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**Course- Ma 3d Animation**

**Title of research -Facial muscle system and expression.**

As an artist, study of human anatomy such as proportion and muscle system is vital. Rather than studying about name of every muscle, it is important to study how they react. Human facial muscle system consists of 11 major muscles. They act as agents of expressions according to the human emotion and gestures. (Faigin,G.,1990)

In the following research work, I would like to investigate about the human facial muscle system and expressions in an artistically way. As a part of computer animation the better understanding of human anatomy, the principles of muscle system is a base for artistically exploration. Before talking about human facial muscle system I would like to give an outline of human figure portion and structure of the human head as well as the skull.

**Brief introduction about portion of the body and structure of human head :**

### **Proportion**

Proportion is the most subjective aspect of the study of human structure .It's a combination of several factors such as historical concepts of the figure throughout the art history ,influence of the society's present standard of beauty ,our own sensibilities as an artist, and when working from the live model, the particular proportion of that individual . A common unit of measurement for the body is a head length(head height) .Artists divided

the figure into six, seven ,seven and half or more times, each giving different result. The body can be measured from its bony landmarks and from its fleshy land marks. Fleshy land marks vary each and every person and tend to shift when the figure change poses. Portions vary according to age, sex and race. (Goldfinger,E.,1991,)

### **The standard proportion of head.**

According to Andrew Loomis, head will naturally vary in measurement and proportion. However, any artist will find it's more practical to carry in his mind, basic measurements such as scale of proportion, built on average and simplified .The front view of the head fits quite well into a rectangle that is three units of measurement wide, and three and half deep. These scales leave a little space beyond the ears on each side. The standard proportion of the human head fig -01(Loomis, A., 1956)

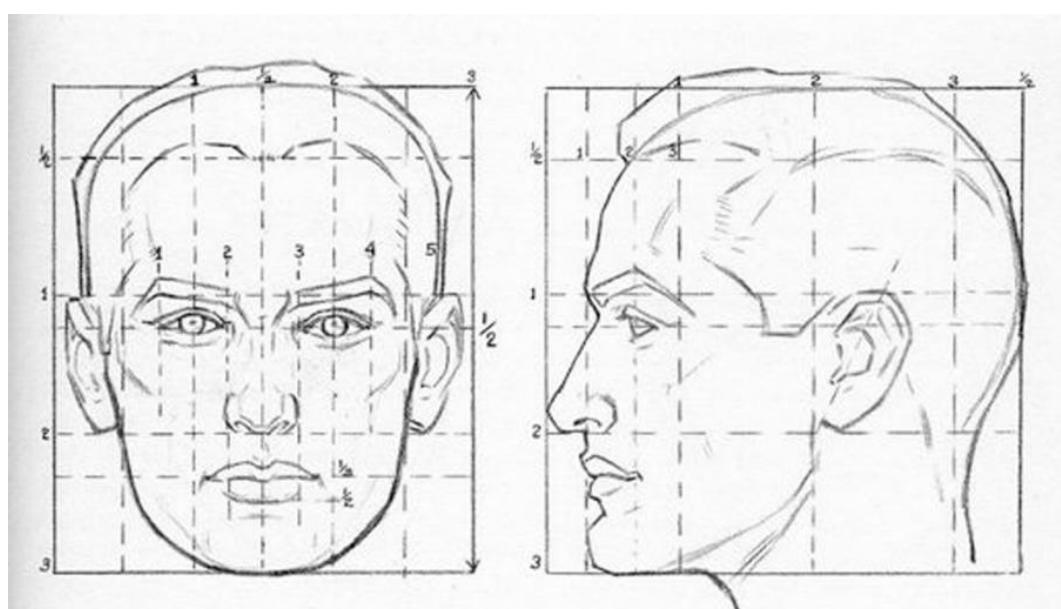


fig -(01) (Loomis,A.,1956)

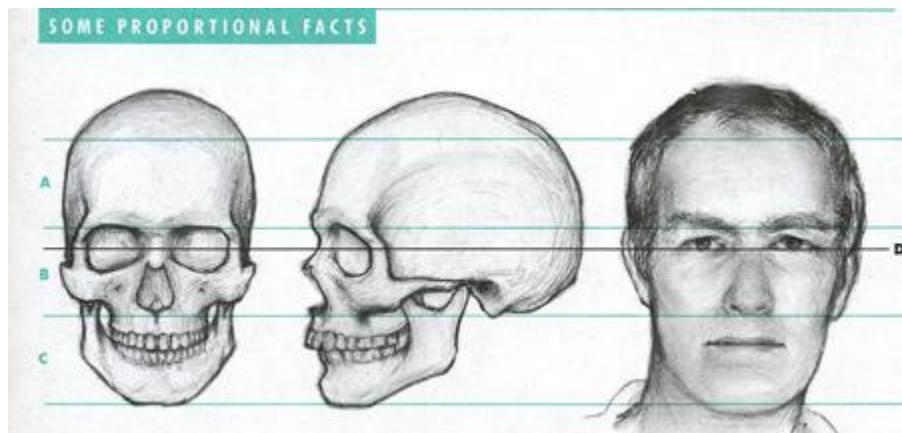


Fig -(02) (Faigin, G., 1990)

A-Upper Third

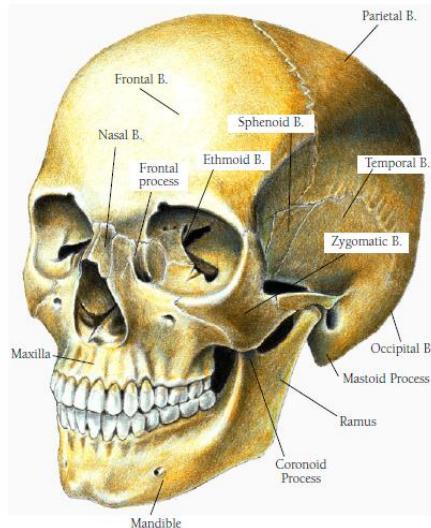
B-Middle Third

C-Lower Third

D-Half way Point

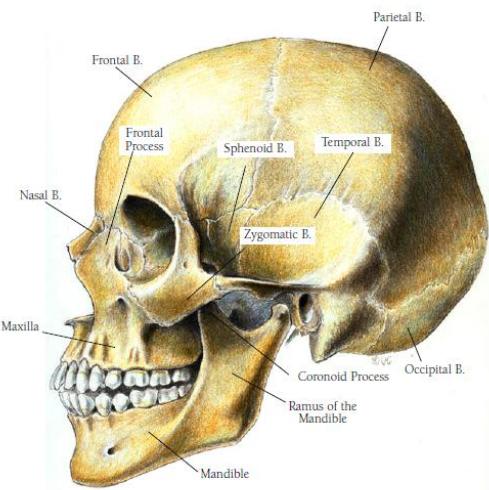
#### **Brief introduction about the skull.**

