Incorporation of third dimension with video dynamics in digital smile analysis & designing: A review.

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Abstract
Smile designing is one of the most challenging at the same time rewarding treatment concepts of esthetic dentistry. From drawing lines on two dimensional photographs to evolution of smile design software and CAD-CAM technology, this concept has come a long way in realizing that perfect smile. Digital smile design protocol takes into account hard and soft tissue perception from a three dimensional aspect by utilizing videography. Consecutively this data is uploaded to the smile design software. This data along with photographs of face and oral tissues obtained from different angles helps in conceptualizing a realistic smile development protocol in conformity with the patient's facial form, age, gender and personality. This not only helps the patient to visualize the final results but also helps smooth communication between clinician and laboratory technician. Documentation of the entire process also helps in future referencing. In this review article, an attempt has been made to introduce the concept of digital smile designing, various steps that are followed during digital smile formulations and its implications in improving patient-clinician-technician communication to achieve predictable and superior esthetic outcome.

Keyword: Digital smile, smile designing, digital ruler, visagism, vitruvian third

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Email address: adrita.rc@gmail.com **Phone no:** 8017014590. **DOI:** 10.5281/zenodo.5202831
Submitted: 27-Jul-2021 **Revised**: 4-Aug-2021 **Accepted:** 7-Aug-2021 **Published:**15-Aug-2021

Introduction

An esthetic smile is a harmony between the visible portion of the teeth and dynamic interplay of gingiva, lip balance and perioral musculature.[1-4] A beautiful smile enhances the confidence of an individual in the society. Over decades of research and quality practice, dental surgeon have improvised smile designing to strike a balance between aesthetics and harmony.[5] Photography has long been used as a standard for perceiving the status of the present dental condition.[6-10] Significant minute details are lost in the process of conversion of two-dimensional image to reality due to the static nature of the images. Smile designing with three-dimensional digital smile analysis improves the diagnostic vision of the dental surgeon and achieves predictability, thus enhancing the communication between the dental surgeon and their patients.[11,12] A three-dimensional imaging system comprises of photographs from different angles as well as video of the resting and smiling face.[4] The software available for digital smile designing allows superimposition of desired shape of teeth, simulation of teeth size, shade and documentation of the process including prediction of the design outcome.[13]

A brief history on the evolution of digital smile designing

Esthetic dentistry was recognized as separate discipline of knowledge in 18th century. Pierre Fauchard (1679-1761), French

physician also known as the Father of dentistry in his first scientific writing on dentistry 'The Surgeon Dentist' gave the concept of aesthetics as a separate consideration in dentistry.[14] 19th and 20th century saw a gradual and progressive improvisation in dentistry with the use of acrylic and ceramic.[15] A revolutionary change in the field of esthetic dentistry started with the introduction of 'Hollywood Smile', a concept of modern day laminates and veneers by Pincus in the year 1930.[16,17] Smile designing became a highly demanded restorative procedure henceforth. Over a period of past two decades various methods of smile designing have developed which started with drawing over photos with no connection to the analogue model.[18] This was followed by digital 2-D drawings and visual connection to the analogue model such as PowerPoint. Three dimensional wax-up evolved next succeeded by complete 3-D workflow.[18] The final concept was 4th dimension where motion/video was introduced to the existing workflow which brought a paradigm shift in digital dentistry.[18]

Understanding the need of DSD over 2-d smile designing

Digital smile designing (DSD) scrutinizes and preserves detailed documentation of facial and dental features, which is often overlooked in a photographic record.[10] It simplifies the communication between the patients and the dental team.[19, 20-22] A sense of depth can be appreciated in a video, with the advantage of freezing each moment for the purpose of analyzing the related structures like dental midline, interpupillary line, smile line, inter-commissural lines, buccal triangle, and gingival display (Fig 3b).[18] Addition and alteration of data during the diagnostic and treatment phases is an advantage over two-dimensional smile designing.

The success of a smile designing with the help of DSD is dependent on [23]

1. Diagnosis of the smile and determining steps for enhancing its aesthetics

2. Two way communication between the Dental surgeon/Technician and the patient

3. Feedback from the patient after temporization

4. An Education tool

1. Diagnosis

The chief complain of the patient reveals his or her expectation and helps the identification of unrealistic goals and non-requirement of any smile alteration and exclusion of such cases.[24,25]

2. Communication

A DSD encourages patients' active participation during the designing and customization of the smile according to his needs and desires.[24,25] This grants a positive psychological reinforcement and increases their confidence in acceptance of the predetermined treatment outcome.[11,12,.24,25,57]

3. Feedback

DSD provides a vivid documentation of the sequence of treatment registered on slides with illustrative information like photographs, video, notes, graphics and sketches. The ability to change the size, form, shape, shade and arrangement of the teeth according to the patient's acceptance, helps in receiving feedback from the patient at the end of each procedure.[24,25] The available feedback and privilege to use digital ruler and reference lines, the communication becomes easy between the dental surgeon and the technician.[18, 26-29]

4. An education tool

DSD is a tool which allows the problem associated with each case to be recorded and super imposing the same over the patient's original photograph.[20] This helps in differentiating between types of smiles and selecting the one which will be the best suited for individual cases.[30]

Requirement for DSD[20]

1. DST software
2. A digital SLR camera or a smart phone
3. A digital intraoral scanner for digital impression
4. A 3-D printer and CAD-CAM additional tools for complete digital 3-D workflow
5. Accurate photographic documentation is essential
6. A video documentation is required for dynamic analysis of teeth, lips and face during smiling laughing and talking.

Flowchart for the steps deciding the DSD [19,20]

Digital smile designing requires keynote software like Keynote (iWork), Microsoft PowerPoint to redesign the smile.

Two dimensional photographic views from three directions are necessary:

1. Full face with a wide smile and the teeth apart

2. Full face at rest

3. Retracted view of the full maxillary arch with teeth apart.

(Use of DSLR with 100 macro lens is recommended to avoid distortion and encourage reliability of the quality of the photograph.)

