

# Downs' analysis template transparencies for application directly to cephalometric x-ray films

ALFRED T. BAUM, D.D.S., M.S.D.  
Los Angeles, California

When Downs<sup>1</sup> published the set of values which has come to be known as Downs' Analysis, he placed at the orthodontist's disposal a systematized analytical diagnostic procedure of inestimable value. The accepted manner of analyzing a cephalometric x-ray according to the method of Downs is first the preparation of a tracing of the x-ray image from the film by the use of some type of transilluminated drawing table and translucent drawing paper. Then, according to the location of the anatomical landmarks involved, the various planes and angles are laid out and their magnitude and relation to each other determined. The numerical values so obtained are then compared with Downs' normal mean values and ranges.

The complexity of this procedure and its time consuming nature have militated against its use among many men who are, however, keenly aware of the significance and value of Downs' analysis. It was, therefore, the object of the author to devise a less involved system of applying Downs' analysis directly to the x-ray films themselves, without the necessity of making tracings.

The method which promised the most success was that which had been employed by Wylie<sup>2</sup> for similar angular measurement systems. This was a series of transparencies on which were outlined the normal limits of a particular relationship from a base line or grid. Wherever practical, the templates have been devised so that as many measurements as possible can be made from each.

In the interest of sound statistical evaluation the limits of the normal range have been established by the employment of the mean plus and minus two standard deviations, rather than Downs' range of observed values. Thus the magnitude of variation from the mean outlined on the transparencies includes 95% of the population.

## LANDMARKS AND PLANES USED IN DOWNS' ANALYSIS

*In the Order in which they are required for use with the templates. (Fig. 1)*

*Frankfort horizontal plane.* The plane determined by a line drawn from porion, the machine registration of the superior border of the external auditory meatus, to the lower border of the bony orbits. (It might be found helpful to draw this plane directly on the x-ray film. This may be done with an ordinary pen.)

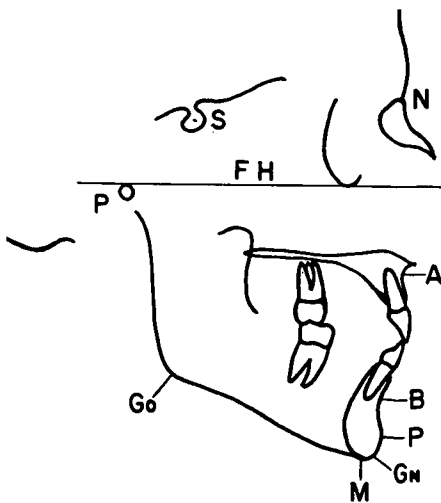


Fig. 1. Land marks used in Downs' Analysis.

