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Artificial Intelligence-Assisted and Conventional CAD Software for Smile Design: A Critical Review

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Abstract

The evolution of digital smile design (DSD) has transitioned from manual 2D drawings to sophisticated 3D workflows, with artificial intelligence (AI) emerging as a transformative tool in prosthodontics. While conventional CAD software remains the gold standard for clinical precision, AI integration promises to automate complex tasks like facial analysis and prosthetic simulation. This narrative review evaluates the impact of AI-integrated platforms compared to conventional CAD software in DSD, focusing on workflow efficiency, clinical precision, and aesthetic outcomes. Comparative literature reveals a significant discrepancy. AI-driven workflows offer superior efficiency, reducing average planning time from 63.48 minutes to 30.82 minutes. However, aesthetic evaluations remain inconsistent; while patients often accept AI-generated designs, expert prosthodontists maintain a preference for the artistic characterization and secondary anatomy provided by manual CAD systems. Current evidence indicates that while AI is an essential, high-efficiency adjunct that streamlines planning, it does not replace the artistic intuition and oversight of the prosthodontist. Future practice should adopt a hybrid approach, leveraging AI's computational speed for initial simulations while maintaining strict manual control over definitive design parameters to ensure individualized patient care.

Keywords: Digital Smile Design (DSD), Artificial Intelligence, Digital Dentistry, CAD Software.

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1. Introduction

A smile has long been a cornerstone of social integration. The pursuit of dental aesthetics isn't a modern obsession; it dates back to ancient civilizations like the Etruscans (900 BC) and Phoenicians (800 BC), who meticulously carved animal tusks to mimic natural teeth. However, dentistry only emerged as a distinct professional discipline in the 18th century. This shift was led by Pierre Fauchard, who, alongside his contemporaries, modernized the field and laid the groundwork for aesthetic dental practices [1]. Smile design is the process of crafting an aesthetic appearance by blending scientific principles with artistic intuition, shaped by long-standing cultural and racial standards. It is a dynamic discipline that evolves alongside modern trends, balancing facial aesthetics and lip movement with "pink" (gingival) and "white" (dental) harmony, all while considering the patient's unique personality (Sabbah, 2022). While traditional approaches focused narrowly on the teeth and mouth, modern smile design adopts a more holistic perspective of the entire individual. At its core, this process is deeply subjective; a purely scientific approach often produces generic, overly symmetrical results that appear artificial. True aesthetic success avoids "copy-paste" dentistry. Because no two individuals are identical, each smile must be custom-tailored to possess its own distinct identity [1-2]. Until the mid-1990s, dental aesthetics were limited to modifying tooth shade and shape or replacing missing units [3]. Today, however, the surging demand for facial and dental beauty drives patients to seek treatment primarily to improve their attractiveness. Achieving harmony between dental texture, color, and facial features is vital for a patient's well-being, as dentofacial appearance dictates social attraction and interpersonal relationships [4-6].

Ruel Kellerman noted that people with well-aligned teeth often viewed as more sincere, kind, and conscientious [7]. "Even the simulation of an emotion tends to arouse it in our minds" [8]. Charles Darwin was the first to explain hidden power of a smile. In his Facial-Feedback hypothesis, he suggests that a smile has a systematically positive effect on mind and body. An attractive or pleasing smile clearly enhances acceptance of an individual in our society by improving initial impression in interpersonal relationships

[8]. A defective smile might be considered properly as a physical handicap. Smile is one of most important facial expressions and is essential in expressing friendliness, agreement, & appreciation. Research indicates that eyes and mouth are the primary elements in hierarchy of features defining facial attractiveness [9]. Evidence suggests that an infant's temperament and environmental engagement directly shaped by parental smiles. Furthermore, functional magnetic resonance imaging (fMRI) data shows that adult brains process attractive, happy faces as neurological reward stimuli. Consequently, smile is rightfully called universal language [10]. Its impact is truly exponential, casting dentists as architects of this transformation. Enhancing smile improves not only personal confidence but also overall facial harmony, significantly boosts social engagement [2-11-12]. One study revealed that individuals with smiles improved via cosmetic dentistry perceived as more intelligent, successful, interesting, and wealthy [13]. Pilkington argued that true aesthetics involve mimicking and harmonizing with nature [14], while Lombardi described it as visual perception governed by composition & proportion [15].