The skull is the most important of the deep forms that give shape to the face .Difference between one person and another is largely a result of differences in skull. The skull shape gives the overall shape and characteristic of human head. (Goldfinger, E., 1991)



THE SKULL

Fig(03) (Cantarella,V.,1999)



THE SKULL

Fig(04) (Cantarella,V.,1999)

The skull is made up of 19 bones, 12 which are pairs. Most of the bones are illustrated in the above pictures fig -03,fig-04 (Cantarella,V.,1999)

## THE FACIAL MUSCLE SYSTEM

Our face is as expressive as it is because of a complex group of tiny, thread-like muscles: the muscles of expressions here is a network of these muscles running beneath the surface of the face. .(Faigin,G.,1990)

## HOW FACIAL MUSCLES ACT

The facial muscle system is different from the other muscles in human body .Usually facial muscles are attached to the bones of the skull directly or indirectly, the other end connected to the skin or in another muscle that attached to the skin. For example

when somebody is smiling, the zygomatic major ,is attached to the cheek bone ,just below the outer corner of eye .When smiling the muscle stretch diagonally downwards towards the mouth ,where the other end is attached to the outer corner indirectly. When it contracts, the corner of the mouth rises up towards the cheekbone, and we smile. This is the typical way of most of the muscles work while in an expression. . ( Faigin,G.,1990,p.54-p.56)

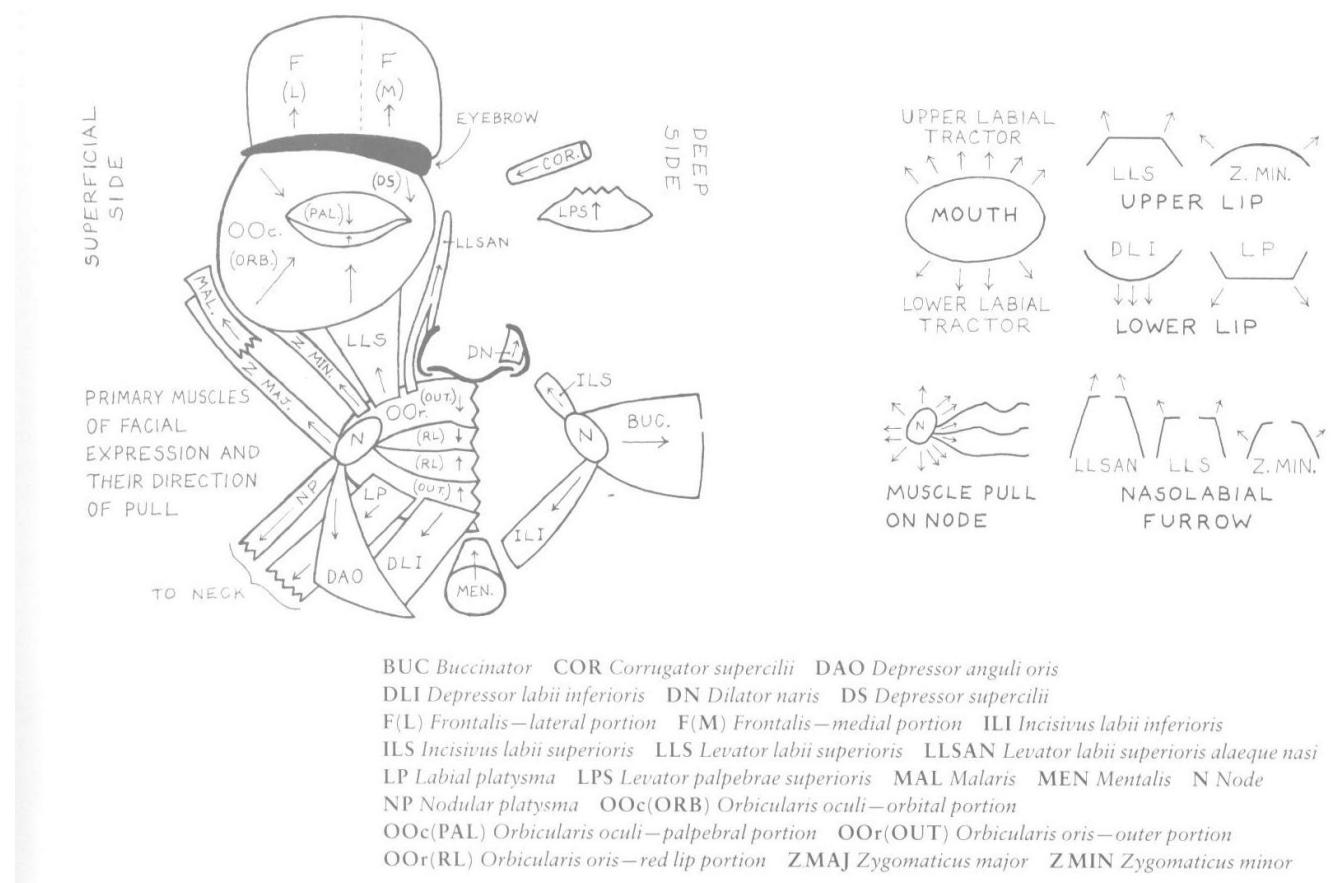
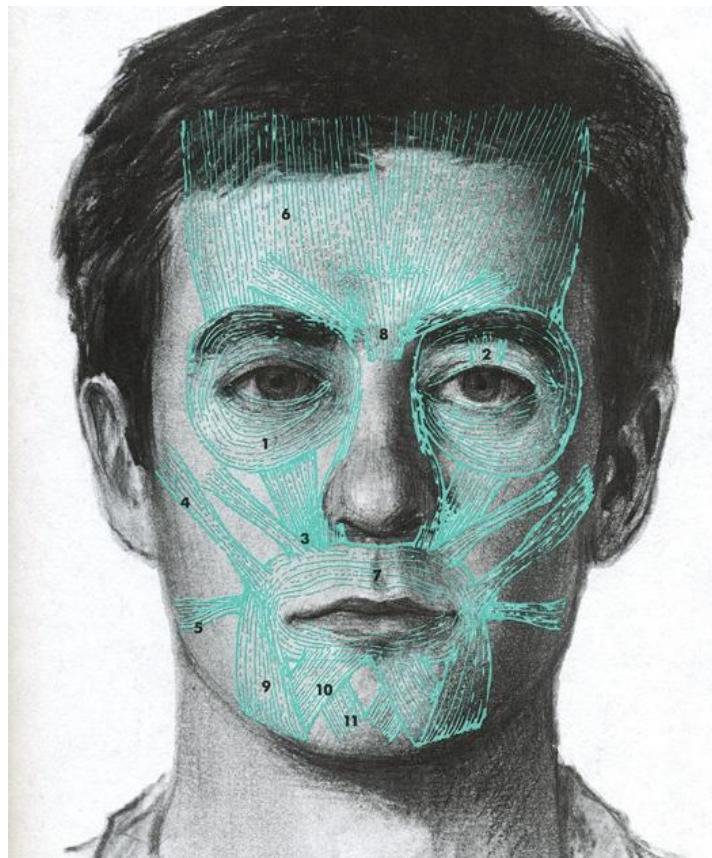