# DOWN'S' ANALYSIS TEMPLATE I

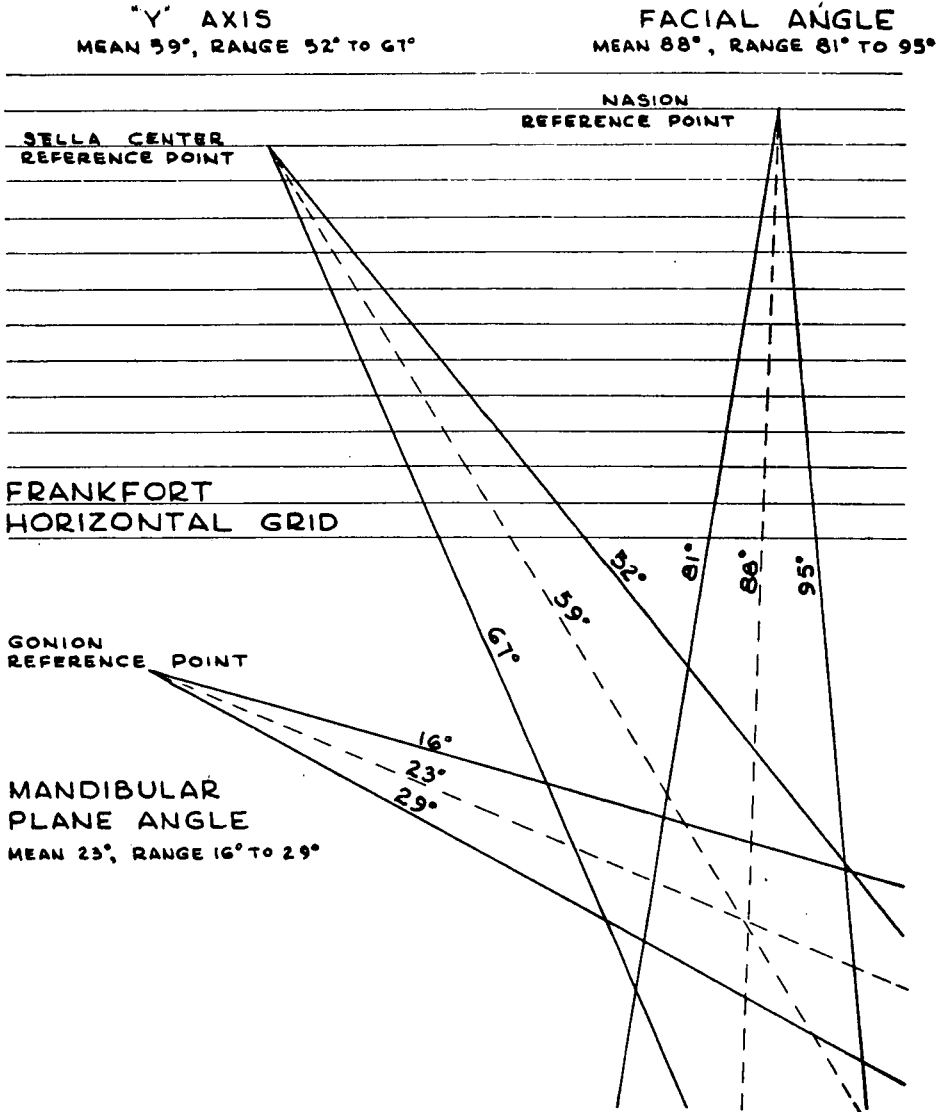


Fig. 2. Template I; for determination of Facial Angle, Mandibular Plane Angle, and Y Axis.

*Nasion.* The fronto-nasal suture, or junction of the frontal and nasal bone.

*Pogonion.* The most anterior point on the symphysis of the mandible.

*Gonion.* The most outward everted point on the angle formed by the junction of ramus and body of the mandible on its posterior inferior aspect. (The angle of the mandible).

*Menton.* The most inferior point on the symphysis of the mandible.

*Sella Turcica.* The center of the bony crypt occupied by the pituitary body. This usually appears in the form of a somewhat flattened  $\frac{3}{4}$  circle, its open segment directed upward.

*Gnathion.* The most downward everted point on the profile of the symphysis of the mandible. (The chin point).

*Point A.* The most inward point on the concave curved line from the maxillary anterior nasal spine to the crest of the maxillary alveolar process.

*Point B.* The most inward point on the concave curved line from the crest of the mandibular alveolar process to pogonion.

*Facial Plane.* The plane determined by a line drawn from nasion to pogonion.

*Occlusal Plane.* The plane determined by a line drawn from the occlusal termination of the buccal groove of the lower left first permanent molar, and bisecting the overbite at its anterior end.

#### USE OF THE TEMPLATES

The templates should be laid directly on the cephalometric x-ray films. For best results some sort of transillumination should be employed. This may be a conventional x-ray viewbox. Templates must be re-oriented for each measurement.

##### Template I (Fig. 2)

For the Determination of:

- A. Facial Angle
- B. Mandibular Plane Angle
- C. Y Axis

#### *Facial Angle*

This angle is established by the intersection of the facial plane with Frankfort horizontal. Numerical value of the angle tends to increase with prominence of the chin.

Orient the template so that the nasion reference point of the template lies on nasion of the x-ray and the Frankfort horizontal grid lines on the template are parallel to the Frankfort horizontal plane of the x-ray. (See Fig. 3) The Facial Angle is then read from the location of pogonion with reference to the lines radiating from the nasion reference point. The dashed center line indicates the mean facial angle of  $88^\circ$ . The normal range is delineated by the solid line at either side. If pogonion falls outside the Facial Angle Triangle, the facial angle is beyond normal limits.

