

Univerzitet u Novom Sadu
FAKULTET TEHNIČKIH NAUKA
Biomedicinsko inženjerstvo
Predmet: Dizajn i izrada implanata i medicinskih modela

CAD-INSPEKCIJA

Uvodne napomene

Razvoj i primena CAD-modela u inženjerskim oblastima implicirala je razvoj metoda za iskorišćavanjem najpre određenih parametara, a zatim i ukupnih modela i za potrebe kontrole/verifikacije/inspekcije.

- Preduslov za dobar inženjerski proces jeste sprovođenje kontrole/verifikacije tokom njegovog odvijanja.
- Jedan od savremenih pristupa kontrole je i **računarom podržana inspekcija (computer-aided inspection CAI)**.
- CAI podrazumeva komparaciju (poređenje) oblaka tačaka u odnosu na CAD (površinski, solid ili mrežni) model.
- Rezultat analize tj. odgovor na pitanje: “Koliko oblak tačaka odstupa od CAD modela?” je mapa u boji ili kolor mapa kod koje svaka boja predstavlja određeni nivo odstupanja.
- Ova metoda je prihvaćena kao brz, efikasan i kredibilan način provere kvaliteta izrade delova različitim tehnologijama (3D štampa, rezanje, plastično deformisanje, oblikovanje plastike itd.).

CAD-INSPEKCIJA

CAD-inspekcija podrazumeva korišćenje *CAD*-modela proizvoda, odnosno njegovih parametara, sa ciljem provere geometrijskih i dimenzionalnih odstupanja izrađenog dela ili virtuelnog modela (kreiranog na bazi rezultata 3D digitalizacije).

CAD-inspekcija je, prateći razvoj *CAD* modeliranja, najpre bila zasnovana na 2D podacima, da bi se zatim sa pojavom solid modela razvila i 3D *CAD*-inspekcija, danas poznata i pod nazivom “*CAD-to-part*” inspekcija, koja podrazumeva proveru odstupanja geometrije realnog proizvoda (na bazi njegovog digitalizovanog modela) od nominalne geometrije, definisane *CAD* modelom.

Računarom podržana inspekcija

Termini-sinonimi koji se upotrebljavaju za opis ovog procesa, sa manjim ili većim modifikacijama procesa su:

- **Rapid 3D Inspection**
- **računarom podržana verifikacija (computer-aided verification CAV)**
- **3D color comparison-to-CAD**

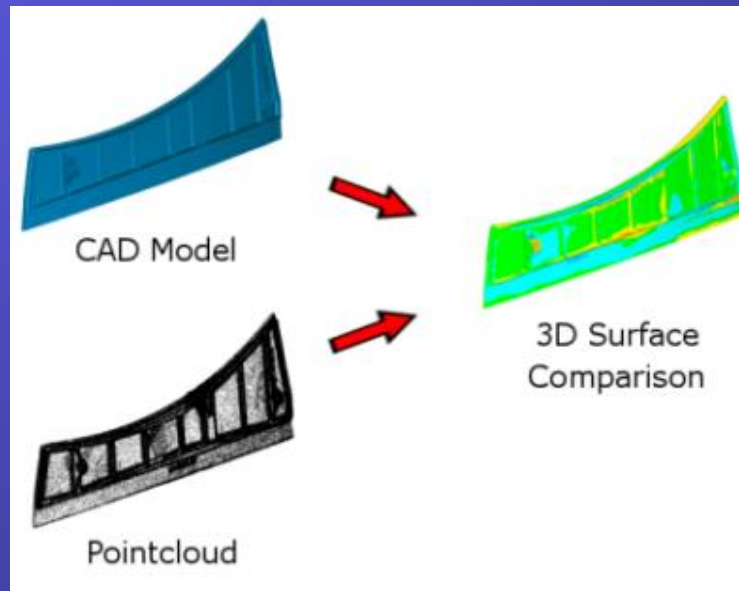
Zahvaljujući zasnovanosti na CAD-modelu, ova vrsta inspekcije je postala poznata pod nazivom *CAD-inspekcija*.

Računarom podržana inspekcija

Računarom podržana inspekcija (Computer-Aided Inspection CAI)

predstavlja metodu koja poređi geometriju proizvedenog dela (rezultat 3D digitalizacije) u odnosu na referentnu geometriju (originalni CAD model) i podrazumeva sledeće korake:

1. **3D digitalizaciju**
2. **Generisanje površinskog modela – opciono**
3. **Komparaciju sa referentnim CAD modelom**



CAD-INSPEKCIJA

Metodologija

Dva osnovna segmenta *CAD*-inspekcije su:

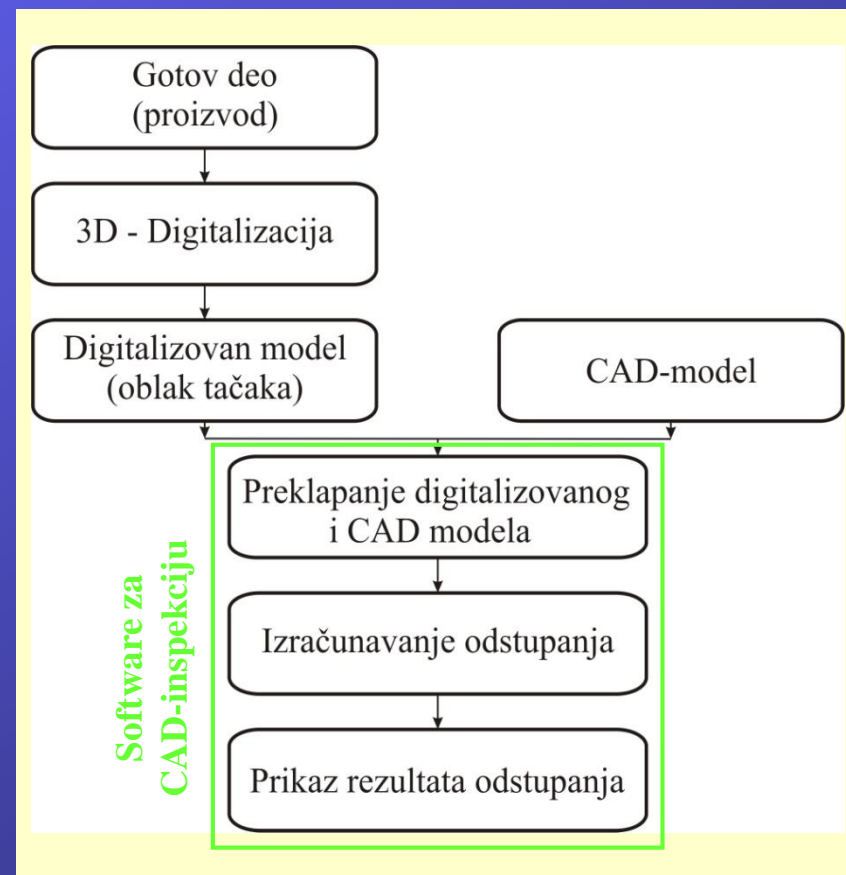
- **3D-digitalizacija** (dominantno hardverski proces) i
- **provera odstupanja** (dominantno softverski proces).

CAD-INSPEKCIJA

Procedura provere odstupanja

Procedura se sastoji u sledećem:

- izrađen deo se digitalizuje nekom od metoda 3D-digitalizacije;
- 3D digitalizovani model (*oblak tačaka*) unosi se u neki od specijalizovanih softvera za CAD-inspekciju, zajedno sa referentnim CAD-modelom;
- sledi orijentisanje digitalizovanog modela prema CAD-modelu u cilju njihovog međusobnog preklapanja;
- potom se vrši izračunavanje nivoa odstupanja digitalizovanog modela od CAD-modela;
- prikaz rezultata odstupanja (mogu se dobiti i u grafičkom obliku radi lakše preglednosti).



Algoritamski prikaz toka procesa

Qualify Report

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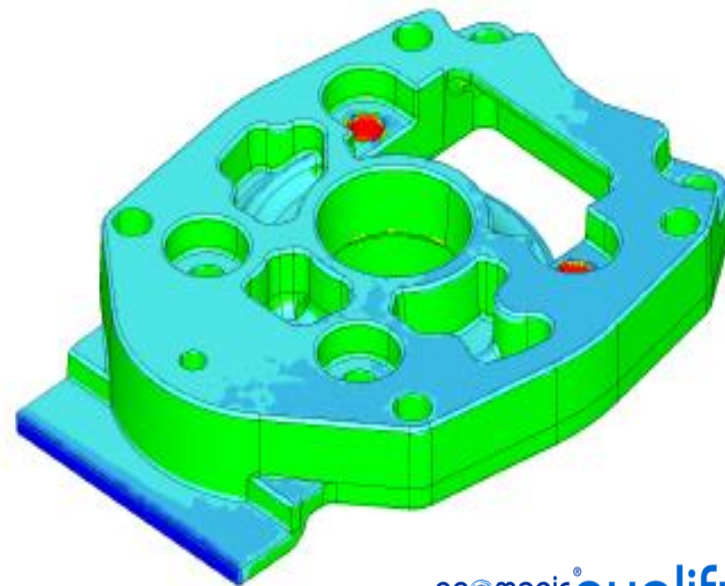
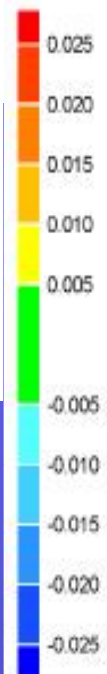
Author: Kevin Scofield