Fig (05) ( Goldfinger,E.,1991) The above picture shows the direction of the pull of each muscle.



Fig(06) (Faigin, G., 1990)

**The eleven key muscles of a human face are illustrated in the above picture.**

According to Gray Faigin (1990), there are among 25 or more human facial muscles. The following eleven muscles are responsible for the human facial expressions they are :

## **1. Name of the Muscle- Orbicularis oculi**

**Origin** -Attaches to inner orbit and skin of cheek

**Expression**- squeezes eye, as in squinting



Fig(07) (Cantarella,V.,1999)



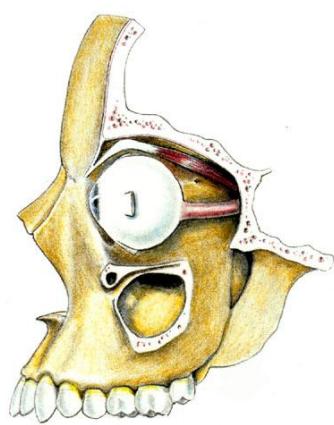
Fig(08) ( Faigin,G.,1990)

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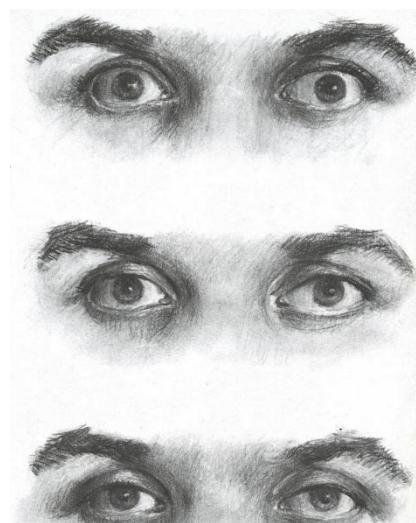
## **2. Name of the Muscle- Levator palpebrae**

**Origin** - Originates on orbit, attaches to upped eyelid

**Expression**- Raises eyelid, as in surprise.



Fig(09) (Cantarella,V.,1999)

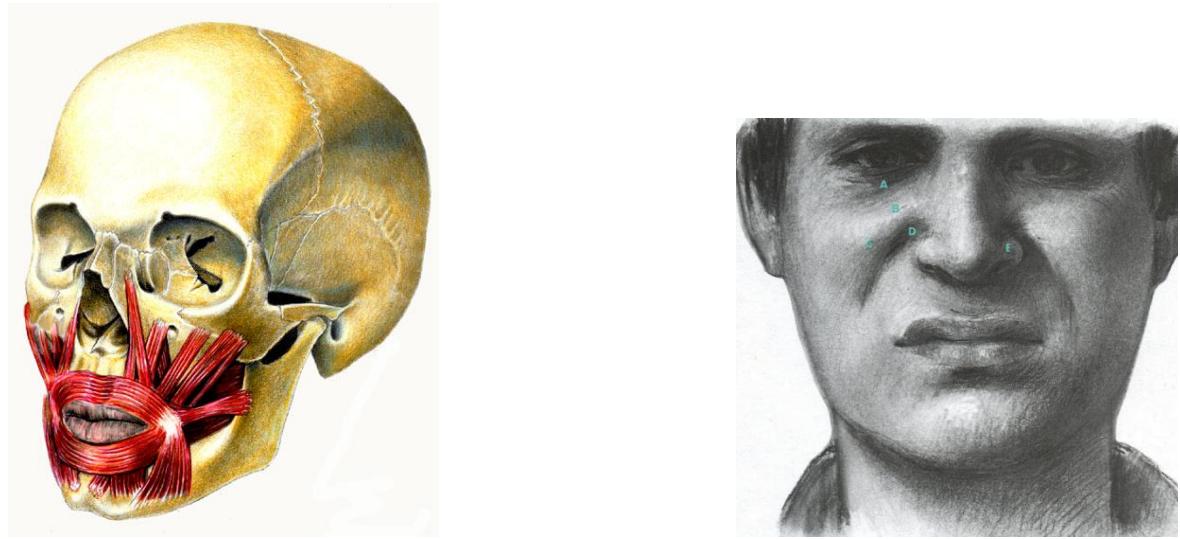


Fig(10) (Faigin,G.,1990)

### **3. Name of the Muscle- Levator labii superioris**

**Origin** -Three branches -inner branch originates on base of nose; middle branch on bottom edge of orbit; outer branch on zygomatic arch. All insert into skin above upper

**Expression**- Known as the sneering muscle.



Fig(11) (Cantarella,V.,1999)

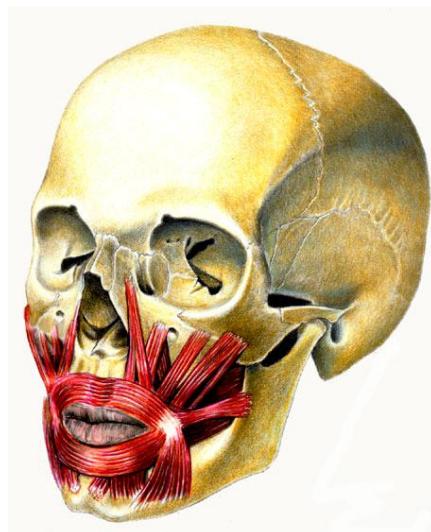
Fig(12) (Faigin,G.,1990)