#### *Mandibular Plane Angle.*

This angle is established by the hypothetical intersection of the mandibular plane with Frankfort horizontal. High numerical value indicates a steep mandibular border.

Re-orient the template so that the gonion reference point of the template lies on the gonion of the x-ray, keeping the Frankfort horizontal grid lines of the template parallel to the Frankfort horizontal plane of the x-ray. The mandibular plane angle is then read from the location of menton with reference to the lines radiating from the gonion reference point. The dashed center line indicates the mean Mandibular Plane Angle of  $23^\circ$ . The normal range is delineated by the solid line at either side. If the menton falls outside the Mandibular Plane Angle triangle the mandibular plane angle is beyond normal limits.

#### *Y-Axis.*

This angle is often designated as the growth axis which is followed by the

## DOWNS' ANALYSIS TEMPLATE I

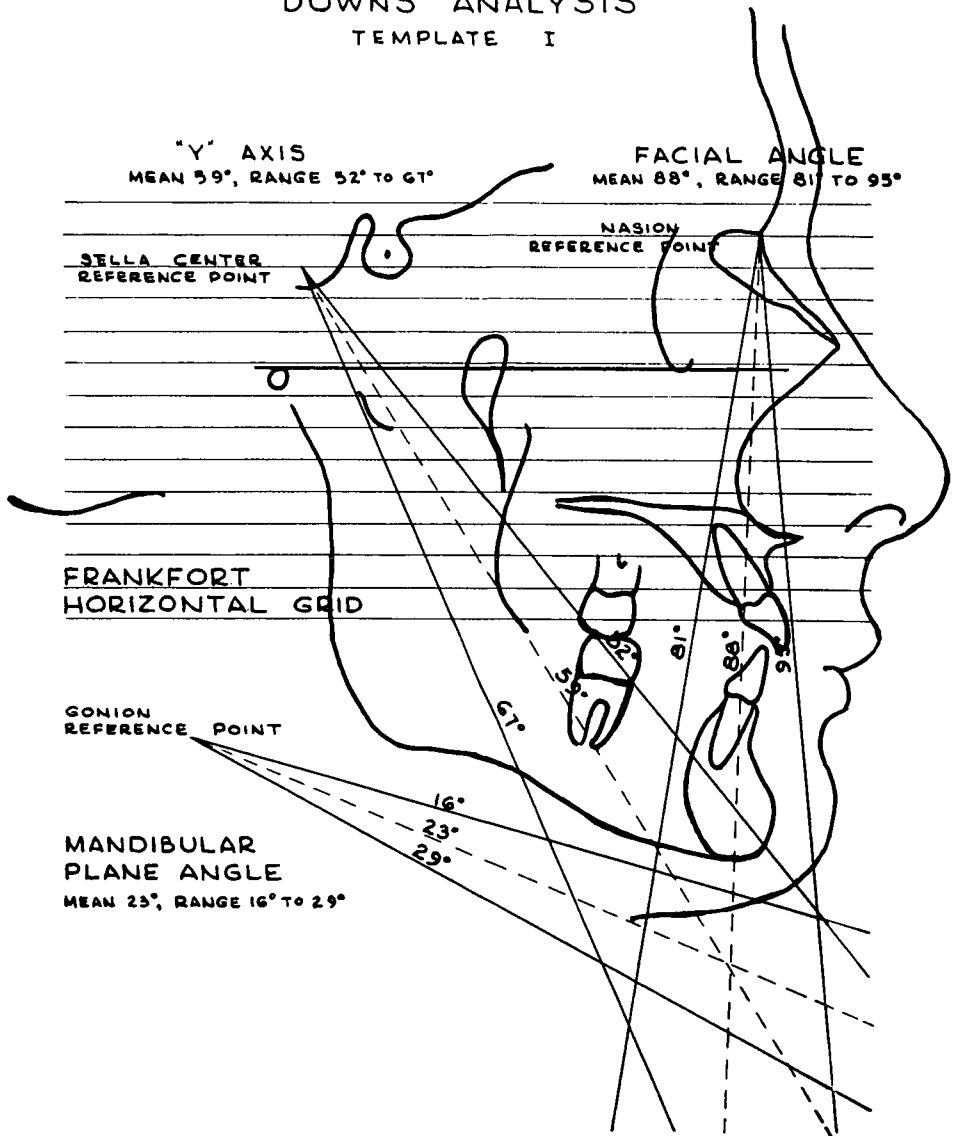


Fig. 3. Template I oriented over head plate for determination of Facial Angle. Note nasion reference point of the template on nasion of the x-ray; and the Frankfort Horizontal Grid lines of the template parallel to the Frankfort