Univerzitet u Novom Sadu
FAKULTET TEHNIČKIH NAUKA
Animacija u inženjerstvu
Predmet: Metode 3DD

CAD-INSPEKCIJA

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 CAD modela za potrebe kontrole, tj. verifikacije i inspekcije.

- Preduslov za dobar inženjerski proces jeste sprovođenje kontrole/verifikacije tokom njegove realizacije.
- Jedan od savremenih pristupa kontrole je **računarom podržana inspekcija (eng. computer-aided inspection CAI)**.
- **CAI podrazumeva komparaciju (poređenje) oblaka tačaka u odnosu na CAD model.**

CAD-inspekcija – uvodne napomene

- **Specifičan oblik CAI je CAD-inspekcija.**
- Rezultat ovakve analize se dobija u nekoliko oblika – od numeričkih podataka, do grafičkih u vidu mapa u boji (ili kolor mapa) kod koje svaka boja predstavlja određeni nivo odstupanja.
- Ova metoda je danas prihvaćena kao brz, efikasan i kredibilan način provere kvaliteta izrade delova različitim tehnologijama (3D štampa, rezanje, plastično deformisanje, oblikovanje plastike itd.)

CAD-inspekcija – definicije i terminologija

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.

CAD-inspekcija – definicije i terminologija

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

- **Brza 3D inspekcija (eng. Rapid 3D Inspection)**
- **Računarom podržana verifikacija (eng. computer-aided verification CAV)**
- **3D color comparison-to-CAD**
- **i dr.**

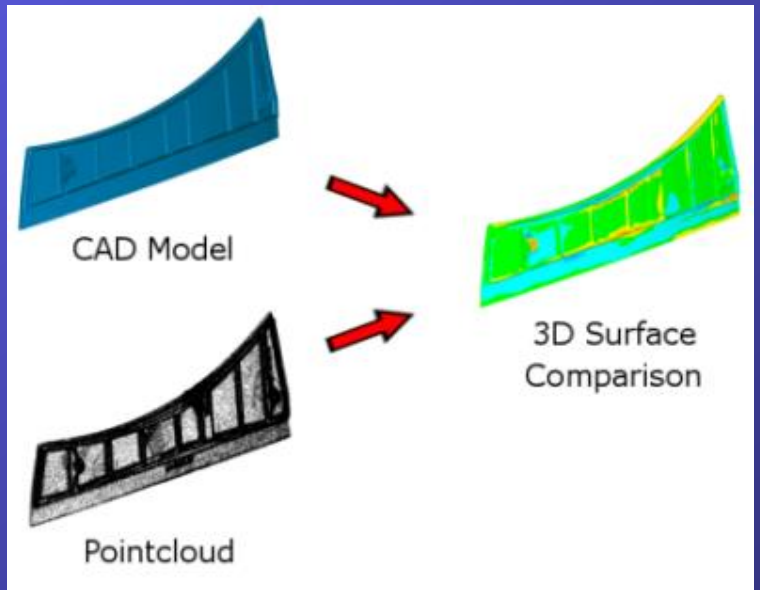
Zahvaljujući zasnovanosti na CAD-modelu, ova vrsta inspekcije je najpoznatija pod nazivom ***CAD-inspekcija***.

CAD-inspekcija - metodologija

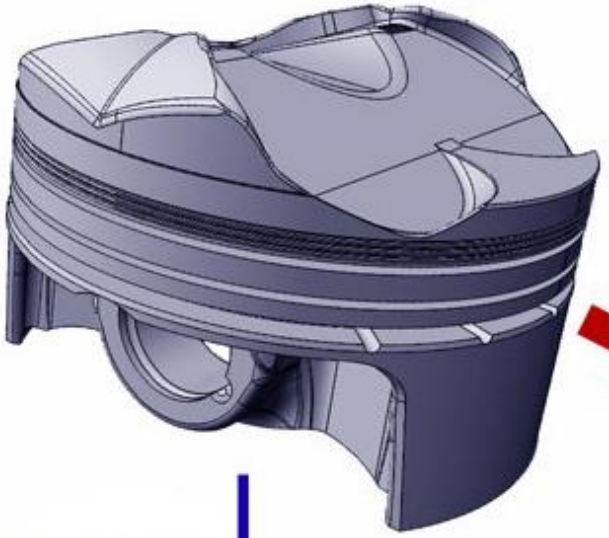
CAD inspekcija predstavlja metodu koja poredi geometriju proizvedenog dela (rezultat 3D digitalizacije) u odnosu na referentnu geometriju (originalni CAD model) i

podrazumeva sledeće korake:

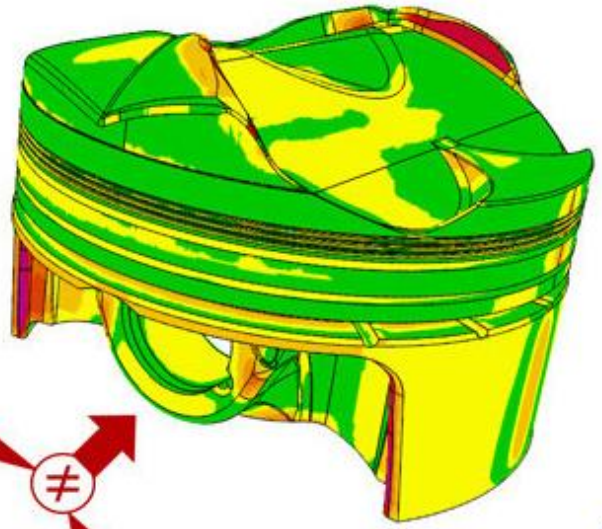
1. **3D digitalizaciju**
2. **Generisanje površinskog modela – opciono**
3. **Komparaciju sa referentnim CAD modelom**



CAD file
- Ideal Design



Comparison CAD / CT Scan
- Visualisation of dimensional defects



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Manufacturing

Real part

3D Computed Tomography

3D data
- Dimensional measurements

CAD-inspekcija - metodologija

Dva osnovna segmenta *CAD*-inspekcije su:

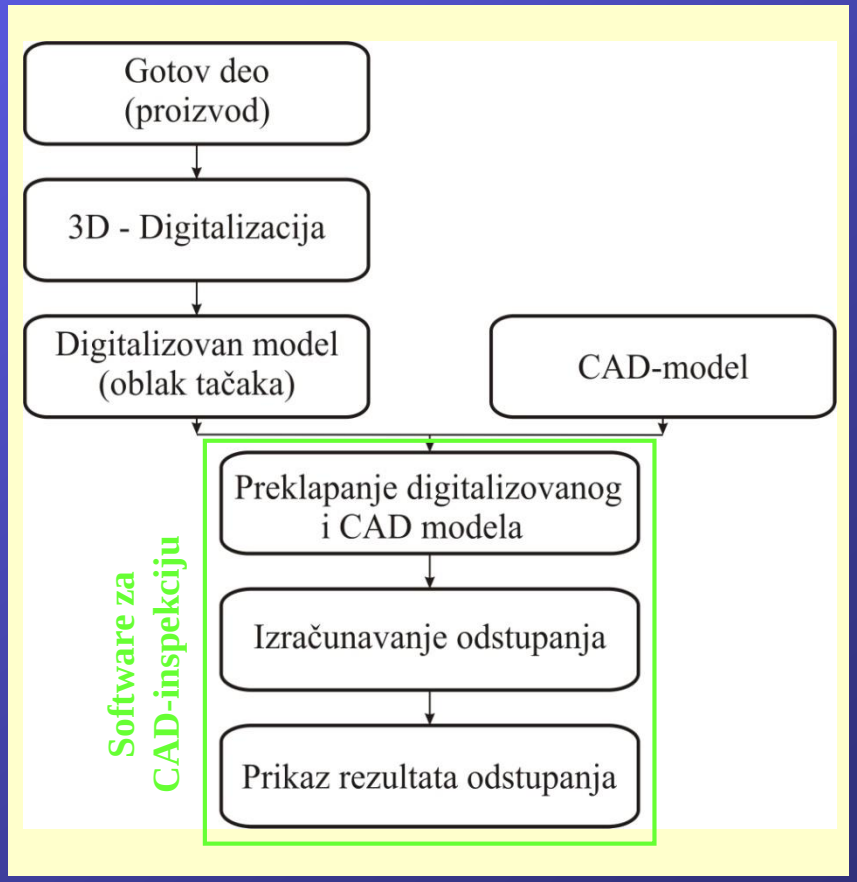
- **3D-digitalizacija** (dominantno hardverski proces) i
- **provera odstupanja (**dominantno softverski proces**)**.