A short video is also recommended [18-20]

The smile and the orientation of the facial musculature of the patient needs to be depicted with a short video. Utmost care is taken while making the video of the patient so that the patient speaks spontaneously without being conscious that a video on purpose is being recorded. The best way to achieve this is by prompting the patient to explain his or her treatment concerns and expectations. This promotes documentation of the concern of the patient as well as the simultaneous facial movement and the smile.

Videography protocol [18-22, 31-33]

According to Coachman during videography should be framed from a distance of 1 meter

1. A facial frontal video with retractor and without retractor smile

2. A facial profile video with lip at rest and wide E smile

3. At 12 o'clock video above the head that allows visualization of the incisal edge.

4. And anterior occlusion video to record maxillary teeth with visibility of first quadrant second premolar to second quadrant second premolar.

5. Oblique view of videography which allows clinician to observe detailed smile characteristics. (Fig 4a,4b)

Rationale behind using Video dynamics[31-33]

Gender and age are the two ruling factors determining the redesigning of a smile, a concept first given by Frush and Fisher. A static two dimensional image may not do justice to the entire smile designing as the third dimension of the sense of depth and motion are lacking. A videographic depiction of a smile reveals minute details at any moments within the recorded frame of time

(30 frames in one second) along with the provision of playback and pause.[18-20] An original research by **Chetan et al in 2013**[34] noted that all dynamic measurements while redesigning a smile (upper lip length, upper lip thickness, and commissural height, inter-commissural width at rest and at smiling position) decreases with advancing age in both males and females. The upper lip length and the commissure height decreased significantly in the males where as it was not statistically significant in the females. On the other hand the inter-commissural width decreased significantly among the women under review.

Another study by **Tarantili et al in 2004**[35] revealed the dynamic nature of a spontaneous smile from a child's reaction to a source of stimulus that was funny. A genuine smile comprises of three phases: the initial attack phase, the sustaining phase and a fade-out phase. Attack phase being the shortest (less than half a second), sustained phase being the longest and may bridge two consecutive smiles. Its duration varies. Fade away phase is often masked by the initiation of another smile. The longest duration of the sustainable phase of the smile gives a window of time frame in which all the facial features like lip length, gingival display, intercommisural width, commissural heights can be carefully noted and incorporated in the future smile.

DSD workflow then proceeds as follows [18-22] (Table 1)

1. **The Cross (created by intersection of a vertical and one horizontal line)**

Two lines must be placed in the center of the slide forming the cross (Fig 1a, 1b). The Facial photograph with the teeth apart should be positioned behind these lines.

2. **The digital Facebow (Fig 1a)**

A facebow is actually a caliper like device that orients the maxilla to the spatial relation with the help of certain reference lines. The idea of a Digital facebow is to relate the full facial smile to that of certain reference points like

1. Inter-pupillary line (first horizontal reference line)

2. Facial midline (first vertical reference line)

3. A line running tangentially along the lower border of the central incisors

4. Curvature of the lower lip while smiling

Determining the horizontal and vertical reference lines along the various parts of the face is necessary for entire facial analysis.

The horizontal lines [26-29,36,37]

1. Inter-pupillary line

2. Inter- alar distance

3. Horizontal lines passing through Trichion (Tr), Glabella (Gl), Subnasale (subN) and Menton (Me) divides the face into three parts. A face is considered in harmony and esthetics when all the three parts are near to the golden ratio of 1.618.[38] (Fig 2a)

The vertical lines [26-29,36,37] (Fig 2b)

Postaurale right (R1)- Exocanthion right (R2)

Exocanthion right (R2)- Endocanthion right (R3)

Endocanthion right (R3)-Endocanthion left (L1)

Endocanthion left (L1)- Exocanthion left (L2))

Exocanthion left (L2)- Postaurale left (L3)

3. **Facial midline (Fig 1a)**

It is also considered as important reference line for determining the symmetry of the smile.[19,26-29]

4. Curvature of smile (Fig 3a, 4a)

On smiling a curvature formed by a line passing through the cusp tip of second premolar, canine, incisal edges of lateral and central incisors of the first quadrant crossing the midline to the similar structures of the second quadrant if parallels the curvature of the lower lip line, the smile is considered esthetic.[24,25] Visibility of buccal corridor is determined by this curvature.[23] Oblique view with videography magnifies the visibility of the smile arc, from canine tip and maxillary incisor to lower lip curvature on smile. This angle of vision also includes molars and premolars (Fig 4a,4b).[32]

5. Smile analysis [19-25]

Apart from the horizontal lines, vertical lines dividing the face into equal five parts determines the symmetry and aesthetics of the face which influences a more predictable outcome of the redesigned smile (Fig 2b). The digital software makes it easy to create these horizontal and vertical lines over the static photograph as well as superimposition of the predetermined smile design over the existing pretreatment photograph which allows for the forecast of the outcome of the smile redesign (Fig 5a, 5b). Even the minute discrepancies in the shift of the midline and the occlusion plane canting can be easily detected.

6. Smile simulation [19-22] (Fig 5a, 5b)

Simulations of the future smile is predicted with the digital software to alter the position of the incisions edges, cant of smile, midline shifting, tooth shade and soft tissue outline (Fig 6a).

7. Transferring the Cross to the intra oral image [18-22] (Fig 1b, 2a, 2b)

The intra oral area can be zoomed in and positioned in alignment with the facial reference line, i.e the cross formed by the horizontal and vertical line. Three lines are drawn on the intra oral photograph to compare the parallelism and symmetry with the cross as described in **(Table 2)** (Fig.6a, 6c).