Horizontal Plane of the x-ray. The Facial Angle is read from the location of pogonion with reference to the lines radiating from the nasion reference point. The dashed center line indicates the mean Facial Angle of 88°. The solid lines on either side delineate normal range. The actual numerical value of the Facial Angle in this case is 91.5°.

DOWN'S' ANALYSIS  
TEMPLATE II

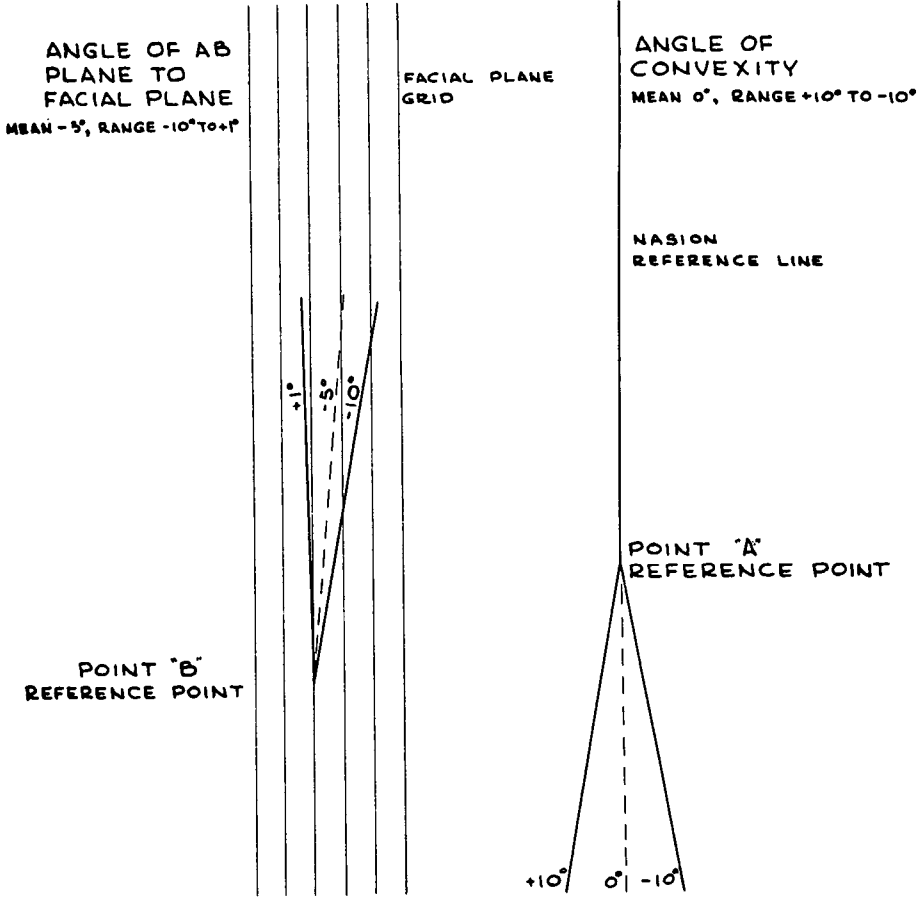


Fig. 4. Template II; for determination of Angle of Convexity and Angle of AB Plane to Facial Plane.

chin point in downward and forward growth. The numerical value of this angle increases with prominence of the chin.

Re-orient the template so that the sella center reference point of the template lies at the center of the sella turcica of the x-ray, keeping the Frankfort horizontal grid lines of the template parallel to the Frankfort horizontal plane of the x-ray. The Y Axis

is similarly read from the location of gnathion with reference to the lines radiating from the sella center reference point. The dashed center line indicates the mean Y axis of 59°. The normal range is delineated by the solid line at either side. If gnathion falls outside Y Axis limits, the Y axis is beyond normal limits.

