Fig 2-2). It is indeed impossible to find two perfectly identical natural smiles.

(a) Treccani is the name under which we commonly call the "Enciclopedia Italiana di scienze, lettere ed arti," which was first published in 1925.



(a) Natural smile.



(b) Digital smile made by duplicating in mirror the right hemi-smile instead of the left hemi-smile, which gives a perfectly symmetrical effect.

(c) Editing a digital face by combining two right hemi-faces in mirror. The smile and the face are then symmetrical.

Fig 2-2 From natural to stereotypical smile.

Compared to the asymmetrical faces (a) and (b), the symmetrical face (c) appears inexpressive and unbalanced. Why then would a symmetrical smile (b) and (c) be more harmonious?

Create a personalized smile

It is necessary to establish a dialogue between the rational and the analytical part of our brain and its creative and artistic part. We must train ourselves for this cerebral complementarity. Arnheim wrote: "We must improve our knowledge and our feelings through the practice of art and the study of art history literature, more precisely by understanding the psychology of perception."[3] If we think about a mouth, we visualize the lips in their shape and thickness, then the size of the smile with the teeth and gums more or less visible. The layout of the teeth has an infinite number of combinations between the lines' orientation, shapes, and colors, which make each mouth unique, every composition personal and every smile truly natural. The teeth, like the rest of the body, have a history and a life of their own. They belong to a person singular in his way of being. For Arnheim: "The artist is an author who has been able to develop his artistic sensitivity."[3,4] An artistic dental surgeon is one who, when planning an esthetic restoration, is able to take into account the person he is treating as a whole, to study the composition of the smile in order to create a totally personal and very close to natural work of art (Fig 2-3).

"To hear a hundred times is not worth seeing once."

Writings from Confucius 551–479 BC

(a, b) The initial state shows a disharmony of shape and color of the central incisors in the smile and the patient's face.

(c, d, e) You can appreciate the difference after the restoration in two feldspathic veneers on 11 and 21. They embellish the smile but also illuminate the patient's entire face, although they have a significant asymmetry (c).

Fig 2-3 "Natural" restorations of two central incisors.

Freeing the artist within us

We all have creative potential

Creativity and rationality, their combination as well as the dominance of one over the other depend, for each of us, on the constitution of the cerebral hemispheres, and established neural circuits. Although the right and left hemispheres appear symmetrical from an anatomical point of view, each hemisphere has specific functions and differentiated. Neurologists recognize the control of verbal functions, arithmetic, logical, analytical, and temporal thinking and rational analysis in the left hemisphere. The right hemisphere would be responsible for the synthetic, non-verbal, timeless, irrational, intuitive, spatial, and artistic functions.

It is often mistakenly believed that artistic talent and creative sense are hereditary or that an individual has a gift, that is, an innate predisposition for art.[4] Each one of us actually has creative potential. Artistic sense is not only linked to gifts and individual aptitudes, but also to a socio-cultural context that values creative work and allows his constant confrontation with his surroundings and society. The training of creative skills must be seen as one of the most ambitious goals of education. Translating life into artistic terms is one of the faculties that every healthy person possesses and which should not be blocked.[5] According to Polacek[6]: "A child's creative capacity is conditioned by two environments: the family and the school. In order to develop a child's creative abilities, we need to encourage independence."

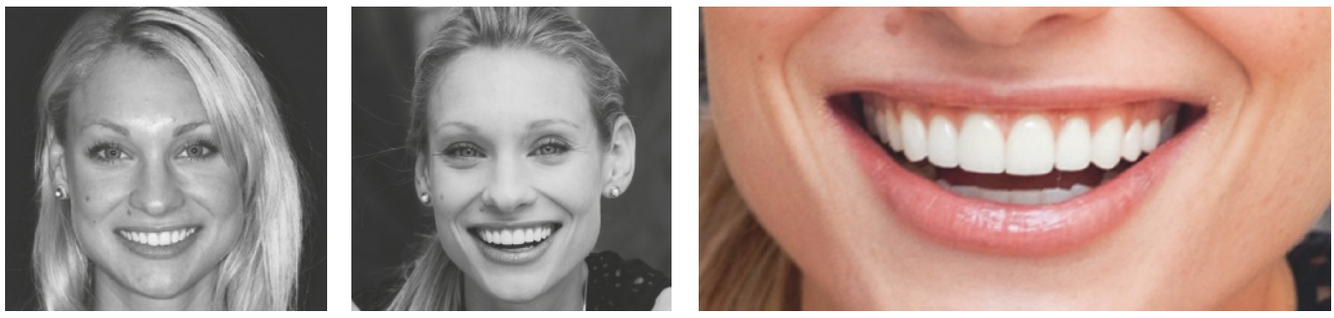
This may come as a surprise, but in order to become an expert practitioner or dental technician in the field of esthetics, we must increase our artistic perception by practicing an art.[3,5] It is a misinterpretation to say that a good esthetic result depends only on a set of well-defined rules. Although it is essential to understand a number of basic principles and parameters, limiting our work to pre-established protocols, anthropometric measurements and mathematical rules will only guide us toward a simplistic and stereotypical smile[7–10] (Fig 2-4a, b). In a healthy face and in a natural smile we never find symmetry, and yet these faces and smiles are harmonious, attractive, and do not generate visual tension (Fig 2-4c). The functions put in place by natural evolution obey a surprising minimalism where nothing is wasted and everything that is present is necessary. Leonardo da Vinci wrote: "Even if human ingenuity can lead us to inventions that lead to the same results as natural organizations and structures, they will never be more beautiful, simpler or more accomplished than the works of Nature, because in his invention nothing is missing and nothing is superfluous."[11]

Finally, artistic talent can be defined as an individual's ability to see things differently and with greater intensity, to perceive compositions as a balancing act forming a whole, to have a better overall perception of contours, space, relationships between forms and effects of shadow and light. It is the theory developed by Gestalt[(b)] which finds its perfect

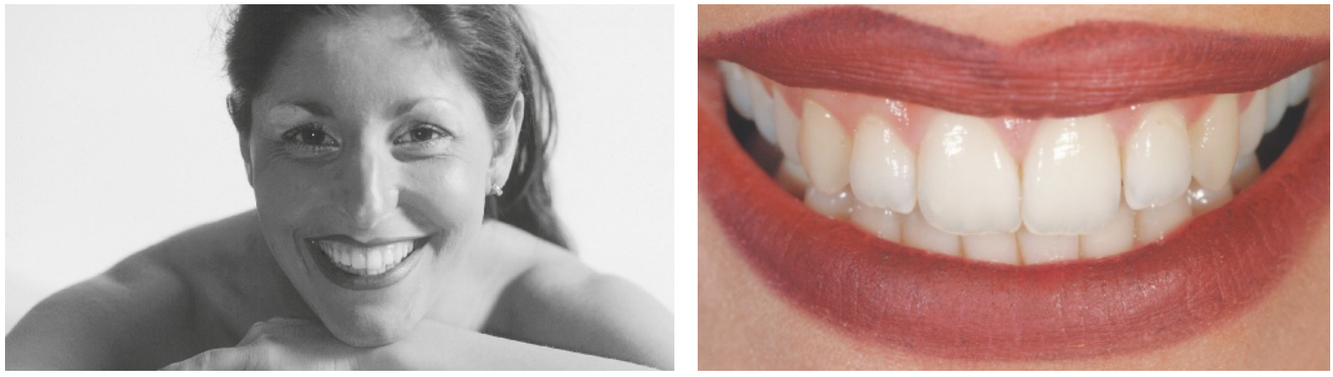
(b) The "Gestalt theory" is the psychology of form (in German: Gestalt). It is one of the many currents that have paved the way for the psychology of perception. The followers of this current no longer consider the phenomena of the psyche as a sum of isolated elements, but as sets forming autonomous units.

Fig 2-4 **Stereotypical vs natural smile.**

(a) There is a significant improvement before and after the prosthetic treatment but the final smile is far from natural.



(b) This young woman, a fashion model, had ceramic veneers made for her while she initially had a harmonious smile. The final result, perfectly symmetrical and made under the control of precise esthetic rules, appears artificial and lifeless (documentation: Dr. B. Lesage[10]).



(c) In this harmonious natural smile the asymmetry of shapes and positions is marked. However, the teeth arrangement does not create any visual tension on the scale of the smile and the face.

application in the analysis of dental-gingival-facial composition where formal and chromatic interactions are capable of generating tensions and movements within the balance of the smile.[12]

Creativity and rationality

There is a profound idiosyncrasy in accepting that artistic aspects are a fundamental component of the treatment phase and of the design and manufacture of prostheses in the laboratory. The dental world stubbornly seeks to reduce our profession to its scientific and computerized aspects which, although they are unavoidable, are totally insufficient to carry out our esthetic treatments. Dentists should have a more global approach and understanding of the patients.

"Creativity is more important than knowledge. Knowledge is limited, creativity embraces the world."

Albert Einstein

Cerebral creativity and well-being

Creative thinking goes hand in hand with mental and physical well-being; it could be a viable alternative to exclude negative thoughts which are a source of psychological discomfort that in the long term contribute to physical alterations and illnesses. It frees the mind from acquired conditioning, which is particularly important in all those occasions when psychological and mental maturity is needed to adapt to new situations. It also gives us the possibility of using the plasticity of the brain in response to a complex event, making use of the functional, intellectual, and intuitive pluralities that each of us is genetically endowed with. Believing in one's own creative abilities is healthy.

Phases of the creative process

Cognitive sciences have analyzed and documented the creative process but we are still far from having a clear definition of it. On the other hand, it is accepted that the creative process uses both cerebral hemispheres and is divided into five stages[3] (Fig 2-5).

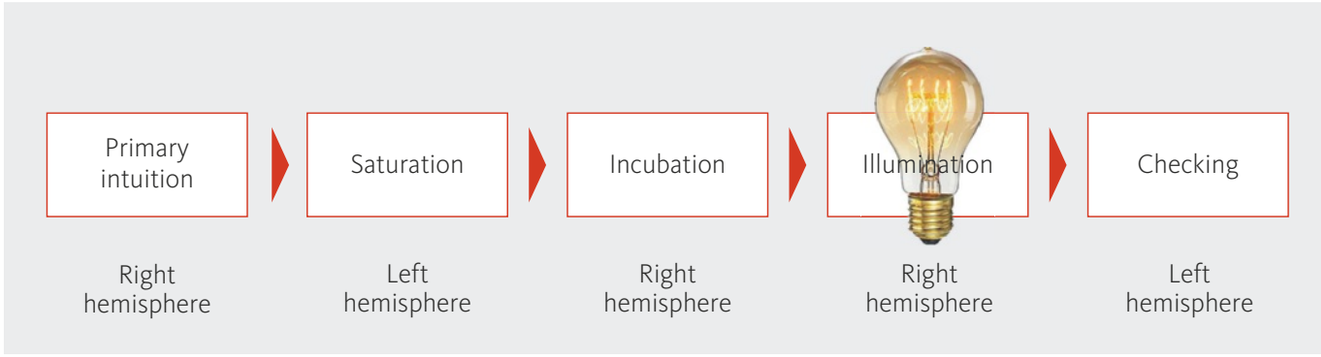


Fig 2-5 **The five phases of the creative process.**

Each of these steps, under the control of one or other of the cerebral hemispheres, can occur at different points in the process, unlike illumination, which appears suddenly as a "flash of genius." Primary intuition occurs spontaneously, saturation deepens knowledge, then comes a phase of stagnation called incubation; then comes the flash of illumination, followed by a feasibility check or checking phase. The balance between the two hemispheres leads us to acquire the capacity for global perception and to have the intuition of what is in tension and what is in balance in the analyzed form.

Mechanisms of perception

From vision to perception

It is common to believe that we see with our eyes; of course, the eyes are essential to vision, but how many of us, perhaps the majority, despite good eyesight, see so little, in the sense that they do not perceive what they are looking at. We could say that the eye/brain relationship is essential, but this is not entirely true because there are people with good eyesight and acute intelligence who, however, do not really see. What allows us to see is visual perception. The ability to view is a normal function that most of us possess; animals also watch and they are helped by their natural instinct to see in detail. Perception involves education, authentic individual training, similar to that of a pianist student at the music conservatory working on his notes and scales for many years. Sight and thought are not independent.

"Knowledge comes from perception."

Leonardo da Vinci

One could say "I see what I think," which is not a simplistic play on words but a real awareness of the eye/brain connection. If we look at a painting for the first time, we will have a global perception more or less rich in details but never a complete reflection of the reality of the canvas. This first pictorial impression will become a real knowledge when, in the course of the following glances, we enter into the structure of the painting (figures, background, dimensions of the masses, relations between the parts) under the light of our culture and our time. We often select mentally from what we see, what we are able to appreciate and understand, in a strongly subjective relationship to reality. This is why each observer can see different things in the same subject. The meaning changes if the mental attitude changes.