8. **Determining the esthetic proportions (Fig 6b, 6c)**

Golden proportions explained by Levin[38] and RED proportion Ward[39-41] are few amongst many determining tools for measuring the acceptable width to length proportions. According to Frush and Fisher [42], patient's SPA (sex, personality and age) along with Leon William's correlation [43] of an inverted facial form with shape of teeth determines the esthetic harmony. With the use of the digital software tooth outlines of desired shape can be drawn and the same can be copied and pasted over the existing photograph.[18-22] (Fig 5b)

9. Hard tissue (teeth) and soft tissue (gingiva) display and aesthetic evaluation[19-22, 44] (Fig 1b, 6b, 6c)

A vivid understanding of the aesthetic considerations necessary for smile designing of the maxillary arch includes:

1. Tooth proportion (outline)
2. Relationship between teeth and smile line
3. The harmony between the gingival display and the anterior teeth.
4. Facial and dental midline
5. Midline and canting
6. Papilla height
7. Buccal corridor display on smiling
8. Intercommisural width
9. Intercommisural height

10. Digital Ruler calibration (Fig 6d)

This technique is pioneered by Coachman.[18] The length of one of the central incisors on the physical cast is noted and the data is incorporated into the Digital Ruler on the

virtual DSD platform. The programmed digital ruler is now ready to determine any measurements needed to alter the anterior region of the image.

11. Role of DSD from Technician's point of view[18-22] (Table 3)

After transferring the cross on the cast with the aid of reference lines and the Cross on the gingival part of the cast along the dental midline, the technician will find it extremely useful in building a precise wax-up for fabrication of provisional restoration. A feedback from patient can be derived regarding any changes to be made prior to fabrication of the final prosthetic smile.

12. Diagnostic wax up (Fig 7a, 7b)

The diagnostic wax-up not only provides the provision for a feedback from the patient but also incorporated the advantage of performing a clinical trial, planning management of diastema and implant placement.[18-19] It is noteworthy here, to perform minimally invasive procedure on the existing anterior dentitions, allowing just enough clearance to place the provisional restoration (Fig 6b) as a trial, having shape memory from the diagnostic wax-up.[46] Final restoration should be fabricated under a monitored supervision with minimum requirement of final adjustment.[28.47,48]

Concept of Visagism (Fig 8)

Dr. Braulio Paolucci, redesigned an existing smile governed by personality traits (physical traits, personality and desires).[49] VisagiSMile is a program fully developed over the Visagism concept.[50]

An Entire Three Dimensional Programme (Software & Prosthesis Fabrication)

Advancement in digital dentistry with the introduction of CAD-CAM technology, one may choose 3D wax-up over conventional technique. The final STL format will be exported to a 3D printer where the desired physical model will be available.[18,19] The entire technique of the 3D/ STL file generation and 3D printing is beyond the scope of this article.

Discussion

An esthetically pleasing smile is a debatable topic and subjective to individual perception. Though social, cultural, racial and age associated factors govern the beauty of a smile, certain key points that balance the harmony and symmetry of a smile are common to all of them. Dynamic nature of a smile recorded in a video and analyzed via DSD is appreciated over photographic method due to the lack of convenience of the later to locate the minute details of a smile on a static frame.[18,31] The technique of videography to capture a spontaneous smile was first explained by Ackerman and Ackerman[31] and Sarver and Ackerman[32].

An original study by **Singh et al[51]** in using the photographic (ph) method recorded 8% of the male group with a flat smile arc compared to 36% with videographic (vd) technique. In the same study other parameters like the visibility of the second molar of the maxillary arch on spontaneous smile recorded 34% with ph technique and 42 % with vd method. **Tarantili et al[35]** in their original study mentioned the three phases of a spontaneous smile, 'sustaining period' being the longest of it, in which a smile can be recorded at its full potential. They also pointed out that a spontaneous smile lasts a duration ranging between 240- 500 ms which is too short a time frame to be captured by a photograph.

The digital ruler (Fig 6d) is yet another convenient tool especially for the technicians for evaluating the pre and post treatment changes.[18] This also helps in proper documentation needed for future alteration if

required. Often the dental and the facial midlines do not coincide.[19,52] According to **Cardash HS in 1989**[53] the greater the deviation of anterior tooth and facial midlines, the higher the detection rate. Midline deviation of less than 2 mm which may go unnoticed with static photography is detected by a Digital ruler due to its reliability and sensitivity.[20] **M. Robert Mack** [54] was a pioneer in relating the practical application of the **Vitruvian third (**by Leonardo da Vinci) of the face with an attractive smile. Rule of **Vitruvian third** divides anesthetic face into equal three parts. The lower Vitruvian third of the face should have subnasale-stomion, stomion-menton ratio of 30%-70% (Fig 2a), to achieve an esthetic smile. Ideal proportions of the face with alteration of smile designing is made easy with a digital ruler.

Customization of smile designing vid DSD encourages the patient participation in their own smile design which reinstates their confidence.[44,55-57] It also ensures the predictability of the smile outcome match the predesigned wax-up model.[18,19,56] Diagnostic wax-up (Fig 7a, 7b) designed with DSD software can be easily converted into a surgical template, stent and a surgical guide using the 3D printing for planning of implant placement, guidance to crown-lengthening as well as index for tooth preparation.[19-22]

Omar and Durante[13] in **2018** compared different DSD applications like Aesthetic Digital Smile Design (ADSD), Cerec SW 4.2 (Sirona Dental Systems Inc.), Planmeca Romexis Smile Design (PRSD) and others. Among them Photoshop CS6 and Keynote provide a more comprehensive smile analysis than most specialized DSD programs as they fulfil the analysis of facial, dentogingival, and dental esthetic parameters.

These qualities mentioned above have helped DSD gain popularity within a short time span. Although other factors such as case documentation ability, cost-effectiveness, time efficiency, systematic organization, and compatibility of the program with CAD/CAM or other digital systems may also influence its application.[57]Scientific studies on the reliability, accuracy, and predictability on the field of DSD needs to be given further attention as till now very few articles have been published meeting the above criteria.

Conclusion

Incorporation of Video in a Digital smile designing has taken the platform of esthetic dentistry to an edge of precision. Superior quality of videography over static photograph in depicting minute details of a spontaneous smile makes it a reliable and predictable tool for realizing the desired smile redesigning.