Client: ACME Manufacturing

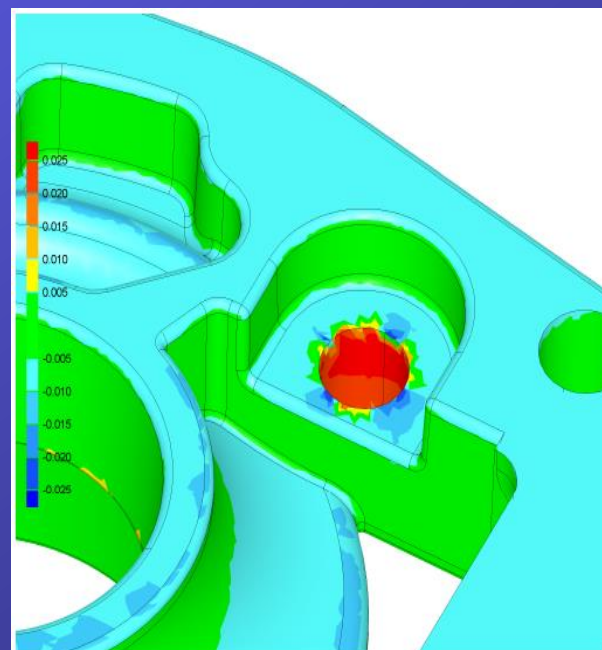
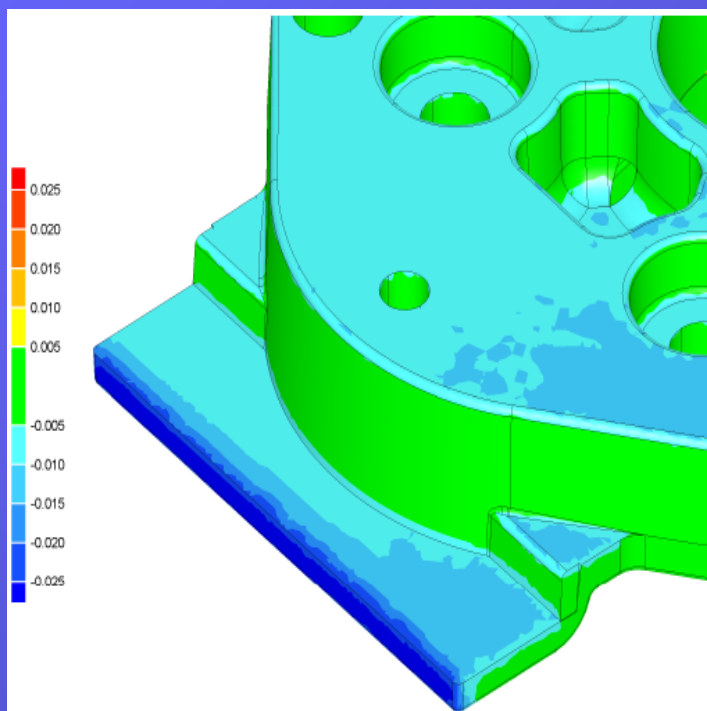
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Test: Injector_plate-SCAN

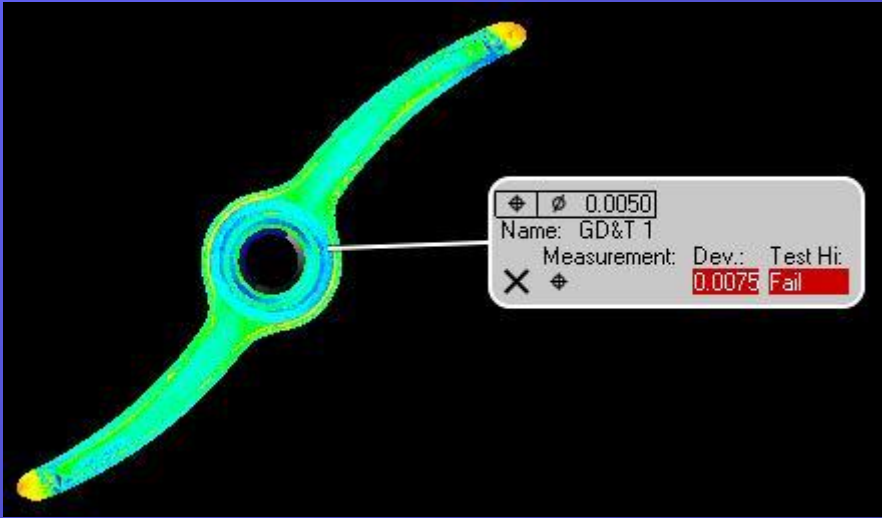
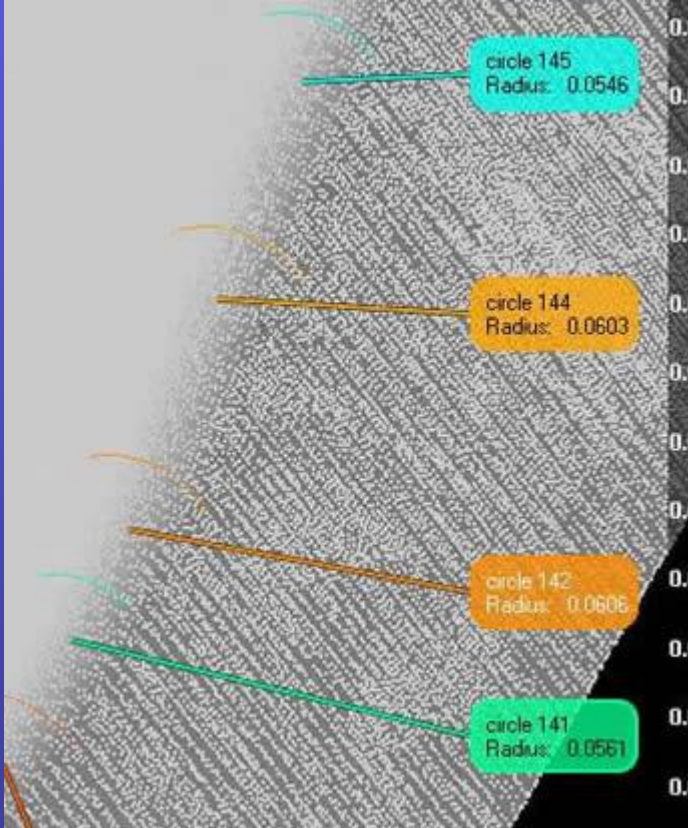
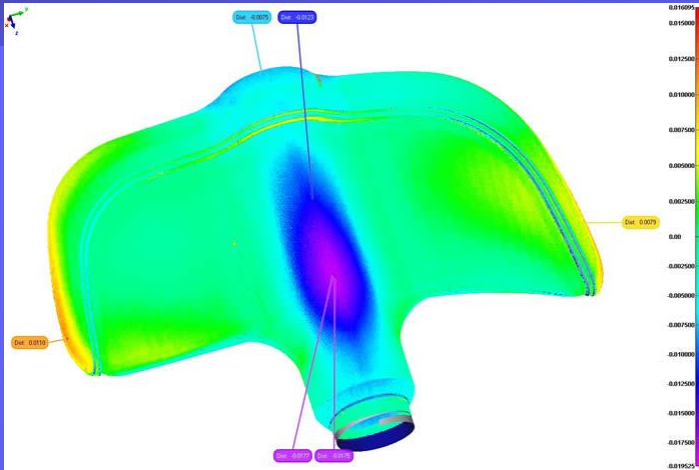
8/13/2002



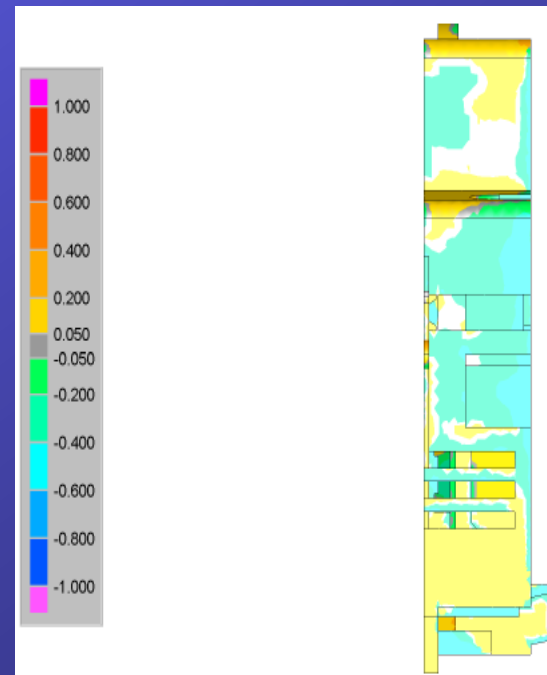
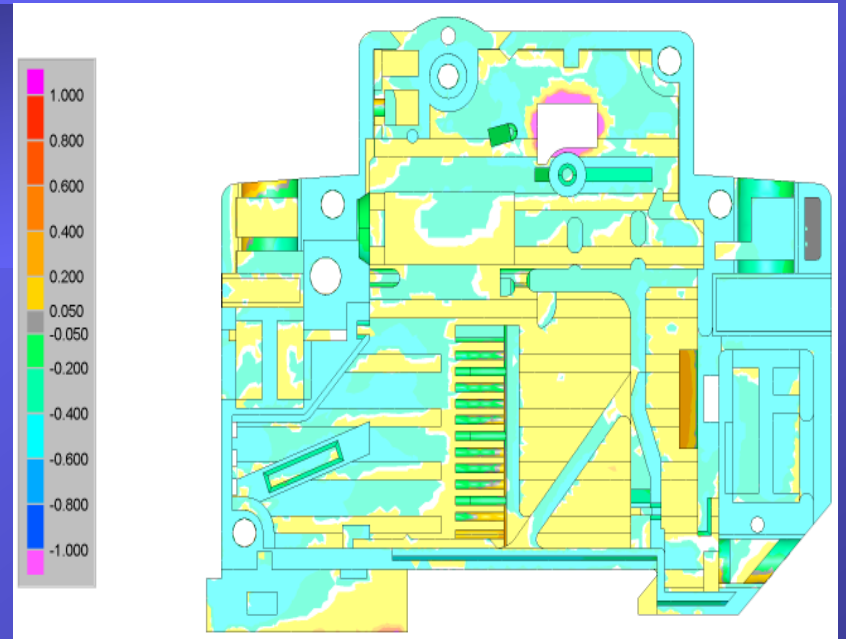
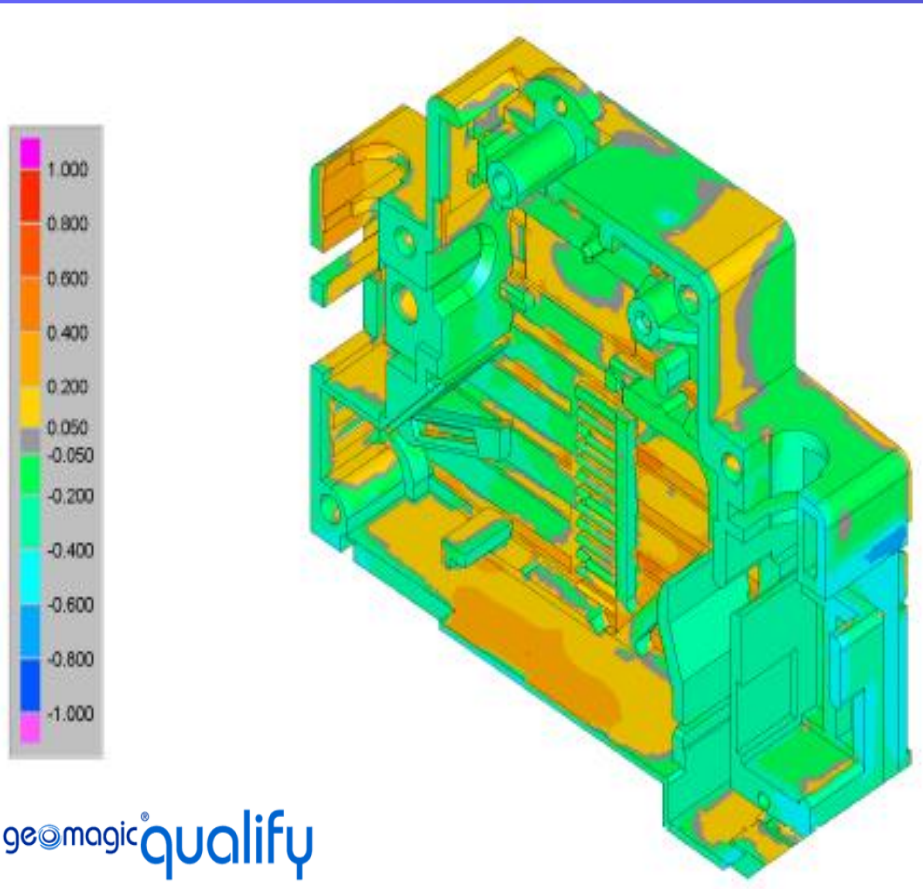
geomagic[®]qualify