This drive for perfection has led clinicians to seek innovative aesthetic solutions, yet it has also surfaced unrecognized psychiatric issues fueled by unrealistic patient expectations. Thus, meticulous planning and clear communication are essential for successful rehabilitation [16-19]. An aesthetic result requires the seamless integration of facial composition—the hard and soft tissues—with dental composition, which focuses on the teeth and their relationship to the gums [20]. Attractive faces typically adhere to the "facial thirds" concept, displaying an optimal balance and proportion that often deviates from standard normative values [6]. Contemporary smile design is governed by a framework of objective parameters categorized into macro-esthetic, mini-esthetic, and micro-esthetic dimensions. Rather than serving as rigid protocols, these principles function as flexible guidelines that allow clinicians to do a harmonious transition between restoration and patient's unique biological substrate [21]. By integrating these multi-dimensional criteria, clinicians can move beyond generic restorative patterns toward a personalized esthetic synthesis. This methodology ensures that the definitive dental arrangement not only aligns with the patient's underlying skeletal and soft-tissue features but also reflects their individual personality and phonetic requirements, ultimately achieving a balance between standardized beauty and patient-specific character [21-22]. In late 2000's the Brazilian dentist Dr. Bráulio Paolucci introduced concept of Visagism in dentistry which link facial features and psychology into dental practice. It effectively added what many refer to as the "fifth dimension" of smile design: the psychosocial impact of the smile on the patient's identity and self-esteem. Before Visagism, dentistry relied heavily on the Dentogenic Concept (introduced by Frush and Fisher in the 1950s), which categorized smile design based on the "SPA" factors: Sex, Personality, and Age [23].

2. Search Strategy

To identify relevant literature, a comprehensive search was conducted across PubMed, Scopus, and Google Scholar. Search strategy utilized the following keywords and Boolean operators: ("artificial intelligence" OR "AI") AND ("smile design" OR "DSD"). Initial search results were systematically screened to ensure alignment with review's scope. Papers were excluded if they did not specifically address AI integration in dental smile design workflows, lacked clinical relevance, or focused on unrelated diagnostic areas.

3. Foundational Theories and Frameworks of Smile Design

3.1. Foundational Theories

- *Williams' Law of Harmony:* This theory indicates that the morphological characteristics of the maxillary central incisors should reflect the patient's facial outline, establishing a visual harmony between dental and skeletal structures [24].
- *Berry's Biometric Index:* This quantitative approach utilizes the bizygomatic distance to determine the appropriate width of the maxillary central incisors, suggesting a proportional relationship approximately equal to 1/16 of the total facial width [25].
- *Pound's Formulas:* These guidelines emphasize the functional and esthetic interplay of tooth positioning, specifically addressing the critical relationship between dentition, phonetics, and facial support [26].

3.2. Contemporary Framework

These foundational theories have set the guidelines for contemporary framework of comprehensive smile design, which systematically categorizes restorative process into:

- *I. Macro-Esthetics (Dentofacial Analysis):* Focuses on structural harmony within the three-dimensional craniofacial complex [21].
    - *Geometric Proportions:* The face is analyzed using horizontal thirds and vertical fifths. Reference planes include interpupillary line and intercommissural lines.
    - *Facial Morphology:* Classified as square, tapering, square-tapering, or ovoid. These guide tooth contour and smile arc curvature.
    - *The Facial Midline:* Intersects the glabella, nose tip, philtrum center, and mentum. Dental midlines should ideally coincide with the facial midline, though deviations up to 2 mm are clinically acceptable and largely imperceptible to laypeople.
- II. *Mini-Esthetics (Dento-Gingival Analysis):* Evaluates the spatial relationship between teeth and facial landmarks during a social smile [21].
    - *Buccal Corridors:* The negative space between posterior teeth and lip corners. Minimal buccal corridors are often perceived as more attractive, though some studies show they do not significantly impact layperson perception.
    - *Lip Line & Gingival Display:* Ideally, the lip line sits at the gingival margin of central incisors. Displays of 0–1 mm ideal; up to 2 mm is acceptable (women show higher tolerance). Displays >3 mm are non-ideal. Smiles are categorized as Low (75% exposure), Average (75–100%), and High (total exposure + gingiva) [7].
    - *Incisal Edge Display (Age Dynamics):* Governed by "42.2 rule" (4 mm resting display, 2 mm gingival show, 2 mm gap). Aging increases upper lip length, decreasing maxillary display by 1.5–2 mm and narrowing smile vertically [4].
    - *Smile Arc:* A "consonant" smile (incisal curvature parallel to the lower lip) is essential for attractiveness [7].
    - *Gingival Zenith:* The most apical point of the margin. It should be distal to the vertical midline for centrals and

canines, and centered for laterals. Asymmetries >1 mm significantly reduce attractiveness [27].

- III. *Micro-Esthetics (Detailed Dental Analysis):* Focuses on tooth and gingiva level [21].
  - *Axial Inclination:* Maxillary anterior long axes should progress distally from the midline.
  - *Connector Space:* Follows the 50-40-30 rule relative to central incisor length [28].
  - *Incisal Embrasures:* "V" shaped gaps that should increase in size and volume moving distally [29].
  - *Tooth Shape:* Influenced by age, sex, and personality rather than strict facial inversion theories. Female smiles (often utilizing round/round-square forms) are generally rated more attractive than male smiles [30].
  - *Tooth Size and Proportion*

The golden proportion: (often applied to successive widths of anterior teeth as viewed from the front) Under this model:

- The lateral incisor is assigned a ratio of 1.
- The central incisor width is calculated by multiplying the lateral width by 1.618.
- The canine width (as seen from the front) is calculated by multiplying the lateral width by 0.618 [31].

While this provides a mathematical framework, studies show most natural dentitions do not strictly conform to it. Applying it universally can lead to an unnaturally narrow maxillary arch. Modern dentistry prioritizes balance and harmony over rigid mathematical formulas [32].