From perception to psychology

To understand what we see, we must also understand how we perceive it. This is the domain of the psychology of perception.[13] One of the many trends that have paved the way for the psychology of perception is the psychology of form (in German "Gestalt"). The Gestalt Theory[14,15] seeks to prove scientifically that human and animal psychic functions act according to a criterion of perception of the whole that is different from the sum of its parts. Perception is not a mental assembly of isolated sensations; the elements are immediately organized in our mind: in a concise and clear form. Applied to esthetic dentistry this means that teeth cannot be considered as isolated elements, but are part of a

whole integrated in the smile and its facial environment.[12] It is this awareness of perception that will allow the practitioner to progress in the art of composition.

According to Gestalt[14, 15] our way of observing can be divided into four phases:

1. Geometric objective visual perception
   We first see the teeth without analyzing their structure, considering them only from the intuitive geometrical point of view; we perceive each tooth with a precise physiognomy.
2. Psychosensory and psychoaffective perception
   Each of us sees teeth from a different point of view and with different emotions and states of mind. Therefore, some may like them and others may not, depending on personal taste and one's own culture of shapes and colors.
3. Overall topological perception
   We also see teeth in their context, which is linked to the mouth and face of the individuals with whom they form a whole.
4. Phenomenological perception
   We also look at the material they are made of and the details that characterize them.

Thus, when we see an object we always see it through these four interdependent filters of perception. This is called "synchronous development." It applies to the production of dental restorations, which will of course be subjected to these different modes of analysis.

Order, disorder, and balance

Although human perception involves several aspects such as color, form, movement, direction, dynamics, and vibrations, it is primarily the result of interactions, of guided tensions between the perceived elements. For example, for each spatial relationship between forms, there is a precise distance, intuitively decided by eye, which leads to a sense of calm and balance in the composition and dissipates tensions[16] (Fig 2-6).
Our visual attention is always focused on the center because the center is a zone of attraction or repulsion. In the center of everything, forces are in balance and are perceived as static, and visual tensions are reduced to a minimum (Fig 2-7). When we use the right hemisphere of the brain, the eye has the spontaneous ability to detect and analyze balance.

Apart from the geometrically regular shapes affordable by Euclidean mathematics, there is no computational system efficient enough to replace the intuitive sense of balance analysis of the human eye. In order to understand the complex forms of nature, one must use fractal mathematics(c) which studies the concept of order in disorder. Fractals are geometric figures characterized by the infinite repetition of the same pattern but with regressive scales. In nature, for example, the structures of cauliflower, broccoli, fern leaf, or the organization of clouds are found in fractals, but their mathematical definitions are still unclear. Fractal mathematics perfectly illustrates the human obsession with rationally analyzing everything around us, but also the inability to accept that balance and harmony can be precisely detected by perceptive intuition, whereas they cannot be perfectly set out in equations.

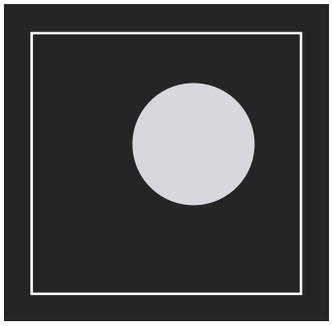


Fig 2-6 Perception and illusion related to visual tensions.

If we look at this white circle very briefly (a few fractions of seconds) by blinking, we have the sensation that it has reached the center. This is the proof that the mechanisms of perception have a tendency to transform the image in the direction of the lowest tension level.

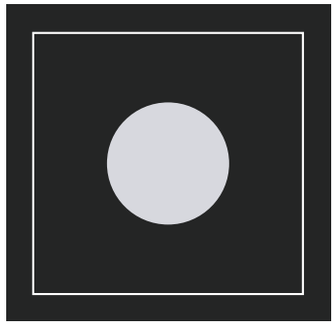


Fig 2-7 Perception and feeling of static balance.

In every spatial relationship of shapes to each other, there is a precise position where balance is achieved, here when the circle is perfectly in the center of the figure. The eye is soothed and appreciates it intuitively.

(c) A fractal figure is a mathematical object, such as a curve or a surface, whose repetitive structure is invariant by change of scale. The adjective "fractal," from which usage has imposed the noun, "a fractal," to designate a figure or equation of fractal geometry, is a neologism created by Benoît Mandelbrot in 1974, from the Latin root fractus, which means "broken" or "irregular" (Wikipedia source).

Art and dentistry

The smile plays a major role in the attractiveness of the face. In a person's overall perception, the smile accounts for 47%, eyes for 31%, perfume for 11%, clothes for 7%, and hair for only 4%. These data may surprise and confirm the fundamental role of the smile in the esthetic aspect. Restoring a harmonious smile is the most important element of rejuvenation. As such, the practitioner plays a much more effective role than most other specialists in esthetic medicine.

The determinants of perceptual weight

Weight and spatial depth

An important aspect of dentistry is the understanding of the concept of "perceptual weight." Depending on its visual impact, each form can be associated with a subjective weight that affects the perception of overall balance. Perceptual weight can be related to the notion of contrast and spatial depth. Some elements will capture visual attention through their spatial situations and contrasts, such as the eyes and mouth within the face.

Weight and color

A second important element in the perceptual weight of the elements of a face is the color dimension. White has more weight than any other color, which is why when the mouth is closed our attention is drawn to the eyes (white of the eyes), but when the person smiles the attention immediately shifts to the smile because the amount of white exposed there is greater (Figs 2-8a and 2-8b).

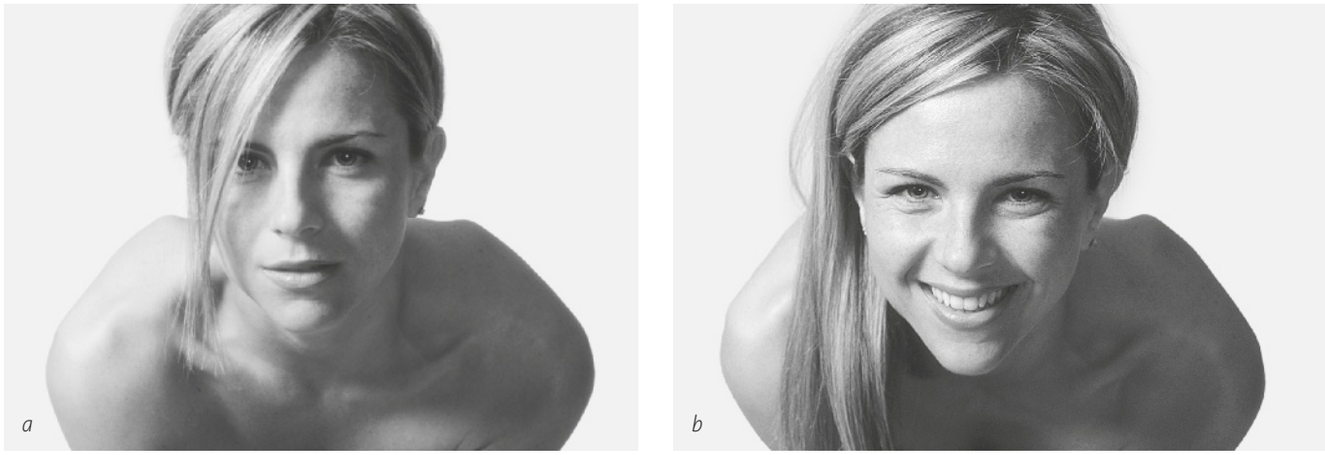


Fig 2-8 Visual weight, spatial depth, and color.

In this portrait, the elements that attract attention are those that create contrast and depth, in this case the mouth and eyes. Depending on the expression, visual attraction is focused on the eyes (a) or the mouth (b).

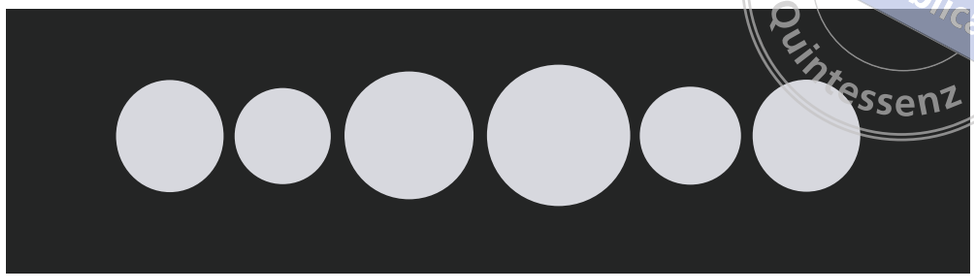


Fig 2-9 **Visual weight vs surface.**

The circles with the largest surface area, center circle on the right and then center circle on the left, require more visual attention than smaller circles.

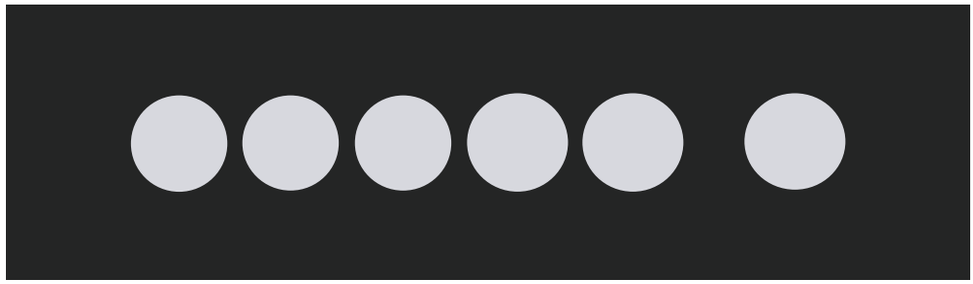


Fig 2-10 **Visual weight and isolation effect.**

The isolated circle on the right is the focus of attention.

Fig 2-11 **Visual weight and shape.**

(a) The two different shapes on the left have a lower visual weight than two identical circles on the right. (b, c) The asymmetrical left teeth (b) have a lower visual weight than the right teeth more present (c) and which then seem to project themselves forward.

Weight and surface

Another aspect of perceptual weight is the ability of the largest object (the one with the largest surface area) to attract more attention than smaller surrounding objects. Larger objects also appear more advanced through perspective (Fig 2-9).

Weight and isolation

The surface effect becomes inoperative when weighed against the isolation of an object, since the isolated object always has a strong visual attraction (Fig 2-10).

Weight and shape

Shape and contour affect perceptual weight. Thus, two adjacent shapes that are identical will exert greater attractiveness than two different adjacent shapes (Fig 2-11).

Weight and inversion

The lateralization of form (left or right) is another determining factor in perception. Anything to the right of the observed object (left for the observer) is perceived more acutely than anything to the left of the object (right for the observer). This aspect is of fundamental importance in the way in which we communicate with the patient. If the patient looks at himself in the mirror, he perceives an inverted image of his face in comparison to the face as perceived by his surroundings or the practitioner. We do not speak the same language because what is more present to us will be erased for the patient. This is why it is recommended to analyze the esthetic result on a photograph or on a computer screen. In this way, the practitioner and the patient will have the same perceptive point of view[16] (Fig 2-12).

Fig 2-12 Visual weight and inversion.

Note how the smile on the left (a), original, is more harmonious than the smile on the right which is its mirror image (b). By the mechanism of the perception of faces, the notch on the central incisor is less perceptible when it is on the left side of the patient's face and the disharmony of the temporary canine is accentuated when it is on the right side of the face.

Fig 2-13 Visual weight and arrangement.

(a) Note in the initial left smile how difficult it is to differentiate between lateral and central incisors.

(b) After treatment with ceramic veneers to rebalance the shapes, the nature of each tooth imposes itself on us.

Weight and layout

The arrangement of the objects is responsible for their apparent forms. It can influence the shape of an object (and thus its perceptual weight) in relation to those of neighboring objects. The identification of shape by the eye can become difficult if its apparent contours are strongly modified (Fig 2-13).

Weight and experience

Our history, and the knowledge we have already acquired, can influence our perception. The evaluation of the visual weights of objects can then be distorted by prejudices, beliefs, or sensory memorization of previous experiences (Fig 2-14).

Weight and centering

The centering effect through symmetrical and balanced shapes is probably one of the strongest visual effects. If the objects in the center of the composition are balanced with each other, they take up the visual attention. The overall composition will appear balanced, even if there are tensions and asymmetry in off-center areas (Figs 2-15 and 2-16).

Fig 2-14 Visual weight and acquired knowledge.

By observing these three different shapes we can think that an identical red square is hiding gradually behind a wall. Our experience can make us imagine situations that are not real.

