

DESIGN & FABRICATION OF 3D PRINTED EAR PROTHESIS FOR MICROTIA & ANOTIA BY USING SILICON RUBBER MATERIAL

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Abstract— Microtia is a one of the birth imperfection of the external ear that happens in 1 of each 5000 births. And truma cancer the outer ear can be injured. Some fire accidents burns external ear. So this problem peoples are suffering and mentally disappointed loss a self confidence. So this problems using the present traditional methods are Rib Cartilage surgery. This surgery require two types of surgerys . one of the surgery is rib bones collected in human body taken from under ribs. the rib bones can be cut ear shapes and arranged 2d template the second surgery is microtia ear back side cut the skin implant 2d template (rib bone) model.

this case one of the problem is need a skin and collected by human body .After completion of this surgeries some irritation problems occur. and confer with a doctor several times . it be time taking process.very risky. So overcome this problem (surgeries), we clarify the possibility of utilizing a three-dimensional (3D) ear prosthesis by using of 3D scanner (SENSE) and 3D printing technology by silicon rubber material .The 3D scanner has scan ear creates 3D dimentional ear model in sense software using anatomic measurements taken by an external ear and a number of of the design in the catia and mesh lab software. 3D printed ear prothesis will manufacturing FDM technique by using of a PLA (polylactic acid) material .

3D printed ear model like a use of die.Rapid prototyping one of the technology is silicon rubber tooling materials is liquid silicone rubber. this material are used presently body implants. To prepare mold die like a injection molding process. used.Rapid Tooling (RT) describe that is the outcome of compare to Rapid Prototyping procedures with customary practices to create a form rapidly or parts of an utilitarian model from CAD information in less time and at a lower cost in respect to conventional methods. the main advantage is over come surgery.

Keywords— SENSE 3D SCANNER, CATIA,JULIA+ 3D PRINTER,SILICON RUBBER,

I. INTRODUCTION

Anotia and microtia are birth imperfections of an infant's ear. Anotia happens when the outer ear (the piece of the ear that can be seen) is missing totally. Microtia happens when the outside ear is little and not framed legitimately. Anotia/microtia as a rule occurs amid the initial couple of long stretches of pregnancy. THESE IMPERFECTIONS CAN DIFFER FROM BEING SCARCELY OBSERVABLE TO BEING A NOTEWORTHY ISSUE WITH HOW THE EAR FRAMED. MORE OFTEN THAN NOT, ANOTIA/MICROTIA INFLUENCES HOW THE CHILD'S EAR LOOKS, YET TYPICALLY THE PARTS OF THE EAR INSIDE THE HEAD (THE INTERNAL EAR) ARE NOT INFLUENCED. BE THAT AS IT MAY, A FEW CHILDREN WITH THIS IMPERFECTION ADDITIONALLY WILL HAVE A TIGHT OR MISSING EAR CHANNEL.

Microtia is an inherent outside ear distortion that happens in around 1 of each 5000 births. Most cases are one-sided however roughly 10% of distortions influence both outside ears .Microtia and related disorders, for e.g., facial separated, faciala symmetry, microphthalmia , polydactyly, or vertebral abnormalities, can diminish patients' personal satisfaction primarily because of their low confidence. Kristiansen et al.

discovered the longing to have indistinguishable ears, seeing their ear diminish patients' personal satisfaction predominantly because of their low confidence. Kristiansen et al. seeing their ear to look interesting, visit remarks and/or questions from mother, the wish to wear sunglasses, and getting teased to be motivational factors for surgery. Also, there are reports that after ear reproduction 91% of youngsters detailed upgrades in self-assurance and that auricular remaking utilizing autologous ligament in kids brought about critical changes in wellbeing related personal satisfaction. Moreover, the achievement of microtia recreation is connected to psychological postsurgical recuperation of the patient. Therefore, microtia reconstructive medical procedure is alluring reshape the Sear deformity and reduce both physical and psychological problems Microtia and truma conditions microtia is ear turned into a small. Microtia is an intrinsic distortion where the pinna (outer ear) is immature. A totally undeveloped pinna is alluded to as anotia.