Recurring Esthetic Dental (RED) Proportion:

The RED proportion offers more clinical flexibility than the golden proportion. it suggests that the ratio of successive tooth widths should remain constant as one moves distally from the midline. Unlike the fixed 0.618 ratio, dentist can select a specific RED proportion such as 70% to better suit the patient's arch and facial features [33]. Sterrett et al. found a ratio of width to length of 0.75–0.85 to be ideal [34].

4. *Evolution of Smile Design: From Analogue to Digital and AI*

Currently, more clinicians are turning to computer-aided design for esthetic prosthetic treatments. Evidence confirms that digital workflows are highly effective at delivering results patients want, offering both predictability and satisfaction. While the development of the DSD concept reportedly began in 2007, it was only until 2012 that Christian Coachman et al. introduced the Digital Smile Design (DSD) concept, titled "Smile Design: From Digital Treatment Planning to Clinical Reality." This paper serves as a foundational concept of DSD [35]. They defined DSD as a "multi-use conceptual tool that can strengthen diagnostic vision, improve communication, and enhance predictability throughout treatment. The DSD allows for careful analysis of patient's facial and dental characteristics along with any critical factors that may have been overlooked during clinical, photographic, or diagnostic cast–based evaluation procedures" [35].

4.1. Evolution from Analogue to Digital [35] (figure 1)

- *Generation 1:* Analog drawings over photos and no connection to the analog model.
- *Generation 2:* Digital 2D drawings and visual connection to the analog model.
- *Generation 3:* Digital 2D drawings and analog connection to the model.
- *Generation 4:* Digital 2D drawings and digital connection to the 3D model.
- *Generation 5:* Complete 3D workflow.
- *Generation 6:* The 4D concept (adding motion to the smile design process).

4.2. Evolution of AI Integration

The concept of "AI," which emerged in the 1950s, was defined by the potential for machines to execute tasks typically requiring human intelligence [36]. Looking forward, AI is projected to streamline and automate essential aspects of esthetic evaluation, smile design, and the development of treatment plans [37-38]. This technological shift automates critical workflow components, including facial analysis, image alignment, and smile simulation, thereby streamlining esthetic treatment planning while minimizing subjectivity and boosting efficiency [37]. The integration of AI with Digital Smile Design (DSD) has further catalyzed advancements, facilitating rapid, automated esthetic evaluations that improve both diagnostic precision and procedural efficiency. By analyzing parameters like facial symmetry, tooth morphology, shade, and alignment, AI generates virtual simulations that serve as a collaborative bridge between clinicians and patients [39].

5. *Clinical Workflow Comparison: Conventional CAD vs. AI*

5.1. Conventional CAD Systems

Despite recent advancements, conventional CAD platforms—specifically Exocad and 3shape—remain established gold standard. These systems are characterized by extensive prosthetic libraries and high customizability; however, they necessitate steep learning curve and significant manual operator intervention. Workflow involves manual data integration, calibration, landmark identification, anatomical alignment, and prosthetic refinement (figure 2). Consequently, while these platforms offer unparalleled control, reliance on manual input poses challenges to workflow efficiency compared to emerging AI-driven solutions.

5.2. AI-Integrated Platforms

In contrast, AI-integrated platforms (e.g., DTS, Smilefy) prioritize automated workflows. While they reduce manual intervention, they involve clinical trade-offs:

- *Software Sophistication:* Less granular control over fine adjustments compared to legacy CAD.
- *Design Limitations:* Typically, less extensive libraries than conventional systems.
- *Facial Analysis:* While automated facial form recognition is efficient, it lacks the training to handle complex or asymmetrical cases, where manual selection remains superior.

5.3. Technical Architecture of AI Tools

The generation of clinically viable, patient-specific smile designs necessitates a comprehensive computational approach, integrating diverse machine learning architectures to process two-dimensional (2D) photographic data and three-dimensional (3D) intraoral scans. This synthesis of technologies ensures that final prosthetic outcome is both aesthetically optimized, biologically and physically accurate.

Pixel-Level Segmentation and 2D Analysis: To achieve precise diagnostic boundaries, Convolutional Neural Networks (CNNs) are employed for automated segmentation of clinical photographs. These networks are highly effective at pixel-level classification, enabling instantaneous identification of gingival tissue (pink) and dental structures (white). By automating segmentation, workflow effectively mitigates inter-operator variability and manual tracing errors inherent in traditional digital design methods [39].

Geometric Deep Learning for 3D Mesh Analysis: Given that standard CNNs are optimized for rigid, grid-based image data, they are insufficient for the analysis of irregular, unstructured 3D triangular meshes (STL files). Consequently, digital dentistry workflows leverage Geometric Deep Learning. These frameworks are specifically engineered to process point cloud data, allowing for the autonomous identification of anatomical landmarks, such as long axes, tooth orientation, and preparation margin detection, without the necessity for manual clinician intervention [40-41].