CAD-inspekcija - metodologija

Procedura provere odstupanja

Procedura se sastoji u sledećem:

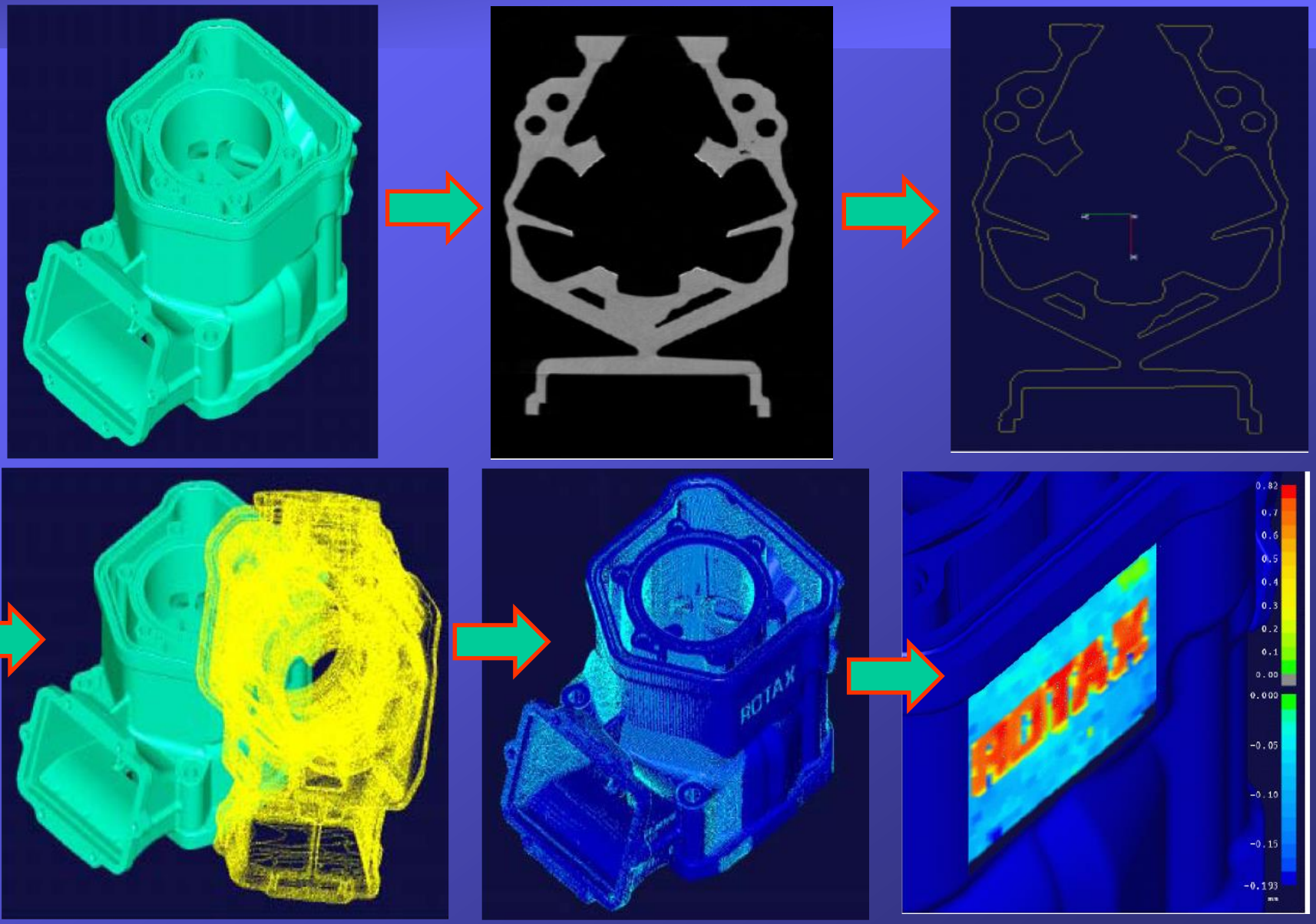
- izrađen deo se digitalizuje nekom od metoda 3D-digitalizacije;
- 3D digitalizovani model (*oblak tačaka*) unosi se u neki od specijalizovanih softvera za *CAD*-inspekciju, zajedno sa referentnim *CAD*-modelom;
- sledi orijentisanje digitalizovanog modela prema *CAD*-modelu u cilju njihovog međusobnog 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

