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Workflow and Efficiency in Smile Designing: Digital vs. Traditional Methods

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Abstract
A comparison between digital and conventional smile design explores two distinct approaches in the field of aesthetic dentistry and aids in designing, evaluating their efficiency, accuracy, and patient's engagement. Traditional smile design, relying on manual sketches and physical wax-ups, provides accurate results but is time-intensive and dependent on skilled technicians. In contrast, Digital Smile Designing (DSD) utilizes advanced software and 3D modeling, allowing patients to visualize treatment outcomes virtually. DSD enhances precision, reduces procedural time, and fosters collaborative treatment planning among patients, clinicians, and technicians. The digital approach allows for improved customization and faster adjustments, which are challenging in traditional methods. However, digital smile design requires specialized training and technology investment, which can be costly. Traditional methods are more accessible but lack the ease of patient communication and visualization that digital tools offer. Overall, digital methods are upcoming trend aesthetic dentistry, offering greater predictability and patient satisfaction, though traditional methods remain relevant in specific clinical contexts. This article reviews the evolution made to enhance esthetic outcomes, workflow and efficiency of digital and conventional method of smile designing, and the advantages and limitations of digital smile designing.

Introduction

In the 21st century, people place significant importance on the aesthetics of their teeth. In fact smile increases the confidence and self esteem of a person. Smile designing is a cosmetic dental procedure that correct imperfections of the teeth and restore dental health and pleasing appearance of the person (Ackerman & Ackerman, 2002). Several modernised developments were made to design smile that enhances the facial profile of the person. Earlier manual drawings were made on printed photographs of the patient to demonstrate the end result of the treatment (Child Jr., 2011). Then, two dimensional printed photographs have been advanced to three dimensional models using computer software. Digital smile design systems are another advanced technology in esthetic dentistry and have demonstrated efficiency and accuracy (Jafri et al., 2020). The fundamental objective of digital smile design is to motivate and educate patient by developing and showing the smile digitally and it helps them to visualize it prior to the treatment by creating and presenting a virtual simulation similar to the end result of the proposed treatment (Ahrberg et al., 2016). It allows easy communication and discussion between smile designers laboratory technicians and patients (Seiler et al., 2018). It is used in prosthodontic, implant and orthdontic rehabilitation. Global digitalization in the field of dentistry can produce repeatable and remarkable results in the anatomical and functional terms of esthetics (Jarad et al., 2005).

History of Esthetics

Dental restoration focusing on aesthetics has historically been a priority among the elite circles. They used toothpaste and mouthwashes for aesthetic reasons rather than in pursuit of health and cleanliness. To retain the shape, form, and contour of natural teeth, they even used animal tusks as dental prostheses. In 1000 AD, the Mayans utilized ornamental materials including iron pyrites, obsidian, and jade to recreate the incisor edges of their teeth. Thus it is considered as some of the earliest instances of esthetic dental modifications (Aschheim, 2014). The timeline of aesthetic dentistry milestones from 1919 to 2019, it highlights significant advancements in the field over the course of a century. It begins with early developments in facial aesthetics and tooth shape by Williams, followed by innovations like acrylic dentures in the 1920s and cephalometrics in the 1930s. The mid-20th century saw the introduction of key techniques such as enamel acid etching by Buonocore and dentin bonding, both of which revolutionized restorative dentistry. Osseo-integration, introduced by Brånemark in the 1960s, marked a major advancement in dental implants, alongside the introduction of porcelain-fused-to-metal restorations. The 1970s brought the development of aluminous jacket crowns and Bis-GMA composite resin, improving the aesthetic quality of dental restorations. The 1980s and 1990s saw technological breakthroughs such as chairside CAD/CAM systems, intraoral scanning, and commercial tooth whitening techniques. By the 2000s, laboratory CAD/CAM, zirconium and lithium silicate ceramics, and 3D printing emerged, enhancing precision and durability in aesthetic dentistry. The 2010s focused on digital innovations like digital smile design and 3D aesthetic analysis, culminating in the widespread use of monolithic high-translucent zirconia for crowns and bridges, which provided unparalleled aesthetics and strength. The evolution of aesthetic dentistry has consistently integrated technological advancements with a focus on improving both function and aesthetics in dental care (Blatz et al., 2019).

