INTRODUCTION

• The wax pattern is a precursor of the finished cast restoration that will be placed on the prepared tooth.
• In as much as the wax pattern will be duplicated exactly through the investing and casting technique, the final restoration will be no better than its wax pattern i.e., errors and oversights in the wax pattern will only be perpetuated in the casting.
Methods of fabrication of wax pattern

• Direct method: in which, the pattern is waxed on the prepared tooth, in the mouth
• Indirect method: in which, the pattern is waxed on a stone cast made from an accurate impression of the prepared tooth
• Advantages of indirect technique – affords an opportunity for visualization of restoration and ready access to waxing the margins
WAXES USED

• Direct technique – type I wax is used
• Indirect technique – type II wax is used – slightly lower melting temperature than type I
• The wax used should meet ADA specification no 4
IDEAL REQUIREMENTS

- It must flow readily when heated, without chipping, flaking, or losing its smoothness.
- When cooled, must be rigid.
- It must be capable of being carved precisely without chipping, distorting or smearing.
- The wax should of some color, such as blue, green, or red that will contrast with and be easily distinguishable from the stone die.
WAX PATTERN FABRICATION

• ARMAMENTARIIUM:

• PKT [Thomas] waxing instruments [no.1, no.2, no. 3, no 4, and no.5]
• Beavertail burnisher
• No 7 wax spatula
• Sable brush
• No.2 pencil
• Laboratory knife with no.25 blade
• Cotton pliers
• Bunsen burner
• Inlay casting wax
• Zinc stearate powder
• Die lubricant
Wax is added by heating the instrument in the bunsen flame, touching it to the wax, and quickly reheating it shank in the flame.

Wax flows away from the hottest part of the instrument, so if the shank is heated, a bead of wax will flow off the tip.

However, if the tip is heated, the wax will flow up the shank of the instrument.
The following sequence is recommended for wax pattern fabrication:

- Internal surface.
- Wax pattern removal and evaluation.
- Proximal surfaces.
- Axial surfaces.
- Incisal/occlusal surface.
- Margin finishing.
• Internal surface: the wax must reproduce all the retentive features of the restoration.
Wax pattern removal: Wax pattern should be allowed to cool thoroughly before the coping is removed from the die.
• Wax pattern evaluation: The objective of the first waxing step is a perfectly adapted reproduction of the prepared tooth surfaces.
Coping fabrication

• First step – fabrication of a thin coping / thimble, on the die
• It is made of wax, but heated resin sheets can also be used
• Vacuum adapted polystyrene and pressure formed polypropylene have been used for making metal ceramic crown patterns
• It serves as a foundation for the axial contours and occlusal morphology
• To prevent the wax from sticking to the stone die, it is coated with a die lubricant and allowed to soak for several minutes. Repeat application if the die appears dry. Remove any excess lubricant with a gentle stream of compressed air
• Flow wax over the surface of the preparation on the die, using quick strokes of a hot no 7 wax spatula. Overlap and remelt the margins of wax already placed on the die – to prevent flow lines or voids.

• Dipping the die into a small metal container filled with molten wax is another method that can be used for developing a uniform, thin initial coping of wax on the die
• To ensure that the finished restoration will have adequate proximal contact with the adjacent teeth, the wax pattern should be slightly oversized mesiodistally – to provide enough bulk in the contact areas to allow casting, finishing, and polishing without creating an open contact in the finished restoration.

• The best way for achieving this is to remove a small amount of stone from the proximal surfaces of the cast on either side of the prepared tooth.
Axial contours

- The proximal contacts of posterior teeth are located in the occlusal third of the crowns except between the maxillary first and second molars, which is located in the middle third.
- The contact must be more than just a point occlusogingivally, but it must not extend far enough cervically to encroach on the gingival embrasure.
- The axial surface of the crown cervical to the contact point should be flat or slightly concave.
• A flat contour may be the optimal shape as it is the easiest to floss.
• Proximal contacts are located slightly to the facial aspect of the middle of the posterior teeth, except between the maxillary first and second molars, which is located in the center faciolingually
• Contacts that are too narrow allow fibrous foods to wedge between the teeth, while contacts that are wide facioligually do not adequately deflect food from the gingival tissue
• The facial and lingual contours should be in harmony with those of the adjacent teeth

• Height of contour on the facial surface of all posterior teeth extends horizontally 0.5mm beyond the plane of the tooth.