Multi-modal Data Registration: The integration of disparate data types is facilitated through automated multi-modal registration. These deep learning frameworks utilize multi-view geometry to correlate anatomical landmarks such as incisal edges and canine cusps across 2D photographic and 3D intraoral datasets. This process enables the instantaneous and highly accurate superimposition of 3D virtual models onto 2D patient photographs [42].

Morphological Synthesis and Statistical Shape Models (SSMs): The final prosthetic proposal is synthesized by combining generative modeling with Statistical Shape Models (SSMs). While 2D Generative Adversarial Networks (GANs) are utilized to simulate realistic aesthetic mockups for patient communication, 3D crown morphology is governed by deep autoencoders trained on extensive libraries of natural dentition. This hybrid approach ensures that the resulting prosthetic designs maintain anatomical integrity and satisfy the biomechanical requirements essential for final clinical fabrication [43].

6. Evidence and Implications

6.1. Patient Perception and Esthetic Acceptance

Kaushik et al. (2025) conducted a study to analyze aesthetic preferences between manually designed smiles and AI-generated smiles using 320 participants (including dental professionals and non-dental individuals) in India between 2024 and 2025. Participants evaluated paired smile designs for four clinical cases created via Exocad software. Statistical analysis revealed that demographic factors like age, sex, and occupation did not influence preferences. Overall, participants consistently preferred manually crafted designs over those generated by AI. However, AI-generated designs showed improved acceptance rates in two of the four cases, suggesting that while AI technology is advancing, it currently lacks the artistic touch, emotional context, and ability to account for facial dynamics that an experienced clinician provides. The study concludes that although AI offers significant benefits for workflow efficiency, it cannot yet replace the individualized judgment of a prosthodontist. Therefore, the researchers recommend adopting a hybrid approach that integrates AI's speed with human oversight to achieve the best balance of efficiency and patient satisfaction in smile design Table 1 [44]. This aligns with Another study by Novak et al. (2026) which investigated the subjective perception of smile aesthetics by comparing manually generated designs using 3Shape Trio software against those produced by the AI-based application, Smilefy.

Standardized DSD photographic protocols were used to create both sets of designs for ten patients, with the AI-generated results manually adjusted for tooth shade to ensure a fair comparison. The designs were then evaluated by 150 participants—divided equally among dentists, dental students, and laypeople—using a 1-to-6 rating scale to assess aesthetic appeal relative to original photographs. The results consistently favored manual designs, which received higher aesthetic ratings in nine out of ten cases across all participant groups. Specifically, manual designs were rated 23% higher by dentists, 27% higher by students, and 16% higher by laypeople. This preference for conventional design further mirrored across dental specialties, with prosthodontists, dentoalveolar surgeons, endodontists, and orthodontists all scoring the manual approach more favorably [45]. Another study by AbdelHafez et al. (2026) evaluated the accuracy and clinical acceptability of smile designs created by artificial intelligence (Smilefy) compared to a conventional digital workflow (Exocad) for ten patients undergoing esthetic rehabilitation. Patient and dentist satisfaction were measured using a visual analogue scale. Statistical analysis revealed no significant differences between two methods regarding overall dentist satisfaction for primary and tertiary anatomy.

However, clinicians favored the conventional Exocad approach for secondary anatomy. Patient satisfaction levels were comparable across both techniques. Researchers concluded that while Smilefy offers acceptable accuracy and high patient satisfaction, it still requires further refinement to fully meet detailed anatomical expectations of clinicians [46]. Conversely, prospective study by Almohareb et al. (2026) compared the efficacy and efficiency of fully automated AI-generated smile designs (SmileFy) against manually designed restorations created by experienced clinicians using Exocad (version 3.2 Elefsina). The study involved 33 patients and utilized evaluations from 20 blinded prosthodontists alongside subjective patient ratings, objective geometric measurements, and recorded design times. Findings revealed that AI-generated designs achieved significantly lower (more favorable) Dental Esthetic Screening Index scores compared to expert-designed ones, with both prosthodontists and patients awarding significantly higher visual analog scale ratings to AI-generated results. Patients preferred the AI-based designs in 69.7% of cases. Furthermore, AI workflow demonstrated superior efficiency, reducing average planning time from 63.48 minutes for expert manual process to 30.82 minutes (a 51.46% reduction in time) with all differences reaching statistical significance [47].

6.2. Workflow Efficiency

AI-driven tools offer a marked advantage in both operational speed and workflow efficiency. Research-based evidence suggests that AI-augmented software can reduce the time required for design processes by approximately 50% compared to conventional CAD systems. This temporal efficiency is realized across the entire clinical or technical workflow, encompassing critical phases such as image superimposition, automated anatomical landmark detection, and the final design execution [47] (Table 2).