Generations of Smile Designing

Table 1 Evolution of Digital Smile Designing System (Coachman, 2020)

Generation	Advancement	Description
First Generation	Manual drawings with pencil over patient's full profile photograph	The correlation between the profile photo of the patient and the model was poor. Digital dentistry was not developed at that time
Second Generation	Drawings were made in Microsoft office digitally. Diagrams were 99% accurate	It was limited to 2D drawings. There was no true relationship between the profile photo and the model made
Third Generation	2D digital drawings were correlated with the model permitted wax up of final smile	There was no link to 3D digital world
Fourth Generation	Evolution in 2D Digital drawing and digital link to the 3D mock up	
Fifth Generation	Complete 3D workflow	
Sixth Generation	The 4D concept	Records movement of face during smile designing procedure

Principles of Smile Designing

The facial profile play an important role for planning the esthetic smile designing that include facial symmetry facial profile, macro esthetics, micro estics and proportion of the facial structures. Since the facial profile of every person is different, a more accurate detail of the muscles and dimensions of the facial profile is to be recorded (Ackerman & Ackerman, 2002). An ideal smile line should expose 2 mm of maxillary incisors with inter dental papilla. Too much exposure reveals gingiva which results in a gummy smile, while two little exposure flatten the philtrum of upper lip producing a rounded appearance (Davis, 2007).

Component of Smile Esthetics

Smile Composition can be divided into facial and dental elements. Facial composition involves hard and soft tissues, such as bones, muscles, and joints, which impact symmetry and proportions of the face. Dental composition relates to tooth alignment, proportion, and harmony with gingival tissues (Helvey, 2007).

Elements Influencing Smile Designing

Interpupillary Line and Lips

These facial features set the horizontal boundaries for an ideal smile.

Facial Dimensions

Ideal facial proportions are outlined, such as horizontal 'five-eye' width and vertical thirds (forehead, nose, chin).

Tooth Components

- Dental Midline: Should align with facial landmarks and is crucial for symmetry.
- Tooth Dimensions and Proportion: Central incisors are dominant; proportions should align with aesthetic formulas like the golden proportion.
- Incisal Edge and Phonetics: Positioning of incisal edges impacts speech and smile aesthetics.
- Symmetry and Balance: Central incisors require high symmetry, with variation allowed for lateral teeth.

Soft Tissue Considerations

- Gingival Health: Healthy, aesthetically pleasing gums frame the teeth.
- Gingival Levels: Proper gingival alignment for each tooth type contributes to a harmonious smile.

Guiding Principles for Smile Design

- Golden Proportion: Ratio guiding the width of teeth for visual appeal.
- Buccal Corridor: Proper spacing avoids negative spaces.
- Zenith Points: Apical position of the gingival margins to create optimal tooth framing.
- Interdental Contacts: Spacing between teeth, preventing 'black triangles' in the smile line (Bhuvaneswaran, 2010).

Requirements of Digital Smile Designing

Table 2 Requirements of Digital Smile Designing (Coachman et al., 2017; Bini, 2014)

DSD Software	Description
Photoshop CS6	Fulfills all the parameters. Cannot be operated using mobile. Cannot be used with CAD/CAM
Keynote	Not able to alter detailed changes on tooth structure. Cannot be operated using mobile. Cannot be used with CAD/CAM
Aesthetic Digital smile design	Contains limited facial analysis parameters. Not used with CAD/CAM
Cerec SW 4.2	Only a few parameters are present. Cannot be operated in mobile. Can be used with CAD/CAM
Planmeca Romexis Smile Design	Provides effective communication. Compatiable with Mac and Windows. Enable perfection alteration of the proportions of the tooth structure. Quick and easy to use.

Other Digital softwares include Smile designer pro, Nemo DSD, Exocad Dental CAD 2.3, Microsoft Power Point, DSD App by Coachman, Digital SRL Camera, etc. Three basic photographs are required-

- Full face view with a natural smile
- Resting face
- A view in which the maxillary and the mandibular arch are not in occlusion

Commercially oriented DSD softwares include CEREC Smile design, G design, Smile composer (3 SHAPE). Photoshop CS6 provides a more comprehensive smile design (Coachman & Calamita, 2012).