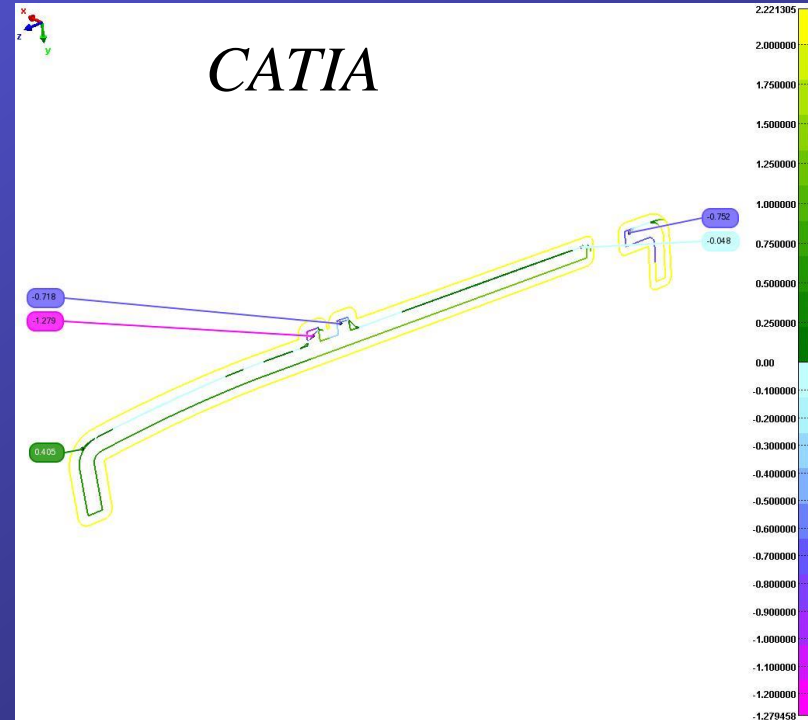
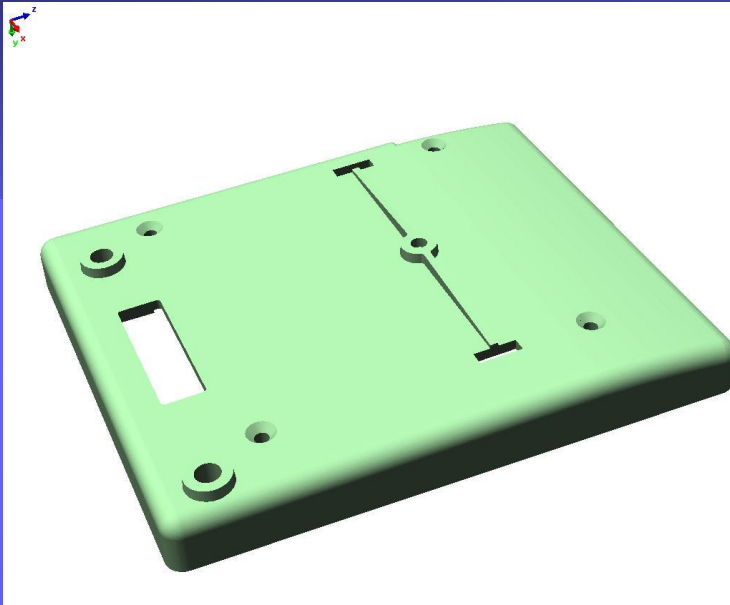


CAD-INSPEKCIJA
kod obrade rezanjem

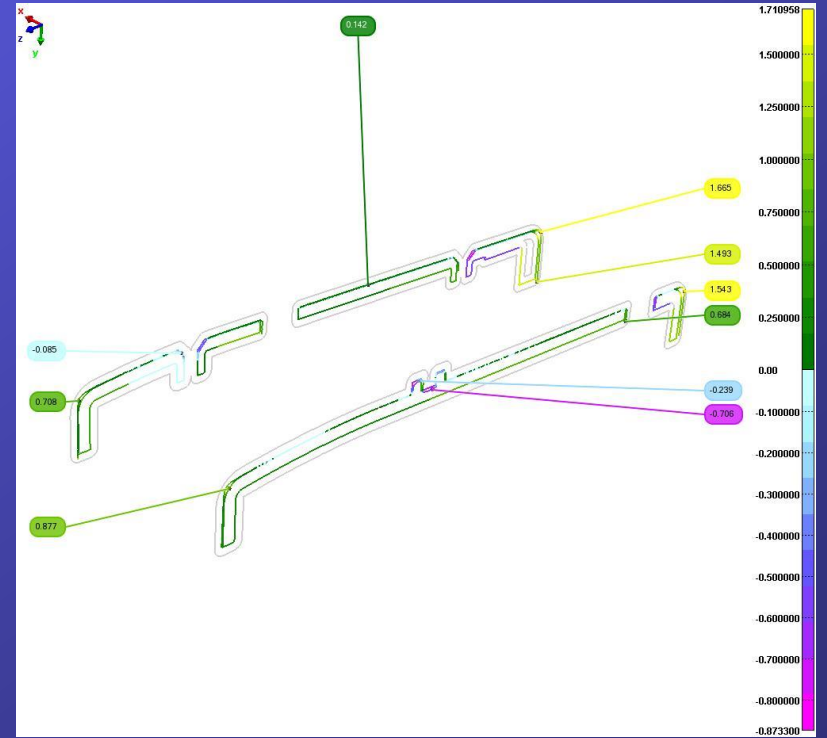
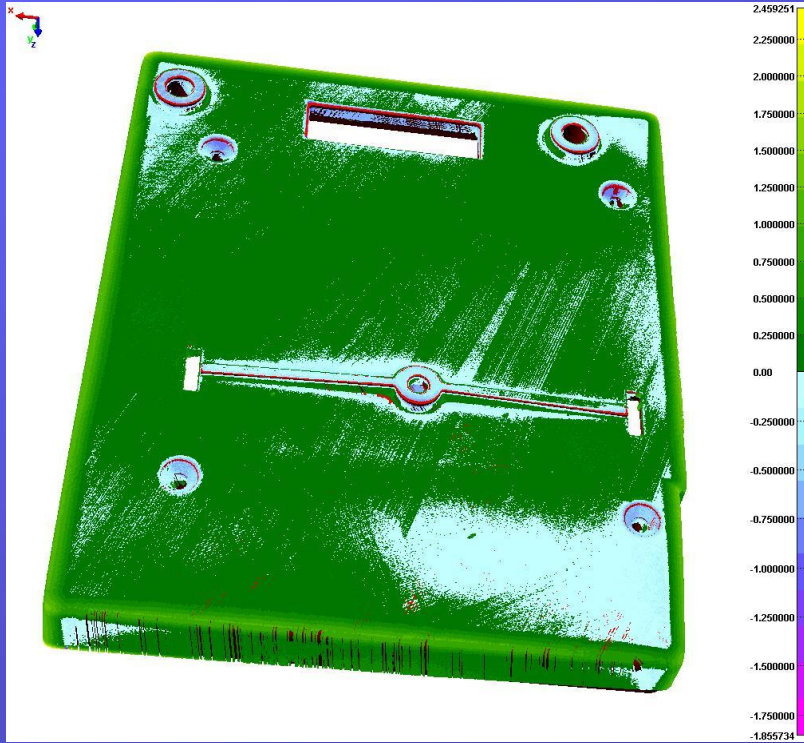


CAD-INSPEKCIJA dela brizganog od plastike





laser scanner MINOLTA VI – 900

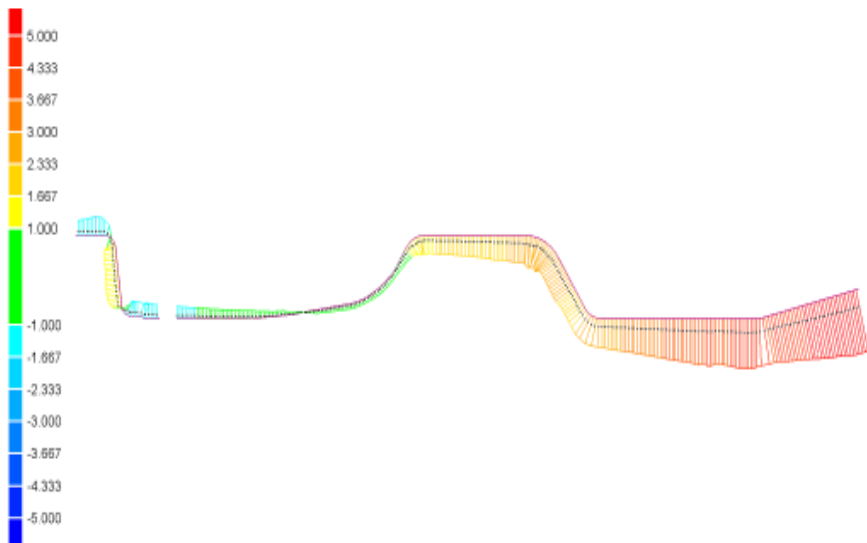
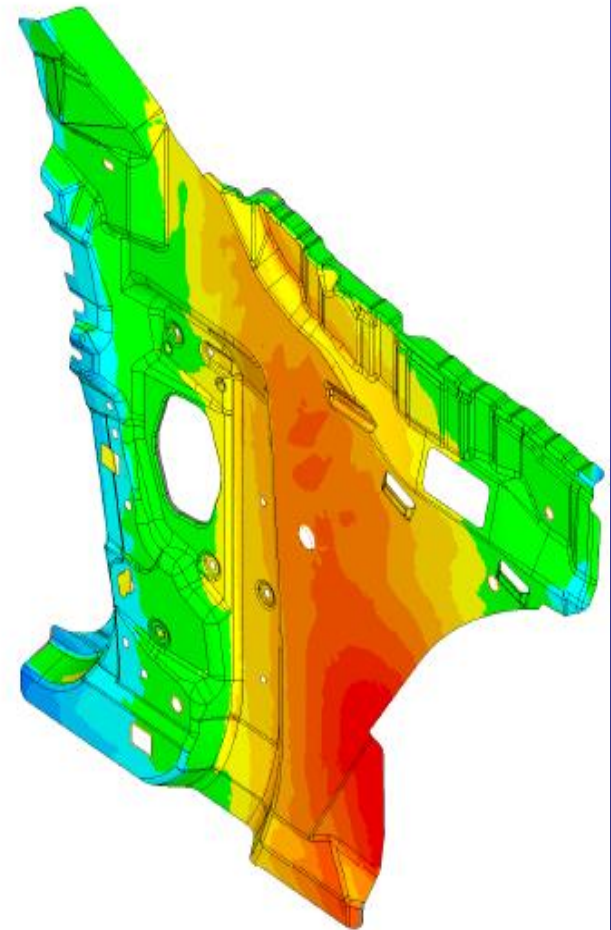