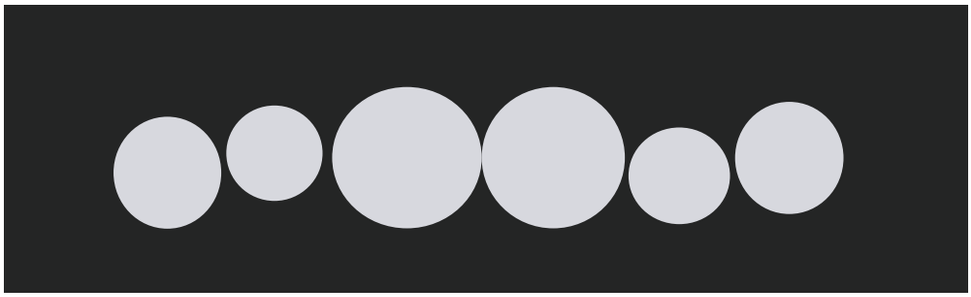


Fig 2-15 **Visual weight and centering.**

The two large and symmetrical middle circles impose balance on the entire composition. The asymmetry of the smaller lateral forms has little influence.

Fig 2-16 **Visual weight and centering in a restoration of central incisors.**

(a, b) Before treatment, the major dental axes of 11 and 21 are strongly deviated to the right, creating a clear imbalance.

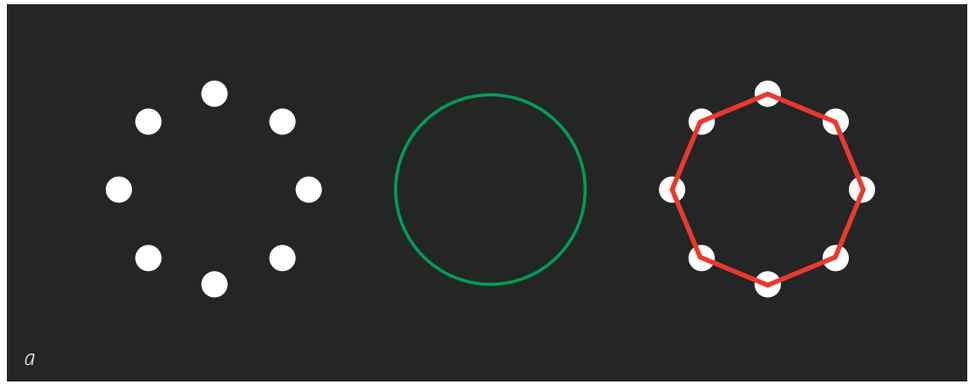
(c, d) After the completion of two veneers, the 11 and 21 are correctly centered with respect to the facial references. Their visual weight balances and illuminates the dental composition, the smile, and the face, without radically changing the expression of the patient.

Perception and simplification

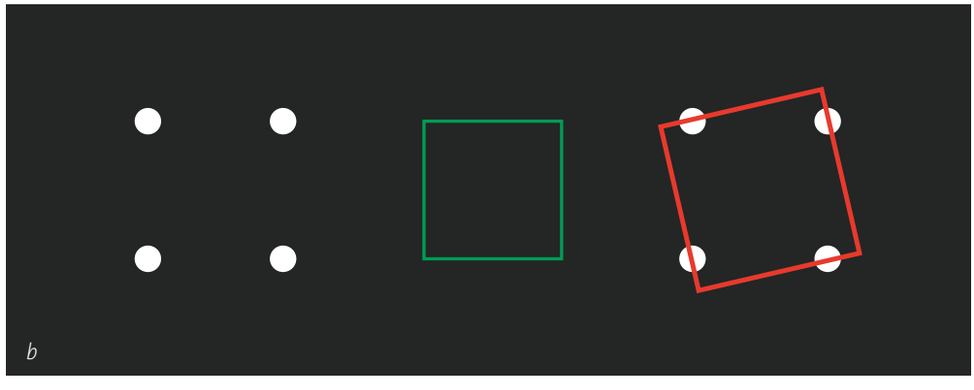
Another aspect that brings us back to the principle of minimalism is the innate capacity of the right brain to analyze and simplify complex forms. Our visual sense, which is in constant activity, tries to break down the image into simple shapes which it associates and combines until it finds meaning in the object being looked at. The interpretation of the form is always done by looking for the most logical and simple proposal according to the visual experiences acquired (Fig 2-17).

Fig 2-17 Simplification and illusion.

From several simple shapes, the brain creates fictitious lines according to principles of extension, closure, and symmetry. This phenomenon gives rise to illusions of "fictional figures" where we imagine a geometric figure, suggested by the union of simple shapes.



(a) When you look at these eight white spots, you immediately see a circle (green line). The octagon proposed on the right (red line) is not the first figure we imagine, because the brain is always looking for the most logical and simple solution.



(b) The observation of four white dots immediately suggests the fictitious figure of a square (green line) of which the four sides would connect the white spotlights. The figure of an offset square proposed on the right (red line) is a form that loses meaning in relation to the initial figure.

What is an artistic approach?

Artistic vision is required to perceive the entire area, not as the accumulation of isolated details but as an intelligent and sensitive construction between all the parts that compose it. We can make a comparison with a musician who has to compose a song. He does not put the notes one after the other in a haphazard way in the hope of creating a melody, but first he has the intuition of the melody, and then he writes the song. The same approach should apply to our dental treatment plans. First, we need to have a vision of the whole previewing the final result (complex overall goal), then we will break down the treatment into simple and partial steps (simple partial goals) that will lead to the final result.

The organization of a dental composition is a creative act based on the perception of variable and constant elements. In the construction of a smile the central incisors, lateral incisors, canines, and premolars each play a very precise role. They are involved in the overall composition of the anterior dental arch.[12,17,18] The proportions, size, shape, texture, and color of the anterior teeth must blend together in a harmonious blend to achieve a well-balanced smile. The concept of equilibrium is directly related to the concept of perceptual weight previously mentioned. It materializes in the clinical balance that is established at the level of the visible teeth, in relation to the horizontal and vertical references of the face. It is necessary to achieve an effect of stability and balance, without tension, with nothing more and nothing less than is strictly necessary[12,19] (Fig 2-18).

Finally, success is also closely linked to the synergy of investment with the laboratory. The indispensable minimum is to provide the dental technician with macro photography, videos, and various casts integrating the prosthetic set-up. This creates the optimal conditions for artistic prosthetic creations.

Fig 2-18 **Esthetic and psychological impact of anterior restorations.**

(a, b, c) In this patient, the initial condition shows significant of the maxillary (b) and mandibular (c) anterior teeth with a dull and saturated color, giving her an aged expression (a).

(d, e, f) Full rehabilitation is achieved using bonded ceramic restorations without preparations (additive veneers). The incisal line regains a marked convexity thanks to the lengthening of the incisal line made with maxillary veneers (e). In the mandible, veneers with overlapping incisal edges also improve proportions and dentogingival harmony (f). There is a clear rejuvenation of the facial expression (d) and a psychological fulfillment of the patient thanks to the application of the rules of natural and artistic esthetics mentioned in this chapter.

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Fusion

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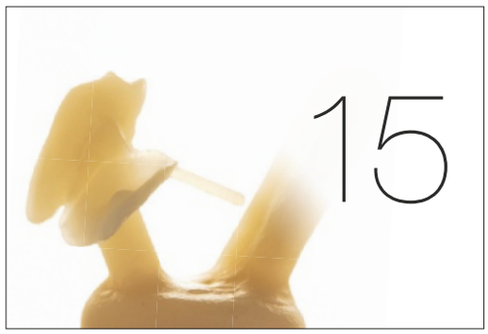

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The art of ceramic

After having revised the fundamentals of the esthetic in fixed prosthodontics, this second volume consists in a manual for learning the ceramic techniques. It is designed for both dentists and dental technicians since as a complementarity and most of all a continuity in the knowledge between the clinic and the laboratory should exist. The numerous methods described in this book are illustrated by numerous clinical examples permitting to apprehend the criteria for success in their application.

The clinicians can find here an update of the ceramic material, a large chapter of how to treat and bond different materials, followed by an arsenal of prosthetic techniques. Adhesive bridges in ceramic, Brabant-bridges, partial veneers, and laminate veneers, porcelain-fused-to-enamel (PFM) crowns, as well as protocols for full mouth rehabilitation by increasing the vertical dimension of occlusion. Each section finishes with a synthetic methodologic diagram.

The lab technicians can find here a detailed description of the traditional layering technique in order to avoid standardization when applying the ceramic powders. The techniques to obtain textures and treat the surface, key elements for achieving esthetic success are also explained in detail. For the lithium disilicate ceramic, where the optimal utilization necessitates a long learning curve, abundant information is provided regarding the precise technique and the appropriate choice of ingots according to the various clinical situations.

Throughout this book, the therapeutic gradient, the tissue economy, and the respect to the enamel within the fabrication of a bonded ceramic restoration (BCR), remain in the heart of the clinical imperatives. The provided knowledge is precise and evidence-based, supported by numerous scientific publications and literature reviews in order to protect a young clinician from the treachery attractiveness of the fashion trends that flourish in the esthetic dentistry. Indeed the “minimally invasive” dentistry is often misunderstood and can easily turn in a “maximum iatrogenic” dentistry!

Let us hope that this book will accompany our colleagues and our friends the dental technicians in their clinical and technical progression. Let us be creative in front of the protocols and the new materials where the indications are not always clearly defined.

The dentistry of tomorrow is yet to be invented.

Jean-François Lasserre

Fig 10-1 Traditional Benjarong ceramic in Thailand.

10

Art and technique

Conventional ceramics

Jean-Marc Chevallier
Jean-Philippe Pia
Jean-François Lasserre

The fabrication of conventional ceramic crowns on the front teeth, historically on metal alloys, has always been the work principally entrusted to the most experienced and talented dental technicians. They learned their skills as makers of plaster models, then as metallurgists, before handling ceramic materials.

Being able to mimic natural teeth in their optical and colored complexities through a skillful layering technique requires a long learning curve and a good talent for observation. The ceramist has to learn how to master a material that is extremely hard to handle.

This material is worked with a brush and a water-based paste whose esthetic outcome only appears after a long series of firing steps.

Good mastery of the layering technique gives rise to a subtle balance between the following characteristics: the value, the chroma, the range of hues and translucency that must lead to naturally "humble" restorations.

Part 1

Stained layering technique

While digital technology is more accurate, more reliable, and less time-consuming, in this context the role played by esthetics remains the Achilles heel of digital technology. Often there is a lack of value and fluorescence of the restorations especially for monolithic stained restorations. The cosmetic layering technique is still very popular for the most esthetic sectors in the mouth. A good experience of the layering technique on conventional ceramic material and an artistic sense are necessary assets for the making of ideally designed all-ceramic restorations.

Three esthetically essential items

Framework design

The design of the frameworks of crowns and bridges must reflect the precise specification which depends on the selected material (metal alloys or ceramic alloys of high grade) and which ensures a robust, functional, and esthetic outcome.

Fig 10-2 **The ceramist's toolkit.**

Crown frameworks

Generally speaking, for mechanical reasons, the thickness of frameworks of all-ceramic crowns and porcelain-fused to metal crowns (PFMs) must not be less than a minimum value that would otherwise be critical: 0.3 mm for non-precious alloys, 0.5 mm for precious alloys and 0.6 mm for zirconia and lithium disilicate glass-ceramic materials. Regarding the layering technique two notions are important: the space available for the cosmetic layers and the homothetic support of the framework.

In the esthetic areas in the mouth, there should be at least 1 mm of space available for the layering technique. Below this value, the cosmetic material will be optically influenced by the framework. In the occlusal areas more thickness is necessary namely about 1.5 mm between the framework and the occlusal contacts so as to reproduce cuspal morphologies that mimic natural teeth and to avoid chipping of the material.

The homothetic approach consists of fabricating a framework that fits with the prosthetic project and which keeps sufficient thickness for the cosmetic material between the outer part of the framework and the peripheral border.

Fig 10-3 The art of the layering technique of ceramic materials.
Having a good mastery of the layering technique is a prerequisite in order to make artificial teeth that are undetectable compared to natural teeth. In this case, four bonded ceramic restorations (BCRs) are made in the anterior region regardless of the presence of a complex situation due to the agenesis of the lateral incisor (laboratory work and photos: H and D Crescenzo, France).

The regularity of the thickness of the material allows a homogeneous resilience of the ceramic material on the framework and ensures good mechanical properties. In the presence of significant occlusal stress – bruxism, parafunctional habits, overbite, crowns placed on the second molars – tapered proximal supports have to be made on the framework in order to reinforce the ceramic material and avoid cosmetic material damage due to shearing.

It is understood that the notion of available space is essential in order to tackle the layering technique for esthetic crowns (Fig 10-3). This is the opposite of minimally invasive protocols or the «no prep» protocols currently used where stained monolithic ceramic materials techniques and cut-back techniques using increments of small thickness, are used. Consequently, the layering technique imposes conventional peripheral preparations that require much thickness for the materials being used.

Bridge frameworks

Regarding multiple-unit bridges, the type of material to be selected has to take account of the number of components to be replaced, the width of the pontics and the available prosthetic height. The available prosthetic height is impactful for the design of the proximal connectors between the abutments and the pontics. This is a fundamental point for the fabrication of bridge frameworks.