Template II (Fig. 4)

For the Determination Of:

## DOWNS' ANALYSIS

### TEMPLATE III

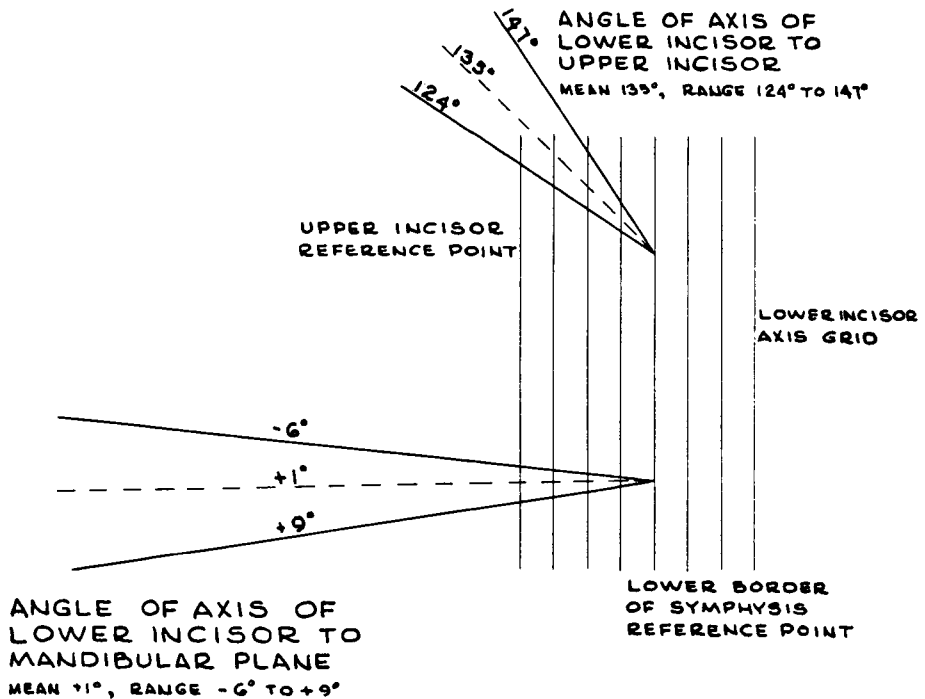


Fig. 5. Template III; for determination of Angle of the Axis of the Upper Central Incisor to the Axis of the Lower Central Incisor, the Angle of the Axis of the Lower Central Incisor to the Mandibular Plane, and the Angle of the Axis of the Upper Central Incisor to the Axis of the Lower Incisor.

- A. Angle of Convexity.
- B. Angle of AB Plane to Facial Plane.

#### *Angle of Convexity*

This angle is a measure of the antero-posterior position of the maxillary denture base in relation to the rest of the profile. The higher the positive value the more prominent is the maxillary denture base.

Orient template so that the point A reference point of the template falls at point A on the x-ray and the nasion reference line of the template passes

through nasion of the x-ray. The angle of convexity is read from the location of pogonion with reference to the lines radiating from the point A reference point. The dashed center line indicates the mean Angle of Convexity of zero degrees. The normal range is delineated by the solid line at either side. If pogonion falls outside the Angle of Convexity triangle, the angle of convexity is beyond normal limits.

#### *Angle of AB Plane to Facial Plane*

This angle is a measure of the harmony in the anteroposterior positions

of maxillary and mandibular denture bases. The larger the negative numerical value the more retrusive the lower denture base in relation to the upper.

Re-orient template so that the facial plane grid of the template lies parallel to the facial plane of the x-ray and point B reference point of the template falls at point B of the x-ray. The Angle of AB Plane to Facial Plane is read from the location of point A with reference to the lines radiating from point B reference point. The dashed center line indicates the mean Angle of AB plane to Facial Plane of  $-5^\circ$ . The normal range is delineated by the solid line at either side. If point A falls outside the AB Plane to Facial Plane triangle, the Angle of AB Plane to Facial Plane is beyond normal limits.

Template III (Fig. 5)

For the Determination of:

- A. The Angle of the Axis of the Upper Central Incisor to the Axis of the Lower Central Incisor.
- B. The Angle of the Axis of the Lower Central Incisor to the Mandibular Plane.