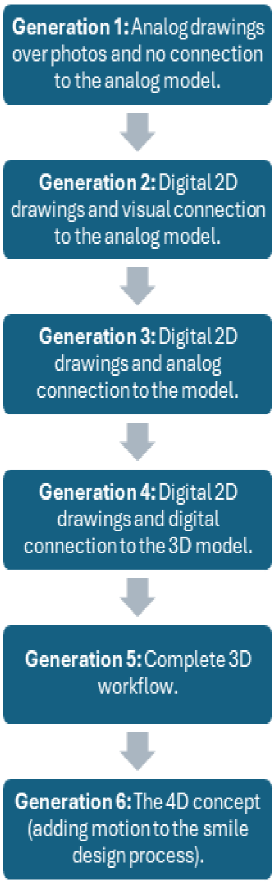
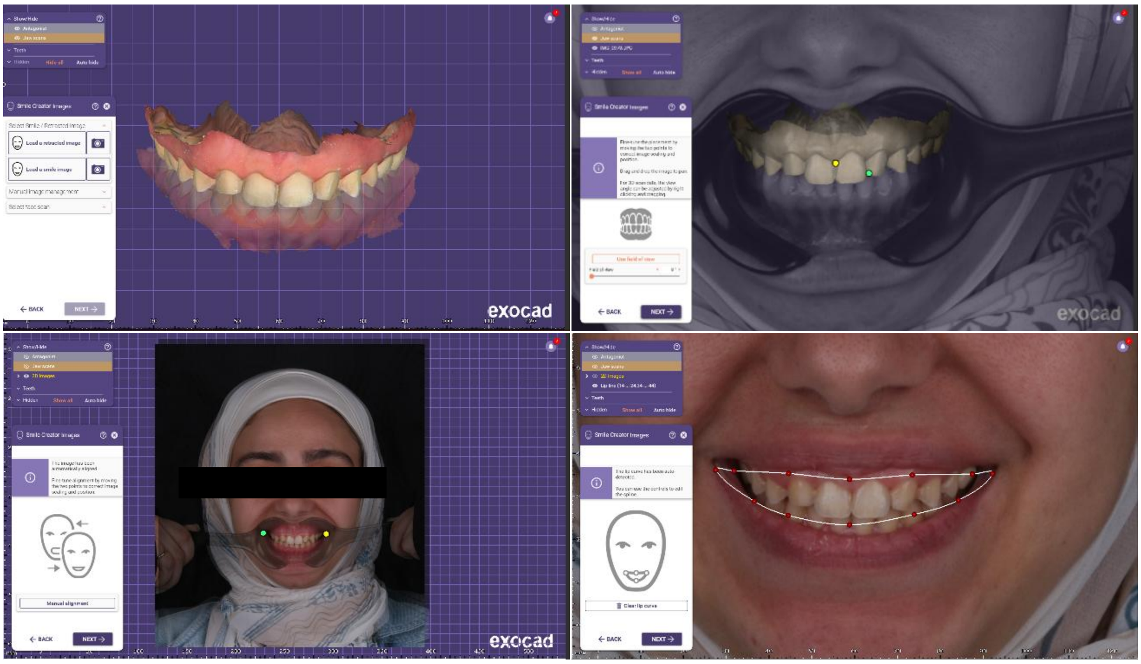


Figure 1: evolution of smile design from analogue to digital.



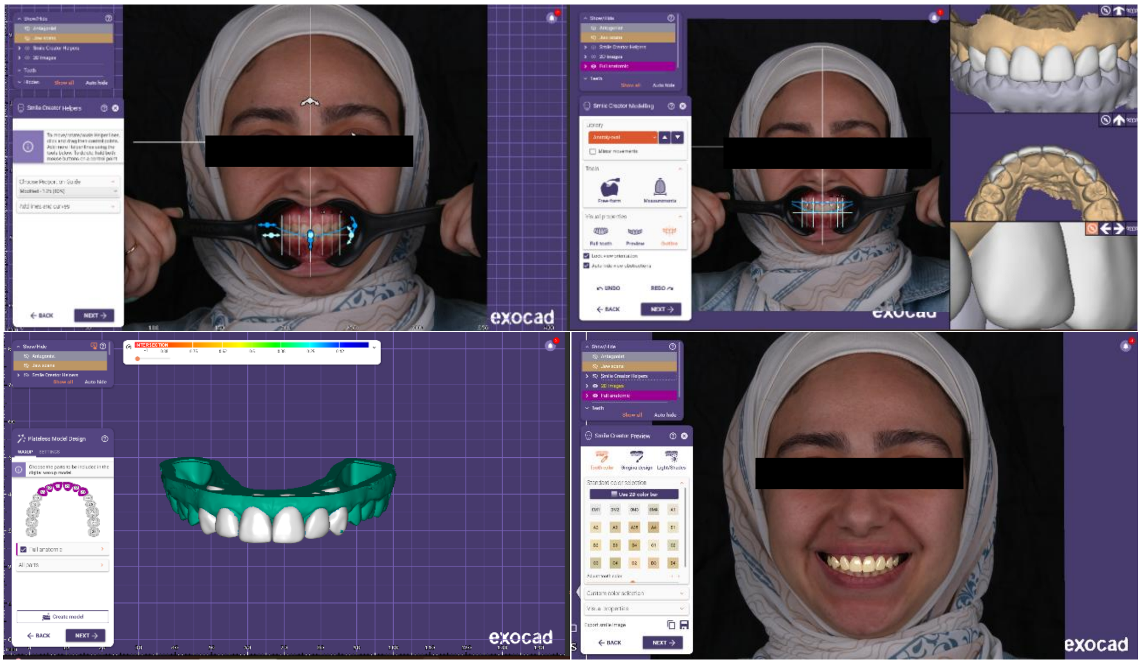


Figure 2: A schematic overview of the smile design workflow on a Conventional CAD software from top left to bottom right. (A) insertion of PLY (B) superimposition of PLY with retracted image (C) superimposition of maximum smile with retracted image (D) adjustment of lip-line. (E) adjustment of helper lines (F) selection of library and teeth adjustments (G) model creator (H) final design on 2D image.

