There is an occlusal sense which develops as the erupting primary teeth first meet their antagonists of the opposite jaw. This occlusal sense is the formation of the neuro-muscular reflex, establishing centric relation. Centric relation is not present at birth. Thus these authors claim that rest position is a neuro-muscular position and thus should be independant of non-eruption, loss or presence of an intact dentition.

Brodie and Sarnat in 1942 even consider they have shown that a normal face height in the rest position had been established in the case of anodontia.

In 1950 Cohen arrived at the same result on the basis of examination of six cases with partial or complete anodontia.

Rest Position as a Postural Position

Posture:

Posture is a position maintained by the muscle tone of skeletal muscle. Muscle tone is a state of reflex contraction which depends mainly on efferent impulses coming from the sense organs in the muscles themselves and to a lesser extent on impulses from the eyes, vestibular apparatus and skin. The reflex arc employed is somatic, and autonomic nerves are not involved. Muscle tone in skeletal muscles is due to low frequency asynchronous discharge from ventral horn cells, producing a partial tetanus which is economical and can be long maintained. Movement is due to a more rapid asynchronous discharge which gives rise to a more complete and powerful discharge.

The various movements of the body are effected against a background of muscular tonus which maintains the various postures. The postural tonus of the musculature is effected reflexly, being built up from afferent impulses from two sources; namely the labyrinths and the muscle proprioceptors and from various subsidiary sources. This

state of tone is suitably modified when any movement takes place.

The postural reactions of the body when at rest are called static reflexes and fall into two groups: The stance reflexes or reflexes of pose in which the body or a part remains in a definite attitude; and righting reflexes by means of which the pose is restored after disturbances. The postural reactions of the body when in movement are called stato-kinetic reflexes and are produced in a definitely predictable manner by the movement itself, which in turn is largely guided by them under normal conditions of life.

It may be said that there are five main levels of postural control. At the periphery there is the simple reflex arc consisting of a receiving cell, for example a proprioceptive nerve ending in muscles, ligaments or peridontal membranes; and two nerves, one running to the spinal column and the other running back to the muscle. This simple reflex may be augmented or inhibited at the second or spinal level. The cerebellum and mid-brain with their integrated functions constitute the third level. The fourth level is in the cerebral cortex; that is voluntary control level. The fifth level is at the level of social or emotional factors and is contained in the association areas of the fore-brain.

The Postural Relationship of the Mandible

In 1942 Brodie and Thompson pictured the skull as a globe seated on top of a column of spools. It is held in this position by a balance of anterior and posterior forces. Anteriorally it is easy to see and understand the function of the group of muscles running from the front of the head in the region of the forehead to the thorax. Also the greater part of the weight of the head lies anteriorally from the axis, the head falling forward when complete relaxation occurs.

Thus gravity exerts an anterior force.

Regarding the rest of the anterior balance, it is found that the work is done by a series of muscle groups acting together. Each group has its own specific function or maintenance. The superior group is the masticatory musculature. All these muscles have their origin on the cranium and run to a moveable bone, the mandible. Thus they are capable of making a unit of cranium and jaw by clamping them together.

But even this would not antagonise the posterior neck muscles. Without connection between the mandible and thorax the head would be tipped back. This connection is supplied by the supra and infra-hyoid muscles. Thus when the head is held motionless in an erect posture it is stabilised by the muscles of the back of the neck on one hand and gravity and the combined action of three sets of muscles on the other hand.

Ricketts (1956) claims that these systems of musculature can be thought of as links in a chain. This chain starts from the back of the head in the post-cervical muscles which support the head in the upright position, and circles the head coming into the temporalis, masseter, the superior and inferior hyoid muscles. In this arrangement the face is supported in a cantilever fashion with the mandible, the tongue and the pharynx operating in an elastic chain. As one muscle is stretched the remaining muscles take up the slack to maintain stability of the system. An appreciation of the chain like function can be gained by observing the acts of chewing, swallowing and speaking in a cinemafluoroscope.

The role of the tongue should not be overlooked in this arrangement for it too serves as a plunger, opposing the lips and cheek on the outside it serves as the moulding influence for the dental arch from within. When the mandible is viewed in this manner it is seen to occupy its place in the muscle system.

In the act of deglutition it serves as support for the tongue, for the hyroid musculature, the muscles of the pharynx. The support is also vital to the function of respiration whereby the mandible serves to maintain the airway through its support to the tongue and muscles of the larynx. It must therefore be remembered that the purpose of the mandible is not only for the support of teeth; factors other than those concerned with the teeth must be considered when dealing with mandibular relationships, and Kazis (1948) points out that rest position of the mandible is determined by the balance of opposing tensions of this chain of muscles in a relaxed state. (See Fig 10)

Stability of Rest Position:

Early investigators and students of rest position felt that since it was postural muscle nosition inherent in the individual perhaps from the time of birth, it would be stable throughout the lifetime of the person. Thompson in 1946 confirmed such belief and found that rest position was not altered during the growth phase - for his experiments he used 75 children. The rest position was expressed as a percentage of facial height. During this experiment the facial proportions also were unaltered. The time interval between the first and second head-plates during this experiment was approximately eight years. Thompson concludes: "The exact similarity of the facial proportions established with the mandible at rest indicates that the rest position has remained constant as growth progressed and that it is part of the inherent growth pattern of the face".

Thompson also found that rest position was constant whilst orthodontic treatment was progressing, except in two cases where inter-maxillary elastics and head-caps were used and both of these devices had long been known to tip the occlusal plane. In his analysis of edentulous adults Thomrson used 30 patients and the time lapse between X-rays varied from a few days to four years.

Since growth was no longer active linear measurements were used. In a few instances (three) there was a variation in measurement that would seem to contradict the contentions that the mandible is stable in rest position. In all other cases there was remarkable duplication.

Thompson seems to disregard the 10% of cases that were not consistent and concludes that the stability of rest position is evident and is shown to be unrelated to the presence or absence of teeth.

This experiment produced results which were in conformity with an earlier test carried out by Brodie and Sarnat in 1942 who also showed that the position of the mandible in relation the head is established by the third month of life and this relation is not altered by growth.

Moyers in 1956 supported the idea of invariability of rest position. He stated that all attempts to increase the vertical dimensions of the face beyond that established by the rest position of the mandible have been shown to result in failure, he backs this up with an experiment which he conducted on edentulous patients. He conducted the study to observe the changes that occur after prosthetic restoration. Lateral X-rays were taken before and after the insertion of the dentures and at six months intervals thereafter.

A typical case is interpretated. The first X-ray showed the total face height of the mandible at rest position to be 125 m.m. With the dentures inserted and the teeth occluded the vertical dimension was 122.5 m.m. Twelve months later this dimension was 122.0 m.m. The rest vertical dimension of 125 m.m. was confirmed

by two additional X-ray films. When the occlusal vertical dimension was unintentionally increased by the dentures to a point beyond rest position there was resorption of the supporting bone resulting in a decrease of vertical dimension.

He reports two cases in detail - in neither case was there any recent extraction. In the first case, the rest position yielded a face height of 111.5 m.m. The bite had been opened about 6 m.m. If we accept 111.5 m.m. as the correct rest vertical dimension and allow 2.5 or 3 m.m. for the freeway space, the occlusal dimension should have been about 109 m.m. In 13 months a considerable amount of resorption of the underlying bone occurred. This closing of the bite not only permitted the mandible to assume its normal rest position but also created a freeway space of 2 m.m.