*The Angle of the Axis of the Upper Central Incisor to the Axis of the Lower Incisor.*

A measure of the uprightness of the upper and lower central incisors with reference to each other. The higher the numerical value the more upright the incisors.

Orient template so that the lower incisor axis grid of the template is parallel with the long axis of the lower central incisor of the x-ray and the upper central incisor reference point of the template is on the incisal edge of the upper central incisor of the x-ray. The Angle of the Axis of the Upper Central Incisor to the Axis of the Lower Central Incisor is read from the location of apex of the root of the upper central

incisor with reference to the lines radiating from the upper incisor reference point. The dashed center line indicates the mean Angle of the Axis of the Upper Central Incisor to the Axis of the Lower Central Incisor of  $135^\circ$ . The normal range is delineated by the solid line on either side. If the apex of the root of the upper central incisor falls outside this triangle the Angle of the Axis of the Upper Central Incisor to the Axis of the Lower Central Incisor is beyond normal limits.

*Angle of the Axis of the Lower Central Incisor to the Mandibular Plane*

This angle is a measure of the uprightness of the lower central incisor with reference to the occlusal plane. It is read as amount of deviation from right angle, with positive values indicating forward inclination of the teeth.

Reorient the template so that the lower border of symphysis reference point of the template lies on the lower border of the symphysis of the x-ray and the lower incisor axis grid of the template is parallel to the lower central incisor of the x-ray. The Angle of the Axis of the Lower Central Incisor to the Mandibular Plane is read from the location of gonion with reference to the lines radiating from the lower border of symphysis reference point. The dashed center line indicates the mean Angle of the Axis of the Lower Central Incisor to the Mandibular Plane of  $-1^\circ$ . The normal range is delineated by the solid line on either side. If gonion falls outside this triangle the Angle of the Axis of the Lower Central Incisor to the Mandibular Plane is beyond normal limits.

Template IV (Fig. 6)

For the Determination of:

- A. Cant of the Occlusal Plane
- B. Angle of the Axis of the Lower Central Incisor to the Occlusal Plane.

## DOWNS' ANALYSIS TEMPLATE IV

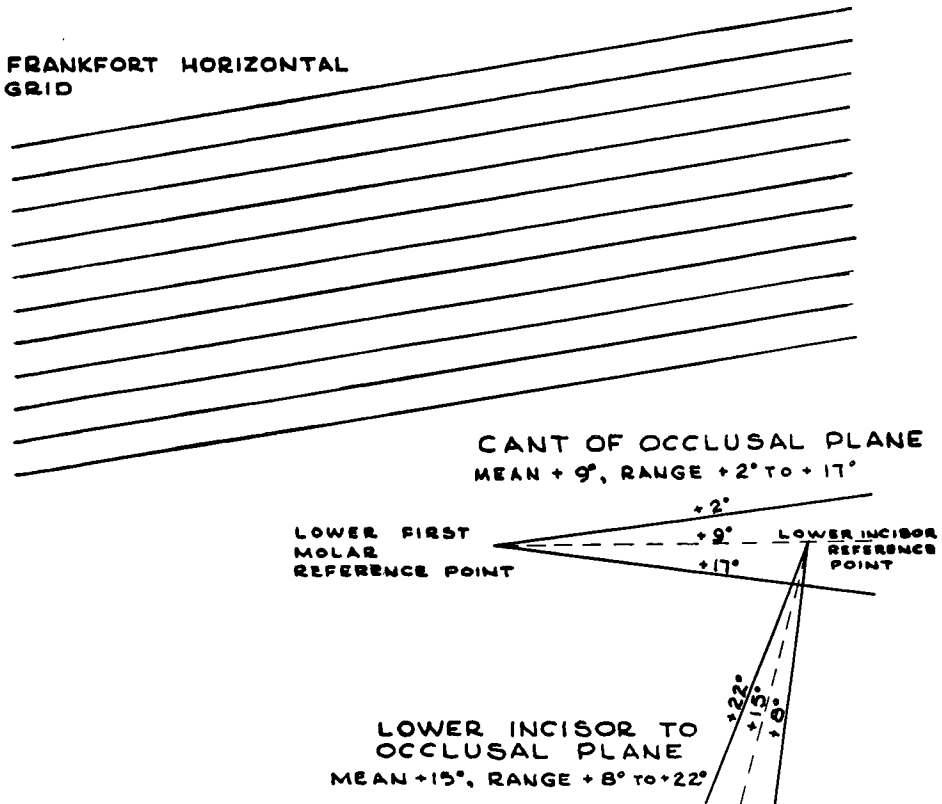


Fig. 6. Template IV; for the determination of Cant of the Occlusal Plane, and Angle of the Axis of the Lower Central Incisor to the Occlusal Plane.