CAD-inspekcija - metodologija

Procedura provere odstupanja - primer

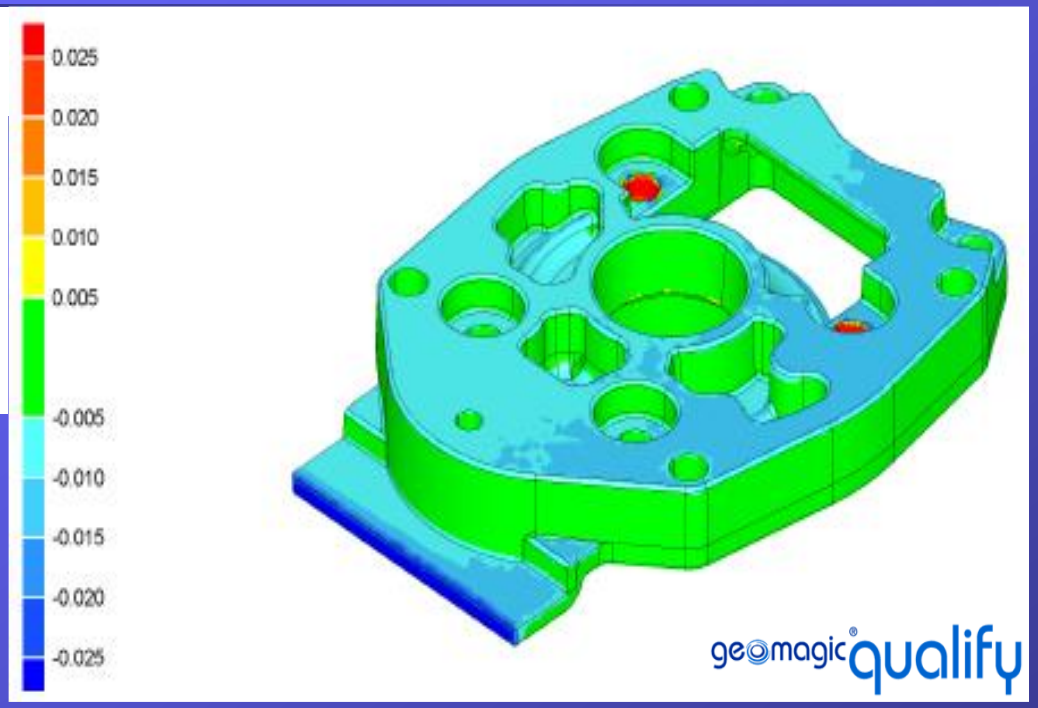


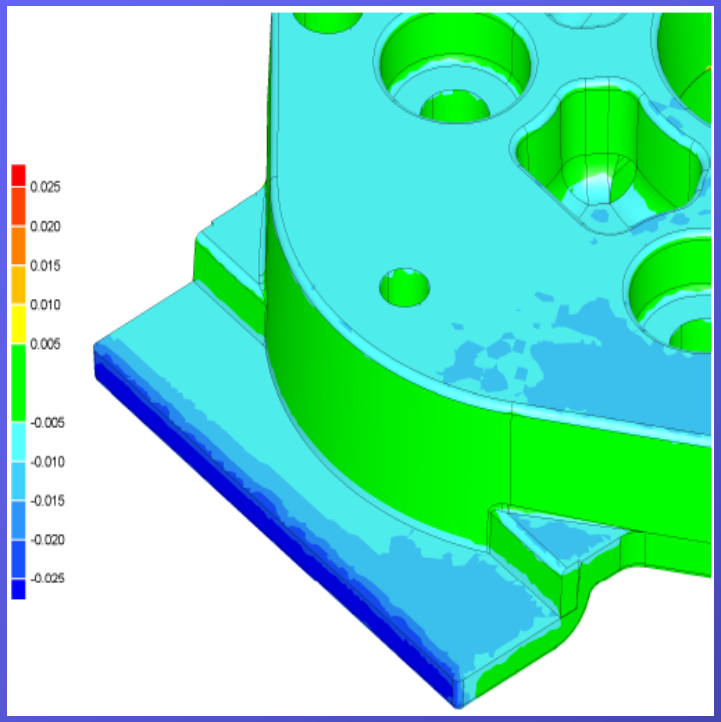
Primeri primene:

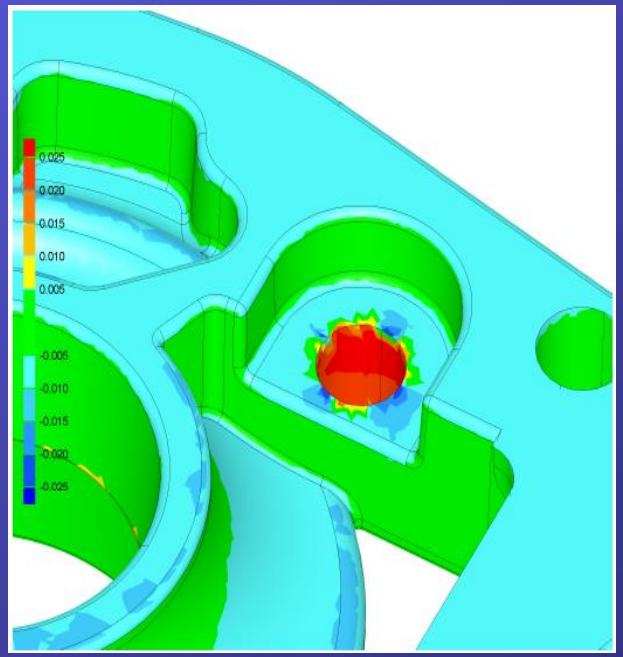
acme ENGINEERING PROD. LTD.