The precious or non-precious metal alloys make it possible to fabricate widespan bridges with several pontics. The accurate fit of these widespan frameworks has been considerably improved by computer-aided design and manufacturing (CAD/CAM) technology. Indeed, the problems due to the previous casting techniques that required the deformed frameworks caused by metalworking to be cut and welded, no longer arise. The surfaces recommended for the proximal connectors are about 6 mm^2 in the anterior region and 8 mm^2 in the posterior region.

"Demand a lot from yourself and expect little from others. That way you will be spared a lot of trouble."

Writings of Confucius

Regarding the zirconia frameworks, the proximal connectors need to be extended up to 9 mm^2 in the anterior region and 12 mm^2 in the posterior region so as to avoid breaking down the material at the connections. The good mechanical properties of zirconia and the precision fit guaranteed by the CAD/CAM technology make it possible to fabricate widespan bridges in the anterior and posterior regions. This is valid provided that the

patient does not suffer from muscle impairment (bruxism) because the chipping effect of the cosmetic material is more significant for zirconia frameworks compared to PFM restorations.

Regarding glass-ceramic frameworks that are reinforced with lithium disilicate – e.max Press or e.max CAD – the flexural strength of the material is much lower than that of zirconia (see Chapter 9). The risks of fracture are higher.[1] In this respect the manufacturer's instructions are very cautious.[2] Regarding the use of the e.max CAD material, the instructions recommend its application to three-unit bridges only (with only one pontic) up to the second premolar. The width of the pontic may range from 9 mm at the premolar level to 11 mm at the central incisor. The dimension of the connectors recommended for the pontics is 16 mm^2. Such a junction surface requires a very high prosthetic height to allow proximal dental hygiene. This choice might represent a contra indication for the selection of a ceramic framework reinforced with lithium disilicate.

Shape and texture

The shape is of paramount importance for the success of the esthetic outcome.[3] Success relies upon having a talent for observation of natural teeth and accurately reproducing the transition lines on teeth in addition to all the surface micro details. All this represents the texture.

Transition lines

At the dental laboratory the typology of the anterior teeth always includes the outline of the transition lines. Regarding the crowns, the transition lines determine the passage from labial walls to proximal walls of the teeth (Fig 10-4 a). They are always drawn by the dental technician with a red pencil on the reference teeth in addition to the bisque-baked crowns so as to guarantee the best symmetry (Fig 10-4 b,c). These lines are not clearly designed. Instead, they are blurred and progressive.[4] It is the reason why the dental technician O. Brix[5] has introduced the idea of a "transition area" and the "non-visible tooth wall." Indeed, he has described six axial walls instead of four. He has added the mesial labial wall and the distal labial wall, which are not visible.

The outlines that are drawn on the model are the best way to capture the transition areas, the curvatures, the well-rounded surfaces, and the vanishing sides on the crown contours. Labiolingually, the outlines are helpful to assess the depth of the interdental spaces and for the precision of location of the proximal contact surfaces. In summary, the dental technician should be able to "volumize" the whole architecture of the tooth to be replaced. In fact, the prosthetic outcome has to mimic nature from all angles.

Texture

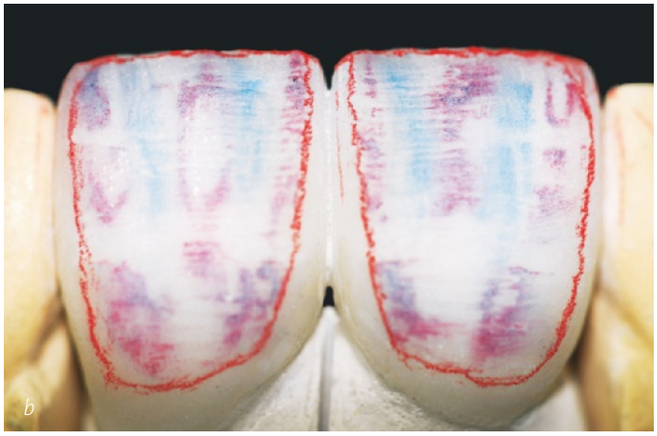
The texture is optically connected with the color. The texture can have an impact upon the color by modifying the phenomena of light absorption and light reflection on the surface. This finishing step is performed by means of special rotary instruments (see Chapter 11, part 1). For example, flame diamond burs, or sharp tips having the shape of a nose cone

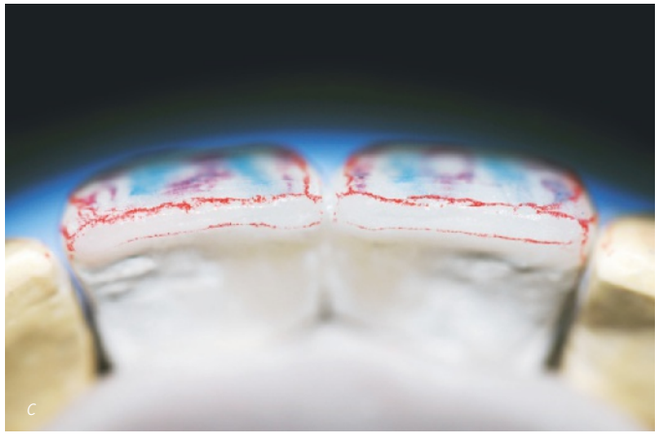
are used to create horizontal wavy effects, waves and fine grooves that recall the natural incremental growth lines of enamel (Fig 10-4b, c).

The «patina» finish is a surface finishing step that gives the ceramic material a matte, satin-like, and bright effect. Brightness may be the result of the final firing with the addition of the glaze material. Nevertheless, the satin-like effect is more appreciated with diamond polishers which enable the marked grooves to be blurred, then to enhance some well-rounded surfaces and some transition areas. The final polishing with a diamond paste gives a more natural aspect than that obtained with the glaze firing, which is brighter.

Fig 10-4 **Transition lines and texture.**

(a) Enhancement of a mesial transition area on the ceramic bisque of the central incisor.





(b, c) Outline of the transition lines with a red pencil on two feldspathic laminate veneers that are fabricated. The surface texture is visualized with colored carbon papers that display the irregularities and cavities on the ceramic bisque.

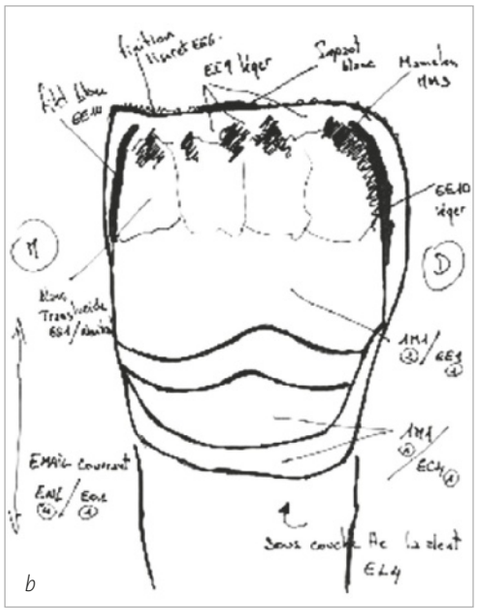
Color management

The dental technician's perspective

The way in which the color chart is sent to the dental laboratory has been described in Chapter 5. Regarding the layering technique, the identification of the tooth shade goes beyond the 3 D color mapping of the reference tooth namely the value, the chroma, and the range of hues as per the Munsell color system.[6] Regarding the art of ceramics that includes glassy materials and semi-translucent materials, there is another optical dimension that is essential for the shade profile, namely the dimension of translucency and opacity. Indeed, the shade of a ceramic material cannot be measured as for the even and opaque shade of the plane surface of objects such as car bodywork, wall paintings, and floor tiling. Regarding teeth, the complexity of their shade is that their buccal wall is convex and irregular. It is also heterogenous due to the various constituent tissues and has a semi-translucent surface with shaded effects that appear in depth.[7,8] The more opaque the material is, the more it returns light. And the more translucent the material is, the more it absorbs light and its value diminishes and it becomes more grayish. The natural central incisor displays both characteristics. It is both transparent and shaded at the incisal third and opaque with a high degree of light reflection in the dentin core.

For the dental technician there is another issue namely the management of the optical rendition of the shaded characterizations, such as the spots, the food infiltrations, and the high translucency of the incisal angles. In this case the dental technician should be precise, moderate, and parsimonious in his work especially for the effects that are highly translucid, highly chromatized, or opaque, otherwise the outcome might result in a caricature of the tooth.

Fig 10-5 **Creating the shades with ceramic powders.**



The conversion into a chart of powders

Most of the time the dental technician receives only the shade of the tooth identified by the prosthodontist as a reference to the shade guide. The most popular shade guide is the Classical Vita shade guide.[9] Sometimes this choice is completed with the colorimeter or spectrophotometer that are helpful objective instruments in resolving complex prosthetic cases.[10,11] Photographs taken at the dental office or at the dental laboratory are essential to have a good understanding of all the shade details and to have a precise idea of the characterizations. Photographs include: the facial view, the smile, and a focus upon two teeth.

This first step helps the dental technician in analyzing the colored composition of the tooth namely its value which is essential, tinges of shades that will help for the build-up of the tooth and for the cutback. Moreover, all this is helpful for the chromatic effects and characterizations on the surface of the tooth and the deep chromatic effects that appear on the whole surface or part of the surface of the tooth. The objective is to capture the right shades that will make it possible for the dental technician to select the right powders and mixtures related to the clinical case (Fig 10-5).

Color composition

Even though the outcome is clearly identified, dental technicians have to find and combine the right ceramic powders in order to reach the objective. This is one of the main issues for dental technicians. They have to transpose their analysis into the selection of dentin powders, cervical translucent powders, opalescent powders, transparent powders, different qualities of enamel materials, and alternate the firing steps until they get a ceramic crown that mimics nature.

Determination of the shades of frameworks

The identification of the shades of frameworks is foundational for the outcome.

- Regarding metal frameworks, the opaque layer should completely mask the metal material. For this reason, it has a covering function. Normally two firing steps are necessary in order to neutralize the gray effect of the alloy. The reflecting power of the opaque layer is extremely high. Consequently, it is impactful for the shade of the ceramic that covers it. Several types of opaquers can be used. If there is almost no thickness for the layering technique, from the beginning some areas can be stained with intensive opaquers.[12]
- Regarding zirconia frameworks, the staining process is performed with stains just after the milling process of TZP (tetragonal zirconia polycrystal) presintered zirconia discs or blocks and just before the sintering thermal treatment which gives the dimensions, the shades, and the final resilience of the material. Nowadays zirconia materials are available with various grades of translucency and chromaticity which makes it possible to avoid hand-made staining[13] (see Chapter 9).
- Regarding glass-ceramic frameworks, reinforced with lithium disilicate and concerning their fabrication either with the press set technique (eg.: e.max Press from Ivoclar) or with the CAD/CAM technique (eg.: e.max CAD from Ivoclar) there is a wide choice of

ingots or blocks. These blocks associate different levels of opacity, translucency, and chromaticity. The range of products is wide enough to satisfy all the clinical situations: for example, a deeply discolored stump for which the HO (high opacity) framework would fit; or a vital non-discolored stump for which the MO (medium opacity) or LT (low translucency) frameworks would be more appropriate.

Opacity versus translucency

Generally speaking, the first step of the layering technique consists of assessing the opacity of the selected framework. A high opacity is necessary in the buccal middle area in order to maintain a high degree of value. At the beginning of the layering process a much too high opacity is better than too much translucency that would decrease the brightness. Conversely the translucency effect should be emphasized on the cervical and incisal areas. In the cervical area translucency promotes the integration with the surrounding gingival tissues. In this case special powders such as the cervical powders, the margin powders, or the shoulder powders can be used. They are available with some ceramic kits or can be prepared and mixed directly according to the manufacturer's instructions.

Regarding the sub-surface and during the layering process, the emphasis is put on the translucency and transparency in order to create several stained effects in depth (Fig 10-6). The condition is that the reference natural tooth be characterized with such effects because sometimes natural teeth are very opaque.

Brightness

Regarding metal ceramic frameworks, the adjustment of the brightness has to be done at an early stage with the firing process of the opaque layer that has a high covering power.