Microtia and truma conditions

Sorts of Microtia There are four kinds of microtia, going from Type 1 to Type 4. Sort 1 is the mildest frame, where the ear holds its ordinary shape, however is littler than common. Sort 4 is the most extreme compose where all outside ear structures are missing — anotia. This condition can influence one or the two ears.

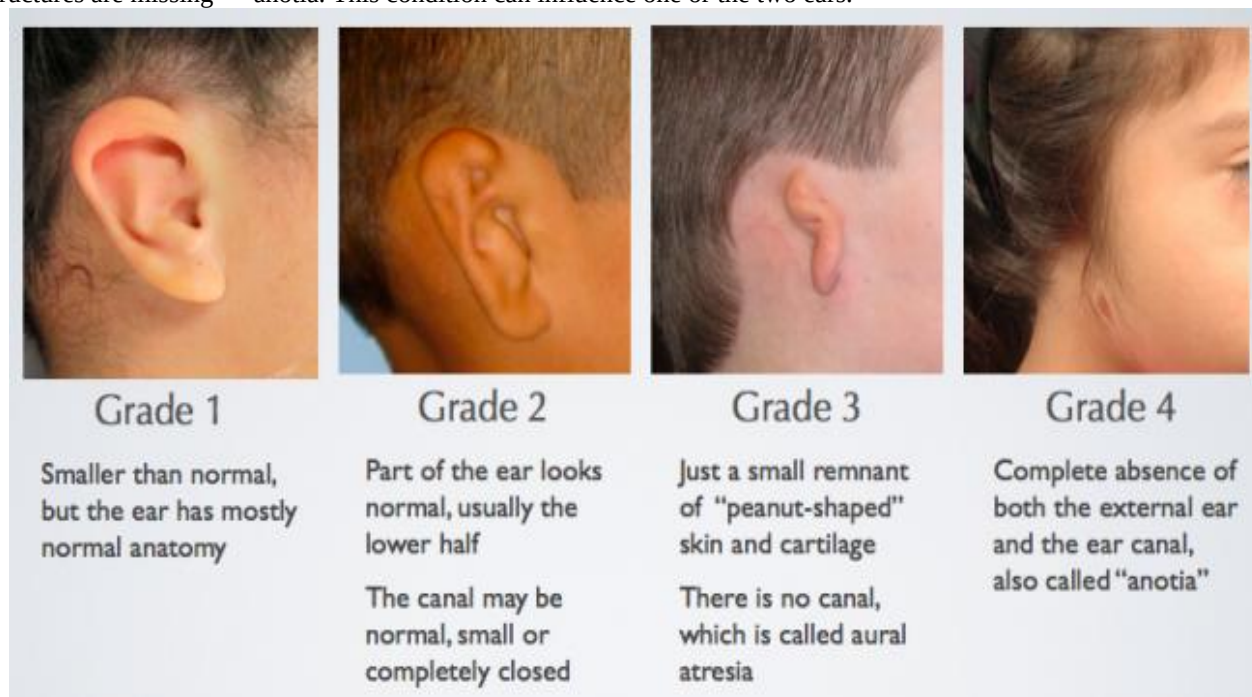


Fig 1 Sorts of microtia and anotia



Fig 2 Grade 3

Be that as it may, it is more typical for children to have just a single influenced ear. 1-2 microtia is ear turned into a small. Microtia is an innate distortion where the pinna (outside ear) is immature. A totally undeveloped pinna is alluded to as anotia. Since microtia and anotia have a similar beginning, it tends to be alluded to as microtia-anotia.

Truma condition

Truma is a one of the cancer Ear reconstruction generally takes place after removal of a cancerous lesion or acute traumatic injury to the ears.



Fig 4 truma

PROCESS AND OBJECTIVES :

- 1.hair remove part
2. Sense 3D Scanner
3. Catia v5 r20
- 4.3D printing
5. Rapid tooling

1. hair remove part :

First I have to design hair disappearing part by using of a catia. the part purpose is disappearing of hair and ear back side unknown shapes.