In the other case the rest vertical dimension was found to be 106.5 m.m. as determined by four X-ray examinations. The dentures with the teeth occluded should have yielded a face height of 103 or 104 m.m. instead of the 111 m.m. shown.

Ten months later this dimension had decreased to 105.5 m.m. and in another year to 104.5 m.m. The previous rest position has substantiated by additional rest X-ray films which measured 106, 106.5 and 107 m.m.

Standard and Lepley (1955) also agree that rest position is due to the tone of the muscles and in constant to each individual throughout life. These authors are joined by Coloumbe (1954) who also believes in the constancy of rest position; Tuckfield in 1953 who feels that the constancy makes rest position a most valuable landmark in establishing vertical dimension of the face, and Kazis[1948] who feels that rest position is a reliable starting-point for the design of a physiologically correct occlusion.

Variations in Rest Position

Thompson in 1954 admitted that since rest position is determined by muscular action there must be variables which are related to variations in the tonicity of the musculature, such as hypotonicity as seen in fatigue and disease, and hypertonicity which in the extreme is muscle trismus.

In 1960 the stability of mandibular rest position was tested by Hickey, Williams and Woelfel. These workers found that the rest position was stable in the individual at the same sitting, was stable within the individual at different sittings approximately one year apart - there were however differences which were of a magnitude to make the stability of rest position questionable for certain individuals.

Atwood (1956) feels that under clinical conditions there may be variability of rest position because the rest position is actually a postural position and is subject to the same physiologic and pathologic factors as the posture anywhere else in the body. For example:

1. Physiologic - (a) voluntary control
   (b) postural reflexes
   (c) fatigue and sleep
   (d) physhic factors
   (e) heat, cold or pain
   (f) function

2. Pathologic - (a) Diseases of muscles
   (b) Diseases of nerves
   (c) Diseases of bones
   (d) Diseases of joints
   (e) Any disease causing fatigability
   (f) Anaesthesia and sedation
   (g) Mental diseases
   (h) External factors
   (i) Malfunction

1. Physiologic Factors:

Sicher in 1951 pointed out that the rest position of the mandible varies slightly for different positions of the head, according to whether more or less strain is put on the soft tissues stretching from the mandible to the clavicle. In establishing the rest position at various times it is necessary not only to have the head in the same position but also in the same relationship to the chest and neck.

In 1957 Cohen studied the effects of variations of head position, on rest position. He took cephalometric X-rays with the pointer at the orbitale, at the base of the nose and at the nasion. All the X-rays were taken at the same sitting. Six exposures were taken of ten patients, each of three positions with the dentures removed. He found by this technique an absence of any consistent pattern of variation according to head position. The averages of the readings at each position also showed no inclination to be aligned in a systematic manner, in fact there was almost equal distribution of the averages into high, low and middle groupings for the three head positions.

Shpuntoffs in 1956 stated that physiologic rest position is markedly influenced by the relative position of the head and the body to gravity. When the mandible is suspended in the relaxed position, free of contact with any support, movement of the head produces a shift of the mandible.

In 1954 Landa pointed out that rest position is never absolutely static but can be only so in a relative sense of the word, that is, when the head is oriented properly and the patient and his jaw are in complete state of relaxation.

On the basis of his experiments Cohen[1957] concluded that the dogmatic statements about the constancy of the resting vertical dimension is unjustified. "It would seem that since rest position is a physio-

logic state just as body temperature we would expect there to be a range of normality of the position of the mandible, varying with age, health, emotional state, etc.".

Landa[1952] indicates that rest position varies as head position changes, such as when deglutition and respiration (inspiration augments it, expiration reduces it), occur and during ~~physiologic~~ psychic disturbances such as fear, anxiety and fatigue.

Earlier in 1951 Walsh had pointed out that jaw posture may be effected by such factors as skin temperature and fatigue and emotional states such as anger, fear, determination and surprise.

2. Pathologic Factors:

Attwood in 1957 states that because it is a living response, physiologic elasticity may be impaired in diseased or pathologic states. A muscle may lose some of its ability to relax. This occurs in both reflex muscle spasm, due to pain (trismus), and in spasticity which occurs in certain neurologic diseases. In addition there may occur in general nervous tension a state of muscle hypertenseness.

Acceptable clinical terminology for that state of muscle function in the antonyms of overstretch and stretch weakness would be shortness and tightness. If a muscle is left shortened for a long time it may assume the reduced length permanently due to fibrosis.

It has been shown that as teeth are lost, broken, tilted or drifted the occlusion becomes abnormal due to interceptive occlusal contacts, or to absence of teeth. It is also accepted that under such pathological conditions the entire mandible on occlusion may be deflected out of centric relation. The main question is whether

under the pathologic conditions of function and anatomy, the mandible will return to its normal resting position.

Walsh in 1951 indicated a premature occlusal contact will cause a revision of the conditioned reflexes and a complete shift of the mandible to avoid this contact. The activity of these relatively simple reflex arcs is usually considered to be relatively fixed or stable. These previously mentioned are simple reflex arcs of a low level.

There are many higher levels of control. Afferents also pass to the thalamus and cortex and efferents pass from the mid-brain motor centres and the premotor and motor cortex. These in turn are influenced by impulses from the cerebellum and other centres. At the cortical level conscious control of mastication is established and here conditioned reflexes play a major role in modifying the masticatory reflex. Sicher* compares mastication with walking and emphasises the adaptability of the mechanism. Another point he mentioned is important: "The muscle pattern operates with the least waste of muscular energy .....Loss of teeth or changes in their position are followed by a rapid adaption of movement in order to achieve maximum effect with minimum effort".

It will be noticed the same sensory nerve endings, the muscle spindles, serve both the masticatory and postural reflexes, the same afferent pathways are used and both are under cortical control. It seems reasonable to deduce that modification of masticatory functions will affect the rest position. Most writers in considering rest position pay particular attention to the vertical dimension and neglect other dimensions, yet a three-dimensional concept is essential. Increasing evidence from such workers as Atwood (1954) suggests that the clinical rest position may vary when occlusal contacts are lost, when dentures are removed, as ridge resorption occurs under dentures, etc.

* Quoted by Walsh J.F. 1951

Moreover, electro-myographic studies as by Moyers in 1949, Pruzunsky (1952) and Perry in 1957 suggest that sometimes when patients appear clinically to be in a state of rest, there may be electro-mygraphically detectable muscle spasm or hypertonia which may be altering the habitual resting position of the mandible, in any of three dimensions.

Habits also may be pathologic factors influencing rest position. It has been pointed out by Lindstrom in 1953 that certain patients have a tendency to protrude the lower jaw in order to improve the profile. Bruxism may influence the rest position. The opposite habit, a tenacity of the lateral pterygoids, as part of a general tenacity of the body posture, has been described by Rogers in 1935 and results in a rest position which is abnormally distal.

Factors Related to the Status of Rest Position

Atwood (1958) feels that although there are a great number of factors which influence the position of rest, the small size of the structures involved together with the relative crudity of the measuring devices, makes the range of variation too small to be appreciated. He found that rest positions varied slightly if the patient had just finished talking and he noted that a resting vertical dimension was different depending on whether the dentures were in or out of the mouth. After removal of the occlusal contacts in some cases great variation of rest positions were evident. He followed his patients through various phases and discusses various factors related to mandibular rest position.