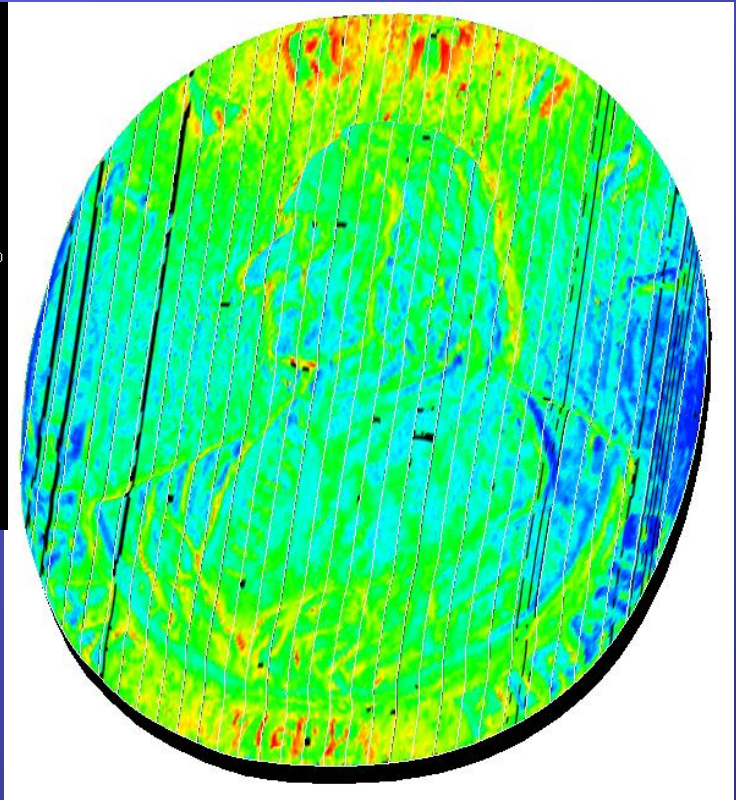
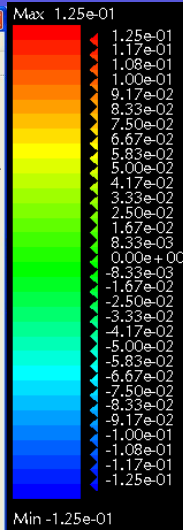
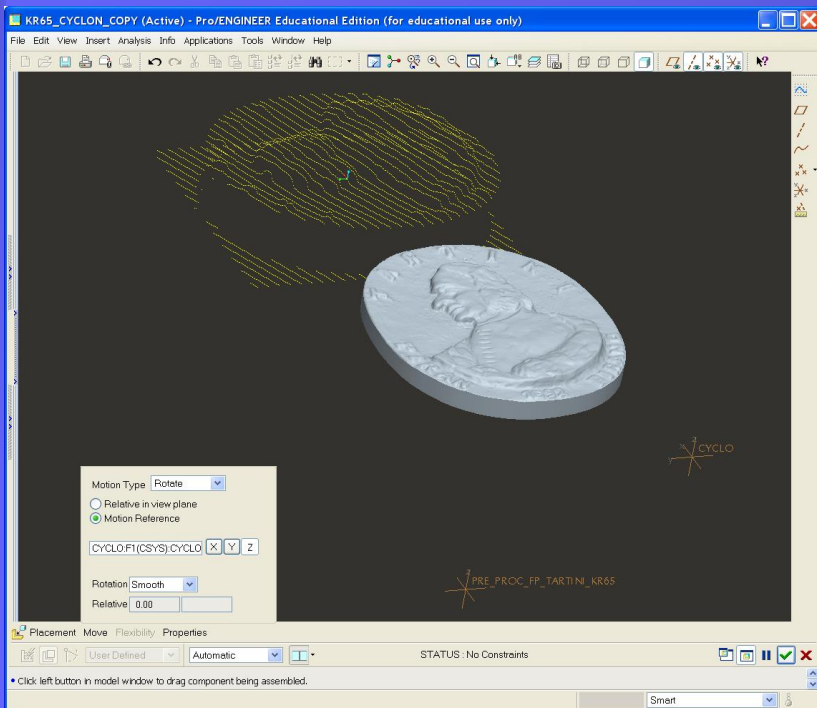
CAD-INSPEKCIJA

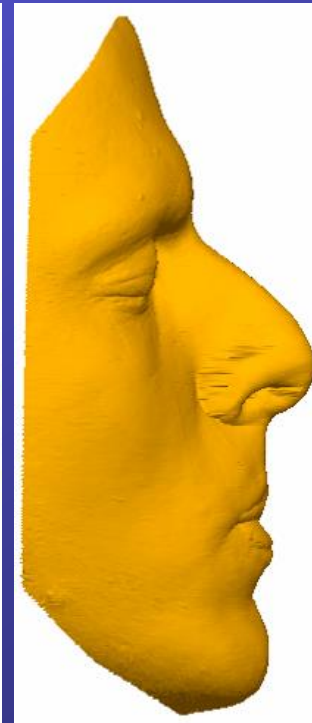
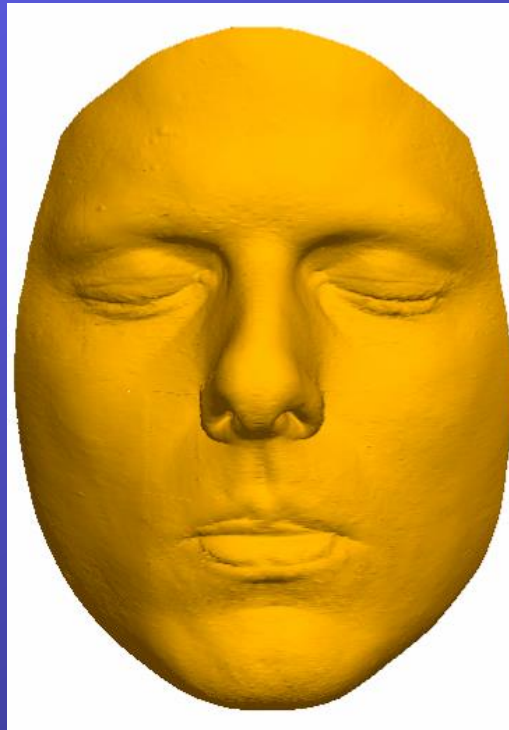
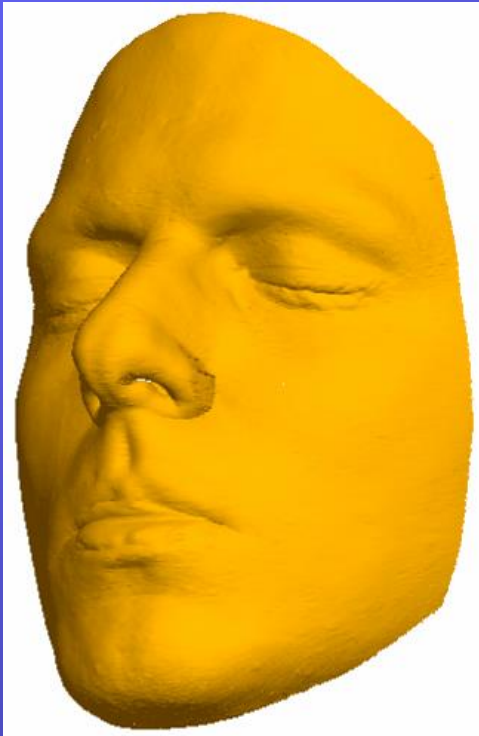
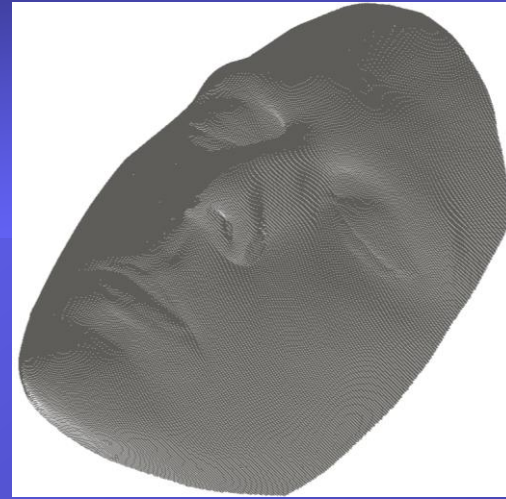
kod obrade deformisanjem