Qualify Report

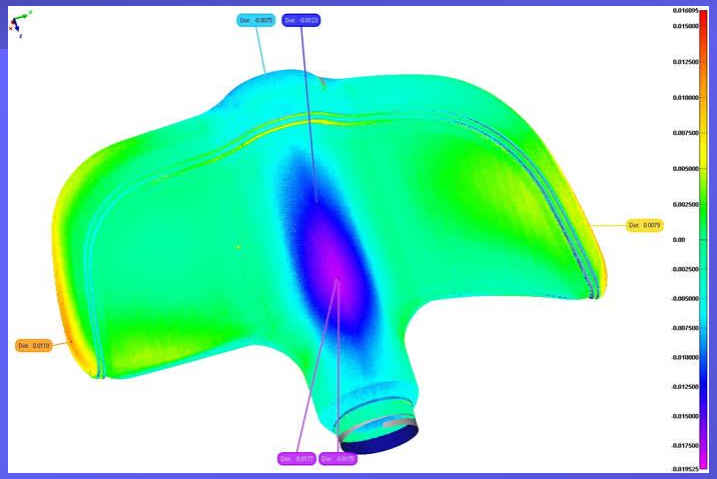
Title: Injector Plate Inspection Report
Author: Kevin Scofield
Client: ACME Manufacturing
Part: No. GP-5634 (AL 7075)
Test: Injector_plate-SCAN
8/13/2002