Reference

1. Manjula WS, Sukumar MR, Kishorekumar S, Gnanashanmugam K, Mahalakshmi K. Smile: A review. *J Pharm Bioallied Sci*. 2015;7(Suppl 1):S271-S275.
2. Dawson PE. Determining the determinants of occlusion. Int J Periodontics Restorative Dent 1983;3:8-21
3. Goldstein RE. Change your smile. Chicago, US : Quintessence Publication; 1997.
4. Tjan AH, Miller GD , The JGP . Some esthetic factors in a smile, J Pros Dent 1984:51:24-28.
5. Talarico G, Morgante E. Psychology of dental esthetics: dental creation and the harmony of the whole. Eur J Esthet Dent. 2006 Winter;1(4):302-12.
6. Casaglia A, DE Dominicis P, Arcuri L, Gargari M, Ottria L. Dental photography today. Part 1: basic concepts. Oral Implantol (Rome). 2016;8(4):122-129.

7. Gopi Chander N. Essentials of dental photography. J Indian Prosthodont Soc. 2017;17(2):107-108.
8. Kalpana D, Rao SJ, Joseph JK, Kurapati SKR. Digital dental photography. Indian J Dent Res. 2018 Jul-Aug;29(4):507-512
9. Desai V, Bumb D. Digital dental photography: a contemporary revolution. Int J Clin Pediatr Dent. 2013 Sep;6(3):193-6.
10. Shagam J, Kleiman A. Technological updates in dental photography. Dent Clin North Am. 2011;55:627.
11. Jafri Z, Ahmad N, Sawai M, Sultan N, Bhardwaj A. Digital Smile Design-An innovative tool in aesthetic dentistry. J Oral Biol Craniofac Res. 2020;10(2):194-198.
12. Zanardi P.R., Zanardi R.L., Stegun R.C., Sesma N., Costa B.N., Laganá D.C. The use of the digital smile design concept as an auxiliary tool in aesthetic rehabilitation: a case report. Open Dent J. 2016;10:28.
13. Omar D., Duarte C. The application of parameters for comprehensive smile esthetics by digital smile design programs: A review of literature, The Saudi Dental Journal,Volume 30, Issue 1,2018,Pages 7-12.
14. Spielman, Andrew.The Birth of the Most Important 18th Century Dental Text: Pierre Fauchard's Le Chirurgien Dentist. Journal of dental research. 2007;86: 922-6.
15. van Wyk CW, Theunissen F, Phillips VM. A grave matter--dental findings of people buried in the 19th and 20th centuries. J Forensic Odontostomatol. 1990 Dec; 8(2):15-30.
16. Morita RK, Hayashida MF, Pupo YM, Berger G, Reggiani RD, Betiol EA. Minimally Invasive Laminate Veneers: Clinical Aspects in Treatment Planning and Cementation Procedures. Case Rep Dent. 2016;2016: 1839793.
17. Gurel G, Morimoto S, Calamita MA, Coachman C, Sesma N. Clinical performance of porcelain laminate veneers: outcomes of the aesthetic pre-evaluative temporary (APT) technique. Int J Periodontics Restorative Dent. 2012 Dec;32(6):625-35.
18. Evolution of Smile Design. https://media.digitalsmiledesign.com/christian-coachman-thoughts/smile-design-evolution (Accessed on 24th July 2021) Available online:
19. Coachman, C. & Calamita, Marcelo. (2012). Digital Smile Design: A Tool for Treatment Planning and Communication in Esthetic Dentistry. QDT 2012 Quintessence. 35. 1-9.
20. Coachman C., Calamita M.A., Sesma N. Dynamic documentation of the smile and the 2D/3D digital smile design process. Int J Periodontics Restor Dent. 2017; 37(2):183–193.
21. Zimmermann M, Mehl A. Virtual smile design systems: a current review. Int J Comput Dent. 2015;18(4):303-17.
22. Paul SJ. Smile analysis and face-bow transfer: enhancing aesthetic restorative treatment. Pract Proced Aesthet Dent. 2001 Apr;13(3):217-22
23. Rufenacht Claude R. Fundamentals of esthetics. Quintessence Publishing Co.; 1990. p. 73, 80–2, 89, 94, 95, 125–7, 138.
24. Davis NC. Smile Design. Dent Clin N Am. 2007; 51:299–318.
25. Donitza A. Creating the perfect smile: prosthetic considerations and procedures for optimal dentofacial esthetics. J Calif Dent Assoc. 2008 May;36(5):335-40, 342.
26. Bhuvaneswaran M. Principles of smile design. J Conserv Dent. 2010; 13(4):225-232.