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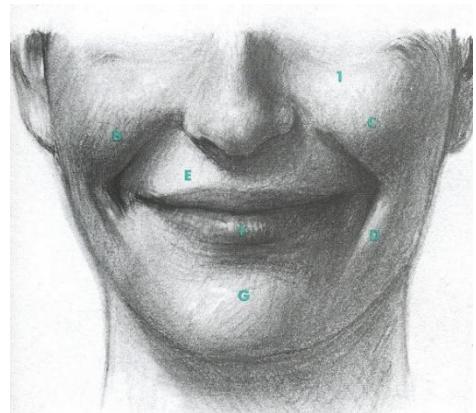
### **4. Name of the Muscle- Zygomatic Major**

**Origin** -Originates on zygomatic arch; insert into mouth corner

**Expression**- Pulls mouth into smile; known as the smiling muscle.



Fig(13) (Cantarella,V.,1999)

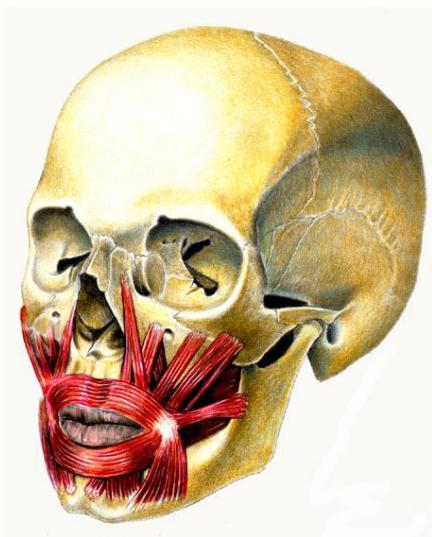


Fig(14) (Faigin,G.,1990)

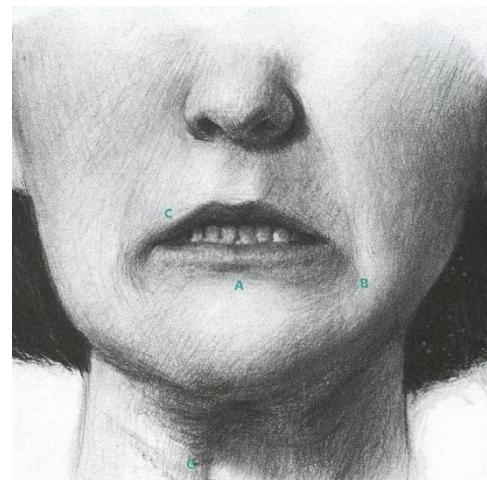
### 5. Name of the Muscle- Risorius /platysma

**Origin** - Risorius originates over rear of jaw , inserts into mouth corner ;platysma originates an upper chest ,inserts into mouth corner

**Expression**- stretching mouth, as in crying known as the lip stretcher



Fig(15) (Cantarella,V.,1999)



Fig(16) (Faigin,G.,1990)

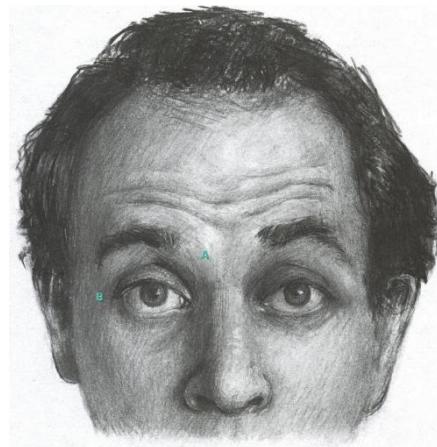
## **6.Name of the Muscle- Frontalis**

**Origin-** Originates near top of skull, along hairline; inserts in skin under eyebrows

**Expression-** Raises eyebrows straight up, as in surprise. Known as the brow lifter



Fig(17) (Cantarella,V.,1999)

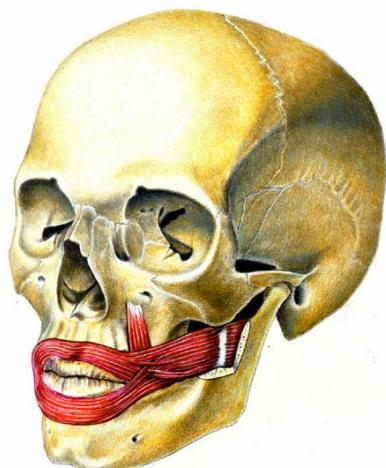


Fig(18) (Faigin,G.,1990)

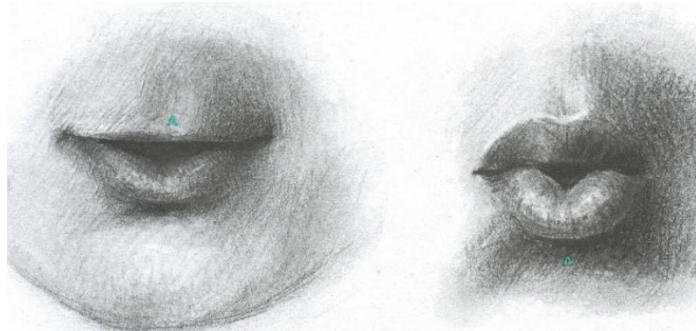
## **7.Name of the Muscle- Orbicularis oris**

**Origin -** Originates from muscles of corner of mouth

**Expression-** Curls, tightens lips. Known as the lip tightener.



Fig(19) (Cantarella,V.,1999)



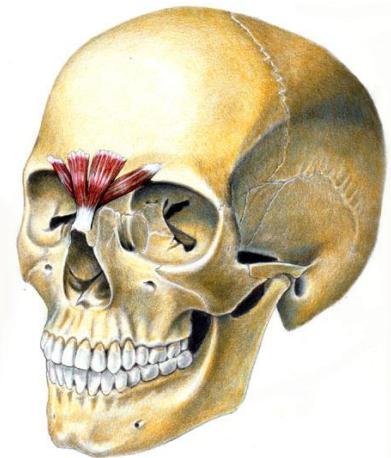
Fig(20) (Faigin,G.,1990)

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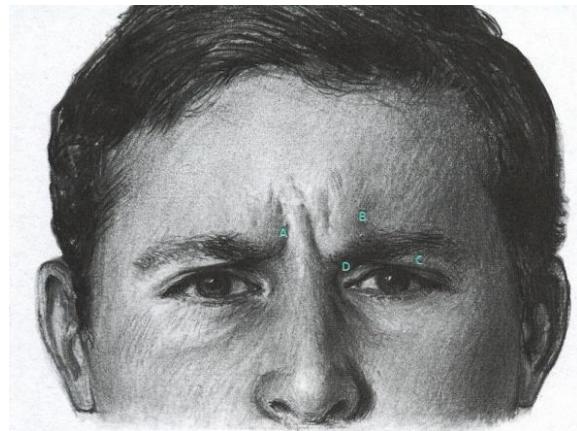
## **8.Name of the Muscle- Corrugator**