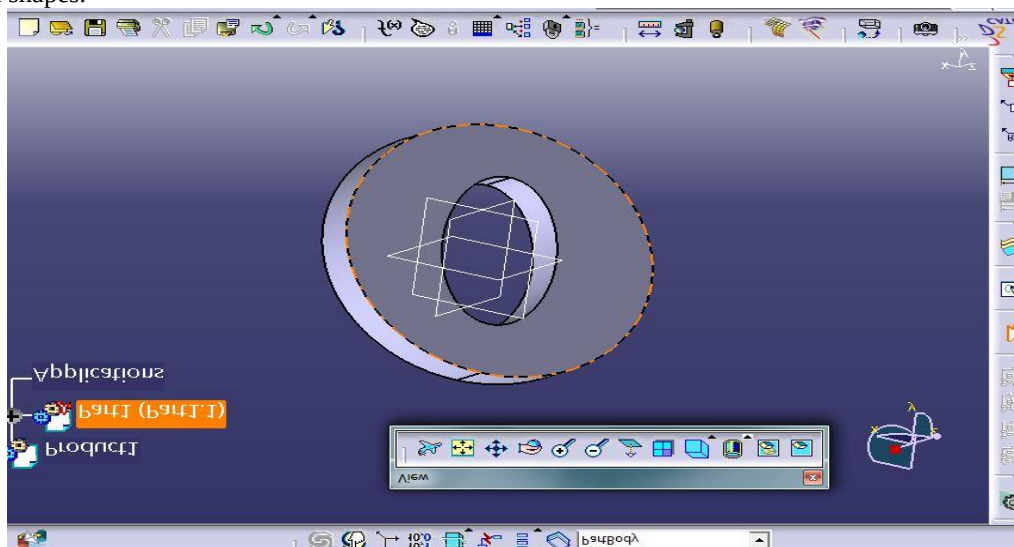


Fig 5

Part saved in STL FORMAT The part is printed in JULIA + 3D printer. Drag the part import fracktory software convert g-code.

2. Sense 3D Scanner:

You can believe of scanning as a sort of physical photography. By scanning a physical question, you can make a 3D computerized demonstrate. Not at all like conventional photography, be that as it may, you can utilize the computerized model to come back to the physical mode by sending the picture to a 3D printer. You can likewise utilize Cubify Sculpt to import your sweep, where you would then be able to control the output as you would a dirt model.

You can include surface, pound up numerous models, include shading, and outline with symmetry. The last model you make in Cubify Sculpt is a 3D print-prepared document. The Sense 3D scanner enables you to watch a scene in three measurements and after that makes an interpretation of the perceptions into a 3D display. You would then be able to utilize different Geomagic applications to make an interpretation of the sweeps into data, for example, 1 Identification of individuals and their body properties 1 Classification of items, for example, furniture, packages and so on 1 dimensions such as range and size 1 place of walls and ground the scanner can scan the image in this process objective constant scanner is rotating at a distance of 15 inches the scanner can be scanned the object in 3D model by using of a sense software.

The object and scanner distance;

- ☐ Small objects less than 16 inches
- ☐ Medium objects less than 40 inches
- ☐ Large objects less than 80 inches

Scan the ear until fully cover ear shapes and ear back, top and bottom sides until over all image model. I have scanned several times first disappearing part is place ear after than scan. The ear scanning maintain the distance between less than 16 inches proper maintain a distance scanner can move top bottom left right cover all ear .

the scan ear is appeared in computer screening how much ear scanned but some of dotted lines appeared that lines means scanner cannot scan that portion so again scan that portion white spotted outline are disappeared. This process is repeated until the remove of white dotted lines..