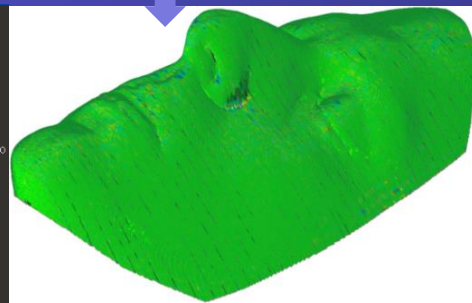
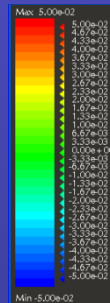
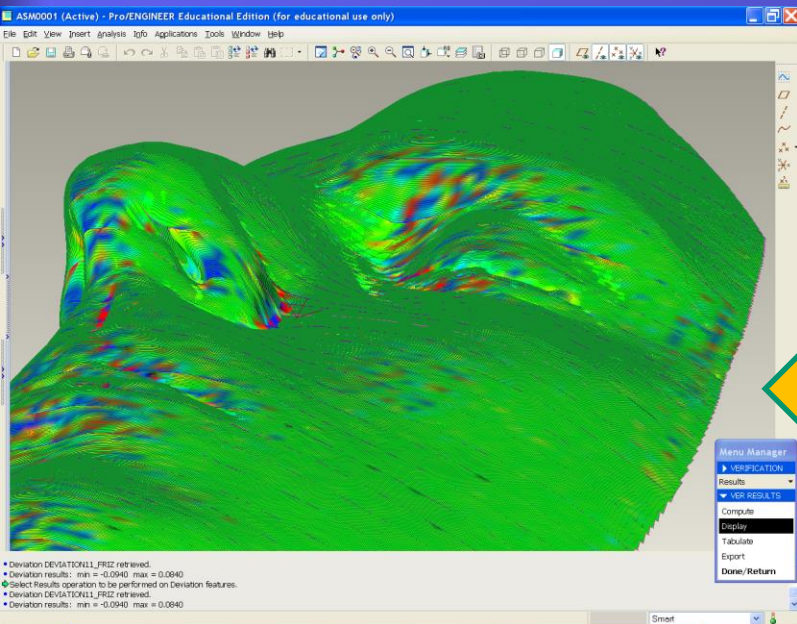
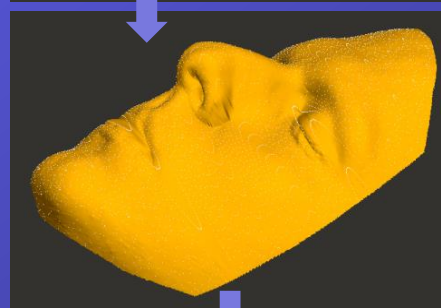
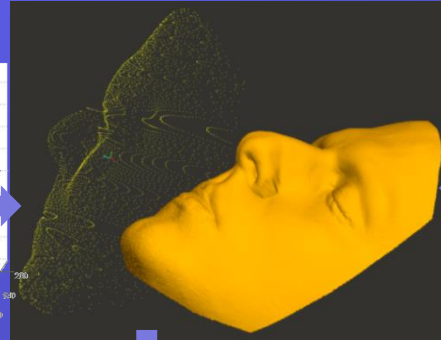
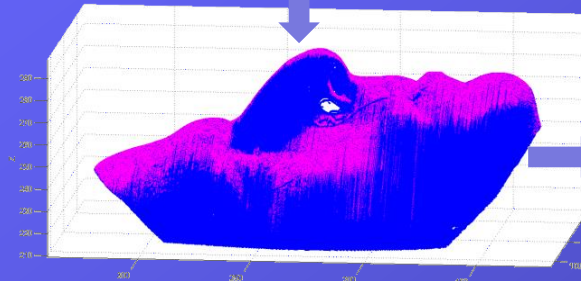
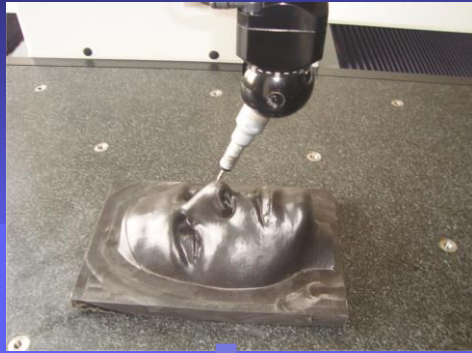
Qualify Report

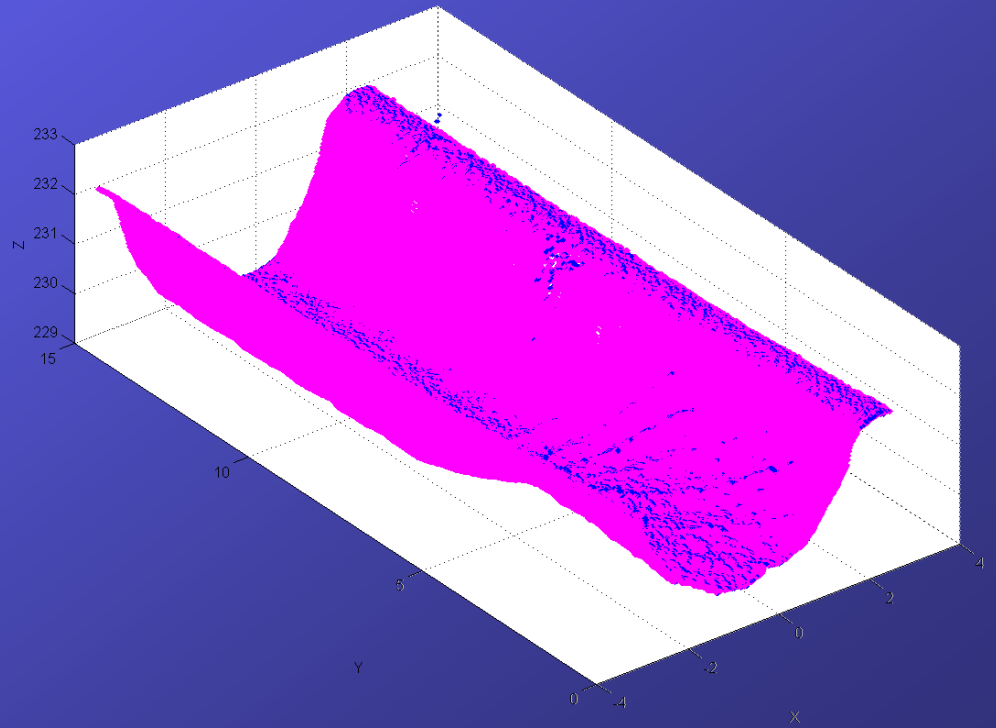
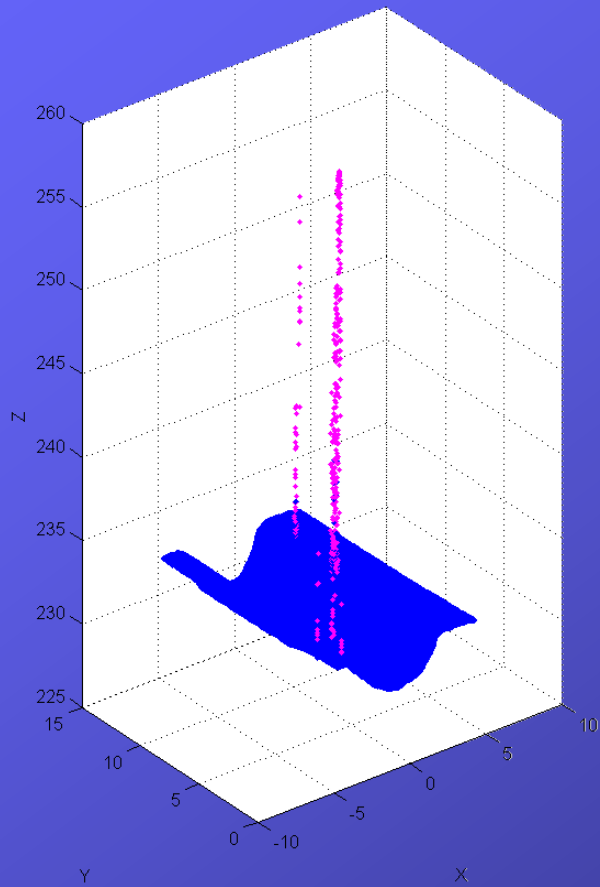
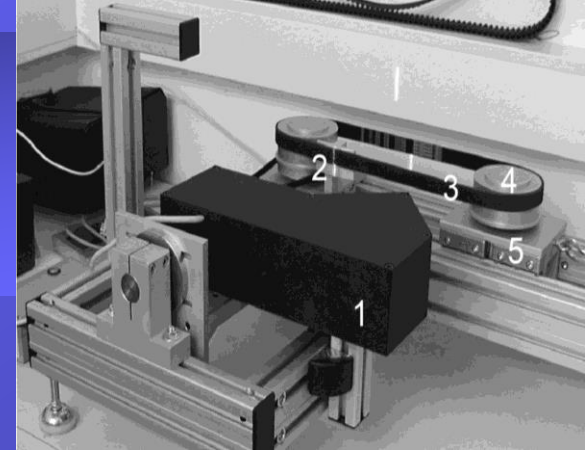
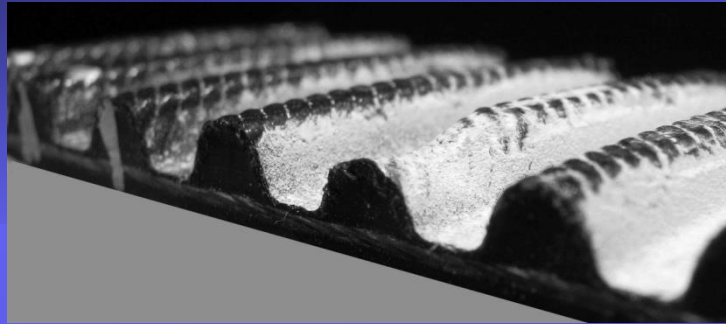
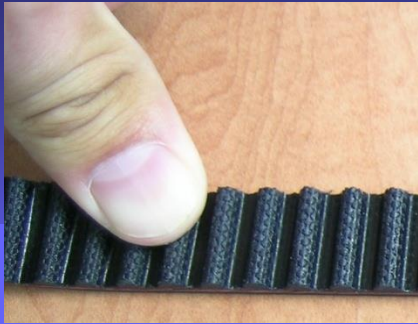
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Author: John Smith
Client: Ford Motor Co.
Part: SM-56G
Test: Sheet Metal - Scan
4/30/2003, 5:44 pm