**Origin** - Originates on nasal bridge attaches to skin under middle of eyebrow

**Expression**- Lowers inner end of eyebrow. Known as the frowning muscle.



Fig(21) (Cantarella,V.,1999)

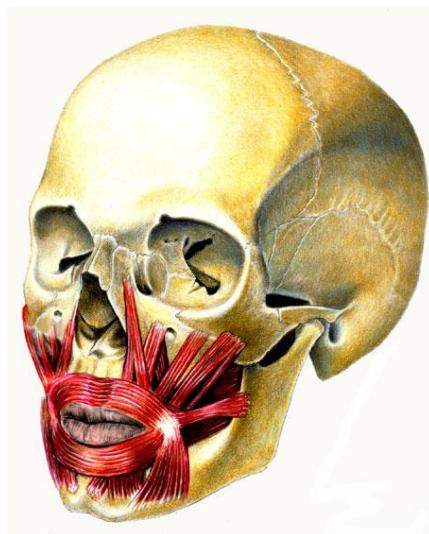


Fig(22) (Faigin,G.,1990)

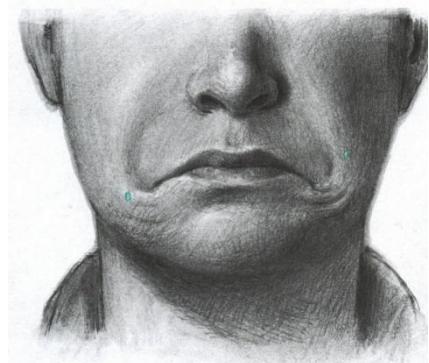
## **9.Name of the Muscle- Triangularis**

**Origin** - Originates along lower margin of jaw ;inserts in to mouth corner

**Expression**- Pulls down on mouth corner .This is the "HAVE A -BAD -DAY "muscle.



Fig(23) (Cantarella,V.,1999)



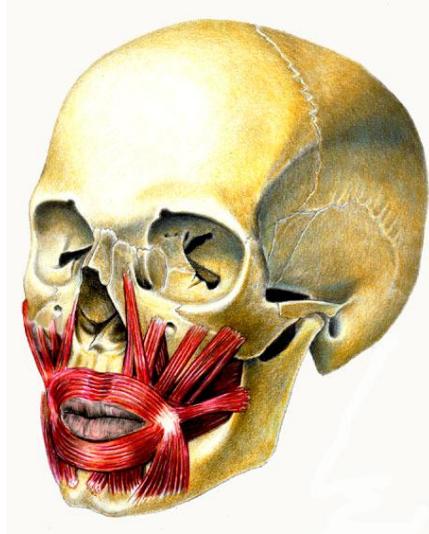
Fig(24) (Faigin,G.,1990)

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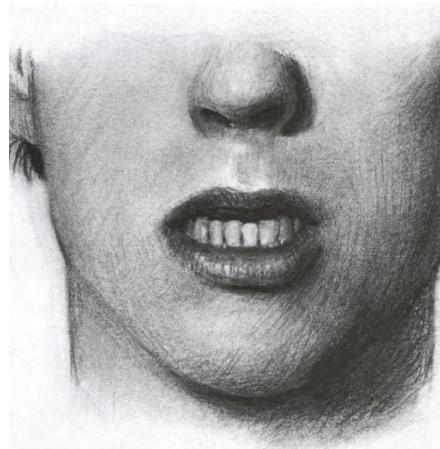
#### 10. Name of the Muscle- **Depressor labii inferioris**

**Origin** - Originates along bottom of chin ; inserts into lower lip

**Expression**- Pulls bottom lip straight down ,as in speaking



Fig(25) (Cantarella,V.,1999)

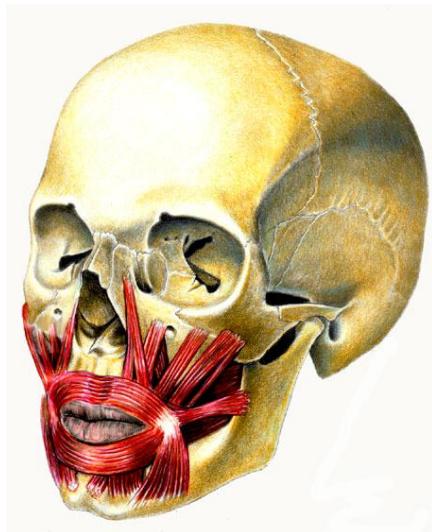


Fig(26) (Faigin,G.,1990)

## 11. Name of the Muscle- Mentalis

**Origin** - Originates just below the teeth, on lower jaw; inserts into skin of ball of chin

**Expression**- Wrinkles chin, creating raised "is land", pushed lower lip up .Known as the pouting muscle



Fig(27) (Cantarella,V.,1999)



Fig(28) (Faigin,G.,1990)