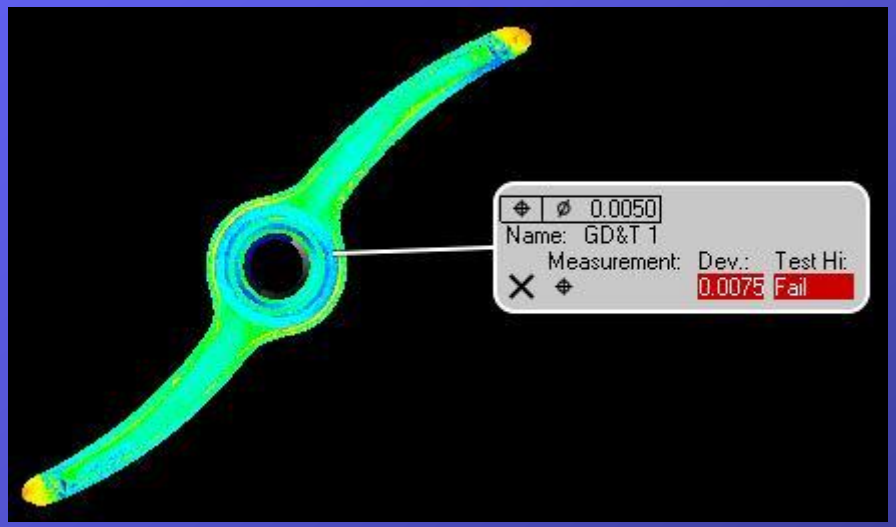






CAD-INSPEKCIJA
kod obrade rezanjem

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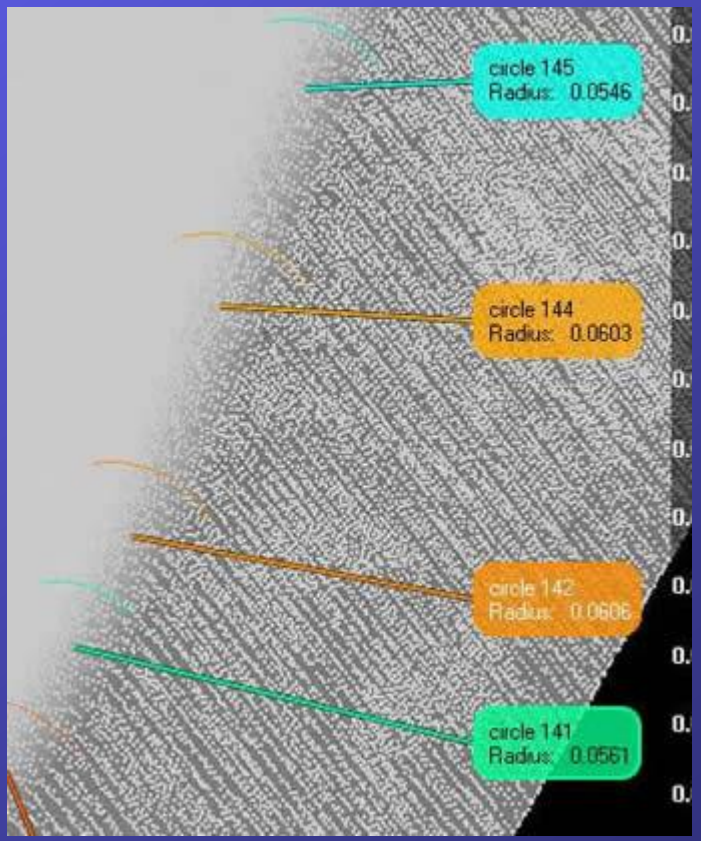
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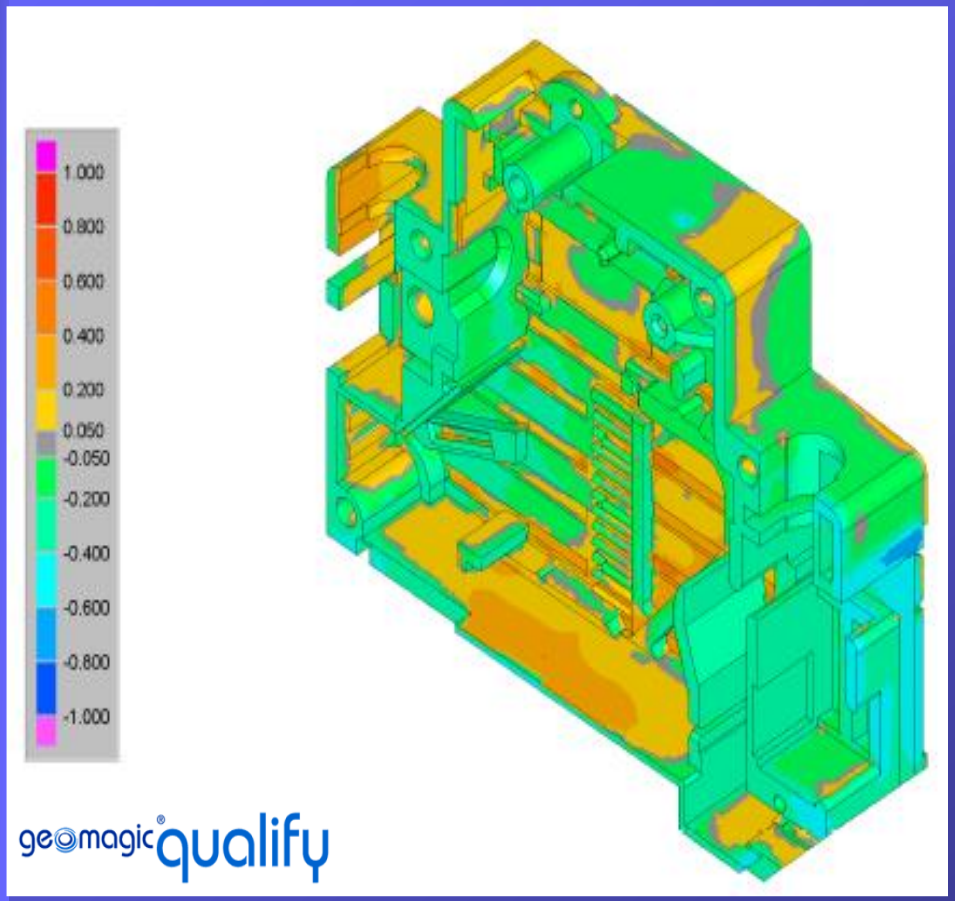
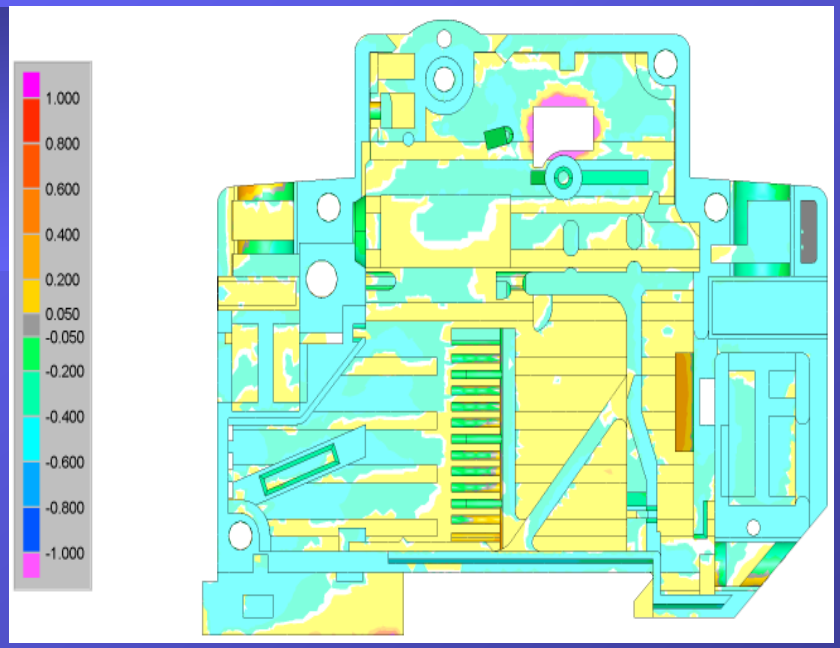
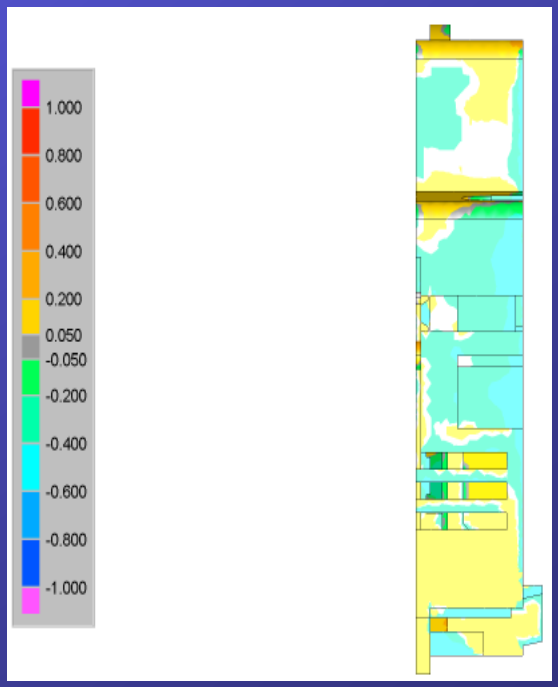
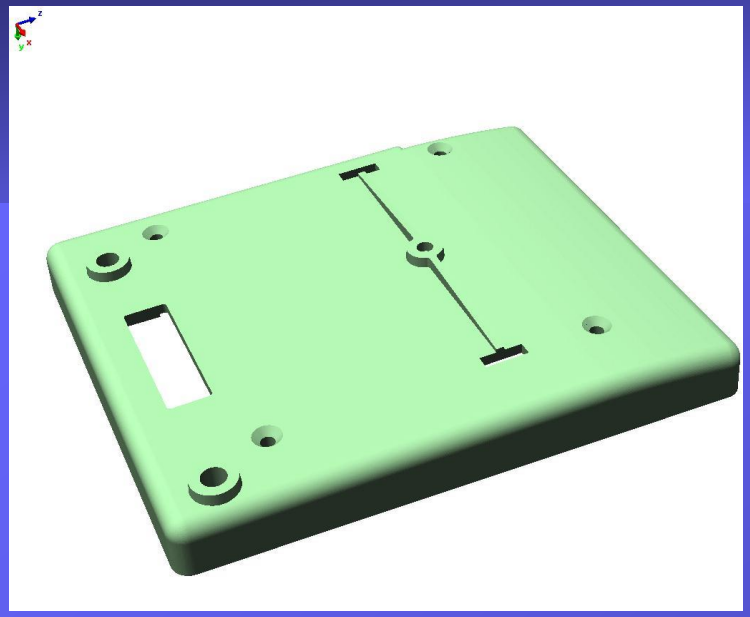
Radius: 0.0546
circle 144
Radius: 0.0603
circle 142
Radius: 0.0606
circle 141
Radius: 0.0561