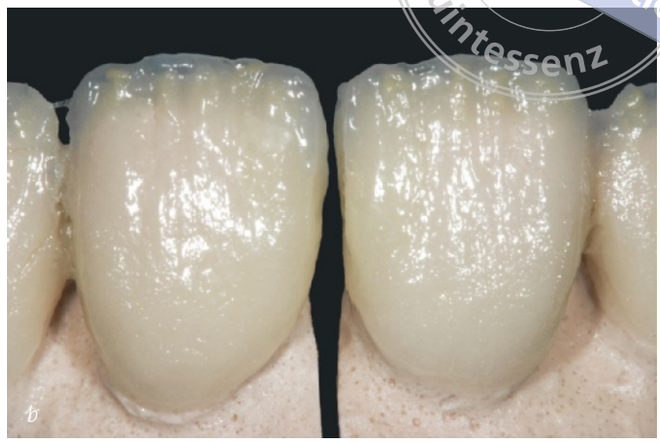
Regarding all-ceramic frameworks, the liners, the hyper fluorescent dentin powders, and the enamel powders make it possible to adjust the brightness. However, the value build-up has to be all in depth. The right choice of liners and dentin powders will guarantee the success of the value build-up. The liners are used as a sub-layer to partly or totally cover the all-ceramic framework. They are initially selected according to the value of the shade guide (Vita 3D Master). Several liners are fluorescent and make it possible to increase the value of the tooth like a natural light and to compensate for the absence of fluorescence of zirconia.

Recently all ceramics manufacturers have developed hyper fluorescent dentin powders. They have a high masking effect, and enable the value to be adjusted and the chromatic range selected at the beginning to be accentuated. At the cervical areas these powders promote the transmission of light toward the roots and avoid unsightly shade effects.

Finally enamel powders are of paramount importance since they help in adjusting the final value of the tooth while increasing or decreasing the opacity and the grayscale. The selection of enamel powders has a relative impact upon the bright effect of the incisal third in addition to the opaque or transparent rendition of the incisal edge. Some enamel powders like the Incisal, the Transparent, and the Edge materials have a high degree of opalescence. In other words, they create a light reflection within bluish wavelengths and an orange transmission of light like the optical properties of a natural tooth. These powders have a real impact upon the final value of the tooth build-up.

Fig 10-6 **Creation of translucent and transparent effects.**

(a) Layering process of feldspathic ceramics on refractory dies for the fabrication of BCRs.



(b) Following the firing process, appearance of the usual shrinkage of the feldspathic ceramic material about 15 to 20% of the volume. One can see the translucent glassy layer (TN = transparent neutral) that covers the tooth surface and whose objective is to diffuse light.

Glossary of ceramics

Sometimes the dental technician cannot do an excellent job due to some constraints. Indeed, the first problem is due to the fact that the dental technician does not have the opportunity to meet with the patient in order to proceed with the shade identification and to draw a color chart related to the ceramic powders. The second problem is the difficulty for the prosthodontist of communicating with the dental technician about the optical and ceramic effects to be obtained. Consequently, a common glossary of terms is absolutely necessary between the clinician and the dental technician.

Glossary of powders

Opaque powders or opaquers

Powder or paste opaquers are used for the metal ceramic technique. They have a high covering power in order to mask the metal material. They are used for the two firing processes: the first one is dedicated to the wash layer and the second one to the opaque layer.

Dentin or base dentin powders

The dentin powders provide the basic hue to the dentin core. Their sometimes, overmarked translucency necessitates an association with sub-layers that are more opaque and more stained.

Opaque dentin or deep dentin powders

These powders are more opaque than the conventional dentins. However, they are of the same shade. They are not automatically used but they can be used in order to capture the right rendition of the shade in the event of low available thickness.

Intensive powders

The INTENSIVE powders are fluorescent and deeply colored. They have the same physical properties as dentins. They are normally mixed with dentin powders in order to alter the shade. They can also be used alone to reproduce colored effects identified during the shade identification.

Underlayer (or liner) powders

These powders can replace the opaque dentin powders. They replace them advantageously to cover the frameworks. They are deeply fluorescent and provide a higher value during the layering process.

Transparent powders

These powders are as transparent as glass. They give relief to the prosthetic restorations. Whenever they are used alone, they increase the gray effect and reduce the value. Transparent dentins and enamels are available.

Translucent powders

Translucent powders have the same effect as airborne-particle-abraded glass. They diffract light and largely diffuse it while increasing the value. Due to their neutral aspect, they reduce the chroma of dentins. They have different shades – bluish, amber, brownish and orange, or white – and can be used for the chromatic characterizations of enamel or as enamel.

Opalescent powders

The opalescent powders interact with light in the same way as natural enamel. Whenever the light is transmitted, they provide an orange and amber effect. Whenever the light is reflected, the effect is bluish. The opalescent powders also increase the value of teeth. Their resilience is a little unstable after firing which might reduce the expected outcome.

Enamel or incisal powders

These powders are classified according to a decreasing order from the whitest to the grayest shades and present different opacities and hues. Regarding the layering technique, one can use up to six types of enamel powders. They are helpful in adjusting the value at the end of the layering process.

Stain or effect powders

These are intense stains that reproduce effects and natural characterizations on the surface or sub-surface. They can be fluorescent. The effect powders can be selected according to their optical behaviors as the opal effect or the pearl effect.

Glaze powders

This is a layer of transparent glass which is applied at the last firing process in order to block the ceramic porosities and to obtain a luster effect on the surface. Its melting temperature is lower than that of dentin and enamel powders.

Customized samples and conversion charts

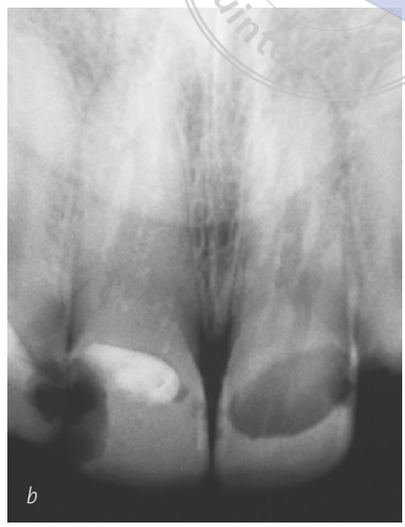
It is essential for the dental technician to have a better understanding of the ceramic powders and the firing parameters which have a direct impact upon the optical outcome after the firing process. In this respect the dental technician can fabricate customized samples by means of a special mold. Consequently, he obtains a customized shade guide of all the powders that are appropriate for the firing parameters. These customized samples of ceramic powders are a prerequisite which helps the dental technician to determine the expected effects in a more objective way.

The dental technicians who use several brands of powders sometimes for the same layering process have the possibility to use «conversion charts» recommended by the manufacturers with the following indications: the degree of opacity/translucency; the level of chroma and the range of hues. They are very useful in order to have a better understanding and to quickly identify the various powders to be used (Fig 10-7).

Name	Opacity	Level	Chroma Hue	Indication
EL2 Vita	8	2		Ivory mamelon liner
EC5 Vita	6	8		Orange intensive dentin
Sunset Dentsply	2	3		Amber translucent
Dentine 2R1,5 Vita	4	4		Dentin powder 2 R 1.5/A2
ST 35 GC	4	5		Yellow/orange shoulder or margin
EE10 Vita	2	3		Bluish translucent
EO2 Dentsply	3	1		White/amber opalescent
WS Dentsply	5	1		White opalescent translucent
Clear/Neutral Dentsply	1	0		Neutral
TC Dentsply	0	0		Super transparent
Power Chroma Dentsply	6	8		Orange fluo liner
Fluo Dentine 92 GC	8	5		Deep yellow fluo liner

Fig 10-7 **Example of a conversion chart for ceramic powders.**

Fig 10-8 **Esthetic rehabilitation of a clinical case for a patient having multiple caries.**



(a, b) The initial situation shows severe multiple caries (a). However, the central incisors (teeth 11 and 21) are still vital (b).

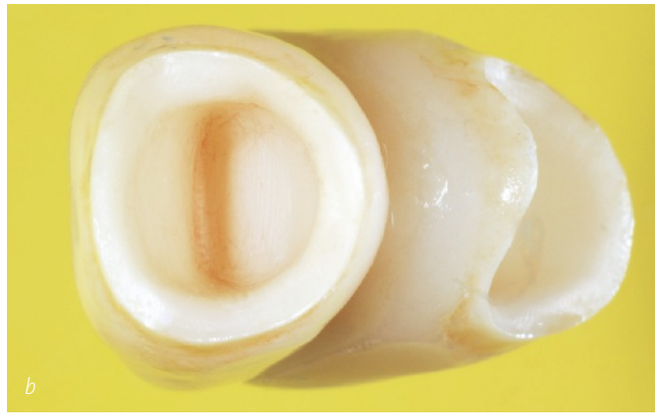
(c, d) All-ceramic crowns with subgingival margins are fitted on the maxillary central and lateral incisors and canines. The teeth are kept vital despite their severe initial conditions. The pulp chamber of tooth 22 has been removed. An inlay core which was made opaque after two firing processes was applied on tooth 22.

(e, f) The surface of the all-ceramic crowns is bright – Shade 1 M1 of the Vita 3D Master Shade guide – and has a young texture (e). The patient is happy again and displays a nice smile that looks sound and natural (f).

Clinical case

This young 26-year-old patient presents for an esthetic improvement of his teeth. He is affected with severe multiple caries of behavioral and dietary origins (Fig 10-8a, b). Following an emergency dental treatment, the root causes are analyzed. The prosthetic rehabilitation starts with the posterior region in order to stabilize the occlusion. Several implants are placed in the posterior region. All-ceramic crowns are fabricated for the maxillary anterior teeth while trying to keep them as vital as possible (Fig 10-8c–e). At the mandible, laminate veneers and all-ceramic crowns are applied on the central and lateral incisors in addition to the canines. The all-ceramic crowns are fitted on the most damaged teeth. The crowns are fitted on zirconia frameworks (Fig 10-9b) with the build-up of a thin cosmetic ceramic material – Vita VM9 (Fig 10-9c–h). With a thermal expansion coefficient (TEC) ranging from 8.8 to 9.2, the ceramic material is particularly well adapted to zirconia whose TEC is 10.5[(a)]. A ten-year follow-up confirms the clinical stabylity of the case (Fig 10-8e–f).

Fig 10-9 **(a, b) Layering process of the maxillary incisors.**



(a, b) The subgingival finishing lines leave some room for the ceramic material - about 1.5 mm – on the axial walls the irregularities correspond to areas of infiltrated dentin which have been cleaned and prepared (a). The zirconia frameworks are milled (b).

[(a)] The cosmetic ceramic material should have a thermal expansion coefficient (TEC) not higher than that of the framework material. During the cooling period the ceramic material fits with the thermal behaviour of the framework material while maintaining its cohesive bond with a slight tangential compressive constraint due to the low TEC difference between both materials. This is a constraining effect of the cosmetic material upon the framework. If the TEC difference is too high cracks will appear due to radial tensile effects (TEC of the cosmetic material much too high) or tangential compression (TEC of the cosmetic material much too low).

Fig 10-9 **(c–h) Layering process of the maxillary incisors.**

(c) Build-up of the VM 9 Base Dentin (1M1) totally covered with the Transparent Dentin VM9 with a cutback that leaves room for the enamel material.

(d) The VM9 Enamel is applied on the incisal third by alternating the deep effects with the Mamelon and Transparent powders. The Pearl Effect powders are added on the cusps and the crown is slightly over-contoured to compensate for the shrinkage after firing.

(e) The bisque-baked crowns after the first firing.

(f) Rectifications with the contribution of VM9 Base Dentin and Enamel.

(g) After the second firing the proximal contact surfaces are adjusted on the study cast.

(h) The last glaze firing process with the glaze material that highlights the surface texture and the effects of young enamel on the incisal edges.

Four layering biotypes

Dental technicians have produced many ceramic restorations and undertaken many assessments with the prosthodontists. It seems evident that some types of layering process are recurring. It is clear that a certain number of teeth cannot be classified. However apart from age, a new classification of teeth seems to be necessary. Each family or biotype can include teeth that are somewhat similar or different. Unclassifiable teeth are teeth that due to natural changes in their shape, hues or effects stand between two families.[14]

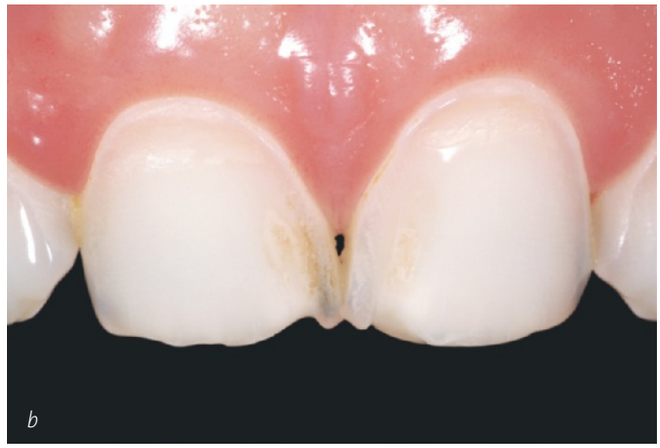
Such classification relies upon four distinct biotypes based on different layering processes, that are directly related to dentinogenesis and amelogenesis. Moreover, most of the natural teeth belong to such a classification. Superficial characterizations such as spots, cracks, and surface texture are not taken into account in the determination of the biotypes.