1. Tooth bone factors: Throughout the patients, a variety of mandibular sizes were noted, as also of the maxillae. Tracings of these indicate that the inter-arch distance depends on the relative height of the mandible and maxillae. In addition to maxillo-mandibular disproportion there may be disproportion in tooth jaw size. Strong presumptive evidence that teeth

can also be too large vertically for the existing bony and muscular framework is found in such common clinical conditions as marked vertical overlap, fanning of anterior teeth, tilting of posterior teeth, infra eruption or depression of occlusal stops, severe attrition, absence of a freeway space and teeth that look too big.

2. Tongue Factors: In some patients, as revealed by cephalometric X-rays, the tongue is consistently high in position when at rest, almost completely filling the oral cavity, or at least touching the ridges or anterior part of the palate; in other patients the tongue is consistently low relative to the occlusal plane and never touches the maxillae when at rest. Tongue size is relative to the bony framework of the oral cavity. Atwood[1958] suggests that the contact of tongue with the maxillae may be neuro-muscular or mechanical "stop". It may be postulated that the amount of contact of the tongue with the maxillary denture is one of the factors influencing rest position both with and without dentures.

3. Lip Factors: The lips may also play the part of a neuro-muscular stops, If there is good mass, body and tone to the lips before the teeth are extracted, if they are long enough to contact one another at rest and if they meet each other in an end to end relationship they may be said to be favourable for the role of neuro-muscular stops in the minimising of decrease in the resting vertical, following the extraction of occlusal stops. However if the lips are thin and flacid and fall in when the teeth are extracted, if the lips are short, if there is an over jet of the lips due to the disproportion of the bony or dental framework or if the lips tend to pût or evert, there may well be an unfavourable situation for the maintenance of the status quo.

4. Health and Age Factors: One would anticipate that poor health and advanced age would encourage a decrease in the resting vertical dimension. There was some difficulty in assessing the patient's physical age which is not necessarily consistent with the chronologic age. There were some cases of Atwoods which were aberrant to the rule.

5. Neuro-muscular Factors:

Group A Those patients who showed an increase in resting vertical dimension after extraction.

Group B Those patients who fluctuated about their individual prextraction base lines.

Group C Those patients who showed a decrese in resting vertical dimension after extraction.

A history of brusism or other clenching habits is more commonly found in group C than in group A or B. Fatigability was most commonly found in groups B and C. Mouth breathing is often a habit of long standing and is probably unrelated to the presence of teeth.

6. Factors Suggesting Previous Closure: If a patient is to have remaining occlusal contacts removed, it must be assumed that the patient has severe dental disease; that he is a "dental cripple". If the patient is such, how abnormal is his mandibular posture? There may already have been a closure even though there are some remaining occlusal contacts. If there has already been a decrease then one would expect less additional decrease following an extraction or perhaps even an increase in the resting vertical dimension. On the other hand previous closure in spite of occlusal stops may indicate a strong tendency for closure. Hence one might expect further closure. No one rule fits all patients. Amongst factors suggesting previous closures may be listed an extreme anterior vertical overlap, absence of freeway space, marked attrition or occlusal breakdown, fanning of anterior teeth and tilting of posterior teeth.

7. Miscellaneous Factors: Certain miscellaneous factors which were studied showed such overlaps or such similarities in the three groups that no correlation was evident. However, this does not rule out the possibility that in any given patient any one of these factors may be important. These factors included pre-extraction freeway space, pre-extraction vertical overlap, pre-extraction number of teeth, pre-extraction number of occlusal contacts, pre-extraction dental disease and the number of teeth extracted.

Correlation: There appears to be no single factor that can be exactly correlated with the degree of variability of rest position, rather there seems to be a complex interplay between at least six groups of factors. Perhaps it can be said that if a patient has no disproportion in teeth and bone, if he has favourable neuro-muscular stops in tongue and lips, if he is not too old and sick, if he has no clenching habits and does not tire easily, then there probably will be little change in clinical rest position following the extraction of occlusal contacts. It is shown ~~[illegible]~~ that patients in groups A and B in general had more favourable factors than those in group C.

If the patients are arranged in accordance to the numerical amount of average change, the further down the list one goes the fewer favourable factors are found. Certain patients in each group had certain favourable factors and certain unfavourable factors. No one factor was always consistent. In some patients closure occurred despite the presence of favourable factors and in some patients closure failed to occur despite the presence of unfavourable factors.

Condylar Anatomy of Rest Position:

Eberle in 1951 has stated that the condyles are in their most retruded position in the glenoid fossa when the mandible is in the rest position. However, his concept of mandibular condylar position seems to be in error together with his concept of closure from rest position to occlusal position. In the same year Brodie showed that in rest position the position of the condyle in the fossa may show considerable variation. It is almost invariably forward, seeming to rest lightly against the anterior wall of the fossa, but the supero inferior position may show considerable variation. The condyle and eminence are not in contact due to the presence of the disc between them.

In 1956 Nevakari also commented on the variability of condylar position. He stated that according to the prevailing conception the condyle must be located upward and back in the fossa both at rest and with the teeth in occlusion. In line with this view it has been thought that the path of closure of the mandible upward and backward would signify thrusting the condyle deeper into the fossa, that is the positional relation of the condyle to the fossa in occlusal position would be farther back than is accepted as normal. On the other hand accordingly to Ricketts in 1952 a large part of the aforementioned condyle fossa relationship are characterised by a resting position of the condyle that is downward and forward to its normal position, and that the upward and backward thrusting of the mandible witnesses a movement to the generally accepted position.

Freeway Space

Landa (1952) in discussing the freeway space feels that there are three phases which require study:

1. the formation.
2. the maintenance in a relatively static state
3. its closure.

Its formation is accounted for by an active descent of the mandible in a downward direction. It is followed by a passive movement of the mandible downward and forward by the force of gravity to its relatively stable position of equilibrium. Its maintenance in this state depends upon the orientation of the head in space. Thus if the head is orientated downward the mandible tends to close and the interoceulsal space is reduced. If the head is orientated backward the mandible passively falls backward and the interocculsal rest space becomes passively smaller. Thus the freeway space and its constancy depends upon the constancy of rest position and will therefore vary according to the postural position of the rest position the mandible is slightly protruded. What actually happens if first a disengagement of the condyles from the glenoid cavities in a downward direction. The subsequent second movements of the mandible in a forward and downward direction is effected by the force of gravity. The slight lateral component when present is probably also occasioned by force of gravity. Its maintenance in this stage depends upon the orientation of the head in space. Thus if the head is orientated downward the mandible tends to close and the interocculsal space is reduced. If the head is orientated backward the mandible passively falls backward and the interocculsal rest space becomes passively larger.

Swenson (1953) states it must be remembered that freeway space is an intangible and variable distance depending upon many factors such as tooth wear, size of the patients head, muscular habits and muscle changes. The amount of freeway space becomes more difficult to determine when the patient becomes partially or totally edentulous. Other changes may have influenced the amount of freeway space especially through the years of becoming edentulous through irregular loss of teeth causing the muscle pull to be out of balance and the bony relations to be changed. This freeway space has thus been

mutilated in most cases and its registration is of little value. There is as much variation in the amount of space between the teeth at rest as there is in sizes of teeth, sizes of noses, or sizes of persons. The figures 2 - 4 m. cannot be depended upon as being an accurate measurement but they do represent an average distance for this freeway space. (See fig 16)

Colourites (1955) reports the average freeway space has been reported as measuring 4.32m., 2.5m., 3.5m., 2-4m., 1-4m., and 1-3m. These figures represent an average not an exact measurement for this distance and there have been cases reported where patients have been quite comfortable with freeway space measuring 0m., 1m., 5m. and 8m. The slight differences in the average freeway space suggest that there is something intangible about it and perhaps more undiscovered information will be needed before it is thoroughly understood. When a patient is given an average freeway space he either ends up with his exact or a compatible freeway space or unknowingly becomes easily adapted physiologically to such a small deviation from his exact freeway space. This same author also quotes Leof (1950) who found by studying patients over a 10 year period who had developed grinding and clamping habits, that increased tonus in the muscles of mastication, subsequently decreased the freeway space.