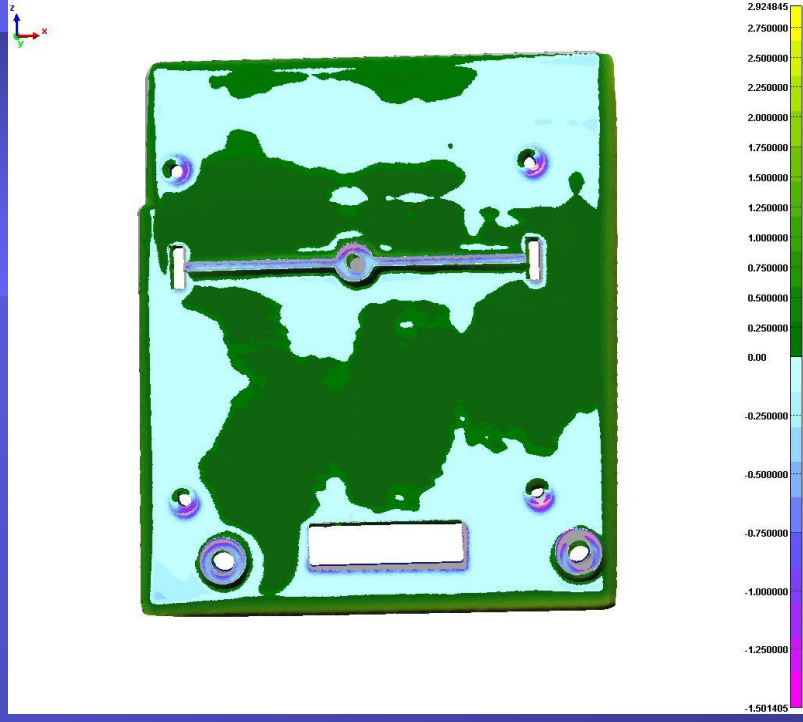
CAD-INSPEKCIJA
dela brizganog od plastike