Table 1: Clinical Decision-Making Matrix for AI integration in Smile Design [44].

Case Complexity	Recommended Primary Platform	AI Role	Rationale
Simple	AI-Integrated (e.g., Smilefy)	Primary Design Engine	High efficiency; sufficient anatomical predictability for standard aesthetic requirements.
Moderate	Hybrid Workflow	AI-Automated Mapping	Utilize AI for patient communication, rapid initial alignment, followed by manual refinement using a conventional CAD software.
Complex/Asymmetrical (e.g., Severe wear, misalignment)	Conventional CAD (e.g., Exocad)	Diagnostic Adjunct Only	Requires granular control over secondary anatomy, gingival architecture, and occlusion that current AI lacks.

Table 2: A comparison between conventional smile design and AI generated smile design.

Parameter	CAD Software (Conventional DSD)	AI-Driven DSD
Workflow Speed	63.48 minutes per case	30.82 minutes per case [46]
Data Alignment	Requires meticulous manual calibration between 2D photos and 3D meshes.	Highly automated 2D/3D superimposition with minimal operator plotting.
Artistry & Customization	Deep manual control over micro-esthetics and volumetric contouring.	Excellent for establishing macro-proportions and symmetry, but struggles with real-world variables.
Consistency	Subject to inter-operator variability and fatigue.	Standardized outcomes based on mathematical rules and datasets.

Bias Vulnerability	Operator bias (relying on subjective preference).	"Algorithmic bias" if trained on non-diverse demographic datasets.

6.3. Technical Specifications and Regulatory Compliance of Digital Platforms

Software selection for digital workflows requires an assessment of both clinical utility and regulatory validation. Systems such as Exocad and 3Shape maintain extensive international certifications, including MDSAP and specific FDA 510(k) clearances for diagnostic-capable modules. While tools like Smilefy provide significant advantages in aesthetic planning and communication, their integration into a clinical study necessitates acknowledging their current positioning as adjunct planning software rather than enterprise-level medical diagnostic systems.

7. Ethical Dimensions and Clinical Implications

Beyond technical efficacy, the adoption of AI-driven smile design necessitates a paradigm shift toward ethical clinical practice.

7.1. Ethical Education and Oversight

Practitioners often lack depth in understanding AI ethics, such as equity and autonomy. AI must remain an assistive tool under human oversight, not an autonomous authority [48].

7.2. Clinical vs. Marketing Utility

A significant risk is the use of smile design software as a marketing tool to drive sales rather than a medical instrument for identifying genuine patient needs. The clinician must remain the primary judge of treatment [48].

7.3. Algorithmic Bias and Data Security

AI models trained on homogenous datasets may impose cultural biases on diverse patients. Clinicians should advocate for "precisely biased" algorithms that respect cultural aesthetics while strictly adhering to data protection laws like GDPR to secure patient information [48].

8. Conclusion

While artificial intelligence is rapidly evolving and offers significant advancements in workflow efficiency, current evidence-based literature maintains that conventional, expert-led CAD software remains the gold standard for clinical smile design. The manual design process provides a degree of artistic control, characterization, and sophisticated color management that is currently beyond the capabilities of fully automated systems. However, the existing limitations in AI's ability to achieve consistent, expert-level precision particularly in complex cases underscore that these tools should be viewed as efficient adjuncts rather than replacements for clinical judgment.

9. Clinical Recommendations

- AI should be leveraged for rapid visual mockups: these tools are best used to enhance patient understanding and build trust during consultations.
- Strict clinical oversight should be maintained: AI outputs are not definitive. Every suggestion must be reviewed, verified, and approved by a qualified clinician.
- Conventional CAD should be prioritized for definitive designs: For clinical components where structural integrity and exact tolerances are non-negotiable, traditional CAD tools remain the gold standard.

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References

[1] M. Bhuvaneswaran. (2010). Principles of smile design. Journal of Conservative Dentistry and Endodontics. 13(4): 225-232.

[2] A. Sabbah. (2022). Smile analysis: diagnosis and treatment planning. Dental Clinics of North America. 66(3): 307-341.

[3] D.A. Garber, M.A. Salama. (1996). The aesthetic smile: diagnosis and treatment. Periodontology 2000. 11(1): 18-28.

[4] W.C. Shaw, G. Rees, M. Dawe, C. Charles. (1985). The influence of dentofacial appearance on the social attractiveness of young adults. American journal of orthodontics. 87(1): 21-26.