DSD Workflow

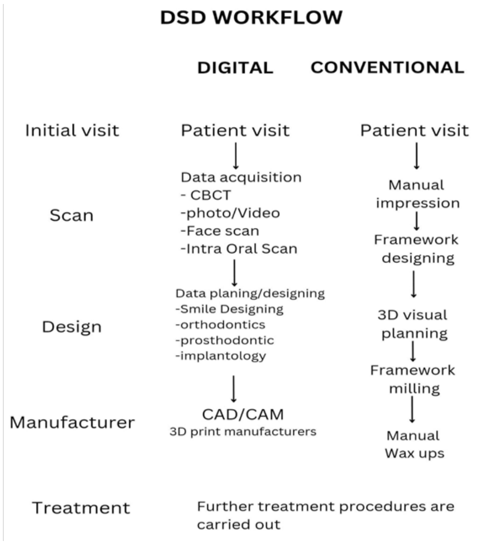

Figure 1 DSD Workflow (Jafri et al., 2020; Coachman et al., 2021)

During a patient's initial visit, comprehensive data is gathered to inform dental treatment planning. Intraoral photos are captured from various angles, including facial view with horizontal and vertical reference lines, and occlusal views of both the maxilla and mandible. Intraoral scanning using a digital scanner provides a 3D model that reflects the correlation between facial and dental structures, showing the ideal tooth contour. Extraoral images such as OPG, facial views (at rest and with a full smile), smile photos, and retracted mouth views are also taken. Alignment is established using horizontal (intercommissural and interpupillary) and vertical (glabella, nose, chin, dental midline, and mandible) guidelines to ensure accuracy in smile design. The smile photo is then aligned with Digital Smile Design (DSD) images, enhancing the precision of the analysis. Patient data is securely stord in the cloud.It enables asynchronous collaboration among specialists. Whichhels to develop interdisciplinary treatment plans.

Digital guides can be used for precise execution during procedures and to standardize treatment steps, reducing errors and to obtain optimizing results. For conventional wax-ups, skilled dental technicians work on a semi-adjustable articulator using inlay wax, allowing for initial trials and adjustments as needed. Patients can view these models to understand potential treatment results.This increases patient's confidence and acceptance. Digital wax-ups are created to simulate treatment outcomes, with the cervical portion of the wax-up maintained at approximately 0.3 mm in thickness and covering all buccal surfaces while leaving the occlusal surface open. This prevents pink showing through. These wax-ups help in smile design, orthodontic planning, prosthodontics, or implantology, depending on patient needs. Ultimately, a model is produced by superimposing the digital wax-up on the scanned image, which serves as the basis for taking impressions to fabricate veneers, crowns, and other restorations (Figure 1).

Advantages of Digital Smile Designing

- Better Predictability: Visualizes the expected outcome of treatment, thus enhancing the predictability of treatment.
- Patient Motivation and Education: Deals with the patient's apprehensions, educates, and motivates them about the benefits of treatment.
- Better Diagnosis and Planning: Allows aesthetic visualization through digital analysis of facial, gingival, and dental parameters.
- Customization: Personalizes the smile design with the patient's involvement, thus ensuring a more humanistic and emotional connection.
- Patient Satisfaction: Patients can approve the final smile design before treatment, thus reducing post-treatment regret.
- Comparison and Evaluation: Permits easy comparisons pre- and post-treatment using digital devices.
- Enhanced Communication: Provides good communication between the clinicians, patient, interdisciplinary team, and laboratory technicians.
- Transparency and Feedback: Facilitates feedback for modification in desired aspects of shape, arrangement, and color.
- Team Collaboration: Enables remote access and collaboration during all phases of treatment by various team members
- Medico-Legal Documentation - Showing the final outcome to the patient before starting the procedure can serve important medico-legal purposes by documenting patient consent and understanding (Jafri et al., 2020).

Limitations of DSD

- Digital Smile Design (DSD) treatments are often costly, which can make them less accessible for some patients.
- Clinicians require in-depth familiarity with specialized software and must undergo specific training to use DSD effectively (Jafri et al., 2020)
- Achieving consistent results across different devices or clinics can be challenging due to variations in technology and operator skill.
- DSD may not be suitable for all cases, especially complex dental or orthodontic conditions that require traditional methods (McLaren & Goldstein, 2018).

Conclusion

From the above discussion, it can be concluded that both conventional and digital method for smile designing are accurate. Conventional method requires more time and well handed technician as compared to digital method. There are many multi disciplinary 3D approaches made in different branches of dentistry. The digital method is convenient to be used and for communication between the clinician and the patient to improve the treatment plan.

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