27. Chiche G., Pinault A. Aesthetics of Anterior Prosthodontics. Quintessence. 2004. Diagnosis and treatment planning of aesthetic problems; pp. 13–25.
28. Cohen S.E. third ed. PMPH; 2007. Fundamentals of Dental Aesthetics: Analysis. Atlas of Cosmetic and Reconstructive Periodontal Surgery; pp. 217–238.
29. Paul SJ. Smile analysis and face bow transfer: Enhancing esthetic restorative treatment. Pract Proced Aesthet Dent 2001;13:217-22.
30. Khan, M., Kazmi, S.M.R., Khan, F.R. et al. Analysis of different characteristics of smile. BDJ Open **6,** 6 (2020).
31. Sarver DM, Ackerman MB. Dynamic smile visualization and quantification: part 1. Evolution of the concept and dynamic records for smile capture. Am J Orthod Dentofacial Orthop. 2003 Jul;124 (1):4-12.
32. Sarver DM, Ackerman MB. Dynamic smile visualization and quantification: Part 2. Smile analysis and treatment strategies. Am J Orthod Dentofacial Orthop. 2003 Aug; 124(2):116-27.
33. Burres SA. Facial biomechanics: the standards of normal. Laryngoscope. 1985 Jun;95(6):708-14.
34. Chetan P, Tandon P, Singh GK, Nagar A, Prasad V, Chugh VK. Dynamics of a smile in different age groups. Angle Orthod. 2013 Jan;83(1):90-6.
35. Tarantili VV, Halazonetis DJ, Spyropoulos MN. The spontaneous smile in dynamic motion. Am J Orthod Dentofacial Orthop. 2005 Jul;128(1):8-15.
36. Milutinovic J, Zelic K, Nedeljkovic N. Evaluation of facial beauty using anthropometric proportions. Scientific World Journal. 2014 Feb 20; 2014:428250.
37. F. B. Naini, J. P. Moss, and D. S. Gill. The enigma of facial beauty: esthetics, proportions, deformity, and controversy. American Journal of Orthodontics and Dentofacial Orthopedics. 2006.; 130(3): 277–282.
38. Levin EI. Dental esthetics and the golden proportion. J Prosthet Dent. 1978 Sep;40(3):244-52
39. Ward DH. Proportional smile design using the recurring esthetic dental (red) proportion. Dent Clin North Am. 2001 Jan; 45(1):143-54.
40. Mack MR. Perspective of facial esthetics in dental treatment planning. J Prosthet Dent. 1996 Feb;75(2):169-76.
41. Al-Johany SS, Alqahtani AS, Alqahtani FY, Alzahrani AH. Evaluation of different esthetic smile criteria. Int J Prosthodont. 2011 Jan-Feb;24(1):64-70
42. John P. Frush, Roland D. Fisher. The dynesthetic interpretation of the dentogenic concept. The Journal of Prosthetic Dentistry.1958; Vol 8 (Issue 4): Pages 558-581.
43. Williams JL (1914) A new classification of natural and artificial teeth. Dentists supply Co, New York City
44. Davis Nicholas C. An artistic approach to smile design. Dent Today 1999;18(8):57.
45. Messing MG. Smile architecture: beyond smile design. Dent Today. 1995 May;14(5):74, 76-9.
46. Romeo G, Bresciano M. Diagnostic and technical approach to esthetic rehabilitations.J Esthet Restor Dent. 2003;15(4):204-16.
47. Simon H, Magne P. Clinically based diagnostic wax-up for optimal esthetics: the diagnostic mock-up. J Calif Dent Assoc. 2008 May;36(5):355-62.
48. Bichacho, Nitzan & Musella, Vincenzo & Feraru, Mirela. (2016). Individualizing a smile makeover. Current strategies for predictable results.. 32. 109-119.
49. Paolucci B, Calamita M, Coachman C, Gurel G, Shayder A, Hallawell P.

Visagism: The art of dental composition. Quintessence Dent Technol. 2012;35:1–14.
50. Feraru, M., Musella, V., Bichacho, N., 2016. Individualizing a smile makeover: current strategies for predictable results. J. Cosm. Dent.32 (1), 109–114.
51. Singh, Nandini & Abdulla, Roopa & Sable, Ravindranath & Bhosale, Veera & Halli, Rajshekhar. Smile analysis: A comparison between photographic and videographic methods. Journal of Indian Orthodontic Society.2016; 50: 8.
52. Rufenacht CR. Principles of esthetic integration. Quintessence Publishing Co; 2000:109-11
53. Cardash HS, Ormanier Z, Laufer BZ. Observable deviation of the facial and anterior tooth midlines. J Prosthet Dent. 2003 Mar;89(3):282-5.
54. Mack MR. Vertical dimension: a dynamic concept based on facial form and oropharyngeal function. J Prosthet Dent. 1991 Oct;66(4):478-85.
55. Sousa Dias N, Tsingene F. SAEF - Smile's Aesthetic Evaluation form: a useful tool to improve communications between clinicians and patients during multidisciplinary treatment. Eur J Esthet Dent 2011;6(2):160-76.
56. Mizrahi B. Visualization before finalization: a predictable procedure for porcelain laminate veneers. Pract Proced Aesthet Dent. 2005 Sep;17(8):513-8
57. Davis LG, Ashworth PD, Spriggs LS. Psychological effects of aesthetic dental treatment. *J Dent.* 1998;26:547–54.

Tables And Legends:

DSD Workflow	Significance
1. Cross	An intersection of vertical and horizontal line through the middle of the screen for easy referencing and assessing the symmetry of extra-oral and intra-oral images.
2. Digital Facebow	With reference to the cross it analyses entire smile with respect to certain reference points.
3. Facial Midline	Vertical line of Cross decides the facial midline and any deviation associated with it and the dental midline.
4. Smile Curvature	Curved line drawn on the incisal edges of the maxillary anterior teeth and its parallelism with the lower lip dictates the attractiveness of a smile.
5. Smile Analysis	Overall analysis of the entire smile and soft tissue structures surrounding it.
6. Smile Simulation	Softwares like ADSD, PRSD, Photoshop CS6, Keynote help in superimposition of the future smile designing on the existing dentition.
7. Transfer Of Cross To Intraoral Image	Analyzing outline of teeth and possible canting, emergence profile, dental midline.
8. Esthetic proportion	Golden proportion, RED proportion, Vitruvian Third of the face determines the attractiveness of the smile.
9. Hard and soft tissue display	A spontaneous smile is a harmony maxillary anterior teeth display, gingiva and the buccal corridor.
10.**Digital Ruler Calibration**	Helps in transferring marks from software to the cast.
11.**Role of Technician**	Transfers important data to cast and fabricates the diagnostic wax-up
12.**Diagnostic Mock-up**	Determines the final restoration design, need for crown lengthening, implant placement and others.