# **The Six Basic Facial Expressions**



**Fig(29)** (Cantarella, V., 1999)

**Fig (30)** (Faigin, G., 1990)

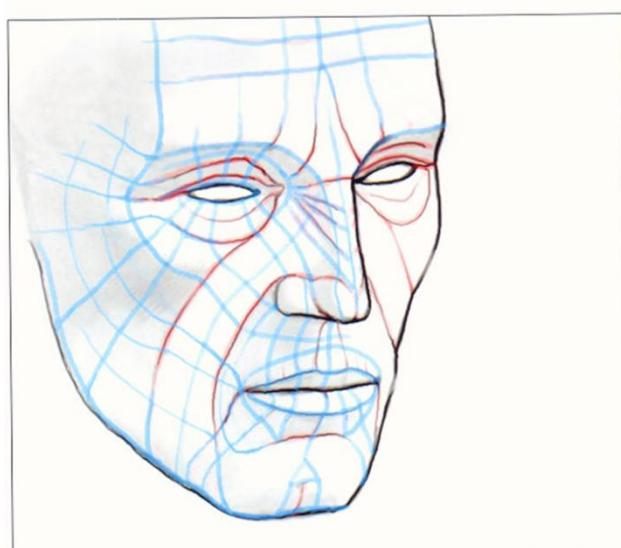
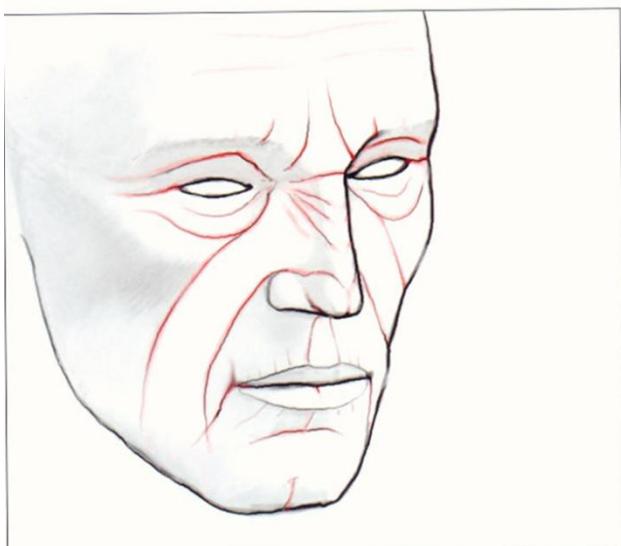
The above pictures show the artistic and realistic photographic representations of the six principle human facial expressions and some of its variations. Group of facial muscles are associated with each and every expression. According to the expression we can divide the muscles in to in to different groups.

## **How the facial muscle system working in 3d modelling**

In order to achieve good quality of topology in 3d, I will try to make the base mesh very simple and then will add details according to the concept art, which will help for further purposes such as facial rigging and animation. When all the references are gathered, planning of the topology should be done according to the facial muscles.

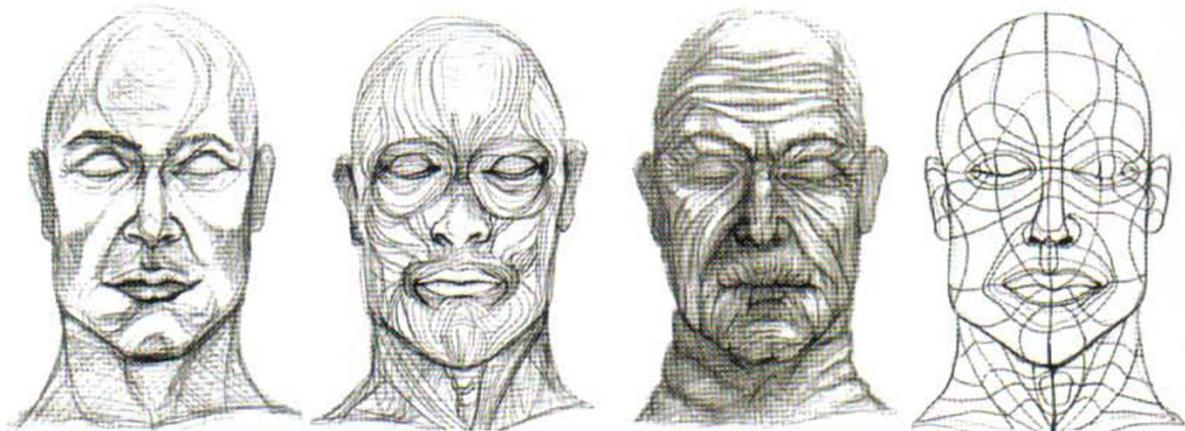


Fig(31)(Cortina, F.A.Blanche, P.Stahlberg, S., 2005)



Fig(32)(Cortina, F.A.Blanche, P.Stahlberg, S., 2005)

The above pictures show the method of planning the topology according to the flow of muscle. They show the major wrinkles of face. The blue lines show the logical way of constructing the topology in a model. That have based on the intersection of muscle line and the wrinkle lines. (Cortina, F.A.Blanche, P.Stahlberg, S., 2005)



*Facial muscles and skin wrinkles lead to good topology*

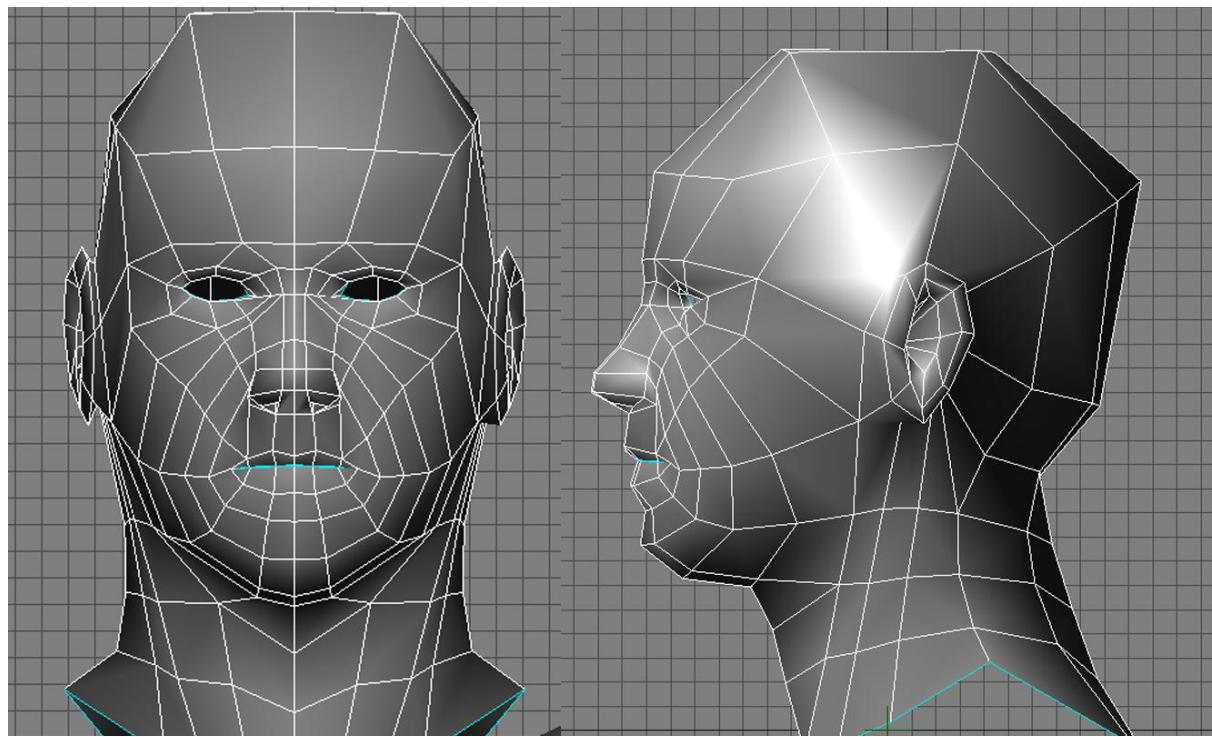
Fig (33) (Miller, E., 2006)

