Nomenclature for Device Design

Device design is a very important part of providing effective oral appliance therapy and is reviewed throughout the AADSM Mastery Program. To ensure unbiased education that remains applicable as device manufacturers change and products evolve, the AADSM Mastery Program uses design categories, rather than device names, to guide dentists through oral appliance fabrication. Industry has been provided with a listing of these classifications along with the nomenclature used in the program and should be able to provide you with details about their products using these classifications.

The order of the following classifications is intentional in that it directs practitioners through a linear thought process to design a device, first excluding the components that may be most problematic for the needs of their unique patient, followed by a consideration of those potentially most beneficial to that patient, and finally arriving at a selection of one or several patient compatible devices with custom design features.

Materials and Manufacturing: Overview
Laboratories often use relatively generic language, nicknames or their own proprietary nomenclature when describing device construction materials (e.g., plastic, acrylic, resin, "hard-soft", "flex", Astron Clear Splint™, ThermAcryl™, etc.). Some of these proprietary terms are used below to aide you in conversations with laboratories, but it is important to recognize that the laboratories will select which brand of the construction materials they use and the AADSM does not endorse or support any specific brand of these construction materials.

Fundamental knowledge in polymer chemistry and use of more specific language can assist the clinician in clinical decision-making and laboratory communication regarding materials used in commercially available devices.

Polymer manufacturing continues to evolve but the most common processes used in fabrication of oral appliances include:

- Historical additive techniques (e.g., powder-liquid) (i.e., "salt and pepper"), self-polymerization, with or without the addition of heat as a catalyst (i.e., auto- and thermo-polymerisable polyacrylics or resins)
- Subtractive techniques (e.g., milling of industrially polymerized blanks or blocks) (i.e., "medical grade, controlled-cure")
- Thermoforming techniques, a process of heating a thermoplastic sheet to its softening point then using compressive or vacuum forces to mold to a desired shape
- Developing additive technology in:

- Photopolymerization 3D printing techniques where biocompatible liquid polymers are incrementally polymerized with specific electromagnetic wavelengths from a focused energy source (e.g., laser, LCD, projector, LED, halogen light, LED, fluorescent bulb)
- Selective laser sintering (SLS) where a laser power source sinters powdered material (typically nylon or polyamide)

When combined with material choices, manufacturing processes influence multiple properties such as surface texture, degree of structural homogeneity, tensile/compressive strength, and precision of fit. It is important to gather information on both materials and manufacturing when making device design decisions.

Some definitions will help:
Monomer: a small molecule which may react chemically to link together with other molecules of the same type to form a large molecule called a polymer
Polymer: a large molecule composed of repeating structural units connected by covalent bonds
Plastic: (noun) a broad term often interchangeable with polymer, encompassing a wide range of synthetic or semi-synthetic materials including acrylic and resin, or used as an adjective in this document to describe a property
Resin: a general term used as part of a classification system for dental materials (e.g., denture base construction materials); for this document, synonymous with polyacrylic and Poly-methyl Methacrylate (PMMA)
Thermoplastic resins (i.e., self-polymerizing polyacrylics)**:** a type of polymer that changes shape or becomes moldable above a certain temperature and solidifies upon cooling

- **Autopolymerisable polyacrylic:** formed when two components (i.e., powder particles and monomer) are mixed creating irreversible bonds that may produce a heat releasing chemical reaction, an additive manufacturing technique
- **Thermopolymerisable polyacrylic:** a single or multiple mixed components are subjected to heat to form irreversible bonds, generally an additive manufacturing technique, used in laboratory denture fabrication

Plasticizers: monomer or polymer additions that introduce flexibility into a polymer
Elastomeric: having a flexible property, either naturally or through the addition of plasticizers
Synthetic fibers: additives that provide flexibility and tensile strength (e.g., nylon)
"Salt and Pepper": a common nickname for an additive manufacturing technique where powder and liquid monomer are alternatively added by hand to form desired shape
Milling: a subtractive manufacturing process where a thermoset "blank", "block" or "puck" is mechanically shaped by drilling guided by a 3D model design
Selective laser sintering (SLS): an additive manufacturing technique that uses a laser as the power source to sinter powdered material (typically nylon or polyamide), aiming the laser at points in space guided by a 3D model design, binding the material together to create a solid structure

Materials and Manufacturing

What should be considered during device design: patient allergies or sensitivities, inherent material strength and flexibility, manufacturer's recommended minimum thickness, ability to repair or modify chairside, ability to reline in the event that restorations are planned.