• On the lingual surface of the maxillary teeth and mandibular first premolars, the height of contour extends about 0.5mm, but it increases to 0.75 mm on the mandibular second premolar and nearly 1mm on mandibular molars
• Incisal/occlusal surface: Opposing incisors should make even contact during protrusive movements but not during lateral excursions. The cusps and ridges of the occlusal surfaces should be shaped as to allow even contact with the opposing teeth while stabilizing the teeth and directing the forces along the long axes of the teeth.
• Margin finishing: For finalizing and adaptation, the margins should be reflowed and refinshed immediately prior to investing the wax pattern.
• STEIN and KUWATA described emergence profile as the part of the axial contour that extends from the base of the gingival sulcus past the free margin of the gingiva
• the emergence profile extends to the height of contour, producing a straight profile in the gingival third of the axial surface
• Production of a straight profile should be the treatment objective in restoring a tooth, as it facilitates access for oral hygiene measures
• The most common error relating to axial contour is the creation of a bulge or excessive concavity

• Overcontoured restorations with large convexities promote the accumulation of food debris and plaque, and gingival inflammation results.
OCCLUSAL MORPHOLOGY

• Waxing of the occlusal surface is deferred until the axial surfaces are essentially complete
• Functional cusps – palatal cusps of the maxillary posterior teeth and buccal cusps of the mandibular posterior teeth – help in grinding of food
• Non–functional cusps – buccal cusps of the maxillary molars and the lingual cusps of the mandibular molars – act as a rim of a pestle to prevent food from overflowing
## Classification of occlusal arrangements

<table>
<thead>
<tr>
<th></th>
<th>Cusp -fossa</th>
<th>Cusp –marginal ridge</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Location of occlusal</strong></td>
<td><strong>Occlusal fossa</strong></td>
<td><strong>Occlusal fossae and marginal ridges</strong></td>
</tr>
<tr>
<td>contact on opposing</td>
<td><strong>Occlusal forces directed parallel to long axis of tooth- very little lateral stress</strong></td>
<td><strong>Most natural type of occlusion -95% of adults. Can be used for single restorations</strong></td>
</tr>
<tr>
<td><strong>Relation with opposing</strong></td>
<td><strong>Tooth –to - tooth</strong></td>
<td><strong>Tooth-to-two-teeth</strong></td>
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<tr>
<td>teeth</td>
<td></td>
<td></td>
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<tr>
<td><strong>advantages</strong></td>
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<tr>
<td><strong>disadvantages</strong></td>
<td><strong>Rarely found in natural teeth – used only when restoring several contacting teeth</strong></td>
<td><strong>Food impaction and displacement of teeth may arise if the functional cusps wedge into the lingual embrasure</strong></td>
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<tr>
<td><strong>applications</strong></td>
<td><strong>Full mouth reconstruction</strong></td>
<td><strong>Most cast restorations</strong></td>
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### Mandibular cusp placement

<table>
<thead>
<tr>
<th>Mandibular buccal cusps</th>
<th>Maxillary occlusal surfaces</th>
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</thead>
<tbody>
<tr>
<td>Cusp-marginal ridge</td>
<td>Cusp-fossa</td>
</tr>
<tr>
<td>First premolar</td>
<td>M marginal ridge of 1(^{st}) PM</td>
</tr>
<tr>
<td></td>
<td>M fossa of the 1(^{st}) PM</td>
</tr>
<tr>
<td>Second premolar</td>
<td>D marginal ridge of 1(^{st}) PM</td>
</tr>
<tr>
<td></td>
<td>and M marginal ridge of 2(^{nd}) PM</td>
</tr>
<tr>
<td></td>
<td>M fossa of the 2(^{nd}) PM</td>
</tr>
<tr>
<td>MB cusp of first molar</td>
<td>D marginal ridge of 2(^{nd}) PM</td>
</tr>
<tr>
<td></td>
<td>and M marginal ridge of 1(^{st}) M</td>
</tr>
<tr>
<td></td>
<td>M fossa of the 1(^{st}) M</td>
</tr>
</tbody>
</table>
DB cusp of first molar  C fossa of the 1st molar  C fossa of the 1st M
D cusp of first molar  Usually not functional  D fossa of the 1st M
MB cusp of 2nd molar  D marginal ridge of 1st M  M fossa of the 2ND M
& M marginal ridge of 2nd M
DB cusp of 2nd molar  C fossa of the 2nd molar  C fossa of the 2nd M
D cusp of 2nd molar  Usually not present Usually non-functional
## MAXILLARY CUSP PLACEMENT