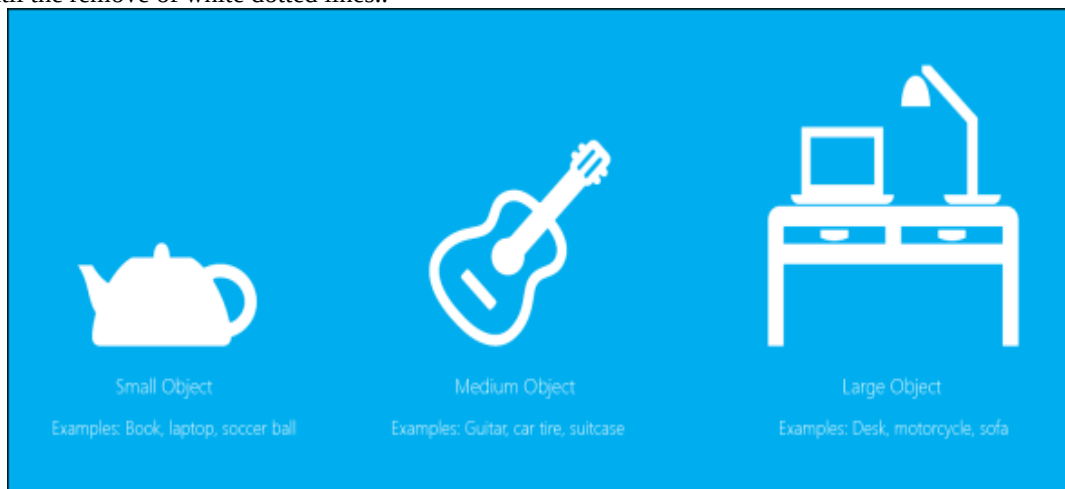


Fig 6

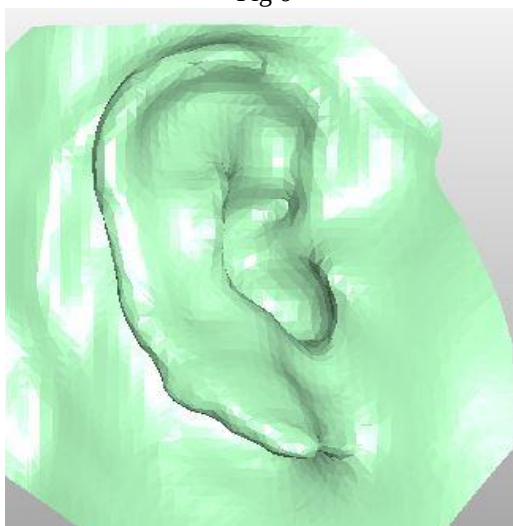


Fig 7

After conclusion of the scanning the file save in STL, PLY OBJ formats. We can saved STL format.

3. Catia v5 r20 :

CATIA stands for (Computer Aided Three-dimensional Interactive Application). It's a commercial CAD software used for physical modelling in various industries including Mechanical and Aerospace. It was industrial by Dassault Systèmes in early 80's mainly for aerospace industry.

Open Catia software

- ☐ open part part assembly we can import or existing component open the model next click on to
- ☐ the digital mockup click on
- ☐ DMU optimizer. we can select offset set as zero next save in model.
- ☐ The file saved in cad model
- ☐ open the model copy the master tree paste the part profile.
- ☐ now we can changes the design modifications.
- ☐ the part click on wire frame modeling create a surface.
- ☐ In wire frame modeling surface plate is created attached to the ear back surface. Then the model is created.

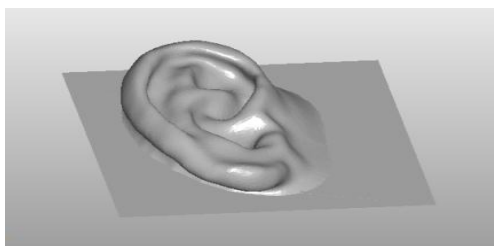


Fig 8

After completion of the ear part saved STL format. And also save required format.