Age a relative criterion

Among the four biotypes, age is not taken into account even though it is considered as a common classifying criterion in order to customize artificial ceramic teeth – for example the Klaus Mutherties classification.[15] Obviously, age is an essential criterion which increases the chroma of the tooth, smudges away the texture, and changes the shape of the tooth due to wear. However, it is not uncommon to observe young patients who have worn teeth due to poor dietary habits or conversely old patients with teeth enamel that is almost pristine and with a young surface texture. In this respect age is a relative criterion (Fig 10-10).

Fig 10-10 **Which are the young teeth?**

(a) These central incisors which have maintained a marked texture and a bright surface are of an 80-year-old female patient.



(b) These central incisors have a totally sleek and mat surface in addition to a loss of volume. This young female patient is only 22 years old. The issue is that every day she eats raw lemon, which has caused severe wear of her teeth.

Classification of layering biotypes (Fig 10-11)

Biotypes are defined by five criteria:

1. Dentin core: hue, tinges, and value
2. Dentin surface of the incisal third: visibility and stains
3. Tooth enamel: whiteness, transparency, and opalescence
4. Enamel on proximal contacts: shade
5. Incisal edge: effects of white line, halo, or stains.

Layering criteria	Biotype 1 "Simple" 20%	Biotype 2 "Opal" 30%	Biotype 3 "Deep dentin" 40%	Biotype 4 "Two area" 10%
Dentin core	Single dentin more or less chromatized, with smooth and even gradation	Dentin of several shades with even gradation and without deep chromatized effects	Deep dentin with several shades with more or less chromatized effects	Dentin that's rather bright, even, and opaque in the cervical area
Dentin surface	Undetectable	Hardly detectable	Detectable with golden and amber effects on the cusps	Slightly detectable to highly detectable
Enamel	White with non-detectable transparency with simple gradation	Moderate transparency with marked incisal bluish opalescence	Marked transparency with mild opalescence	Grayish from brownish gray to amber-gray in the incisal area. Marked transparency or opalescence.
Enamel at the proximal contact points	White	Bluish	Bluish gray	Varying color
Incisal edge	Mild effects	Off-white or amber enamel line which emphasizes the incisal edge and angles	Gray amber halo	Multiple varying effects

Fig 10-11 **Classification of layering biotypes.**

Biotype 1: Simple

The enamel is conventional, without any particular effects and slightly white. The dentin has a smooth and even shade gradation and can be more or less chromatized (Fig 10-12). This biotype represents 20% of the central incisors.

Regarding biotype 1 layering process, a hyperfluorescent and chromatic liner or underlayer covers the zirconia framework. It allows adjustment of the range of hues, the chroma, and the adapted value. Then the layers are applied on the tooth up to its final volume thanks to the dentin powders. Then cutbacks are performed in order to leave some space for the enamel. A very thin layer of transparent is placed between the dentin and the enamel and creates slight deep effects. The incisal enamel has to be bright and semi-opaque. It is simply applied with increments on the whole surface of the tooth (Fig 10-13 and 10-14). This biotype is the one that is provided by manufacturers on their shade guides.

Fig 10-12 **Examples of biotype 1 "Simple."**

(a) One can appreciate the smooth effect of these two central incisors that are devoid of unsightly shade gradation and that are nicely bright with delicate incisal effects.

(b) Regardless of a marked texture and a high chroma these teeth belong to biotype 1. The cervical shade gradation is delicate. The opalescent translucency on the incisal edges is moderate.

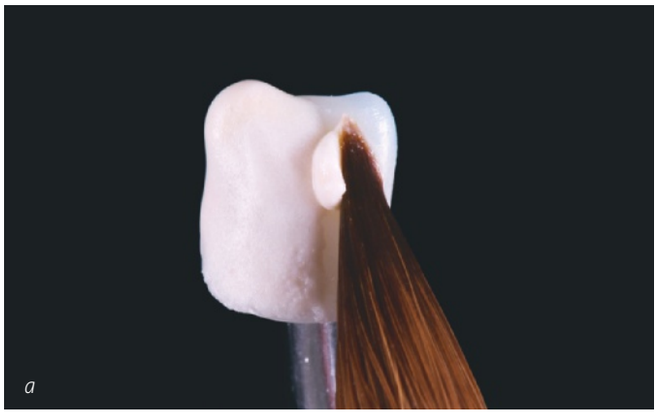
(c) These two central incisors have a high value with an even surface devoid of shade gradation. The only effect is on the opalescent incisal edge.

(d) The incisal edges of these aged central incisors are worn due to exogenous discolorations. The cervical recessions expose the yellow dentin. Due to its uniformity, this tooth belongs to biotype 1.

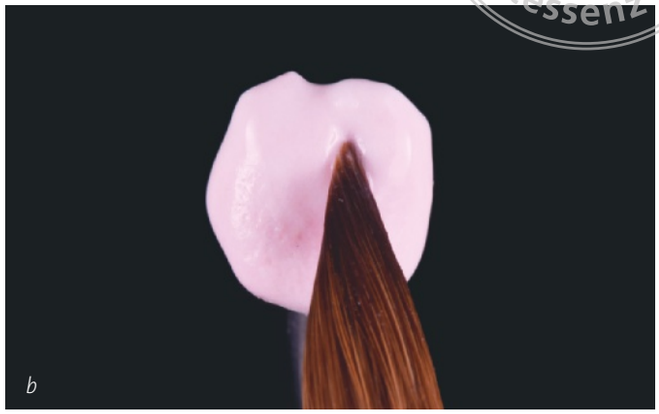
(e) The surface of these central incisors is bright and even with discrete effects on the incisal edges.

Fig 10-13 **Build-up of biotype 1.**

This is a simple build-up using four powders (Cercon Ceram Kiss Dentsly with a TEC of 9.2.)



(a) The framework is covered with the Power Chroma 3 liner (PC3) which provides fluorescence to the tooth.



(b) A single dentin – A2 shade – (DA2 Vita Classical shade guide) is applied up to the almost final volume of the tooth.

(c, d) Following the cutback, a thin layer of TC is applied on the mamelons and the incisal third so as to diffuse the light.

(e) A bright and high-coverage S1 or S2 enamel powder is gradually applied in order to finish the tooth morphology.

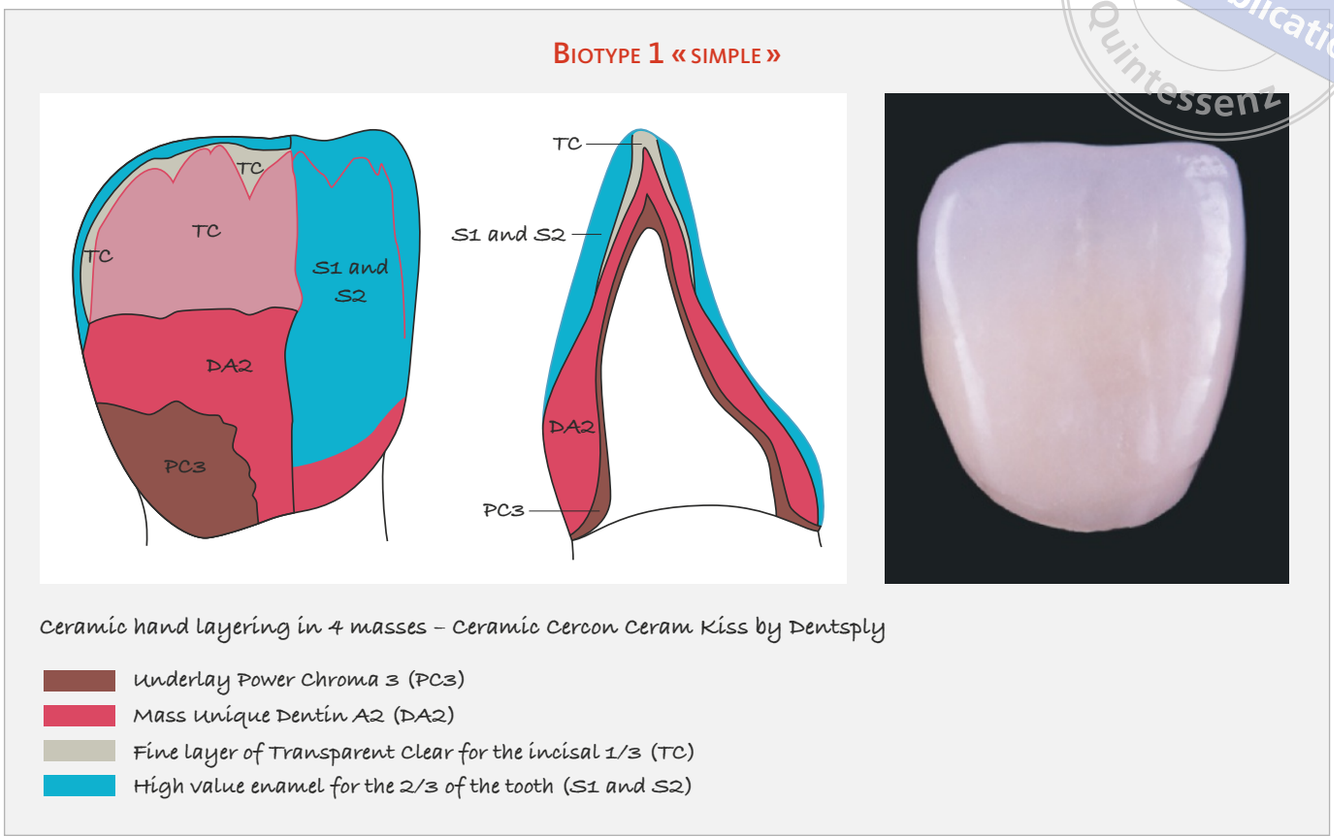


Fig 10-14 **Biotype 1 "Simple" layering technique.**

Biotype 2: Opal

The marked bluish opalescence of the enamel on the incisal edge is the main characteristic of Opal Biotype 2. Moreover, the enamel is sufficiently transparent or opalescent. The optical effect of a «white line» often appears on the edges and the incisal angles. The dentins are characterized by several shades. They display regular tinges with moderate deep and chromatic effects (Fig 10 -15). This biotype represents 30% of the color mapping on central incisors.

The layering process of this group is more complex. The fluorescent underlayer provides the initial range of hues that manages part of the value of the tooth. Several dentin powders with various hues and chromas are used – for example A3 with B2 and B1. They represent a set of cervical gradations which extend down to the fading dentin surface. The enamel creates opalescent effects among the proximal contacts via the incisal edge. At this point a transparent can be alternated with a bluish opalescent. The finishing step consists in a mixture of enamel and amber opalescent which emphasizes the off-white halo of the incisal edge made with the base dentin of the tooth (Fig 10-16 and 10-17).

Fig 10-15 **Examples of biotype 2 "Opal".**

(a) The bluish opalescence of the angles and incisal edges of these central incisors is noticeable. The dentin is characterized by beautiful gradations which end up on a clear dentin surface.

(b) The dentin tinges are highly chromatized. The dentin surface is clear and surrounded by a very opalescent incisal enamel. The effect of white line on the incisal edge is specific to biotype 2.

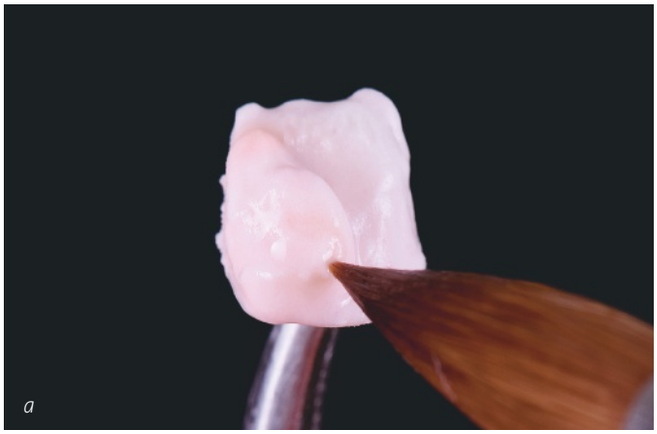
(c) These central incisors have a more grayish aspect. The dentin is sufficiently stained and the opalescent effect of the incisal edge is outstanding.

(d) These central incisors are very bright. The dentin tinges start with a bright hue and end up with clear mamelon effects. The enamel opalescence and the white line effects are outstanding.

(e) The dentin of these central incisors is even. The amber hue of the enamel creates a marked opalescence beyond the dentin cusps that are detectable here.