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#### (Hyper creature creation)

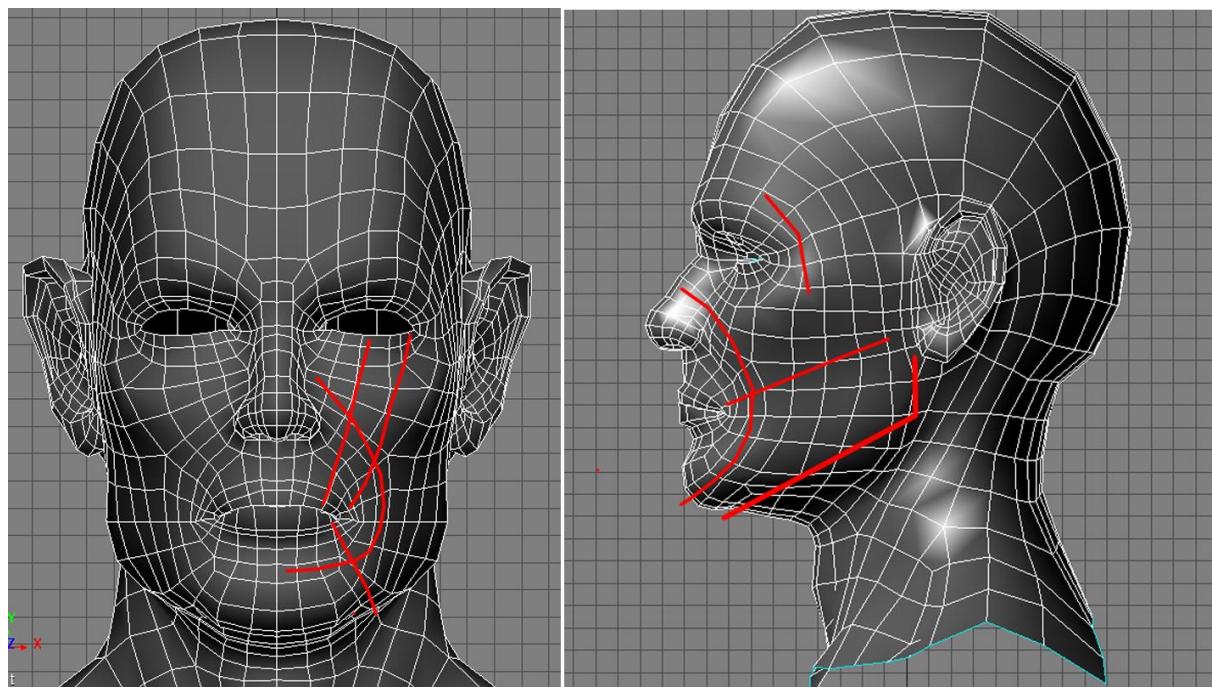
In the above fig (33), the image to left is a simple face illustrating basic shadow planes. The second image from the left shows the muscle structure under the skin, then comes the wrinkle lines and final image shows the primary basic edge flow. Combining these two into the final model is the goal. ((Miller, E., 2006))

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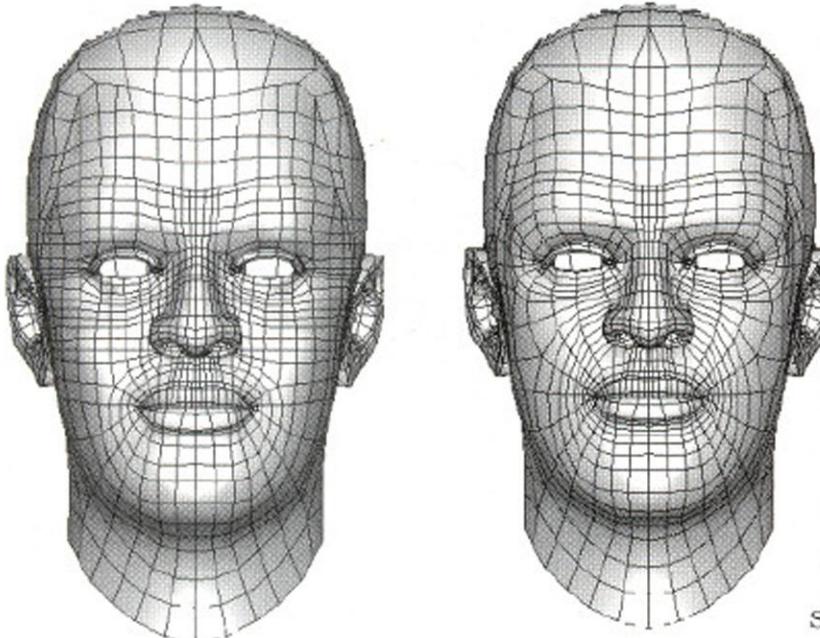
fig(34) (Autodesk .softimage xsi.2010)

The above fig(34), a model to study, to create a good topology according to the facial muscle system , started with a simple base geometry (Autodesk .softimage xsi.2010 -Face\_man) .



fig(35) Clean topology , but bad ...