Table 1: Flowchart depicting the sequence of Digital Smile Designing (DSD) workflow.[18-20]

Reference	Description	Determines
Line 1	From the tip of one canine to the tip of the other.	Size and canting
Line 2	A line drawn through the incision edge of both the central incisors starting from the middle of one and ending at the midpoint of the other incisal edge.	Incisal edge position
Line 3	Vertical line through the dental midline, from the tip of the interdental papilla to the incisal embrasure.	Dental midline coinciding with the Facial midline

Table 2: Three lines drawn on the intra oral photograph comparing the parallelism and symmetry with the cross (Fig 6a)

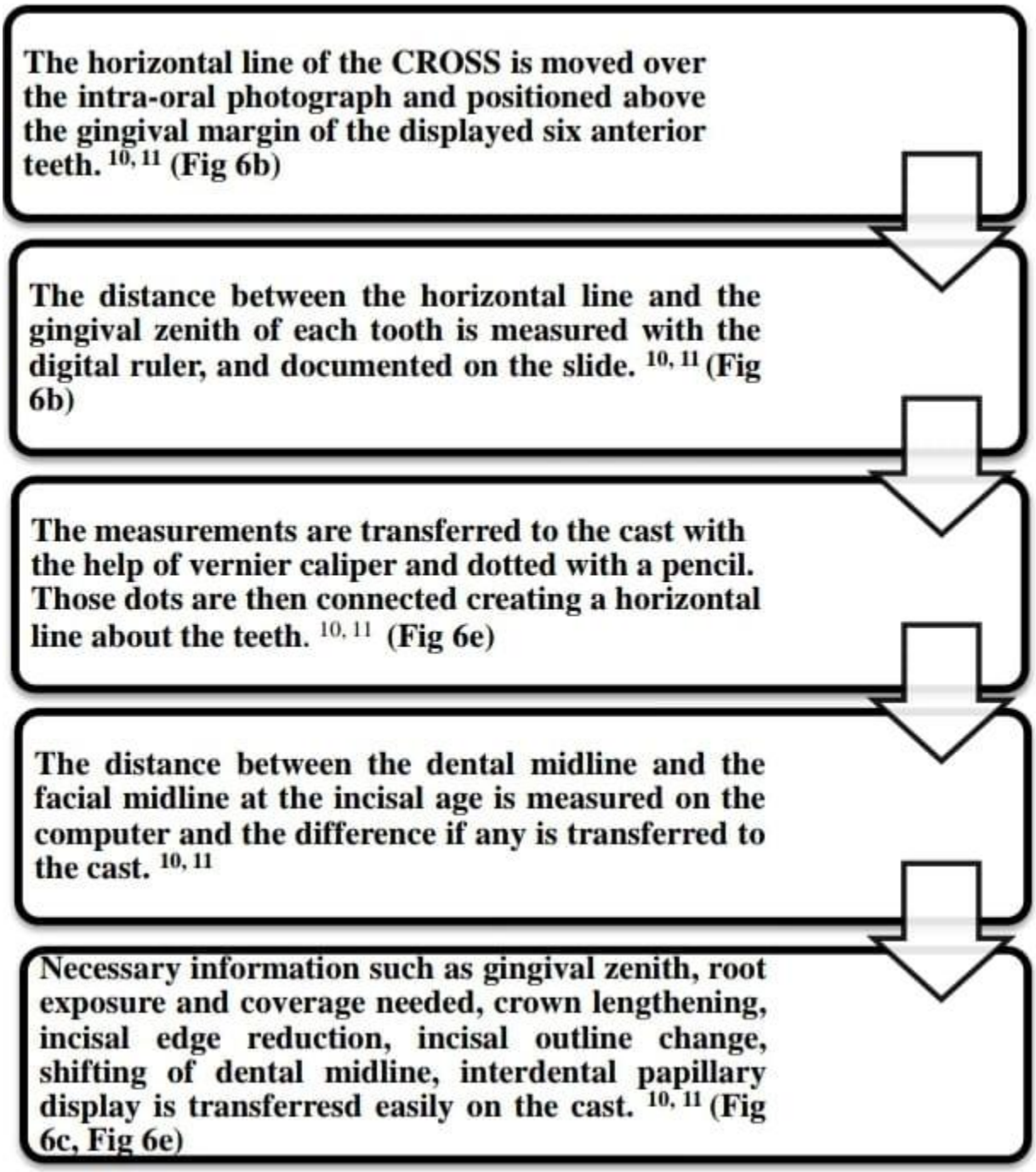

Table 3: Flowchart depicting the role of DSD from technician's view-point[18-20]

Figures:

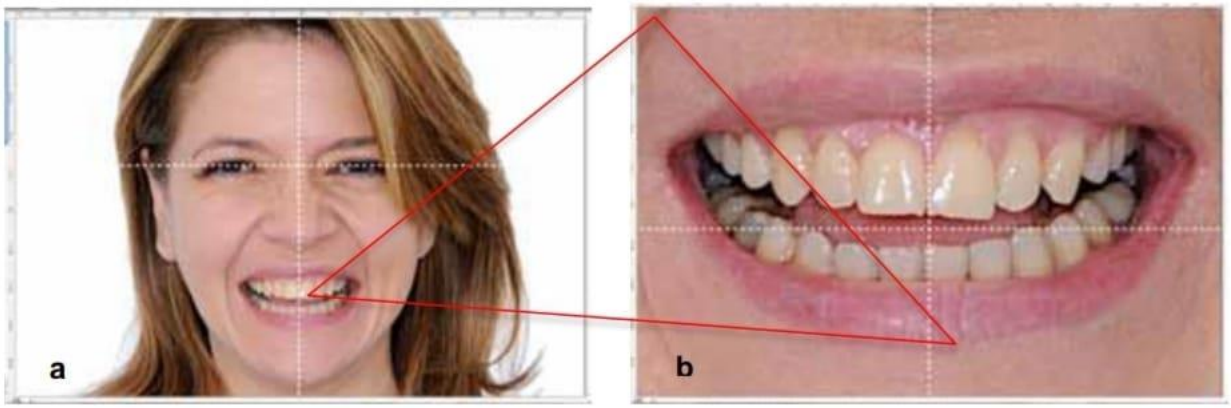

Fig 1a: Extraoral smiling photograph moved behind the cross to determine interpupillary reference line and the vertical midline of the face.[19] **Fig 1b:** Zoomed intraoral view of the full smile.[19]