### *Cant of the Occlusal Plane*

This value is an expression of the slope of the occlusal plane with reference to the Frankfort horizontal plane. When the anterior part of the plane is lower than the posterior the angle is positive. The larger the positive numerical value, the steeper its slope.

Orient template so that the Frankfort horizontal grid of the template is parallel to the Frankfort horizontal plane of the x-ray and the lower first molar reference point of the template lies on

the occlusal termination of the buccal groove of the lower molar of the x-ray. The Cant of the Occlusal Plane is read from the location of the center of the overbite with reference to the lines radiating from the lower first molar reference point. The dashed center line indicates the mean Cant of the Occlusal Plane of  $-9^\circ$ . The normal range is delineated by the solid line on either side. If the center of the overbite falls outside the Cant of the Occlusal Plane Triangle, the Cant of the Occlusal Plane is beyond normal limits.



*Angle of the Axis of the Lower Incisor to the Occlusal Plane*

This angle is a measure of uprightness of the lower central incisor with reference to the mandibular plane. It is read as amount of deviation from a right angle with positive values indicating forward inclination.

Re-orient the template so that the lower incisor reference point of the template falls at the incisal edge of the lower central incisor of the x-ray and the dashed mean occlusal plane line of the template lies on the occlusal plane of the x-ray. The Angle of the Axis of the Lower Central Incisor to the occlusal plane is read from the location of the apex of the root of the lower central incisor with reference to the lines radiating from the lower incisor reference point. The dashed center line indicates the mean Angle of the Axis of the Lower Central Incisor to the Occlusal Plane. The normal range is delineated by the solid line on either side. If the apex of the lower central incisor falls outside this triangle the Angle of the Axis of the Lower Central Incisor to the Occlusal Plane is beyond normal limits.

The distance from the incisal edge of the upper central incisor to the AP plane may be easily determined by laying a straight edge (e.g. the edge of a template) from point A to pogonion and measuring with a millimeter scale the distance from the incisal edge of the upper central to the plane so established. The value is positive when the incisor lies anterior to the plane.

#### DISCUSSION

The method herein presented is not intended to supplant, nor to match in accuracy the conventional Downs' Analysis procedures; although by interpol-

ation surprisingly accurate numerical values may be derived.

The template transparency system for Downs' analysis was prepared to satisfy a need for a method of rapidly and simply scrutinizing cephalometric x-rays. The author has also found the transparencies useful during pre-treatment consultations with parents, to explain to them the implications of an intricate diagnostic system. Students of cephalometrics may also find them useful during their early work in this field to familiarize themselves with the significance of particular measurements.

Because of their universal acceptance the figures used in the preparation of these templates are those originally presented by Downs.<sup>3</sup> However, it has been demonstrated by the author<sup>4</sup> and by others that while these figures represent normal standards for a young adult age group, some consideration may well be given to the differences which have been pointed out in the skeletal and dental patterns of younger individuals. The templates may be adapted to take into account these differences by the addition of other sets of mean and normal range lines originating from the same reference points.

Again, because of their general acceptance, many men may prefer to use Downs' observed range values, as have been used in the polygonic interpretation or "wobble" charts,<sup>5</sup> rather than the standard deviation values. Lines representing these values may also be drawn in on the templates with pen and ink.

Template transparency sets may be prepared by photographing Figs. 2, 4, 5, and 6 with a copying camera, and projecting the negatives on to a sheet of 8 by 10 film with an enlarger; or they may be obtained by writing the author.

## SUMMARY

1. A set of four template transparencies has been devised which may be laid directly over cephalometric x-rays for analysis after the method of Downs.

2. Instructions are given in their use.

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1033 Gayley Avenue