Fracktory(cura):

This is Fracktory, the product for Fracktal Works' 3D printer, Julia. Fracktory expects to disentangle the procedure of 3D printing for the normal client. It is a mix of the most elite open source 3D printing programming. UI centers around alternatives important to the normal client, shunning superfluous controls, while holding the choice to have propelled controls for the accomplished.

The UI has been composed in light of instinct and ease of use. A cognizant choice of deciding on a skeuomorphic configuration style was made to give visual signals to make the product as natural as could be expected under the circumstances.

The part printed below specifications

- ☐ Layer thickness 0.1
- ☐ Shell thickness 0.5
- ☐ Nozzle temp 215 OC
- ☐ Bed temp 60 OC
- ☐ Support type brim

The saved in g-code format. g-code means generative codes.

The part can printed in Julia + printer

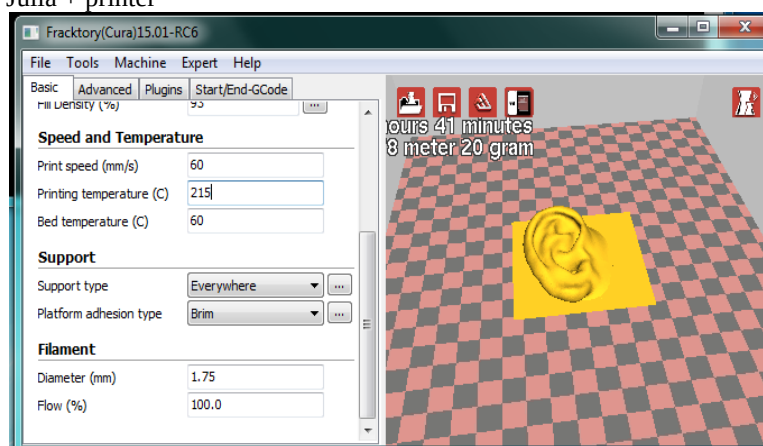


Fig 9

4.3D printing:

Julia+ 3D printer In rapid prototyping technologies one of the technique is Additive manufacturing. it is the process the material is going to deposit deposit by deposit to form the required tangible product. In additive manufacturing fusion deposition modeling (FDM) technologies is used. 3D print is boon for prototyping industry.

Additive manufacturing is going to be the 3rd industrial revolution because 3D printing has new & expanding technical social & economic impact particularly in prototyping. 3D printing permits mass customization in businesses like vehicle, human services, aviation, training, customized blessings and shopper parts. It allows to test the designed parts physically in very less time and allows designers and artists for producing unique and creative parts. Prototyping is the leading one which uses 3D printing.

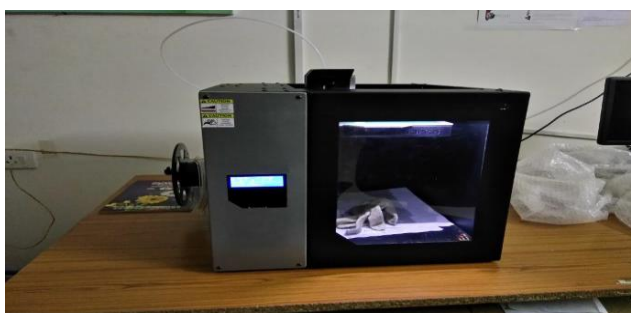


Fig 10

Filaments:

In 3D printing machine usually PLA (poly lactic acid), ABS (acrylonitrile butadiene styrene) filaments are most widely used. In addition to PLA and ABS the following filaments are also used.

PLA(poly lactic acid):

PLA: PLA is the most commonly used 3D printed filament in FDM machine, and PLA is a bio degradable filament. PLA is generally produced from Polylactic acid. PLA is very easy to print which doesn't required heated bed.