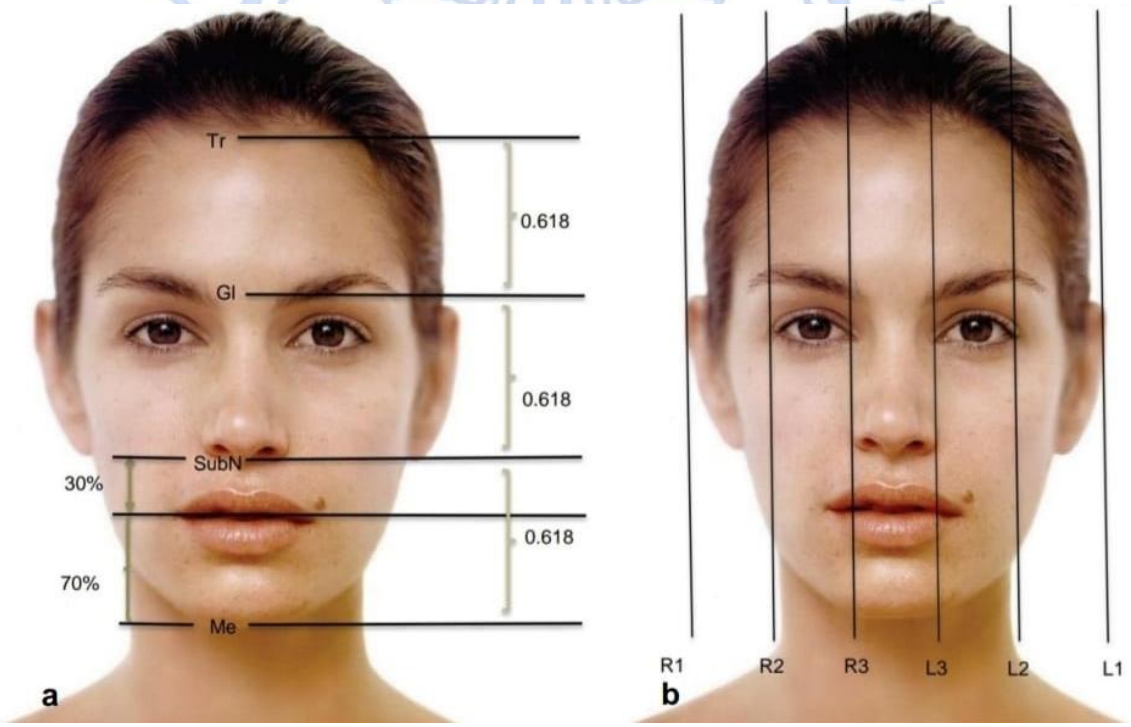

Fig 2a: The horizontal lines dividing the face into equal Vitruvian thirds, with the lower equal third being divided into upper lip and lower lip to chin percentage of 30-70%.[36] **Fig 2b** Depicts the vertical lines dividing the face into equal fifths.[36]

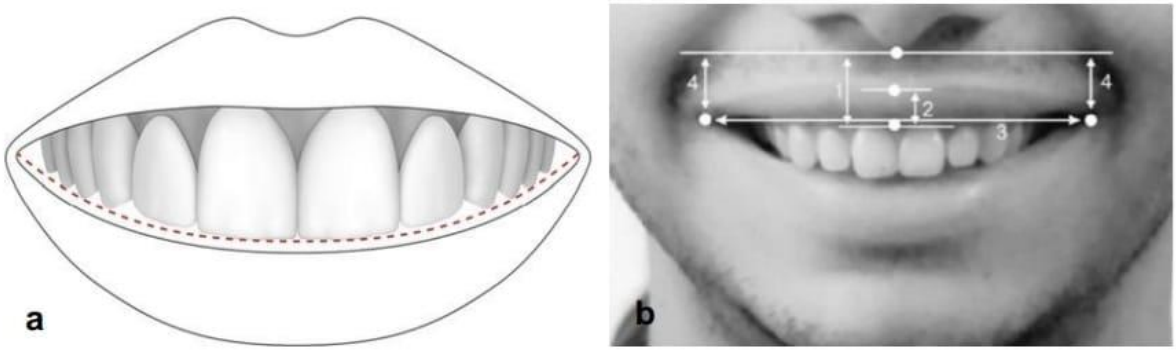

Fig 3a: Depicts the ideal smile line being parallel to the lower lipline.[24] **Fig 3b:** Shows different soft tissue parameters while smiling, like 1.Upper lip length, 2.Upper lip thickness, 3.Outer commisural width, 4.Commisural height.[34]

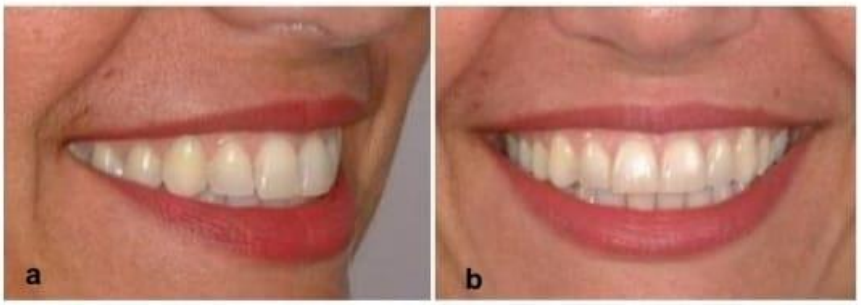

Fig 4a: Oblique view of smile increases the visibility of teeth till the premolars and molars, defining the smile curvature.[32] **Fig 4b:** Frontal view the smile defining the smile curvature only for the six anterior teeth.[32]