<table>
<thead>
<tr>
<th>Maxillary lingual cusps</th>
<th>Mandibular occlusal surfaces</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cusp-marginal ridge</td>
<td>Cusp-fossa</td>
</tr>
<tr>
<td>First PM</td>
<td>D fossa of 1&lt;sup&gt;st&lt;/sup&gt; PM</td>
<td>D fossa of 1&lt;sup&gt;st&lt;/sup&gt; PM</td>
</tr>
<tr>
<td>SECOND PM</td>
<td>D fossa of 2&lt;sup&gt;nd&lt;/sup&gt; PM</td>
<td>D fossa of 2&lt;sup&gt;nd&lt;/sup&gt; PM</td>
</tr>
<tr>
<td>ML cusp of 1&lt;sup&gt;st&lt;/sup&gt; M</td>
<td>C fossa of 1&lt;sup&gt;st&lt;/sup&gt; M</td>
<td>C fossa of 1&lt;sup&gt;st&lt;/sup&gt; M</td>
</tr>
<tr>
<td>DL cusp of 1&lt;sup&gt;st&lt;/sup&gt; M</td>
<td>D marginal ridge of 1&lt;sup&gt;st&lt;/sup&gt; M &amp; M marginal ridge og 2&lt;sup&gt;nd&lt;/sup&gt; M</td>
<td>D fossa of 1&lt;sup&gt;st&lt;/sup&gt; M</td>
</tr>
<tr>
<td>ML cusp of 2&lt;sup&gt;nd&lt;/sup&gt; M</td>
<td>C fossa of 2&lt;sup&gt;ND&lt;/sup&gt; M</td>
<td>C fossa of 2&lt;sup&gt;nd&lt;/sup&gt; M</td>
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<td>D fossa of 2&lt;sup&gt;nd&lt;/sup&gt; M</td>
</tr>
</tbody>
</table>
CUSP-MARGINAL RIDGE ARRANGEMENT

• This technique was originally devised by EV Payne. It was the first wax-added technique for functional waxing
CUSP-MARGINAL RIDGE FOR MAXILLARY TEETH
Gnathologic Concept: Tripodism

• A cusp fossa relation in which the centric cusp makes contact with the occlusal fossa of the opposing tooth at three points of each cusp in each opposing fossa.

• The three contact points are the three ridges which form the fossa against the opposing centric cusp.

• Achieved because of the rounded nature of the cusp ridges.
• Tripod contacts are immediately separated when the mandible performs lateral excursions and protrusive excursions

• The centric contacts are immediately discluded into groove or into interproximal embrasures
• Advantages of Tripodism:
  – *Minimum wear of the cusps tips and cusp shapes is maintained* → prevents the tip of a cusp to come into contact with the fossa of the opposing tooth
  – *Gives Stability to Centric Occlusion* → forces are directed near the centre of the tooth
  – *Distributes Forces on an Individual Tooth* → Allows a multiplicity of pin point contacts
  – *Soft Tissue Protection* → minimum lateral force placed on the tooth is better tolerated by the periodontal membrane
  – *Keeps the Interproximal Contacts Intact*
Additive Technique
Additive technique

• Provides an organized step-by-step procedure to develop the occlusal anatomic form
• Better understanding of the effects of articulation on the individual elements of the occlusal form than the carving technique
Step 1: Buildup of Cones

• Centric Cusp tips are developed
• Centric cones placed at the appropriate mesiodistal position on the BO or LO lines.
• Diameter of the base of the cone is one third of the mesiodistal diameter of the respective cusp
For a Maxillary 1\textsuperscript{st} Molar...