Clinical Techniques

Regarding the confusion of thought about the mandibular position as indicated previously, there is also some confusion as to an exact technique which can produce a correct vertical dimension. It would seem to me that this is a stage of denture construction which will never be defined as a mechanical or mathematical equation nor for that matter a direct physiological rule; for the multitude of factors which influence mandibular position are not able to be confined to any one set rule. I personally feel that the obtaining of vertical dimension depends considerably upon the judgement of the operator and it is one phase of full denture construction which will always make such a construction an art, based on science rather than a mechanical application of a definition.

Assisting the operator, however, there are various techniques which have been devised. These are basically devisable into two types, those which deal with the completely edentulous patient for which no previous records are available, and those which involve the obtaining of dimension before complete extraction is effected.

Of the former there are many separate systems:

(a) Tactile Sense: In 1938 Niswonger described in an article his technique for obtaining vertical dimension, using a gauge which he constructed. The instrument revealed a technique of relating vertical dimension to rest position using a gauge which he constructed, or any sliding scale that has parallel beaks. The instrument revealed that edentulous patients could locate their own centric relation and vertical relation, and the jaw relator was then discarded in favour of the patient's tactile sense of centric occlusion. The technique is as follows. The edentulous patient is told to place his jaw where it

feels most comfortable or to relax or to swallow. After swallowing the jaw returns to the rest position. The patient is told to close until he feels that he would be touching his own natural back teeth. these directions are given slowly and deliberately. After the patient has become acquainted with the procedure, occlusal rims are built up so that they are in even contact while the jaw is in rest position. One rim is then pooled and both base plates are inserted in the mouth. The patient is told to imagine that he has all his natural teeth and to chew into the pooled rims until he thinks his natural back teeth would be touching. We then find that his tactile muscle sense will stop the mandible as it did prior to extraction.

Niswonger has long since dropped the system as a reliable technique.

About the same time Wright in 1939 also described a technique, very similar to Niswonger's, which involved the use of the patient's muscle tactile sense.

Swenson in 1953 commented that he placed no value whatsoever on the tactile sense technique, since the reactions of most patients are unreliable. This would seem to be a fair criticism of the technique, in the light of recent studies concerning the propagation of habitual mandibular positions by persistant reflex arc mechanisms. After the early literature, as mentioned, very little more appears defending this technique, and it is somewhat surprising to see that the system has so much popularity even now, as indicated by a survey of Willie in 1958.

(b) Facial Measurements:

These are of two types, those which involve the splitting of the overall facial height, and those which depend upon interrelation of measurements from individual facial characteristics.

Frahm in 1934 used a system of division of the total face height into thirds. He utilised this in cases where no pre-extraction record existed and simply arranged for the dentures to articulate, such that the distance between the anterior nasal spine and the mental tubercle is an equal third with the other two sections of the face.

Willis (1935)) uses a similar system claiming that the length of the face from the nose downward bears a definite proportion to the upper part of the face. He says: "When the adjusted bite rims or the finished dentures are in the mouth, the distance from the base of the nose to the lower edge of the mandible should equal the distance from the pupil of the eye to the rima oris, or parting line of the lips. In measuring scores of cases having all the natural teeth in first class condition, I have found that the measurement alluded to is approximately correct. At least it gives us a definite basis upon which to proceed, and I know of no other equally good".

Kurth[1959] feels that such a system is based upon an invalid assumption, for in nature faces are not ideal. He is supported by Terrell in 1951 who points out that we cannot make our patients all fit a rule.

Another system of using facial measurements in the establishment of vertical dimension employs the concept that the distance between the base of the chin and the base of the nose is numerically equal to the distance between the rima oris and the inter-pupillary line.

Another technique is described by Denven (1938) who quotes Dr. Sorenson, who he feels has devised a satisfactory scale. It contacts the face at two points, the bridge of the nose and underneath

the tip of the chin. The scale is calibrated in millimetres. Readings are taken from the bridge of the nose to the root of the nose, and from the bridge of the nose to the length of the upper lip in repose. These two measurements added together equal the approximate distance from the bridge of the nose to the tip of the chin in normal profile.

A similar type of system is employed by Scott (1952) using his face meter. The measurements are made from boney tissue to boney tissue to eliminate the error involved with displaceable facial tissues. He measures the combined distance from the inner canthus of the eye to the junction of the alae of the nose to the levator labii alae, and from the inner canthus to the lip line which should, according to his measurements, be equal to the distance from the inner canthus to the gnathion.

Smith in 1958 also advocates the use of facial measurements although in conjunction with other techniques. He does, however, emphasis that before any facial measurements can be effected, the occlusal plane and lip contour must be established. He quotes Thompson (1946): "The vertical dimension associated with sinking in of the lips is greater than the occlusal vertical dimension made before the teeth were extracted. The facial change is not the result of a decrease in vertical dimension but rather the loss of support given the lips by the teeth and alveolar processes".

That one cannot place absolute reliance on these or any system of facial measurements was indicated by the analysis of Brodie and Thompson in 1942 who found that in measuring some 200 skulls, the mean ratio of the distance between the nasion and the anterior nasal spine was very consistently and numerically equal to 43% of the total face height. However, they found values of 39-50% in

this measurement and although they were rare they were enough to discourage the universal use of such dimensions in obtaining vertical dimension.

Kurth in 1959 also criticises such a technique because of the possibility of error due to tissue displacement. In comparison with the relatively small distance such as the freeway space which is ultimately determined by this technique the error introduced by tissue displacement is sufficiently gross to discredit its use.

Phonetic Tests:

An approach at obtaining vertical dimension by the use of function rather than mechanics is, of course, a definite improvement both in its logic of approach and effectiveness. Many authors describe a system of obtaining rest position by the use of phonetic means, but this is not the technique which is at present under discussion.

Perhaps the strongest advocate for the use of phonetics is Meyer Silverman (1950/51/56/57) who feels that phonetic principles may be used as a guide where no pre-extraction records exist; although determination of vertical dimension under such circumstances he feels is largely a matter of guesswork. The dentures are constructed by the usual technique except that the closest speaking space is determined to aid in positioning the mandible. The closest speaking space as used by this author is the level of greatest approximation of the mandible to the maxilla and is determined during the pronunciation of the post dentals "s" and "z". During the bite block stage the closest speaking space of 2 m.m. is employed, although when the artificial teeth are set up in wax this level is determined more accurately. The vertical dimension, he feels, must not be increased beyond the normal for each patient, it is better to use a vertical dimension that istoo small than to use one that is too great. There should be no inter-incisal space visible at the anterior teeth at

the closest level of the mandible in relation to the maxillae while the patient speaks rapidly. Therefore the vertical overlap must equal and at all times be greater than the closest speaking space.