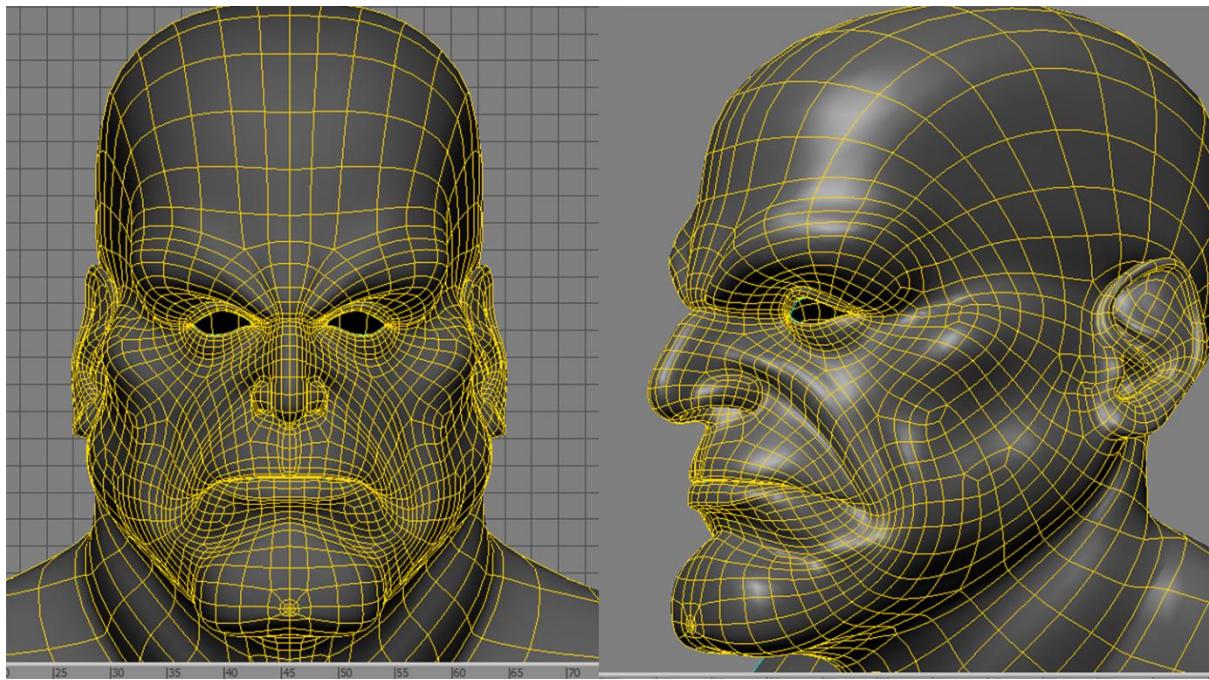
The mesh has a clean topology but most of the edge loops went awkward .The wrinkle line and muscle line are not forming in a proper way of intersection.



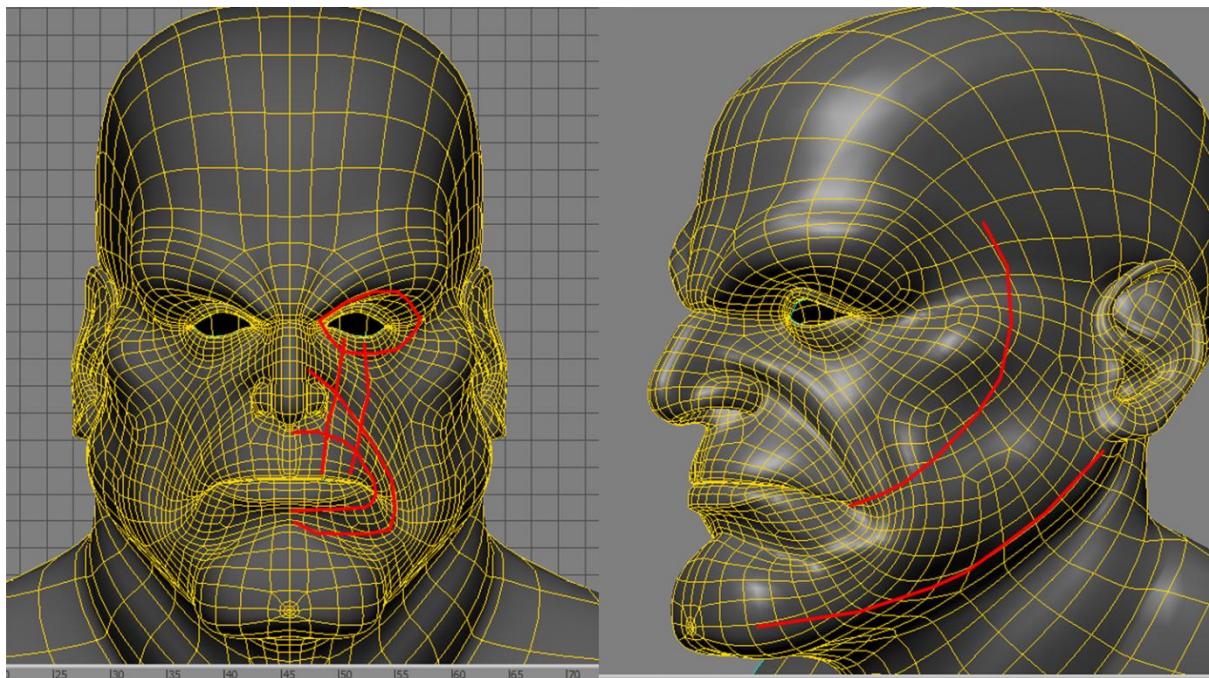
the  
sin  
fig(35)

(Osipa,J.,2003)

The above picture , we can see that most of the mesh are not going to be a perfect circles (left picture ).but the point lay out is clean and there are good circles around the mouth ,but it won't give a smooth facial movement .Creasing in the right areas would be almost impossible because the edge loop are vertically gridded .The right picture shows the clean point lay out as well as circles around the mouth and eye will provide a good facial movement .( Osipa,J.,2003,p.76)



The above picture show the exaggerated the features of the character and its shows the wrinkle lines as well as muscle lines are visible. These are the screen capture of the character that i created in Softimage xsi to study facial muscle system .



## **Reference .**

1.Faigin,G.,1990.*The Artist'S Complete Guide to Facial Expression*.NewYork:Watson-Guptill.

**For the detailed study of human facial muscle system i refer the book**

2.Cantarella,V.,1999.*Bones and Muscles:An Illustrated Anatomy*.NewYork:Wolf Fly.

**Used for to refer and study illustrated muscles and bone structure of human head**

3.Osipa,J.,2003.*Stop Staring-Facial Modeling and Animation Done Right*.San Francisco:Sybex.

**Referred to get the idea of how to create animatable 3d modelling .**

4.Miller,E.,2006.*Maya Techniques-Hyper-Realisitc Creature Creation*.Canada:Alias Sysrem Crop.

**Referred for planning and creating good topology character head**

5.Cortina,F.A.Blanche,P.Stahlberg,S.,2005.*D'artiste-character modelling*.Australia:Ballistic.

**Reffered to investigate about how the digital character modelling artists are working in animation industry .to check the work flow**

6.Goldfinger,E.,1991.*Human Anatomy for artists-the elements of form*.London:Oxford University.

**Reference images for anatomy study of head**

7.Loomis,A.,1956.*Drawing the head and hands*.New York:The Viking.

**To get clear idea about construction of human body and portion of human head**

8. Autodesk .softimage xsi.2010

**I created the head model in softimage xsi .**