Properties of PLA:

1. PLA is much harder than ABS
2. PLA melts at lower temperature than ABS i.e. 210°C
3. Heating bed is not mandatory.
4. Nozzle temperature is maintained at 190 to 215°C

3D PRINTING MACHINE SPECIFICATIONS:

HARDWARE:

[1] Printing technology	[2] Fused Deposition Modelling
[3] Build volume	[4] 210 x 250 x 260 mm ³
[5] Layer resolution	[6] 317 to 127 microns
[7] Dimensional accuracy	[8] XY: 50 - 100 microns, Z: 20 - 50 microns
[9] Filament diameter	[10] 1.75mm
[11] Nozzle diameter	[12] 0.3 mm - 0.8 mm (replaceable nozzle)
[13] Filament compatibility	[14] ABS, PLA, Nylon, PHA, Wood fill, Bronze fill, Carbon fiber

By using Fused deposition modeling

FDM TECHNOLOGY:

The Technology: The Fused Deposition Modeling (FDM) process develops three-dimensional prototypes straightforwardly from 3D CAD information. A temperature-controlled head expels thermoplastic matter layer by layer. The FDM process begins with bringing in a STL document of a model into a pre-preparing programming. This model is arranged and scientifically cut into level layers changing from $\pm 0.127 - 0.254$ mm thickness.

A help structure is made where required, in view of the part's position and geometry. Subsequent to investigating the way information and producing the toolpaths, the information is downloaded to the FDM machine. The framework works in X, Y and Z tomahawks, drawing the model one layer at once. This procedure is like how a craft glue firearm expels liquefied dots of paste.

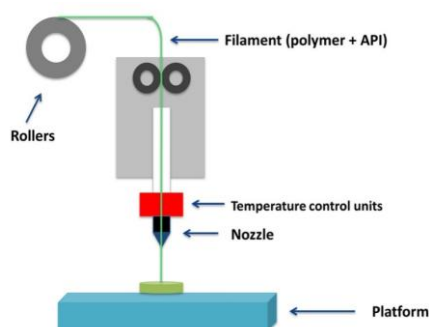


Fig 11



Fig 12

Once the part is finished the help sections are evacuated and the surface is done. Julia+3D printers Fusion testimony displaying is utilized in this strategy part made of layer by layer _ This is the 3D printing model or DIE PART POLYLACTIC ACID (PLA) material are use in intertwined affidavit demonstrating procedure.

After consummation of 3D printing part that part like a bite the dust the part can be put in entrail the material can be poured in pattern.

5.RRAPIDTOOLING :

Rapid Tooling (RT) portrays a procedure that is the after effect of joining Rapid Prototyping systems with regular tooling practices to deliver a form rapidly or parts of an utilitarian model from CAD information in less time and at a lower cost in respect to traditional machining strategies.

This is the 3D printing prototype or DIE PART POLYLACTIC ACID (PLA) material are use in fused deposition modeling technique. In indirect tooling one of the tooling is silicon rubber tooling and manufacturing.

Materials and apparatus:

- ☐ Liquid silicone rubber (LSR2)
- ☐ Curing agent (tin based catalyst)
- ☐ Mold released agent
- ☐ Bowel and spoon

Liquid Silicone Rubber:

Liquid Silicone Rubber be use to create elastic parts by injection molding. Its principle properties extend from high obstruction against temperatures (both, high and low temperatures) and synthetic concoctions to high straightforwardness and great mechanical properties. It is applied in automotive parts, electronics, medical devices, food and household applications and many other sectors.

It is a elastomer (rubber like materials) compoused of silicon –it self a polymer contains silicone to gather hydrogen oxygen silicon rubber wildly used in industry Liquid silicon rubber lsr is silicone rubber made from a liquid compound. The liquid compounds consists of mainly of silicone polymer and well know for being nontoxic and temperature resistant.