In 1959 Morrison advocated also the use of phonetics as a means of determining vertical dimension. He emphasises the use and necessity of closely adapted stable base plates. His technique is to have the patient with his head erect and free from the head-rest repeat the word "sixty-six" and "Mississippi" slowly at first and then more rapidly. Most patients experience difficulty in managing unfamiliar bases and occlusion rims. The dentist must make sure at the time that the patient is aware that he is not being tested for speech, and that it does not make any difference how the words sound. The rims should then be reduced in height until there is the desired clearance in the bicuspid region at the closest speaking level.

The patient can be given more clearance if it is desirable but he must at least have the minimum. The amount of clearance is determined by the requirements of the patient and the judgement of the operator. In some cases where maximum opening is desired for functional and aesthetic reasons the patient adjusts to changes readily, the teeth may even make the slightest contact.

A similar technique has been outlined by Harper in 1942, who makes use of the letter "m". In the sounding of such a consonant the lips make contact, and contracture of the musculature associated with this sound elevates the mandible to a position above its rest position. This establishes a definite relationship of the incisal edges of the teeth and we now have what we call a minimum clearance space which is equal to about 1 m.m.

Harper claims that this position is constant and easy to check.

It would seem that this concept is not in co-ordination with the writings of modern authors who use the pronunciation of the letter "m" to establish thelevel of rest position rather than the level above rest position.

Blanchard (1951) points out that in speech, teeth do not noticeably occlude unless the vertical dimension has been opened too far. To conform with this, the vertical opening between the jaws can be set any any point consistent with comfort and aesthetics, up to within a millimetre or two of occlusal contact, when rapidly pronouncing the words containing "s" or "z" sounds.

A good sentence he points out is "Sixty-six sail boats sailed the Mississippi in 1666". because it contains the necessary sounds and is long enough to produce relaxation when saying it. Another test in use is "Sixty-six a.n.c.".

Morrison (1959) feels that the patient for the phonetic testing should be given something to read. He uses several poems which have been suggested for speech training, for example:

When I go fishing, I'm always wishing,
Some fishes I will get
But while I'm fishing the fish are wishing
I won't, just harder yet.

M Silverman (1956) points out that when we ask the patient to say a speech sound such as "f" or "v" or even the sibilant "s" we are establishing an artificial relationship. Such a view of speech does not imply the symbolic communicative and psychologic aspects of

speech in which phonetics is only an automatic contributory phenomenon rather than the focal point of a speech situation. Thus the patient may subordinate the swallowing and respiratory functions in order to pass the phonetic test of the prosodontist. A better speech test is to engage a patient in meaningful conversation.

The system of using phonetics is not without its drawbacks. Kurth (1959) points out that in the phonetic method a mistake in registration may result if the patient becomes aware of the importance of this step. No measurement should be obtained under such circumstances.

In 1956 Swenson indicated that the phonetic technique is inaccurate because of the difficulty which the patient will experience in effecting correct articulation of tongue and palate and mandible, with new and often cumbersome appliances such as bite blocks, in place. I myself, agree with this, and for that reason feel that this system cannot be used as a means of determining the vertical dimension, but it can be used as a very effective means of checking the mandibular level at the try-in stage of denture construction.

Freeway Space Technique

Probably the most used system of obtaining vertical dimension is by first obtaining the rest position and then allowing for the freeway or inter occlusal space, as the operator feels is indicated for each individual patient. This technique was first described by Niswonger (1934) based on the work by himself and Brodie and Thompson (1942) regarding the relative stability of rest position as a postural position. Holic (1948) describes the technique and states that finding the rest position is the initial step in determining the vertical position of the mandible. The patient is seated erect in the chair withoutsupport to the head. This is important since only the physiologic factors which maintain posture at rest should

be operating and an extrinsic support might interfere with determination of this position. Two circular dots are placed on the skin of the patient one above the bridge of the nose and between the eyes, (glabella), and the other on the skin over the point of the chin. The distance between the two marks is measured at rest position with a pair of calipers. This distance is recorded. Duplication of measurements ensures that rest position has been found. The measurement used must be one which is found constantly rather than an average. This distance can be described as the physiologic face height. The maxillary occlusal rim is contoured and the occlusal level is determined. The centric face height or true vertical dimension is determined by substracting the freeway space from the physiologic face height. The mandibular occlusal rim is then raised or lowered to occlude at the computed vertical dimension.

This technique is advocated by many authors, amongst whom are Burtenshaw (1948), Pleasure (1951), Terrel (1951), Tuckfield (1953), Jaffe (1954) Schlosser (1955) and Boos (1956).

All of these authors advocate the use of rest position level as a reference point in determining vertical dimension. They differ in their concept of the dimension of freeway space. But it will be found that all advise a minimum inter-occlusal space of 2 m.m. with a variation of this dimension depending upon the operator's assessment of the case in hand. As Boos in 1956 points out; the freeway space may be varied according to desired conditions of force and aesthetics, but it must never be reduced to less than 2 m.m. The patient must have a space between his teeth at rest or there will be tension of the muscles.

Aids to Obtaining Rest Position

The essentials of obtaining a rest position measurement for the patient depend upon the mental outlook of the patient, his approach and reaction to the operator, his state of mind at the time of the measurements, his posture, his degree of comfortability. There are certain phonetic aids which enable a patient to assume a rest position. Holic (1948) advises the pronunciation of "m" or "Emma" to put the mandible in rest position He advises that the procedure should be repeated. Burtenshaw puts the upper bite rim in place or the old denture and asks the patient to swallow and then speak the word "Mississippi" or the letter "m". He feels that a second or so after these sounds have been made a relaxation of the lower jaw muscles will be noticed. At this stage he measures the facial dimension. The patient's attention is distracted for a few moments and then the test is repeated. He finds that the distance of the facial measurement remains constant, indicating that a level of rest position has been recorded.

Boos (1956) utilises his theory that the rest position and the position of maximum mastigatory pressure are identical. To obtain the level of rest position he uses his bi-meter. This is carried to the mouth and the patient is instructed in regard to biting force and freedom of mandibular movements. An examination involves the registration of maximum biting force in various vertical positions in edentulous cases. In this way the position of maximum efficiency can be determined on the individual patient. In order to obtain a correct registration the patient must record the maximum biting force for each position.

Boos' technique is as follows:

A preliminary jaw relation is registered and the casts are mounted on an articulator to facilitate the mounting of the grathodynamometer

and the central bearing plate. By starting at approximately a normal jaw relation the vertical dimension can be varied up to 9 m.m. by adjusting the central bearing cap of the instrument. The patient is seated in a chair in a normal upright position supported by the chair. The bases with the instrument mounted are carried to the mouth and a series of registrations are recorded. His usual procedure is to start with the patient's mouth in an extreme vertical opening and to record the force exerted by the patient in pounds. The vertical dimension is then reduced to extreme closure and the patient records biting force with the mandible in that position. Various changes are made and the patient is instructed to make use of any comfortable jaw relation when registering the biting force. After the patient understood the instrument and all adjustments for comfort were made a series of force records were made at various vertical dimensions. The patient is requested to bite as hard as possible and continually urged to bite hard during the registration. The vertical dimension is then closed a millimeter and a half and another registration of force recorded - each patient records a maximum biting power at a specific vertical dimension. When the level of maximum biting force is obtained this is assumed to coincide with the vertical level of rest position and the patient's occlusion is then effected at a level to provide the required inter-occlusal space.

In 1959 Kurth provided some criticism of this technique of Boos. He feels that the devices that measure biting pressure demand sufficient inter-alveolar space for the bulky appliance. He also has found many instances in which the measurable differenc s between the maximum pressures at various vertical dimensions, are so slight that serious errors in determining occlusal-vertical dimension may be made. Also the patient may try too hard, and unintentionally give the operator a distorted result.