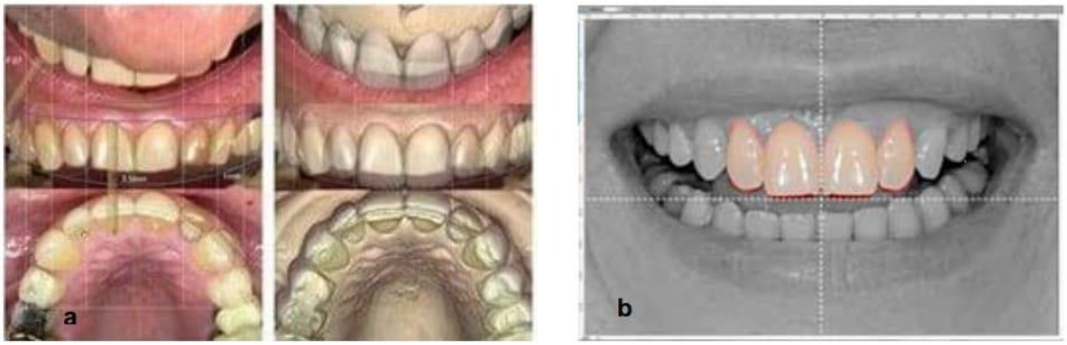

Fig 5a: Simulation of the predicted smile design over the pre-existing smile and transferring it to a diagnostic wax-up.[20] **Fig 5b:** Simulation of the shape and shade of the desired smile outline.[20]

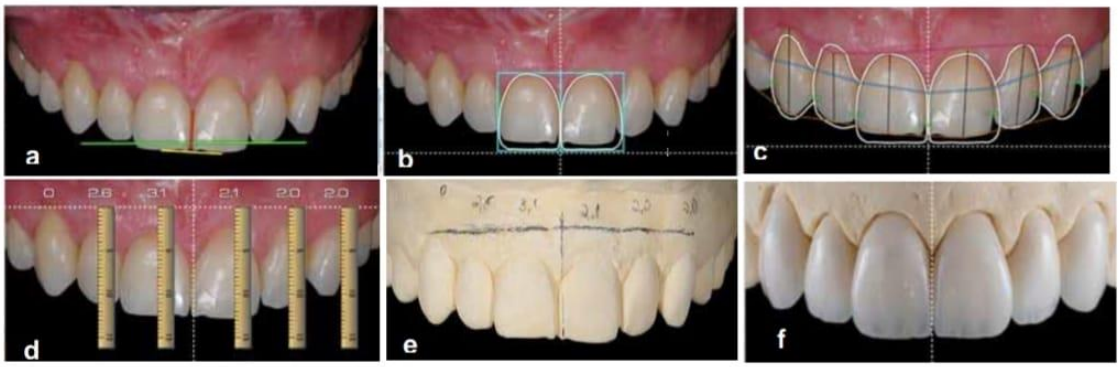

Fig 6a: Depiction of Line 1,Line 2 and Line 3 on the zoomed intraoral photograph (Table 2). [19] **Fig 6b:** Width to length ratio of 80% of incisrs and 0.618 ratio (Golden proportion) between central and lateral incisor; lateral-canine visibility.[19] **Fig 6c:** Retracted zoomed intraoral photograph showing the desired outline of teeth, curvature of the smile and gingival zenith. [19] **Fig 6d:** Use of digital ruler in transferring the required amount of crown-lengthening required to attain the ideal gingival zenith.[19] **Fig 6e:** Using a caliper, technicians transfer the exact marks recorded by the digital ruler onto the physical model. [19] **Fig 6f**: Final partial veneer or full veneer restoration ready to be fitted intra-orally. [19]

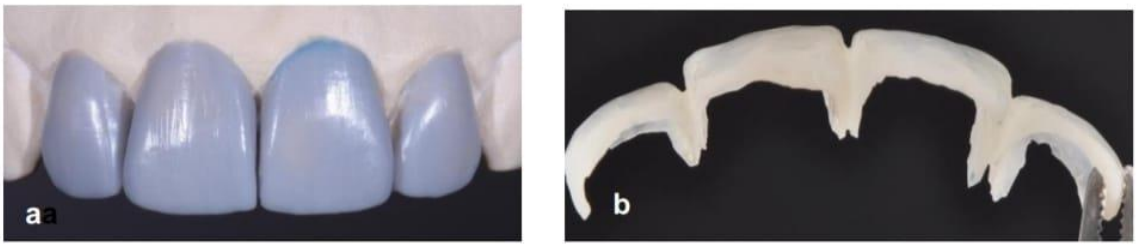

Fig 7a: Diagnostic wax-up.[48] Fig 7b: Acrylic provisional restoration customized from diagnostic wax-up to be placed on surface of minimal tooth preparation.[48]

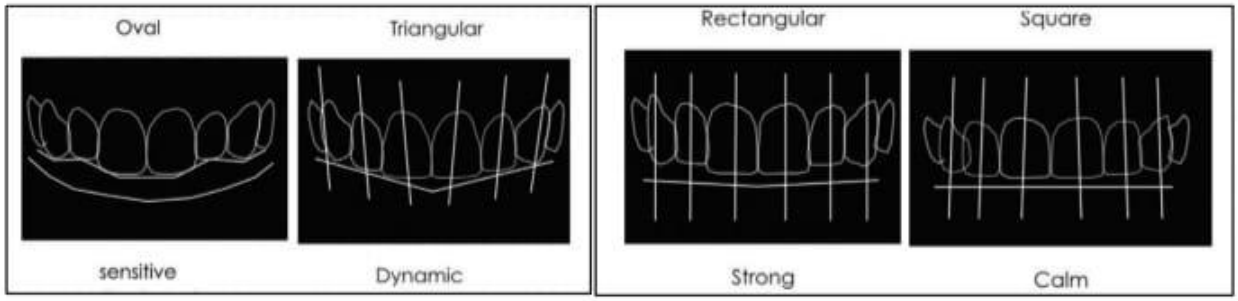

Fig 8: Concept of Visagism governing the outline of maxillary anterior teeth based on patient's personality traits and temperament.[48]