Fig 13

S.NO	DESCRIPTION	PARAMETER
1.	MIXING PROPORTION OF CURING AGENT	3-5%
2.	OPERATING TIME AND TEMP	15-20 MIN / AT 25 TO 30 °C
3.	CURING TIME	3-8 HRS AT 25-30 °C
4.	HARDNESS	15 A°
5.	DENSITY	1.09 G/CM3
6.	VISCOSITY	20000 + -1000 CPS 25°C
7.	TENSILE STRENGTH	≥43 KGF/CM ²
8.	TEAR STRENGTH	≥22KGF/CM
9.	ELONGATION BREAK	≥450%

It is related to the hydrosy functional group c-o-h found in all
 Applications of liquid silicone rubber

- ☐ Cooking
- ☐ Baking
- ☐ Sport wear
- ☐ Foot wear
- ☐ Electronics
- ☐ Medical devices and implants

Curing agent;

Curing agent (TIN BASED CATALYST) curing is a term in polymer science and process designing that alludes to the toughening or solidifying of a polymer material by cross-connecting of polymer chains, realized by electron pillars, warmth, or concoction added substances. At the point when the added substances are initiated by bright radiation, the procedure is called UV Cure. In elastic, the restoring procedure is additionally called vulcanization. Variety of curing agent and catalyst will react with epoxy regins to provide a cross linked adhesions. Curing agent generally react with epoxy and hydrogel groups.

Condensation curing system :

Condensation curing system is used one or more system one part at (RTV) room temperature vulcanization) system. The curing agent is tin based catalyst polymer is used. a) Added with 3% of curing agent silicon can still pour inside 15min mold can be free in 5-6 hours b) Added with 5% of curing agent silicon can still flow within 5min mold can be free in 2-3 hours 100% silicon rubber 3-5% curing agent mixing ratio by weight .



Fig 14

Mould release agent:

Mould release agent Premium silicon sprays for mould release agent application heavy function silicon spray for mould release are silicon based aerosol arrangements and are presented several grades particularly for moulding and industry. They are design to get better release effectiveness in various procedure as well as compression, transport, vacuum forming, pour casting, diecasting and extrusion moulding this mold release sprays are compatible with ABS, NYLON, POLYPROPYLENE and several rubbers. Mould release agent is easy release mould from pattern and die.

Procedure for making of mould ear:

1. stir the base fine before utilize
2. shake the curing agent catalyst container well before use
3. this is 100 % silicon rubber 3-5% curing agent mixing ratio by weight
4. weight the correct quantity of catalyst into the bottle. Mix the silicon rubber and curing agent by strong with a stick a uniform colour is obtained. Scrape the container walls and bottom well to insure a thorough mix.
5. pour the desired material gradually in an enduring from one of the shape so the material streams equally over the example this ought to limit entanglement of air bubbles under the streaming material. a ready might be pour initially over the pattern will also help ease the possibility of entrap air on the pattern and the cured rubber. a mold free agent may be on the pattern initial to get better release.
6. allow the rubber to cure for 4-8 hours at 25 °C earlier than remove the cure rubber mould from the pattern heat increase of rate not suggested with this product\
7. for best result allow the mould to air cure an additional 24 hours before using it in production.



Fig 15

8. after preparation of the mould liquid silicon rubber material poured same as the above procedure.
9. repeat the procedure wait 4 to 6 hours the ear can be made.
10. after 4 to 6 hours removing the mould finally made the part.
11. make a skin colour Create a palette with the essential hues: yellow, blue, red. White and dark are discretionary. Have a photo or reference picture convenient for the tone you are attempting to accomplish. /Step 2 Mix together a balance of every essential shading. Just about each skin tone contains somewhat yellow, blue and red, however in various proportions. Once you've done this a couple of times, you may begin with a greater amount of some

shading. However, to begin, simply ahead and blend equivalent amounts of each shading with a palette cut. Your result will probably be to some degree dim.

This is something to be thankful for! By and large, it's simpler to make skin tones lighter with acrylic than darker.



Fig 16

Results :

The after effects of this clinical examined show the convenience of 3D check to-print innovation for microtia reproduction .We could manufacture the 3D-printed ear model and utilize it as a kind of perspective device to disentangle microtia recreation.

The threw ear show was steady enough to enable the 3D scanner to procure adequate subtle elements of the ear shape. The thickness, profundity, and stature data of every patient's 3D-printed ear models were reliably and precisely spoken to and helped specialists shape the gathered rib ligament and picture the ear of the influenced side.

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