Rest Position as a Reference Point

Up to about 1955 or 56 the rest position was considered a reliable guide to obtaining vertical dimension, as indicated by the many authors who advocated its use. However in more recent years the technique has come under some criticism. Duncan in 1960 conducted studies which were made to determinate the value of rest position in establishing pre-extraction face height with a prosthesis when no pre-extraction records were available. Patients were selected who furnished an acceptable pre-extraction record in terms of the vertical dimension of occlusion. Records were made before extraction and after prosthetic treatment with a Broadbent-Bolton Roentgen unit. Rest observations were made both with and without dentures in the mouth. Measurements were madeof morphelogic face height, rest face height and inter-occlusal distance. The results revealed an instability of rest position which resulted in discrepanci s in the restoration of the pre-extraction vertical dimension with the prosthesis.

This difference in pre-extraction vertical dimension and that restored with the prosthesis was of such magnitude in three of the test patients that rest position was concluded to be a poor guide for establishing the pre-extraction vertical dimension. Boucher in 1960 has indicated that many techniques have been suggested and used for making rest records, but all of them are based on activities carried out by the patient. Therefore these records are subject to possible variations and errors result from the physical condition, the mental attitude and the habits of the patient. Conditioning exercises, hot packs, and mild sedation have been used to overcome the difficulty of getting the patient to relax so an accurate record can be made. Tensions, anxiety or over-zealousness of the patient may cause an error in the record. These factors are involved whether

the method involves simple measurements, electro-myography, cephalometrics, saggital tracers or observations of the teeth at rest and during speech. Judgement is required in evaluating any of these records so the recording of rest position involves a double subjective record. It is subjective on the part of the patient as he tries to do what the dentist wants. And it is subjective on the part of the dentist as he tries to evaluate what the patient has done. Boucher concludes: "this leads me to question the wisdom of placing absolute dependance upon physiologic rest position as a means for determing the vertical dimension of occlusion".

Shore in 1959 had expressed the same opinion stating that the registration of an habitual rest position is fraught with uncertainty. It is impossible to record rest position as accurately as the centric relation can be recorded.

In spite of these criticisms of the stability of the rest position, it would seem that it will continue to be used as a major point of reference in the establishment of vertical dimension until it is replaced by a more accurate and scientifically precise technique.

Cephalometric Technique:

Without the use of X-rays the profession is hampered considerably in any measurements because of the lack of positive spot points, and because of the possibility of tissue displacement wether caused by the measuring devices or by mandibular movement. Cephalometric X-rays obviate this error and in so doing present a considerable and commendable increase in accuracy of technique. In 1949 Hughes indicated that he felt the cephalometer to be the most scientific instrument of estimating vertical dimension in the absence of pre-extraction records.

Pyott and Schaeffer in 1952 describe a technique using the cephalometric X-ray apparatus. Rest position is first determined by a series of X-rays and the distance between nasion and pogonion is measured. These authors use a vertical dimension at occlusion whichis 3 m.m. less than the resting vertical dimension. Centric relation is then determined at an arbitrary vertical dimension and the cephalometric X-ray taken with the inter-oral appliance in place and the vertical dimension of this relation is established. The appliance can then be adjusted to the correct height and a true centric relation established. They describe the system in more detail in a further article (1954), using a cephalometer described by Broadbent. Bite blocks are first constructed and an approximate vertical dimension was recorded and the casts mounted. A gothic arch tracer is then mounted into the bite blocks. The exact vertical dimension was then established as follows. The patient was seated comfortably and upright in the chair with the head supported so that the Frankfort horizontal plane was parallel to the floor. Six exposures were made to record rest position whilst the patient had his mind directed elsewhere. A gothic arch tracing was then made at the arbitrary vertical dimension and another cephalometric X-ray taken with the plates locked in place. The pogonion and the nasion were points of reference made on each X-ray. The distance between these points was measured and rest position was determined. The vertical dimension at occlusion was then selected as being one which is 2 to 3 m.m. less than the resting dimension. The vertical dimension with the arch tracing device in place, was then measured and the device was adjusted till it gave a vertical dimension of 2 to 3 m.m. less than the resting vertical dimension. At this point a new gothic arch tracing was then taken and another cephalometric picture taken to check the measurements. Another final check was made cephalometrically when the dentures were issued.

There are several objections to this technique. The first is the involvement of the equipment which is expensive and of limited application; there is some difficulty in obtaining a true rest position whilst the patient is surrounded by a seemingly maze of apparatus, and the third objection is the number of X-rays that have to be taken throughout the course of the technique. The Pyott and Schaeffer system demands a minimum of eight exposures. Kurth (1959) points out that the roentgenographic may although it claims accuracy has practical limitations. The head positioning devices are not very accurate. Duplication of results is a rarity after a time lapse, even sometimes as small as a few minutes. The public has become acutely aware of the dangers of radiation and therefore this method leaves much to be desired.

Parks Theory

Information for this system which was introduced by Parks is not easy to obtain. Swenson (1953) indicates that according to Parks the mandible opens on a rotational centre, that is away from the head of the condyle and below and behind the angle of the mandible. This rotational centre is held until the point of the former occlusal plane is reached, and then, upon further opening, rotates around the head of the condyle. These two movements would scribe two different arcs and the point of intersection of these arcs would indicate the correct amount of jaw separation.

A practical manner of determing where the mandible changes arcs, if the theory were correct, would be to place marks across the bite rims and note the point at which these marks failed to coincide. The technique was modified by Armstrong in 1943 who employed the following system. Bite blocks with an inter-oral arch tracing device are constructed. These are placed in the patient's mouth with the mandible propped open by the pin. A gothic arch tracing is taken at

this dimension and the centre of occlusion is marked by an identation on the place. The appliance is then adjusted so the mandible is in the closed position; an arch tracing is again taken and the centre of the tracing noted. It will be found to anterior to the the previously made hole. The mandible is now progressively opened by adjusting the height of the central bearing screw until a vertical dimension is reached at which the pin just re-engages the hole drilled on the guiding plate when the arch tracing was made. Armstrong uses this level as the accepted occlusal vertical dimension.

Swenson (1953) indicates that the theory was found to be incorrect by practical tests and further proved incorrect by tests with a Kinematic face bow.

Standard and Lepley (1955 also comment on Park's technique and discuss an improvement which they have devised themselves whereby they point out the ineffectiveness of the Parks system - the error here being that the centre of rotation was considered to be a line on the level of the occlusal plane posterior to the ramus. The Armstrong technique, according to Standard and Lepley, considered the beginning of the translatory movement of the lower jaw in its closed position to be accepted as the occlusal vertical dimension. Standard and Lepley then outline a technique which they have devised. Adhesive platter is placed on the tip of the nose and on the chin. Physiological rest position is obtained and the measurement recorded. Calipers are set at this measurement. A Ballard tracer is attached to the upper and lower base plate at this vertical height and a gothic arch tracing is made to record centric relation. A small hole is made in the metal plate at the apex of the tracing. The screw of the tracing device is then lowered one turn and a new gothic arch tracing is made. The lowering of the screw is continued one turn at a time until the point of the screw no longer engages the hole in the

upper occlusion rim. The calipers, set at the rest vertical height measurement, are now used to locate another point on the chin which will be below the previous point. At this new point translatory movement of the condyle begins and the vertical dimension must be between this point and the physiologic rest position. The research technique used for this system found the difference between the two dimensions to vary between a minimum of 2.9 m.m. and 5.0 m.m. maximum.