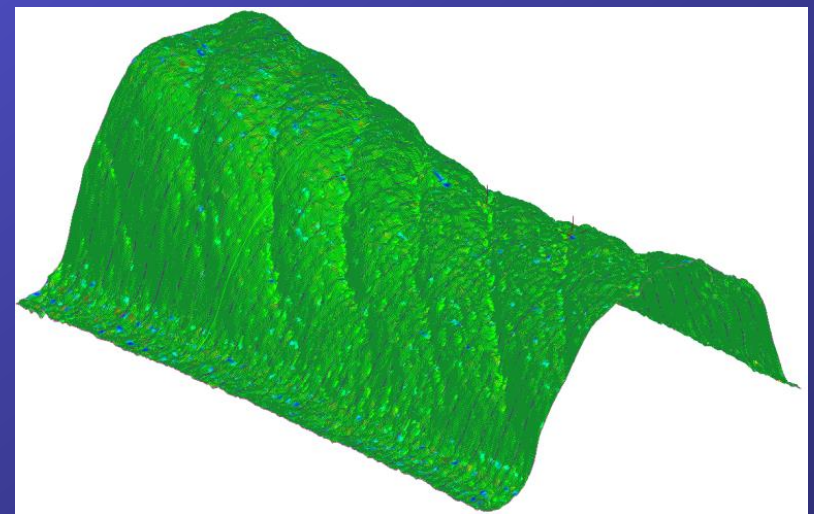
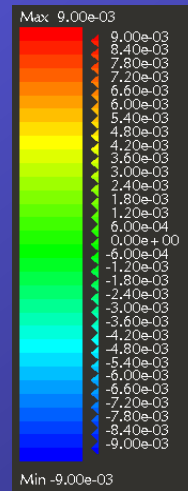
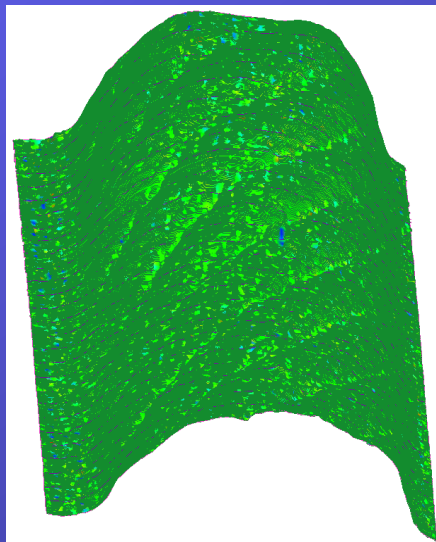
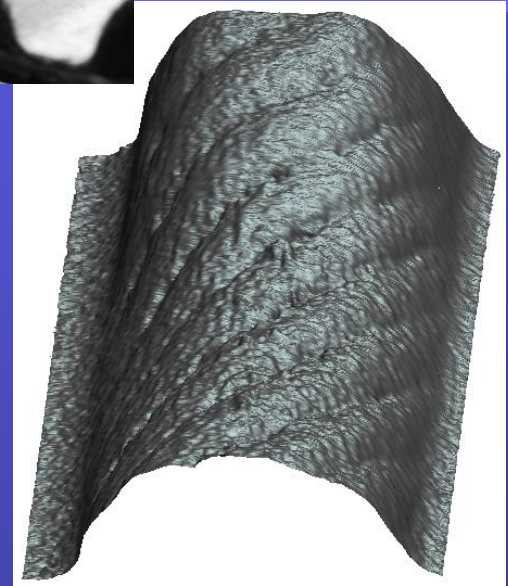
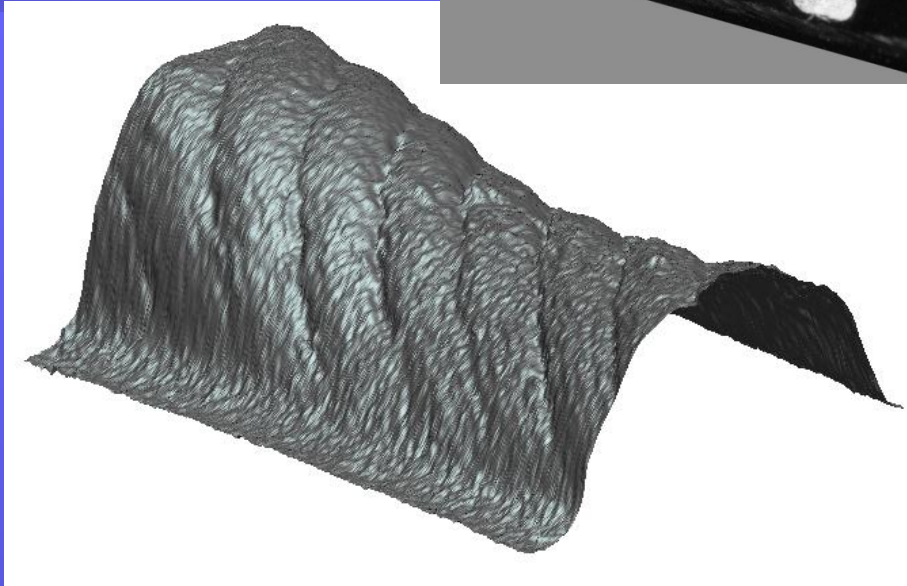
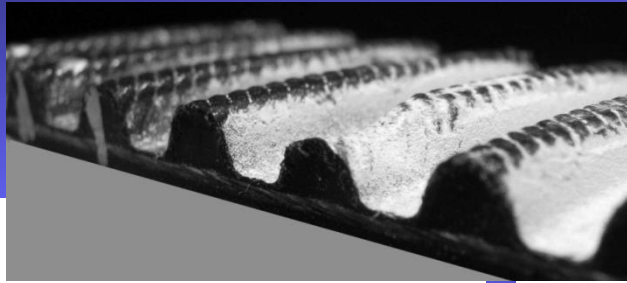


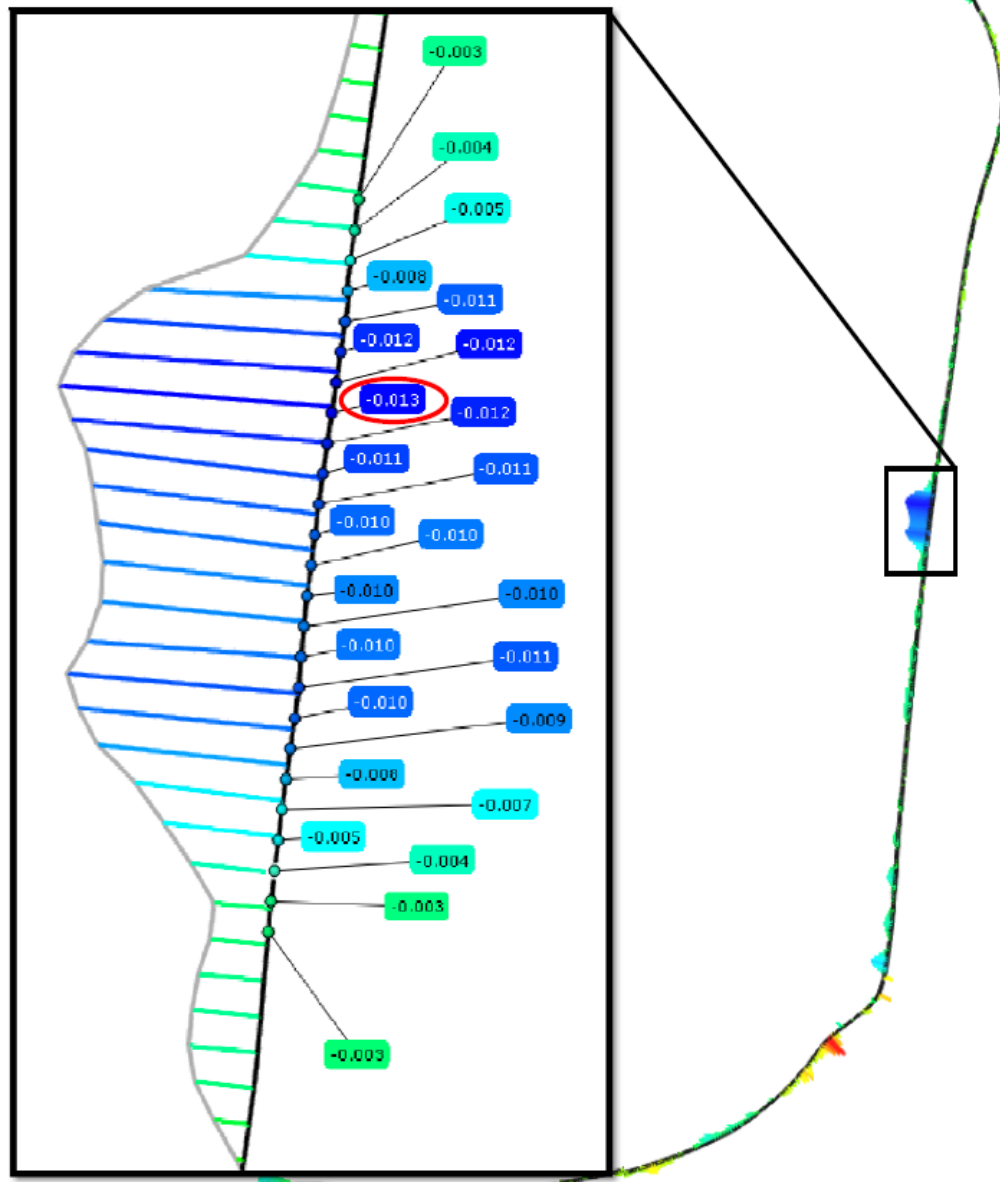
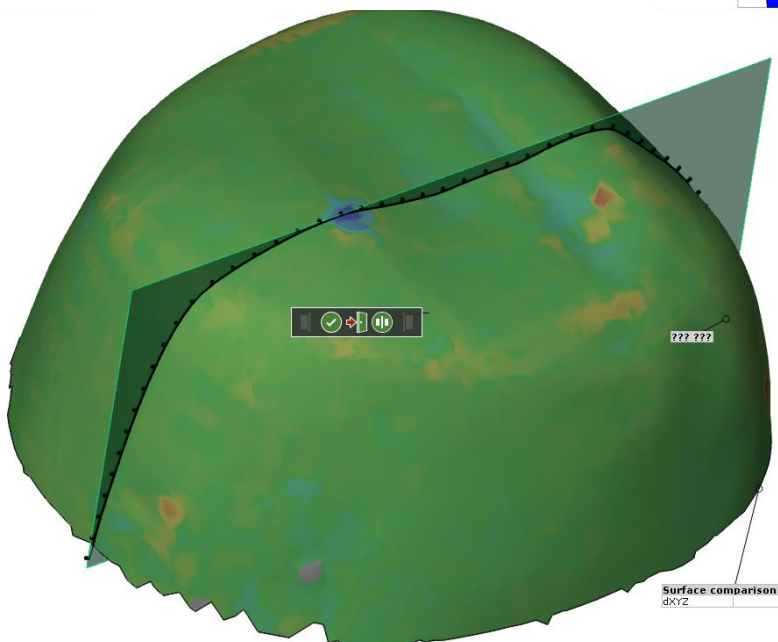
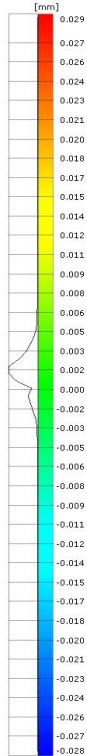
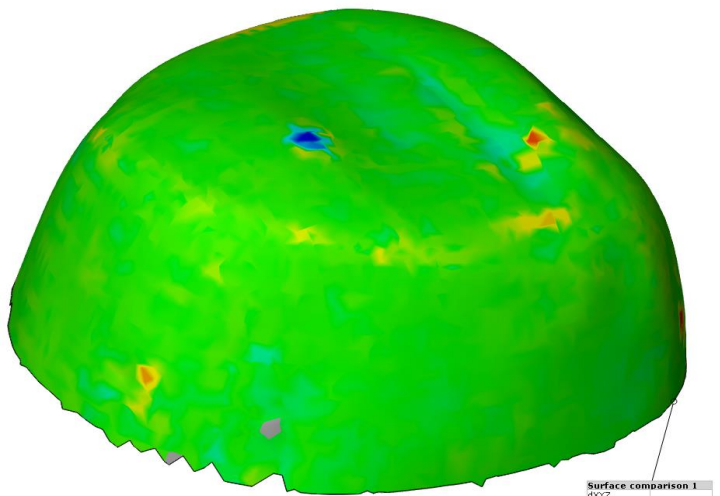