[5] S. Satravaha, M. Dent, K.D. Schlegel. (1987). The significance of the integumentary profile. American journal of orthodontics and dentofacial orthopedics. 92(5): 422-426.

[6] S. Peck, L. Peck. (1995). In Selected aspects of the art and science of facial esthetics, Seminars in orthodontics. Elsevier. 105-126.

[7] P.K. Sharma, P. Sharma. (2012). In Dental smile esthetics: the assessment and creation of the ideal smile, Seminars in orthodontics. Elsevier. 193-201.

[8] R. Abed, P. St John-Smith. (2024). The Expression of the Emotions in Man and Animals: Darwin's forgotten masterpiece. BJPsych advances. 30(3): 192-194.

[9] W. Batwa. (2018). The influence of the smile on the perceived facial type esthetics. BioMed research international. 2018(1): 1-7.

[10] J. Daniel, A. Kumar. (2024). Smile Esthetics in Orthodontics—Review of Literature. Journal of dentistry. 14(3): 701.

[11] D. Bzdok, R. Langner, S. Caspers, F. Kurth, U. Habel, K. Zilles, A. Laird, S.B. Eickhoff. (2011). ALE meta-analysis on facial judgments of trustworthiness and attractiveness. Brain Structure and Function. 215(3): 209-223.

[12] F. Demir, E. Oktay, F. Topcu. (2017). Smile and dental aesthetics: a literature review. Med Sci Int Med J. 6(1): 1.

[13] A.E. Beall. (2007). Can a new smile make you look more intelligent and successful? Dental Clinics of North America. 51(2): 289-297.

[14] E. Pilkington. (1936). Esthetics and optical illusions in dentistry. The Journal of the American Dental Association (1922). 23(4): 641-651.

[15] R.E. Lombardi. (1973). The principles of visual perception and their clinical application to denture esthetics. The Journal of Prosthetic Dentistry. 29(4): 358-382.

[16] S. Nomura, K.M.S. Freitas, P.P.C.d. Silva, F.P. Valarelli, R.H. Cançado, M.R.d. Freitas, R.C.G.d. Oliveira, R.C.G.d. Oliveira. (2018). Evaluation of the attractiveness of different gingival zeniths in smile esthetics. Dental press journal of orthodontics. 23(05): 47-57.

[17] A. Lo Giudice, L. Ortensi, M. Farronato, A. Lucchese, E. Lo Castro, G. Isola. (2020). The step further smile virtual planning: Milled versus prototyped mock-ups for the evaluation of the designed smile characteristics. BMC Oral Health. 20(1): 165.

[18] P.P. Garcia, R.G. da Costa, M. Calgaro, A.V. Ritter, G.M. Correr, L.F. da Cunha, C.C. Gonzaga. (2018). Digital smile design and mock-up technique for esthetic treatment planning with porcelain laminate veneers. Journal of Conservative Dentistry and Endodontics. 21(4): 455-458.

[19] S. Higgins, A. Wysong. (2018). Cosmetic surgery and body dysmorphic disorder–an update. International journal of women's dermatology. 4(1): 43-48.

[20] V.O. Kokich Jr, H. Asuman Kiyak, P.A. Shapiro. (1999). Comparing the perception of dentists and lay people to altered dental esthetics. Journal of Esthetic and Restorative Dentistry. 11(6): 311-324.

[21] R. Meshramkar, P. Mathur, N. Navya, M. Gupta, K. Lekha. (2019). A study to evaluate the role of macro-, micro-, and miniesthetics in an attractive smile. International Journal of Prosthodontics and Restorative Dentistry. 9(4): 117-123.

[22] D.M. Sarver. (2020). Dentofacial esthetics: from macro to micro; Quintessence.

[23] A.K. Sanketh. (2023). Visagism: An Essential Concept in Esthetic Dentistry. RGUHS Journal of Dental Sciences. 15(3).

[24] M. Vasantha Kumar, S. Ahila, S. Suganya Devi. (2011). The science of anterior teeth selection for a completely edentulous patient: a literature review. The Journal of Indian Prosthodontic Society. 11(1): 7-13.

[25] S. Bhagat, V. Gupta, N. Tyagi, E. Sharma, S. Gupta, M. Dadu. (2018). Berry's index: Adjuvant to bite marks. Journal of forensic dental sciences. 10(1): 45-49.

[26] N.B.A. Salim, A.R. Jain, A. Varma. (2017). Reliability of H. Pound's Formula for Anterior Teeth Selection. Biomedical and Pharmacology Journal. 10(2): 1003-100.

[27] M. do Vale Voigt, L.F. Espíndola-Castro, G.Q. de Melo Monteiro, L.S. Ortigoza, A. dos Santos Torreão, R. Georg. (2020). DSDapp use for multidisciplinary esthetic planning. Journal of Esthetic and Restorative Dentistry. 32(8): 738-746.

[28] E.A. McLaren, R.E. Goldstein. (2018). The Photoshop Smile Design Technique. Compendium of continuing education in dentistry (Jamesburg, NJ: 1995). 39(5): e17-e20.