- Give sufficient space to wax the centric cusp ridge and triangular ridges
- Wax the mesiolingual cusp to contact a flat area located in the central fossa of the mandibular 1\textsuperscript{st} molar
- Then wax the distolingual cusp to contact the marginal ridge of the mandibular 1\textsuperscript{st} molar

\textit{DEVELOP THE CONTACTS ONLY ON THE CUSP TIPS}
Fig 19-15  Cones for buccal cusps: P.1T no. 1.

Fig 19-16  Buccal ridges and triangular ridges: P.1T no. 1.

Fig 19-17  Mesial and distal cusp ridges for buccal cusps: P.1T no. 1.

Fig 19-18  Cones for lingual cusps: P.1T no. 1.
Step 2: Mesial and Distal Marginal Ridges

- Develop the mesial and distal marginal ridges in a triangular shape with the apex on the triangle at the occlusal pit.
- Mesial marginal ridge should contact the opposing cusp on the central fossa line.
- Distal marginal ridge should be formed to the same height as the adjacent marginal ridges.
- From occlusal view: marginal ridges should converge to the lingual, creating a greater lingual than buccal embrasure.
Step 3: Central Fossa Contact Area

• Contact area should have a superior surface that is slightly convex with the highest point at the center.

• From occlusal view: area is rhomboidal shaped with each apex fitting into a development occlusal groove

• Mesiodistal and buccal diameters should be approx 2mm
Fig 19-19  Mesial and distal cusp ridges for lingual cusps: PKT no. 1.

Fig 19-20  Lingual ridges and triangular ridges: PKT no. 1 and no. 4.

Fig 19-21  Marginal ridges: PKT no. 1.

Fig 19-22  Supplemental anatomy: PKT no. 3 and no. 5.
Step 4: Lingual Cusp Ridges

- Should have a definite convexity between the lingual height of contour and the cusp tip
- From lingual View: Should be triangular with apex at the cusp tip and base at the wax coping

- SHOULD NOT MODIFY THE EXISTING CUSP TIPS – THEY DO NOT CONTACT THE OPPOSING TEETH IN CENTRIC AND ECCENTRIC POSITIONS
Fig 19-23: Cones for buccal cusps: PKT no. 1.

Fig 19-24: Buccal ridges: PKT no. 1.

Fig 19-25: Mesial and distal cusp ridges for buccal cusps: PKT no. 1.

Fig 19-26: Triangular ridges: PKT no. 1.
Step 5: Mesial and Distal Lingual Cusp Ridges

- Should not alter the cusp tip
- Should provide physiologic occlusal embrasures and proper transitional line angles.
- Most not contact the opposing tooth
- Should leave sufficient space for the triangular and oblique ridges.
Fig 19-27 Cones for lingual cusps. Pkt no. 1.

Fig 19-28 Triangular ridges. Pkt no. 1.

Fig 19-29 Marginal ridges. Pkt no. 1.

Fig 19-30 Supplemental anatomy. Pkt no. 3 and no. 5.

Form marginal ridges by joining the buccal and lingual cusp ridges (Fig 19-29). The form of the mesial marginal ridges on mandibular premolars and first molars is determined entirely upon function.

Each cusp should make contact with the occlusal fossa of the opposing tooth at three points. The contact points are on the cusp.
Step 6: Functional Cusp Triangular Ridges

- Extends from the cusp tip to the central fossa.
- Should be convex from the cusp tip to the central fossa and from the mesial to the distal aspect.
- Should have a greater mesiodistal width at the central fossa than at the cusp tip and should slope down from the cusp tip to the fossa.
• Supplemental grooves should be developed to separate the mesial and distal aspects of the lingual cusp ridges from the respective ML and DL triangular ridges.
Step 7: Non-Centric Cusp tips

- Should be developed on the corresponding BO line
- Should vertically and horizontally overlap the opposing tooth in the occluded position.
- In laterotrusion these cusps are developed to pass through the embrasures and grooves of the opposing teeth without contact.
- Sufficient room should be provided to allow wax up of the surrounding cuspal ridges.
Step 8: Buccal Cusp Ridges

- Should blend into the buccal cusp cones
- Should be triangular with apex at the cusp tip and base on the wax coping
- Should not modify the existing cusp tip
- No contact with the opposing tooth in centric and eccentric positions
Step 9: Mesiobuccal and Distobuccal cusp ridges