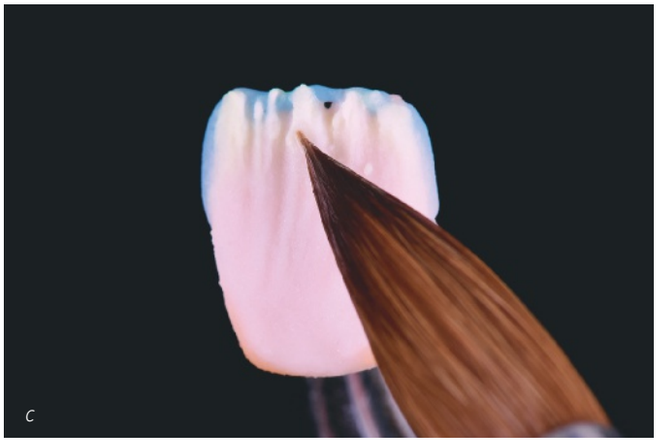
Fig 10-16 **Build-up of biotype 2.**

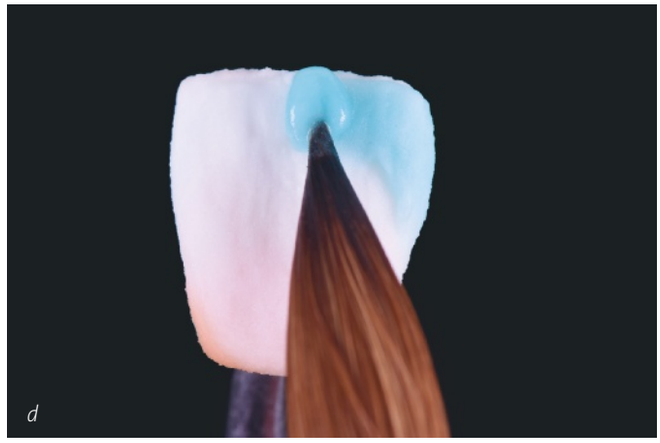
The build-up includes seven powders (Cercon Ceram Kiss Dentsply).



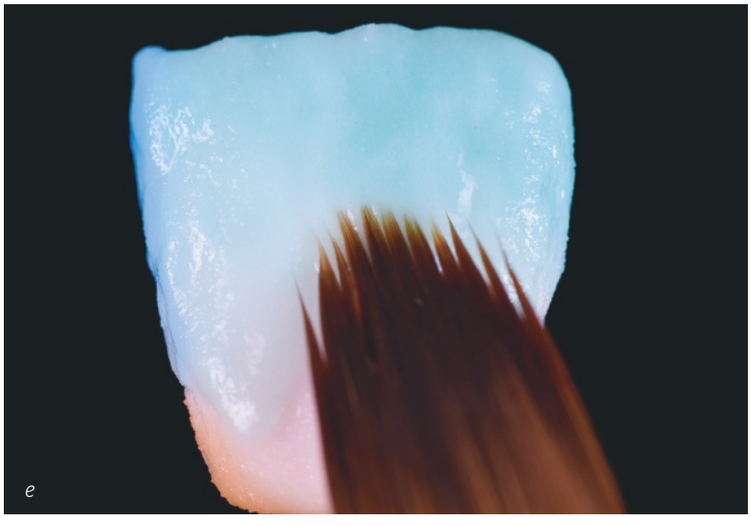
(a) The framework is covered with the Power Chroma 4 underlayer (PC4) that stretches up to the incisal edge. It promotes fluorescence and value.

(b) Two dentin powders DA3 (a) and DB1 (b) promote the chromatic effect and the cervical gradation of the dentin core. Then a cutback is performed on the powders.





(c, d) The complex incisal edge is layered. The Opal Effekt Ocean (OE Ocean) powders promote the bluish effect (c). Then some light effects on the cusps are alternated with the Shoulder 2 Powder (SM2) (c) with the TC (d).



(e) Enamel powders with amber opalescent (S2 + OS2) in a decreasing thickness starting from the incisal edge to finish the crown morphology and dentin A3 accentuates the off-white halo at the extreme edge.

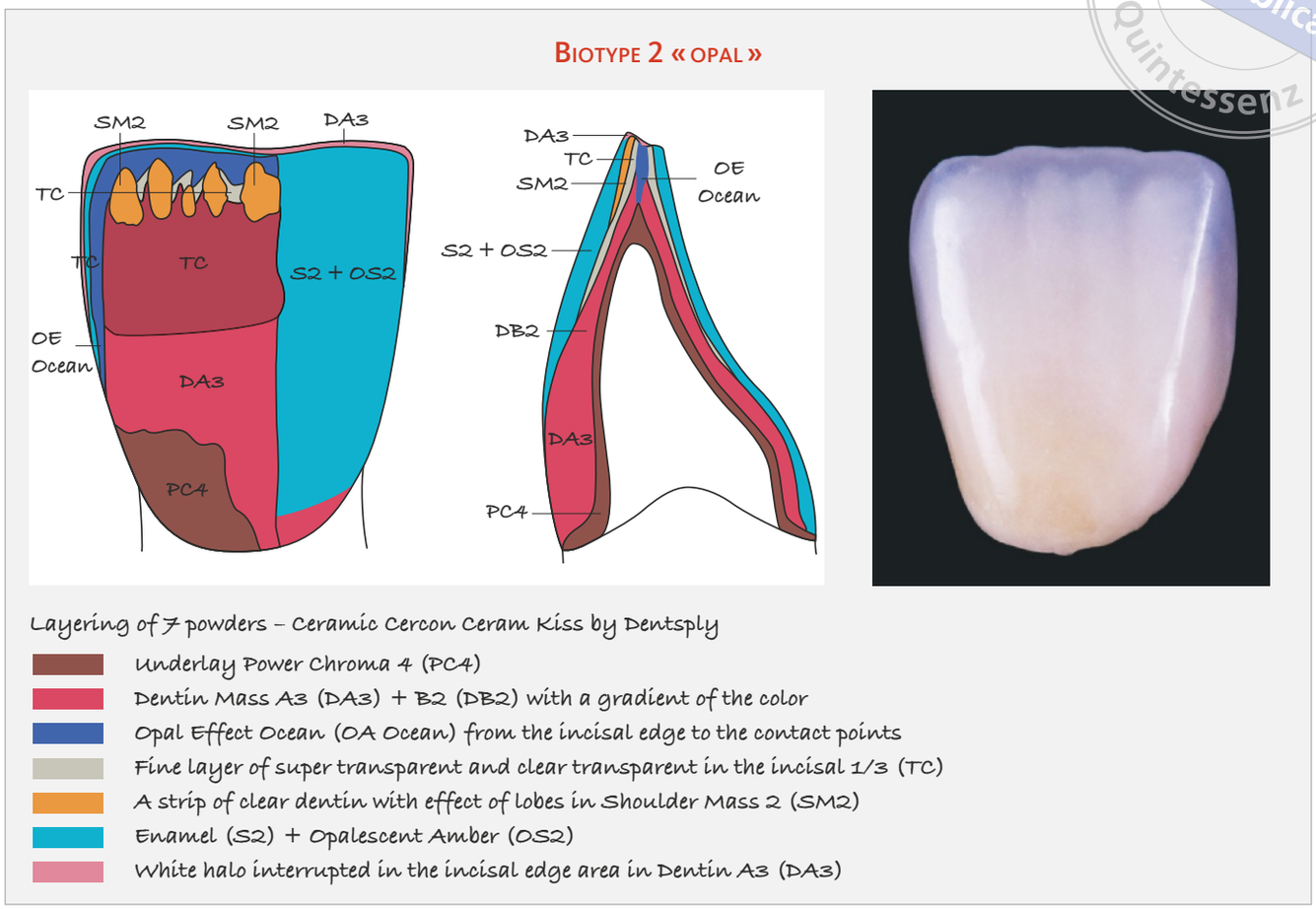


Fig 10-17 **Biotype 2 "Opal" layering technique.**

Biotype 3: Deep dentin

Teeth that pertain to this biotype are characterized by a deep dentin. The amber dentin surface is well detectable. The enamel is very transparent with or without a bluish effect and an amber halo appears on the contour of the incisal edge (Fig 10-18). Biotype 3 encompasses a majority of teeth observed, that is, about 40%.

This type of layering technique is complex and combines several internal effects. These deep effects are located in the dentin core and they also appear on the incisal edge. These effects are obtained by mixing a translucent cervical powder which is lightly stained with the dentin. On the incisal third the effects are obtained by covering the mamelons with a thin layer of transparent powder. It is the base for the amber dentin surface obtained by applying stained fluorescent powders. Once a small quantity of blue is applied on the contact points, the structure is covered with a layer of transparent and the cusps are marked again with the same stained fluorescent powder that has already been used. Finally, the structure is covered with a series of vertical increments of opalescent and transparent enamel (layering technique). The effect of depth on the well-rounded cervical area is finalized with the application of a cervical translucent powder. An equal mixture of dentin and amber cervical powder is applied on the incisal edge of the tooth in order to promote the halo effect (Fig 10-19 and 10-20).

Fig 10-18 **Examples of biotype 3 "Deep dentin".**

(a) Underneath a transparent enamel, the dentin of the central incisors is characterized by a specific depth and chromaticity. On the incisal third the effects of the amber dentin surface are outstanding. The incisal edge is deeply transparent with a beautiful pearly halo.

(b) Here the dentin gradation is brighter than that on the previous picture. Here there is a cervical pinkish glint. The incisal enamel which is very opalescent and amber gray with numerous effects covers the dentin surface.

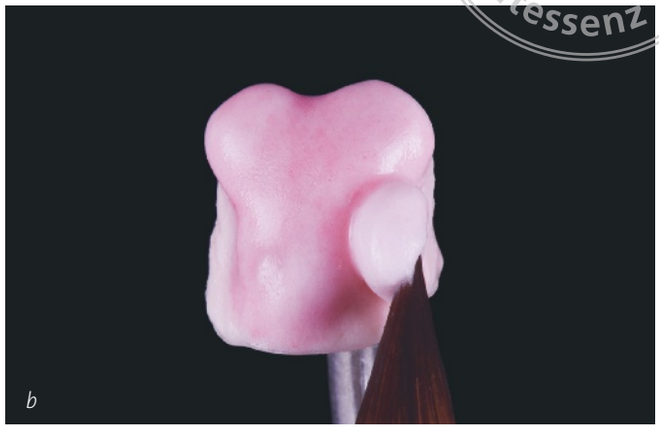
(c) Underneath the surface characterizations that are whitish one observes the dentin chromatic effects. The amber golden enamel has a bluish opalescence on the angles.

(d) These central incisors have very beautiful effects of dentin surface that are golden and orange on the incisal third. The effects alternate with amber transparent areas. The dentin which is highly chromatized is covered with a thick and translucent layer of enamel which decreases the value.

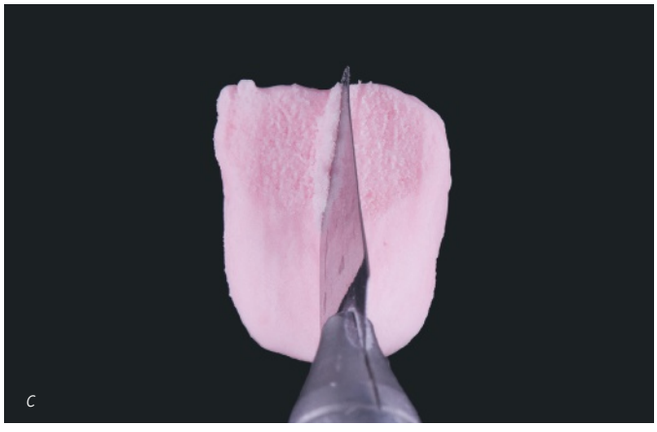
(e) These two central incisors are highly chromatized with a marked cervical gradation. The enamel hue is amber and creates opalescent effects on the angles.

Fig 10-19 **Build-up of biotype 3.**

The tooth build-up is composed of 11 powders (Cercon Ceram Kiss Dentsply).



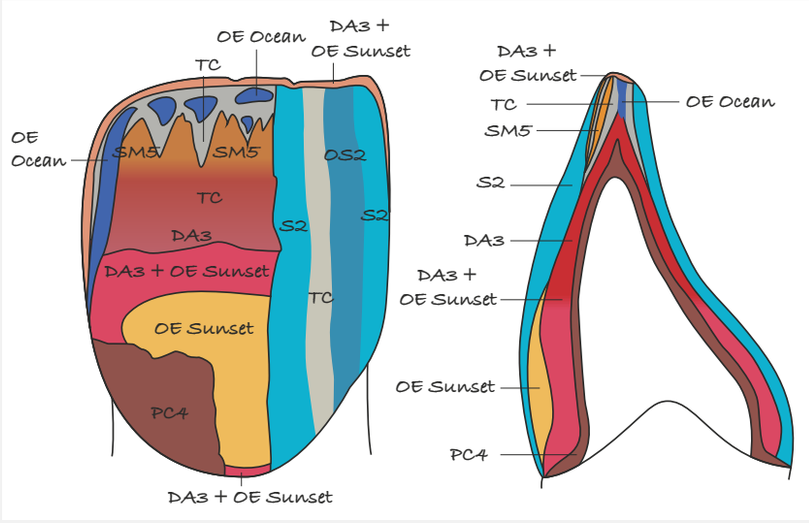
(a, b) Once the framework is covered with the Power Chroma 4 underlayer (PC4), the build-up consists in applying a mixture of Dentin A3 (DA3) with Opal Effekt Sunset (OE Sunset) (a). Starting from the incisal third, the pure dentin powder A3 (DA3) is applied in order to reinforce the chromatic effect (b).