1. Polyacrylic polymers: typically PMMA (polymethyl methacrylate), rigid at room temperature
    a. PMMA-laboratory powder-liquid (i.e., "salt and pepper" technique), auto-polymerizing additive technique
    b. PMMA-milled from industry control-cured (i.e., blocks, blanks or pucks), subtractive technique
    c. Thermal-sensitized elastomeric polyacrylic, PMMA-softens in hot water, retains soft-feel at mouth temperatures, heat responsive elastomers added
        i. Proprietary formulas
        ii. Astron Clear Splint™, Fricke Clear Soft™, Talon™
    d. Non-thermal-sensitized elastomeric polyacrylic, PMMA-elastomeric additions provide range of flexibility, unchanged by temperature changes
        i. Used for total device fabrication
        ii. Used as soft liners in dual laminates (see 2.b. below, under Elastomeric Polymers)
2. Elastomeric polymer liners: flexible at room temperature
    a. Poly-ethylene-vinyl Acetates; may be shaped by salt and pepper
    b. PMMA elastomeric polymers; may be shaped by milling, claim to have better bond to hard PMMA shell
    c. Proprietary names and nicknames (e.g., BFlex™, flex, hard-soft, dual-laminate)
3. Thermalplastic polymer blends: hard at room and mouth temperatures
    a. Biodegradable polyesters
    b. Available as beads or wafers, liquify at 160°F, 130°C
    c. Proprietary names (e.g., ThermAcryl™ and Acufit™)
4. Thermo-formed plastics: moldable above a certain temperature that solidifies upon cooling
    a. Pressure formed sheets
    b. Device manufacturing possible in clinic
5. Polyamides (e.g., nylon)
    a. Nylon fibers provide flexibility and tensile strength
    b. Biocompatible
    c. 3D printing by selective laser sintering (SLS) of powdered nylon
6. Class II photopolymerizing resins: as defined in classification of dental materials
    a. Various materials and corresponding properties
    b. Referred to as "long-term" to distinguish from materials that degrade easily
    c. Biocompatible
    d. 3D printing with specified energy wavelength via laser, LCD, projector, LED, halogen light, LED, fluorescent bulb, etc.

7. Laminates
    a. Layered materials in combinations to optimize properties
    b. Rigid Polyacrylic, PMMA shell combined with liner that provides retention
        i. Elastomeric Polymers (e.g., flex, hard soft, BFlex™, dual-laminate)
        ii. Thermalplastic polymer blends (e.g., ThermAcryl™ and Acufit™)

Retention Mechanism

Retention is achieved through flexion into undercuts and frictional resistance to displacement. What should be considered during design: tooth height, undercuts, anatomy and angulation, missing teeth or compromised teeth, path of placement and removal. In alphabetical order:

1. Dual-laminate liner flexion (i.e., rigid shell with elastomeric polymer liners)
2. Elastomeric polyacrylics flexion-retain flexibility at all temperatures
3. Metal wire flexion
    a. Distal molar wrap, used when interocclusal space is limited
    b. Interproximal ball clasps, C clasps
4. Polyamide elastomeric flexion (e.g., nylon)
5. PMMA milled: precise frictional retention, with less ability to flex
6. Thermal-sensitized elastomeric polyacrylic flexion: run under hot water before insertion
7. Thermo-formed plastic flexion: thin sheets
8. Thermoplastic polymer blends: molded and remolded for precise frictional retention and fit (e.g., ThermAcryl™ and Acufit™)

Extension

What should be considered during design: device materials and manufacturer's unalterable areas of bulk or extension that could interfere with unique oral anatomy (e.g., exostosis, tongue position, lip length and seal, coronoid process) or mandibular or dental alignment (e.g., Curve of Spee, Curve of Wilson, deep overbite, steep mandibular plane angle). In alphabetical order:

1. Fully edentulous or edentulous areas
2. Teeth and extension beyond teeth
3. Teeth only
4. Teeth-partial lingual coverage or lingual-less
5. Teeth-partial occlusal coverage

Attachment and Propulsion

What should be considered during design: PDAC guidelines, patient's ability to open mouth or move mandible laterally with device retained, force vectors of connection mechanism with implications on compromised dentition or retention during mandibular movements, flexibility of propulsion mechanism, hardware impact on soft tissues. In alphabetical order:

1. Attached
    a. Bilateral compression
    b. Bilateral traction
    c. Midline traction

    d. Other
2. Unattached
    a. Bilateral interlocking
    b. Other
3. Semi-attached
    a. Elastics to encourage mouth closure

Protrusive Mechanism and Protrusive Range of Motion (pROM)
What should be considered during design: patient's pre-treatment pROM and treatment goal position. Consider patient's dexterity if self-advancement planned and ability to advance while being worn. Consider possibility of adding CPAP hybrid therapy. In alphabetical order:

1. Incremental units or exchangeable pieces
2. Screw turn
3. Strap or elastic band change

Occlusal Support
What should be considered during design: parafunctional habits, concern for joint support, muscle function, tongue space, vertical interocclusal space. In alphabetical order:

1. Anterior only, discluding
2. Full occlusal
3. Posterior only
4. Tripod

Customizable Options
In alphabetical order:

1. Accommodation for mouth breathing
2. Anterior ramp
3. Attachment for PAP
    a. Adaptable chairside with pre-manufactured components
    b. Lab adaptation
4. Elastic attachments to promote mouth closure
5. Minimal interocclusal distance, cut away of most distal or hyper erupted teeth
6. Open screws during fabrication to allow for retrusive ROM
7. Reinforcement with metal for strength
8. Changeable propulsion options
9. Externally titratable

Nomenclature for Protrusive Bite Gauges

As with device selection, the AADSM Mastery Program provides an overview of protrusive bite acquisition. The AADSM Mastery Program uses the following category descriptors to review the many styles of bite gauges and to educate dentists on the best practices for bite acquisition. In alphabetical order:

1. Horizontal sliding bite gauge
2. Horizontal sliding bite gauge with vertical adjustments
3. System of horizontal positioning simulators and vertical keys
4. Three-axis bite gauge