[29] T. Foulger, C. Tredwin, D. Gill, D. Moles. (2010). The influence of varying maxillary incisal edge embrasure space and interproximal contact area dimensions on perceived smile aesthetics. British dental journal. 209(3): E4-E4.

[30] F.I. Shaabi, B.M. Al-Makramani, F.A. Al-Sanabani, M. Abdo, N.M. Alraawi, M.M. Al Moaleem. (2020). Potencijalni faktori koji utiču na percepciju estetike osmeha kod odraslih pacijenata stomatološke klinike univerziteta jazan the potential factors affecting the perception of aesthetic smile among adult. Acta Stomatologica Naissi. 36(81): 1966-79.

[31] E.I. Levin. (1978). Dental esthetics and the golden proportion. The Journal of Prosthetic Dentistry. 40(3): 244-252.

[32] J.D. Preston. (1993). The golden proportion revisited. Journal of Esthetic and Restorative Dentistry. 5(6): 247-251.

[33] I.V. WAGNER, G.E. CARLSSON, K. EKSTRAND, P. ÖDman, N. SCHNEIDER. (1996). A comparative study of assessment of dental appearance by dentists, dental technicians, and laymen using computer-aided image manipulation. Journal of Esthetic and Restorative Dentistry. 8(5): 199-205.

[34] J.D. Sterrett, T. Oliver, F. Robinson, W. Fortson, B. Knaak, C.M. Russell. (1999). Width/length ratios of normal clinical crowns of the maxillary anterior dentition in man. Journal of clinical periodontology. 26(3): 153-157.

[35] C. Coachman, M. Calamita. (2012). Digital Smile Design: A Tool for Treatment Planning and Communication in Esthetic Dentistry. Quintessence of Dental Technology (QDT). 35.

[36] F.a. Schwendicke, W. Samek, J. Krois. (2020). Artificial intelligence in dentistry: chances and challenges. Journal of Dental Research. 99(7): 769-774.

[37] S.B. Khanagar, A. Al-Ehaideb, S. Vishwanathaiah, P.C. Maganur, S. Patil, S. Naik, H.A. Baeshen, S.S. Sarode. (2021). Scope and performance of artificial intelligence technology in orthodontic diagnosis, treatment planning, and clinical decision-making-a systematic review. Journal of Dental Sciences. 16(1): 482-492.

[38] F. Kunz, A. Stellzig-Eisenhauer, F. Zeman, J. Boldt. (2020). Künstliche Intelligenz in der Kieferorthopädie: Evaluierung einer vollständig automatisierten Fernröntgenseitenanalyse unter Anwendung eines individualisierten „convolutional neural network ". Journal of Orofacial Orthopedics/Fortschritte der Kieferorthopädie. 81: 52-68.

[39] M. Ghaffari, Y. Zhu, A. Shrestha. (2024). A review of advancements of artificial intelligence in dentistry. Dentistry Review. 4(2): 100081.

[40] A. Ossowska, A. Kusiak, D. Świetlik. (2022). Artificial intelligence in dentistry—Narrative review. International Journal of environmental research and Public Health. 19(6): 3449.

[41] M.M. Bronstein, J. Bruna, Y. LeCun, A. Szlam, P. Vandergheynst. (2017). Geometric deep learning: going beyond euclidean data. IEEE Signal Processing Magazine. 34(4): 18-42.

[42] N. Razavian, F. Knoll, K.J. Geras. (2020). In Artificial intelligence explained for nonexperts, Seminars in musculoskeletal radiology. Thieme Medical Publishers. 24(1): 03-011.

[43] H.-H. Kim, S. Choi, Y.-I. Chang, W.-J. Yi, S.-J. Ahn. (2023). Developing a three-dimensional statistical shape model of normal dentition using an automated algorithm and normal samples. Clinical Oral Investigations. 27(2): 759-772.

[44] K. Kaushik, A. Sales, S.J. Rodrigues. (2025). Comparative analysis of facial aesthetics in AI generated versus conventionally crafted digital smile designs—a cross-sectional study. BDJ open. 11(1): 79.

[45] N.E. Novak, V.V.P.T. Xuan, M. Linninger, J. Borbely. (2026). Conventional vs. AI-powered digital smile design. Journal of dentistry. 167: 106375.

[46] M. AbdelHafez, A. Afia, O. Shaalan. (2026). Artificial intelligence versus conventional methods in digital smile designing: An accuracy study. Journal of Esthetic and Restorative Dentistry. 38(4): 828-836.

[47] T. Almohareb, A. Abou-Bakr, F.E. Hassanein, Y. Ahmed, M. Hamza, M. Aboheikal, N. Nagi. (2026). Clinical and patient comparison of AI and expert digital smile design: a prospective paired study. Dentistry journal. 14(3): 166.

[48] R. Rokhshad, T. Karteva, A. Chaurasia, R. Richert, C.M. Mörch, F. Tamimi, M. Ducret. (2024). Artificial intelligence and smile design: An e-Delphi consensus statement of ethical challenges. Journal of Prosthodontics. 33(8): 730-735.