(c, d) The cutback is performed to leave some space for the Transparent and enamel powders (c). On the incisal edge, powders of Opal Effekt Ocean (OE Ocean) promote the bluish effect. The effects on the cusps are followed by Shoulder Powder 4 (SM4) with the TC (d). On the cervical area the opalescent powder (OE Sunset) covers the first dentin layer in order to accentuate the hue (d).

(e) The final enamel layer is applied with a layering technique: by alternating the enamel powders (S2) with the amber opalescent (OS2) and TC. On the incisal edge, the halo is made with a mixture of Dentin A3 (DA3) with an Opalescent Effekt Sunset (OE Sunset).

Biotype 3 « Deep dentin »



Layering with 11 powders – Ceramic Cercon Ceram Kiss by Dentsply

- Underlay Power Chroma 4 (PC4)
- Dentin Mass A3 (DA3) and B2 (DB2) on top with color gradient
- Mass Dentin A3 (DA3) + Opal Effect Sunset (OE Sunset)
- Opal Effect Ocean (OE Ocean) from the incisal edge to the contact points
- Fine layer of Super Transparent and Transparent Clear on the incisal 1/3 (TC)
- Opal Effect Sunset (OE Sunset) presenting an opalescent cervical mass
- A strip of Dentin with effects for the lobes in shoulder mass 5 (SM5)
- Enamel (S2)
- Opalescent Amber (OS2)
- Transparent Clear (TC)
- Halo of finishing the incisal edge in Dentin A3 (DA3) + Opal Effect Sunset (OE Sunset)

Fig 10-20 **Biotype 3 "Deep dentin" layering technique.**

Biotype 4: Two-area

The biotype 4 teeth have much character and can be observed in about 10% of the patients. The rather opaque dentin is characterized by distinct values. The cutback is clear-cut and deep and creates two distinct layering areas. The contact point areas are rather bluish. The dentin surface which is highly stained goes down to the worn incisal edge. The enamel is very transparent with a low value. Its aspect is gray, brownish gray, or amber gray with sometimes the appearance of cracks on the enamel (Fig 10-21).

The layering technique is complex. It is characterized by a chromatic underlayer split into two parts. The first part which is less stained and brighter is located in the cervical area of the crown. The second part which is more stained is located on the incisal edge. It is necessary to take account of the different values of these two areas from the beginning of the tooth build-up. Both areas are covered with several layers of dentin, which are more opaque and brighter in the cervical area and darker and more stained on the incisal third. A deep cut is performed on the incisal part and leaves much space for the enamel effects. The different effects of the dentin surface which are amber or gray are laid in depth on the cut area after the cut area is covered with a thin layer of Transparent Clear (TC). They possibly appear on the worn incisal edge. The incisal edge is covered or partly covered with a mixture of TC and bluish Opalescent Effekt (OE Ocean) which goes down to the middle of the tooth. The effects of the dentin surface are covered with an enamel of low value which is gray, brownish gray, or amber gray. The enamel is made out of three mixtures of powders which are vertically incremented as per the layering technique. It is usual for the enamel to have cracks. These cracks are reproduced with stains in an alternating way. Then the paste build-up is completed with an amber halo on the contour of the labial incisal edge (Figs 10-22 and 10-23).

Fig 10-21 **Example of biotype 4 "two-area."**

(a) The dentin of these two central incisors shows two distinct stained areas. The cervical half of the tooth is bright while the incisal part is amber gray. The effects are subtle with a dentin surface alternating from yellow to opalescent gray.

(b) The different shades that appear on these eroded central incisors are outstanding. The cervical area is very bright while the incisal part is deeply stained and yellow especially on the worn incisal edges.

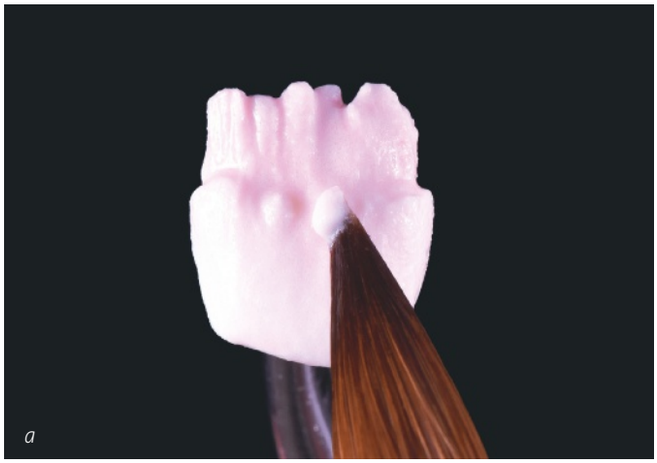
(c) Teeth with a marked surface texture have a distinct colored separation on the incisal third. The central and cervical areas are very bright. The incisal third is composed of a complexity of highly chromatized stains, transparencies, opalescence, and effects on the dentin surfaces.

(d) These central incisors are discolored due to the tetracyclines. The orange and bright cervical areas contrast with the enamel of the incisal third which is gray and rather opaque.

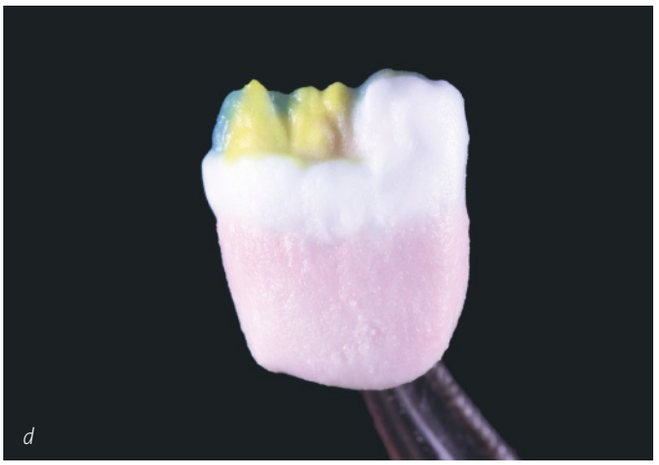
(e) On these incisors there is a clear-cut separation between the bright cervical dentin gradation and the dentin core which is rather bright with the complex effects of the incisal areas that are opaque white, orange, transparent, and opalescent.

Fig 10-22 **Buid-up of biotype 4.**

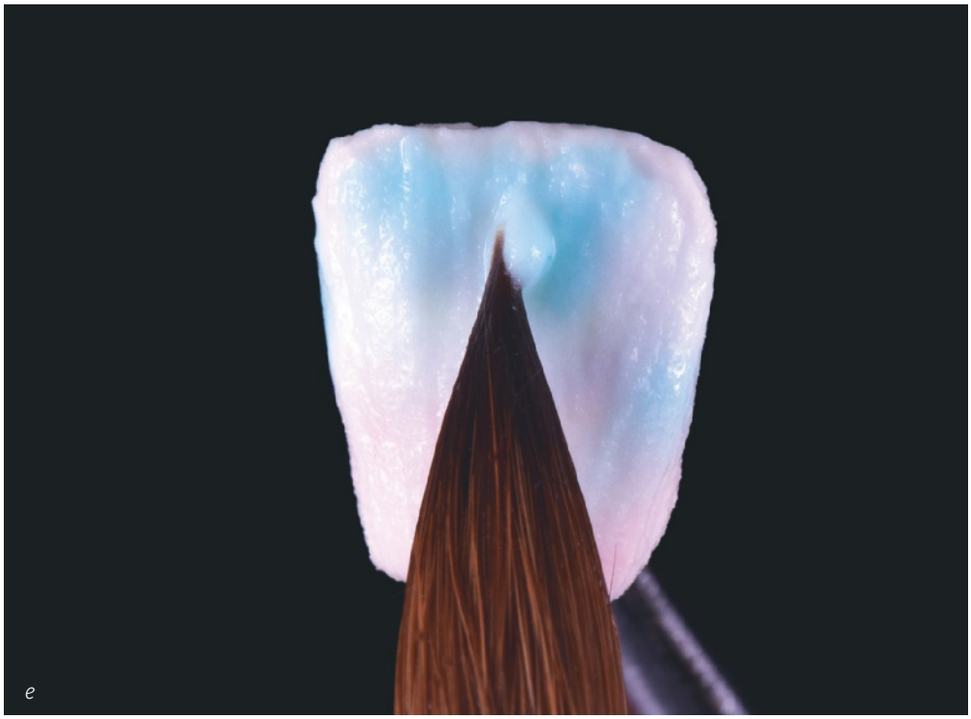
The tooth build-up is performed with 13 powders (Cercon Ceram Kiss Dentsply).



(a, b) The zirconia framework is covered with the Power Chroma 2 underlayer (PC2) at the bottom of the tooth. The chromatized Power Chroma 3 underlayer (PC3) is applied on the incisal half. A rather opaque dentin powder composed of a mixture of dentin A2 (DA2) and Shoulder Powder 1 (SM1) is applied on the well-rounded cervical area (a). Following a marked cutback more chromatized dentin powders composed of a mixture of Dentin A (DA3) and Shoulder Powder (SM3) are applied on the incisal third (b).

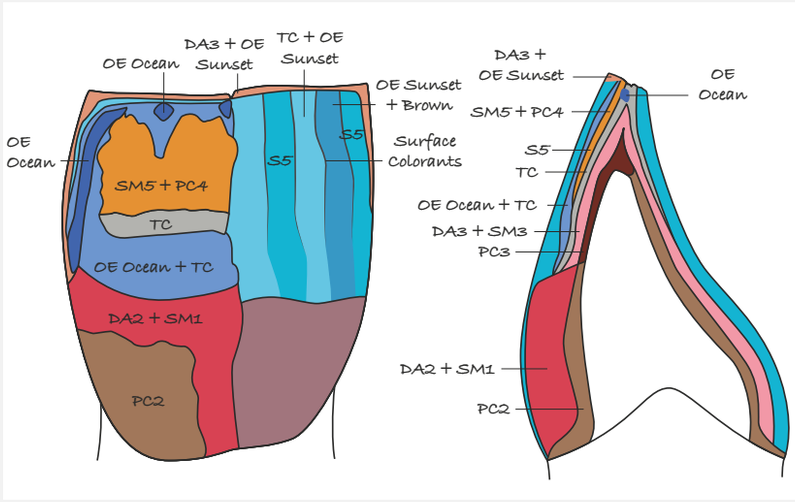


(c, d) The complex layering process of the incisal area includes the blue opalescent on the proximal contact points (OE Ocean), TC, intense effects of dentin surface obtained with a mixture of Shoulder Powder 5 (SM5) and Powder Chroma 4 (PC4) (c). The build-up is covered with a thin layer of Opal Effect Ocean powder (OE Ocean) and TC. Then the enamel powder is layered with powders of gray enamel (S5), Opalescent Effekt Sunset powders (OE Sunset) mixed with TC, Opalescent Effect Sunset (OE Sunset) and a light brown surface stain (d). On the incisal edge powders of Opal Effect Ocean (OE Ocean) give a bluish effect. The cusp effects are obtained with Shoulder Powders 4 (SM 4) mixed with TC. On the cervical part the opalescent powder (OE Sunset) covers the first layers of dentin in order to provide a deep effect to the shade (d).



(e) The final layer can include several surface stains (white, yellow, brown) in order to obtain the effect of stained cracks in the transparent enamel.
Finally on the incisal edge the halo effect is made with a mixture of dentin A3 (DA3) and the Opalescent Effect Sunset powder (OE Sunset).

Biotype 4 « The two-area »



Layering in 13 powders Ceramic Cercon Ceram Kiss by Dentsply

- Underlay Power Chroma 2 (PC2)
- Underlay Power Chroma 3 (PC3)
- Dentin Mass A2 (DA2) + Shoulder Mass 1 (SM1) to increase the value
- Dentin Mass A3 (DA3) + Shoulder Mass3 (SM3) to increase the saturation
- Opal effect Ocean (OE Ocean)
- Fine layer of super transparent + Transparent Clear for the incisal 1/3 (TC)
- A strip of Dentin with an effect of lobes supported by Shoulder Mass5 (SM5) + Power Chroma 4 (PC4)
- Opal Effect Ocean (OE Ocean) + Transparent Clear (TC) surrounding the dentin strip
- Gray Enamel (S5)
- OE Sunset (OE Sunset) + delicate brown staining
- Transparent Clear (TC) + OE Sunset (OE Sunset)
- Halo for finishing the incisal edge in Dentin A3 (DA3) + Opal Effect Sunset (OE Sunset)
- Surface colorants to mimic cracks

Fig 10-23 **Biotype 4 "The two-area" layering technique.**

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