- Each has a slight convexity between the buccal crest of contour and the BO line.
- Do not modify the existing cusp tip or contact any opposing tooth surface in any centric or eccentric position.
- Transition should be continuous with the remaining wax pattern providing physiologic embrasures.
- Inner aspects are convex surfaces that slope down into the marginal ridges and form the buccal portion of the MB and DO Fossa.
- Mesiobuccoocclusal and distobuccoocclusal point angles should align buccolingually with the point angle of the adjacent teeth providing physiologic occlusal embrasure.
Step 10: Buccal Cusp Triangular Ridges

• Should be convex in all dimensions.
• Greater MD width at the central fossa line than the cusp tip line.
• Supplemental grooves are developed to separate the mesial and distal aspects of the buccal cusp triangular ridges from the respective inner aspects of the MB and DB cusp ridges.
• Do not contact the opposing teeth in any centric or eccentric position.
Subtractive Technique
• Develop Axial Contours on the dies.
• Block out areas of the functional core that should not contact the wax.
• Lubricate the blocked out core
• Warm the tip of a chip blower
• Heat each occlusal surface separately with warm air stream from the chip blower
• Close the lubricated functional core onto the soft occlusal wax and observe the wax pattern
• Repeat the above procedure for each wax pattern.
• Close the functional core into all the wax patterns at the same time, making sure the guide pin touches the table
• Coat the occlusal of the anatomic cast
• Close the anatomic cast into the wax pattern making the contacts in white on the wax patterns
• Carve anatomic contours into the occlusal surface, taking care to avoid carving away the white occlusal contacts
• Round the carved occlusal of the wax pattern of the wax pattern with a gentle warm air stream from a heated chip blower
• Close the functional into the warmed occlusal of the wax pattern.
• Remove any excess wax and round any flattened areas with a carving instrument
• Smooth the occlusal of the wax pattern with a gentle, warm air stream from a heated chip blower and check the finished wax pattern both the functional core and the anatomic cast.
MARGIN FINISHING

• The margin is critically important area of any wax pattern. While a good margin may not insure the success of a casting, a poor one can almost guarantee its failure
• Smooth any roughness on the axial surface with a slightly warm beavertail burnisher.
• Any excess wax is carved almost to the margin with a PKT no4.
• Finish carving the margin with a slightly warm beavertail burnisher
• Do not approach the finish line on the die with a sharp instrument as it can remove die material as well as the wax margins, resulting in a casting that will not fit the prepared tooth
• OVERWAXED MARGINS: areas in which wax has been carried past the finish line may break off when the pattern is withdrawn from the die, resulting in a short or shy margin. If the overwaxes area does not break off, it may spring back. When cast in metal, this area will no longer bend as it once did in wax, and the casting may be prevented from seating all the way on the tooth

• SHORT MARGINS: will not provide an adequate seal for the finished restorations
• RIPPLES: any roughness in wax near the margin will be duplicated in the casting. If allowed to remain on the finished, cemented restorations, these areas act as collecting point for plaque, leading to irritation and inflammation of the gingival tissue.

• THICK MARGINS: a thick, rounded margin will result in poor sealing of the restoration and poor axial contours that will ultimately lead to periodontal problems. The margins must come to a knife edge.

• OPEN MARGINS: attention to detail is essential to produce close margins. The pattern must be burnished and melted, as well as cut, to ensure close adaptation of the wax to the die in the marginal areas.
• To finish the occlusal grooves, hold a very small cotton pellet in cotton pliers and dip it in the die lubricant. Run the pellet carefully through the grooves
• Same method is employed to finish the axial surfaces.
• Avoid excessive or prolonged buffing action near margins
• Remove all lubricant from pattern once polishing is over. Any lubricant left on the pattern when it is invested can cause surface roughness
• Depressions cannot be polished away. They are better removed by filling them with wax and then smoothening them

• The purpose of finishing is to provide a smooth surface for casting

• Wax is softer than metal. Anything that can be done in wax, as opposed to doing it later in metal, should be. In wax, anything can be done in a fraction of time, with less effort, and with better results.