Acquisition



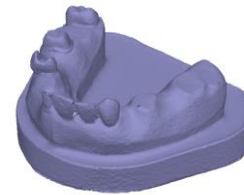
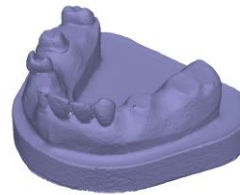
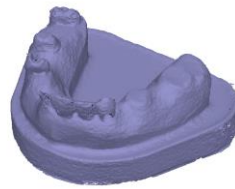
Without pattern

Random pattern

Wavelet pattern



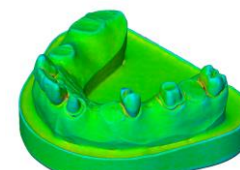
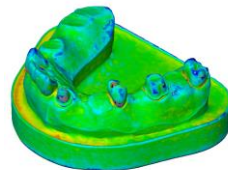
3D models generation



Nominal 3D model



CAD inspection



Acquisition



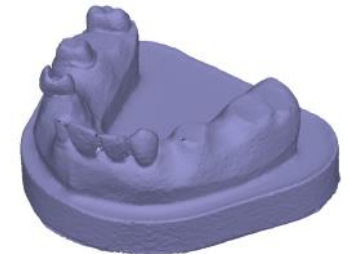
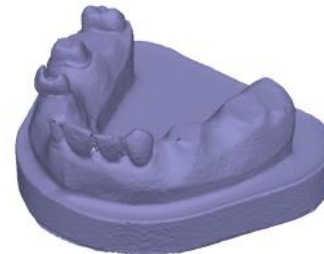
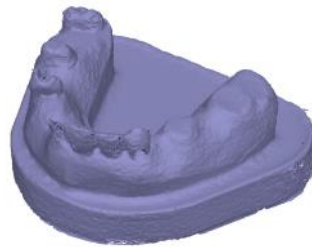
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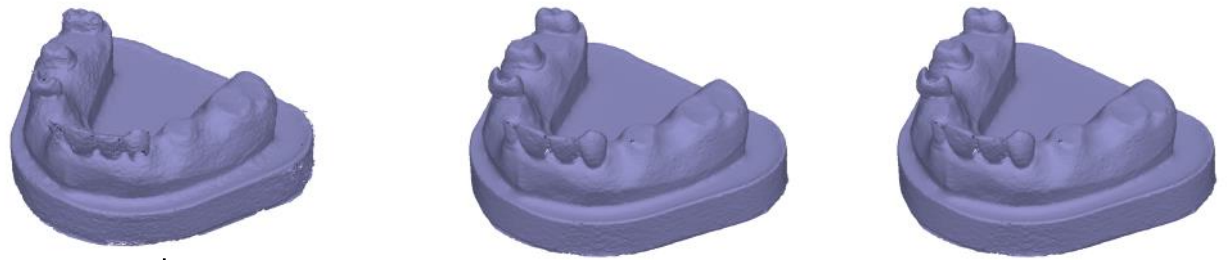
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3D models generation



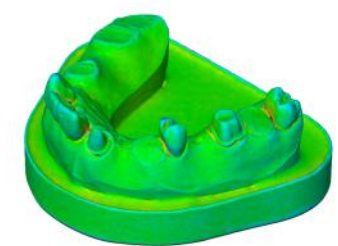
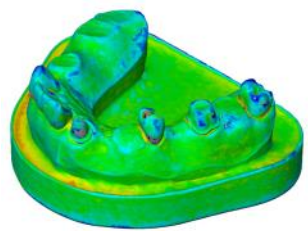
3D models generation