This technique is cumbersome and does not provide an accurate estimation of vertical dimension. It is considered on this basis to be of limited value.

Physiologic Technique

Harper (1942) devised a technique which involved the act of swallowing. He constructed small removeable troughs which are attached to the mandibular base plate over the ridges and as far to the heel as possible. These recording trays are locked into position on the retaining plates. The base plates are placed into the mouth and the patient is requested to close until the top of the side walls of one or both trays contact the upper rim. The buccal and palatal sides of the already determined upper rim are now trimmed to the marked lines, "V" notches are cut in the centre of the contact area.

The upper baseplate is placed in the mouth and recording trays of the lower are filled with softened compound and placed in the mouth. The patient is requested to say "M" "M" "M" with the lips making slight contact. Both plates are then removed and the minimum clearance space is recorded and chilled. The upper rim is placed on the lower record and the heels are examined for clearance. All excess compound is removed from the record. The

trays with the compound records are removed from the retainers and placed in the compound heater with water at 140°F. After these records have become uniformly soft they are re-attached in their respective retainers. The lower base plate is placed in the mouth and the patient is instructed to wet the lips with the tongue and swallow. Owing to the subconscious control of the musculature associated with this action, the mandible is elevated to its normal vertical dimension. The bases are removed from the mouth and the record is chilled. This dimension is used as the vertical dimension. More recently Shanahan (1952/55/56) produced a technique based upon thephysiologic process of swallowing which he feels brings the teeth into normal centric relation. He establishes vertical dimension by first determining the length of the upper teeth on the occlusion rim and then making a tentative vertical dimension determination by using the freeway space technique or any of the usual methods. The lower occlusion rim is reduced 3 m.m. and a cone of very soft wax is placed on the top of the shortened occlusion rim at the median line. The upper and lower occlusion rims are placed in the mouth and the patient is requested to swallow several times. As the patient swallows the soft wax is reduced to the natural and physiologic vertical dimension. This technique is much more practical and simple than the previously outlined technique.

Boucher in 1960 states that the establishment of the vertical dimension by recording the amount of closure during swallowing involved a direct approach to the problem. The repeated swallowing activity with closure against soft wax and stopping at the level of normal occlusal contacts seems to be sound. However, a number of conditions might modify the amount of closure achieved by the patient. Among these are: tenderness of the ridges, tensions, habit, and over-zealousness to test their wax dentures, the thickness of the palate of the recording base etc. This approach to the establishment of vertical dimension should be studied further because it offers an opportunity to balance the results obtained by other

methods.

Miscellaneous Techniques

Francis (1959) employs a device called a vertical tracer which he believes registers and determines the proper vertical dimension together with centric relation and condyle path records. The appliance consists of a vertical tracing plate attached to the upper bite block, extraorally, upon which a tracing of the closing movement of the lower jaw is effected by a stylus attached to the mandibular baseplate.

The baseplates are positioned in the mouth and the patient is instructed to open wide and with a continuous slow movement to close. The patient will tend to stop the closing movement at or near the normal vertical relation but an overclosure is desired. The closing movement must be made in the retruded mandibular position. As the mandible closes an arc is inscribed on the vertical plate of the tracer. When the condyles start into the glenoid fossa a wave is started on the vertical plate which is completed when the overclosing movement begins a different arc. By closing and overclosing the mandible, two different arcs are formed with a definite wave separating them. The centre of this wave is taken as representing the true vertical position of the mandible. The condyles occupied this position in the glenoid fossa in centric occulsion when natural teeth were present. The beginning of the wave is used to establish the vertical dimension because just enough tooth substance will be lost in grinding the occulsion to throw the marker to the centre of the wave. Gysi called this line close of the mandible "the incisal path".

This is a mechanical approach. A more physiological approach is described by Moylan 1953 who has a technique for determining vertical dimension based on "time". He does this by having the patient bring

the occulsal rims into contact and noting the length of time the rims remain in contact before the mouth opens involuntarily, normal separation from contact takes place from three to four seconds. If the vertical height is too great the occulsion rims will stay in contact more than six seconds. They will separate only when fatigue causes the muscles to relax to a rest position without completing the cycle of contraction and extension. If the vertical height is too low the occulsion rims will separate in less than three seconds or contact will be made by effort. This technique relieves the patient of embarrassment of faulty pronunciation when called upon to repeat letters, words or sentences while the occulsion rims are in the mouth. It also permits the dentist to secure the vertical measurement without the help of the patient since the opening and closing of the mouth is involuntary.

Carlton (1955) describes a technique which is most contrary to any physiological approach and its scientific inexactness is amazing. He has stabilised occulsion rims constructed with a flat plate of occulsion at a pre-determined vertical dimension of 40 m.m. The flat plane is established by the incisal edge of the lower anterior teeth anteriorly and by the height of the retromolar pads posteriorly. 18 m.m. is accepted as the dimension of the labial fold close and the labial frenum to the incisal edge of the lower anterior teeth. The vertical dimension can be changed at the time the tracings are made by adjusting the 40 m.m. has proved to satisfy the requirements of 95% of all patients - If a change in the vertical dimension is made it will not effect the centric relationship of the casts. The opening and closing movement of the mandible is a hinge action which occurs with the condyles remaining in their sockets and acting as rotation centres. Therefore centric relation is constant at any vertical dimension within reason

Swenson (1953) discusses not a technique but rather an aid. The parallelling of the maxillary ridges is based upon anatomical fact because the teeth in normal occulsion leave the alveolar ridges in the posterior region parallel to each other. If, however, the patient has lost the teeth at irregular intervals or has suffered a great amount of bone loss due to periodontal disease the line of the ridges is naturally thrown out of parallel.

Kessler (1939): The cubic content of the denture space should be considered with a view to permitting normal physiologic function as far as is possible. Kessler measured the actual cubic contents of the mouth at rest and extended but was unable to develop a definite technique.

It would appear that there are to choose from a multitude of techniques which by themselves will supply an approximate of the correct vertical dimension. None is without criticism. It would seem that the most practical solution would be to use several techniques and to co-ordinate them. As for instance to obtain the dimension by the Niswonger technique and, at the try in stage, to use some type of phonetic test. I feel that whatever technique is employed it must be characterised by simplicity as any system which is complex is bound to have many possibilities of error.

Such an idea is also shared by Smith (1941) who uses his judgement assisted by:

1. The strained or unstrained appearance of the lips.
2. Comparison of the length of the thirds of the face.
3. The results of phonetic tests.
4. The degree of effort exerted in opening the mouth sufficiently to take a bite of food.

Hight (1934) feels that to meet satisfactorily the necessary requirements it will be necessary to correlate the different factors in aesthetics and the mechanical arrangement of the teeth which at times will necessitate a compromise between the requirements of the two.

Thosefactors which serve as a guide in determining satisfactory dentures space are:

1. The distance from the nasion to the gnathion in a satisfactory reposed relation. This determination being for the purpose of satisfying aesthetic requirements.
2. The relation of the ridges in the region of the tuberosities and the rami. In order to meet mechanical requirements it may be necessary to increase or decrease the vertical opening.
3. The ridges - these should be as nearly horizontal to each other as aesthetics and tooth arrangement will permit that the forces of mastication may be approximately at right angles to the crest of the ridge.
4. Proper excursive movements in arranging the upper and lower anterior teeth for a satisfactory appearance. It is necessary to allow for their proper excursive movements and the establishment of the proper relationship between the lower bicuspids and molars and the crest of the ridge.