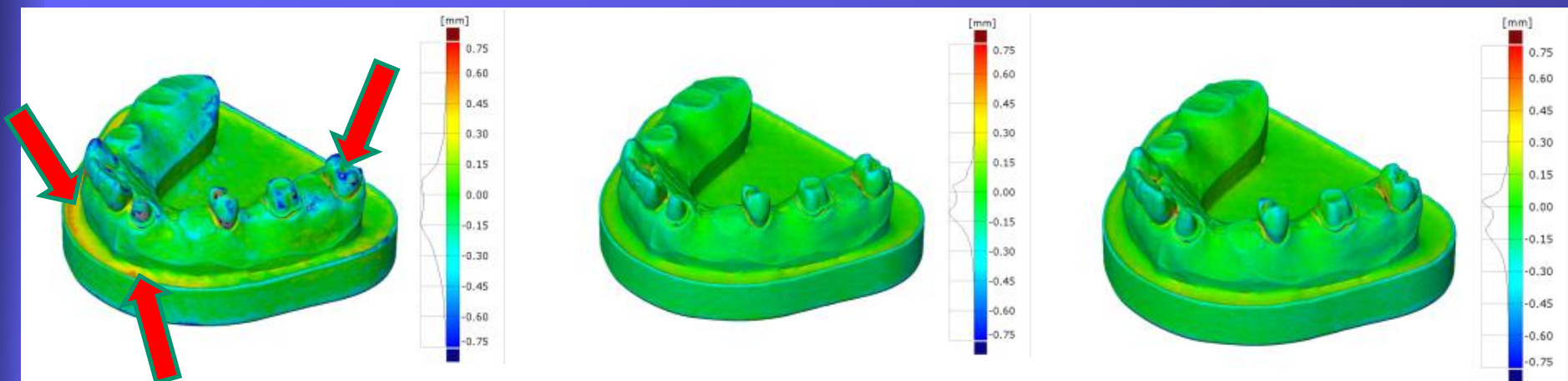


Nominal 3D model

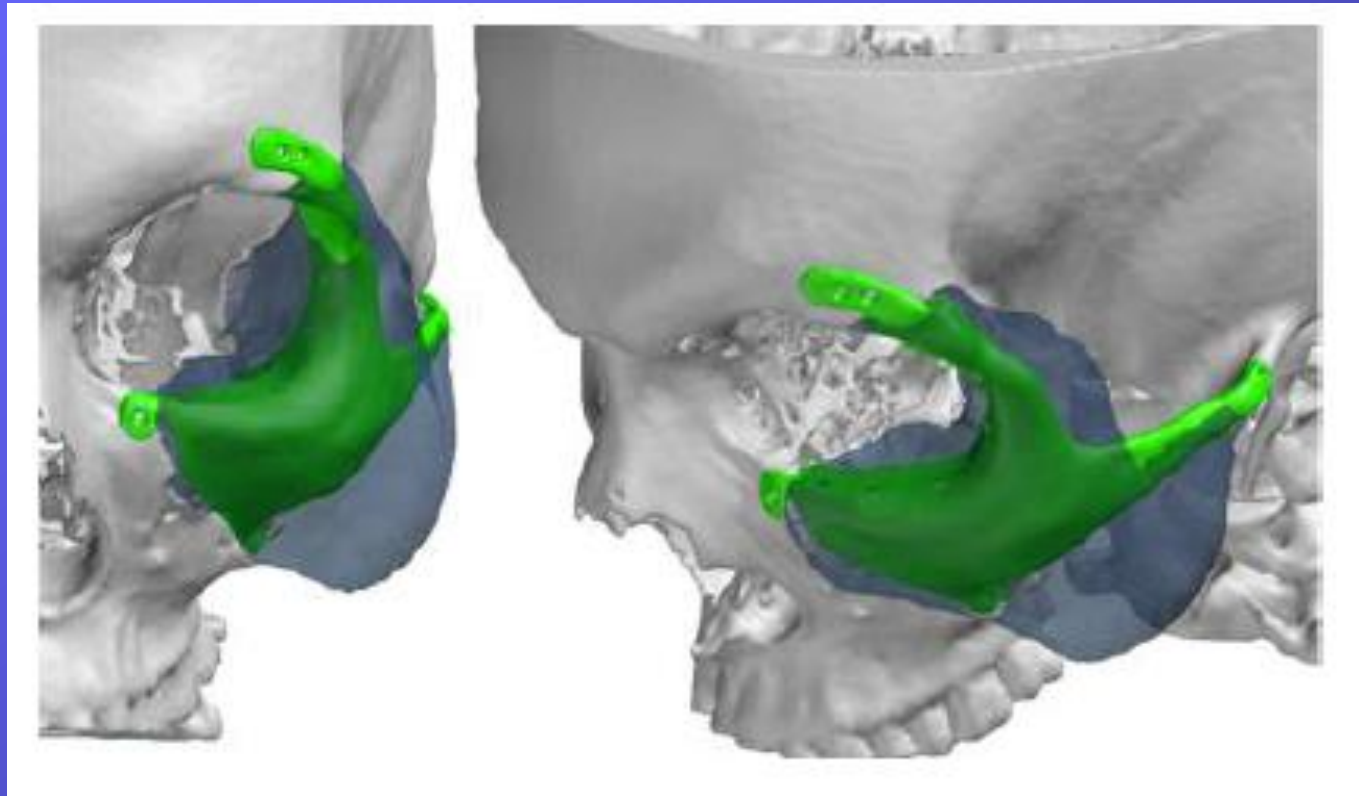


CAD inspection

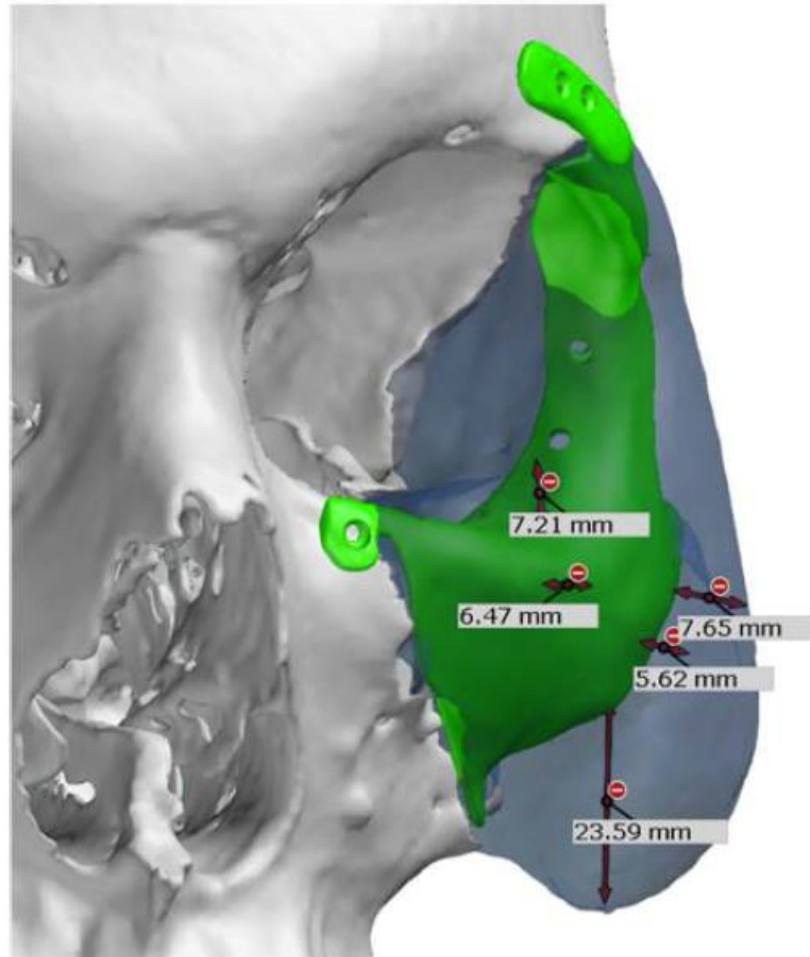




CAD-INSPEKCIJA
Post operativna provera



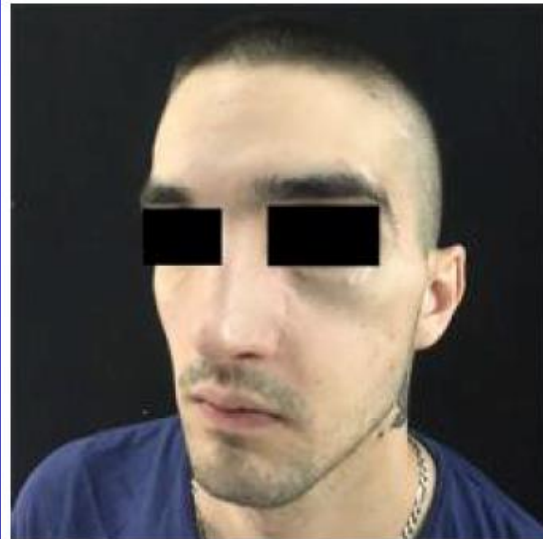
*Rastojanje između obolele kosti i
implanta u 5 kontrolnih tačaka*

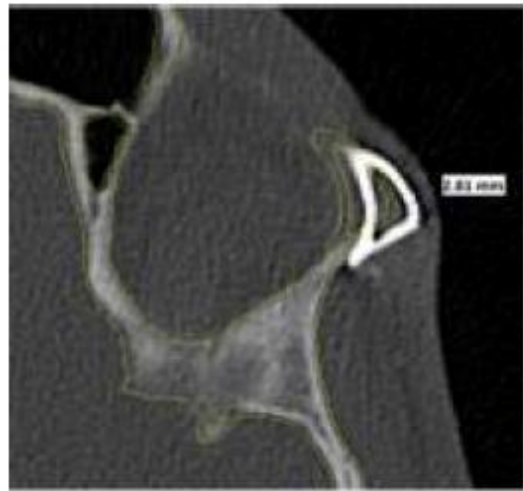


BEFORE

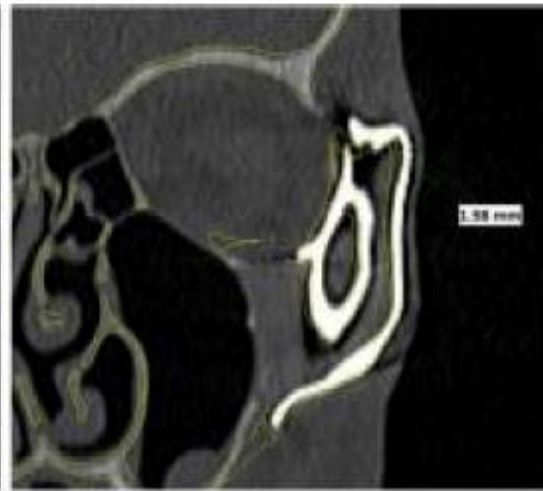


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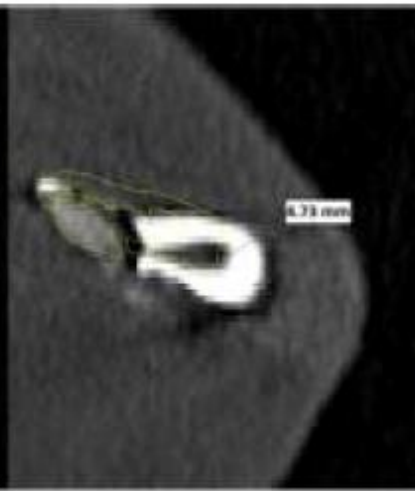




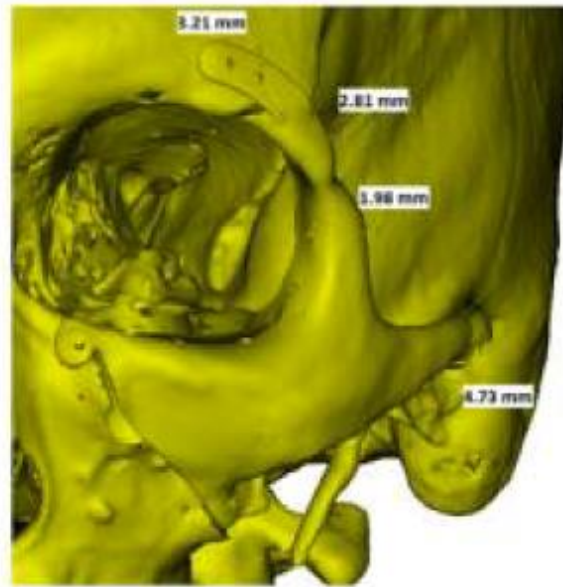
(a)



(b)



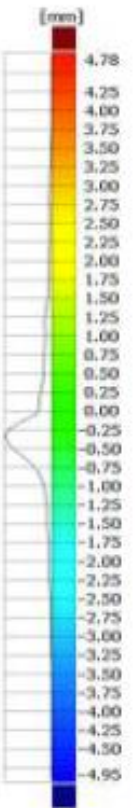
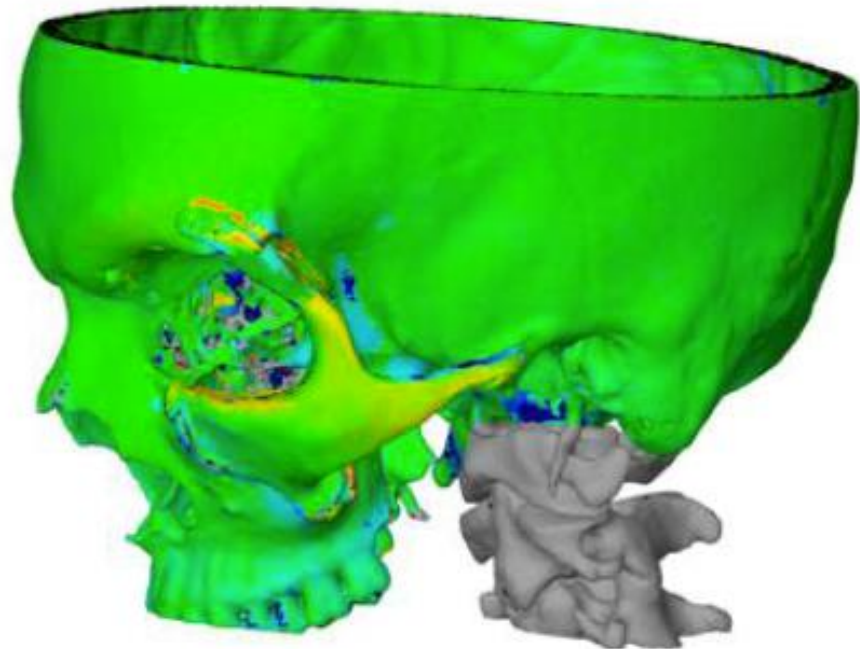
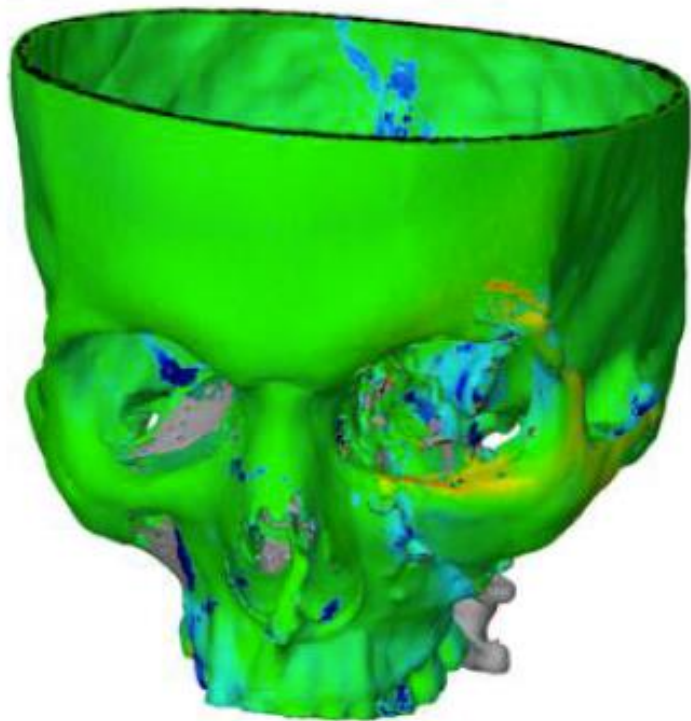
(c)



(d)

Post-operativni CT scan sa izmerenim vrednostima:

- (a) aksijalni pogled;
- (b) koronalni pogled;
- (c) sagitalni pogled;
- (d) lokacije gde su merenja izvršena



Pitanja, komentari, diskusija...