Willie (1958) conducted a survey of the various techniques used and found no one method has proved to be complete in itself.

An indication of the techniques used may be evaluated by the answers to this question which Willie found in his survey.

Q. Which method or methods are employed by you in an attempt to arrive at Vertical Dimension.

1.	Patients tactile muscle sense	56
2.	Willis' bite guage	7
3.	Boos' Bimeter	2
4.	Scott's Precision System	0

5.	Cephalometric Radiographs	7
6.	Phonetics	81
7.	Deglutition	60
8.	Esthetic Appearance	81
9.	Pre-extraction Plaster Casts	36
10.	Plaster Face Masks	1
11.	Pre-extraction Dowels	2
12.	Acrylic Resin Face Matrix	3
13.	Facial Division into thirds	14

It is rather disappointing to notice that many dentists rely on the patient's muscle tactile sense. It would seem that the profession has selected the most simple and least time consuming of techniques although the high numbers using the simple systems may indicate that each operator uses several check techniques. Some authors have attempted to determine the accuracy of each technique among them being Block (1953) who has used various techniques for obtaining vertical dimension and has found no appreciable variation in the vertical dimension achieved by the different methods. He used the Boos' Bimeter, study of inter-maxillary space between physical and physiological rest position, following the theory that patients retain tactile sense as to the proper degree of closure, profile study or attempting in edentulous cases to parallel the ridges.

Indeed as Kurth (1959) points out "All of the methods utilized to determine vertical dimension and centric relation have value, if those who use the methods are aware of the problems involved - The determination of vertical dimension is largely empirical."

Pre-Extraction Records

There are various techniques for recording the vertical dimension of the face with the teeth fully in occlusion or the mandible at least in the correct position supported by occlusal stops. Among these include direct facial measurements, phonetic tests, the use of study

models and the use of X-rays and profile photographs. These techniques are not without their place as Swenson (1956) points out: "Any guide that will enable the operator to restore three dimension of face form is worth the additional time that is taken up in its construction".

Photographic System

Fram in 1934 advises the use of a system of facial measurements based upon a pre-extraction profile photograph.

Crawford in 1934 also advises the use of pre-extraction records, consisting of two profile and two front view photographs, one each smiling and one in repose; the measurements recorded are:

1. from the nasion to the gnathion
2. from the nasion to the nasospinale
3. from the nasion to the lip line
4. from the nasion to the incisal edge of the upper control incisors
5. from the nasion to the incisal edge of the lower central incisors
6. the anterior position of the upper central incisors.

Later Wright (1939) also advised the use of a pre-extraction technique which involved the comparison of facial measurements of a photograph with the facial measurements of the patient. He requires full face sharply focussed photographs of any size but preferably large and he uses the following measurements:

1. the inter-pupillary distance
2. the brow to chin distance, the distance from the top of the eyebrows to the base of the chin.

After recording these measurements of the photograph the operator returns to the patient and takes the measurement of the inter-pupillary distance. The patient's vertical dimension can be calculated as follows.

Vertical dimension of the patient equals the vertical dimension of the photo by the inter-pupillary distance of the patient divided by the inter-pupillary distance of the photo.

Boyle in 1947 felt that pre-extraction records involved having the patient photographed by use of a half plate clinical camera. A front view is taken with the head perpendicularly arranged and the teeth placed in centric occlusion by the patient. The natural teeth are placed in centric occlusion by the patient and a full scale photograph is taken with the lips parted. From the photograph he elicits the following data:

(a) General proportion of the face of the individual.
(b) Actual vertical measurement of the lower third of the face.
(c) Upper incisal edge level (only if there are upper incisors, hence this is a gross limitation).
(d) Widths of upper central incisors and possibly of the upper lateral. (This is extremely doubtful and again depends upon the presence of anterior teeth).

One of the features of this technique is the long term reference, noting the change in facial contours during storage of the picture, changes in the dental arrangement of anterior teeth, it is also said to be important as a record after the absorption of the alveolar ridges has occurred.

The pitfalls in this technique seem to include:

1. Impracticability of photographing patients early to act as reference in case of need of denture.
2. Virtual impossibility of transferring measurements from two dimensional photos to a three dimension subject with the added hazard of tissue compressibility further interfering with accuracy of measurement.

3. Development either before or after the photograph of an habitual centric which may be at an incorrect vertical dimension.
4. Possibility of anterior tooth drifting after the photograph has been taken rendering the aesthetic function of the technique useless.

Kurth (1959) indicates that after the patient has reached full growth the inter-pupillary distance does not change and thus this measurement may be used as a guide for the dentist to determine the relative ratio between the dimension as seen in the photograph and thatpresent in the patient. He points out that the method is not particularly accurate, as photographs in many cases have been altered. The absence of reliable landmarks with which to compare the photograph and the face can result in an inaccurate determination of the rest position.

Swenson also points out that these systems of profile photographs are usable and reasonably practicable but they suffer from the same drawbacks as does any system of facial measurements.

Phonetic Records

A phonetic record of vertical dimension taken intra-orally is advocated byMSilverman (1951/53/55/56/57). His technique can be modified in cases of fully edentulous patients. He directs the patient to close the teeth into centric relation and the centric occlusion line is drawn on the lower anterior tooth at the horizontal level of the incisal edge of the upper incisor. This is a reference line.

The closest speaking line is then drawn on the same lower anterior tooth while the patient pronounces the "s" sound of"yes". This is checked while the patient speaks rapidly or reads from a

magazine. The author believes the patient does not have control over mandibular position during rapid speech. The closest speaking space is thus determined as being the distance between the lower centric occlusion line and the upper closest speaking line. When the patient is edentulous this sameclosest speaking space must be present in the dentures. This closestspeaking space is not the freeway space but is determined when the mandible and muscles are involved in phonetic action. The closest speaking space measures from 0 to 10 m.m. and must be exact for each patient.

Silverman prefers this technique over the rest position system because of accuracy, speed and because the system does not depend upon the patient but the operator's ability.

The Use of Study Models

McKevitt in 1952 employed a system using pre-extraction records whereby the dimension is taken from pre-extraction casts by placing one point of the compass on the labial surface of the maxillary cast at the elevation of the papillae from the rugae, and the other is placed on the crest of the mandibular ridge in the median line. This distance is then recorded. The vertical dimension is taken in two parts. The vertical height of the maxillary rim can be taken from the maxillary central incisor on a cast. With this height as a target the occlusion rim is heated and paralleled antero-posteriorly with a line previously drawn on the face from the lower border of the external auditory meatus to the alae of the nose and laterally with an imaginary line drawn through the pupils of the eyes. The dimension of the mandibular rim is obtained by heating the lower occlusal rim and closing it against the maxillary component to the pre-determined vertical dimension which was measured in millimetres on the cast.

Direct Measurement

Kettlewell (1954) uses direct measurement and cephalometric X-rays as pre-extraction records. He feels that vertical dimension should be recorded before the removal of teeth, provided that the factors concerned indicate that the vertical dimension is normal. He suggests two methods:

(a) simple measurement with calipers

(b) the use of a profile roentgenogram with about a 21 feet target to film distance.

This long distance is so that the roentgenogram rays are nearly parallel so that the image size for all intents and purposes will be the same as the object size. By cutting along the image of the profile with a sharp knife and placing the outside portion against the patient's profile, the vertical dimension, profile, lip contour and meiodistal relationship of the teeth can be reproduced as they existed before the removal of teeth.