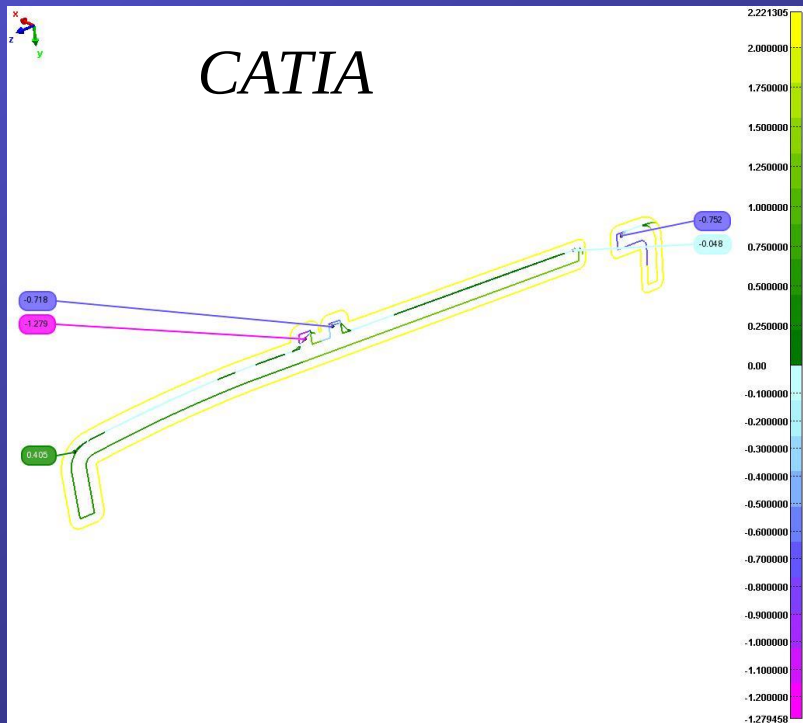




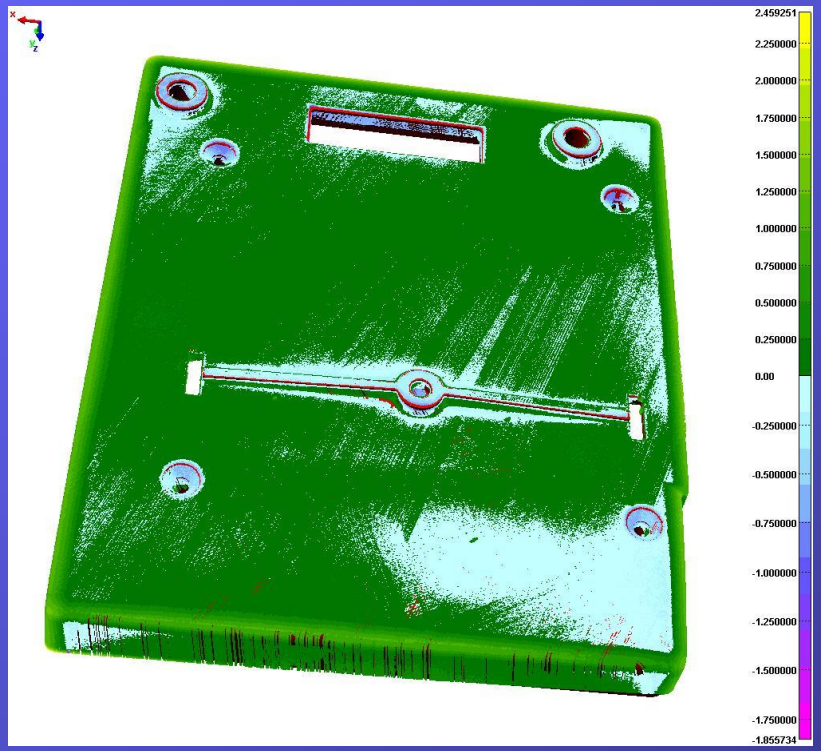




laser scanner MINOLTA VI – 900




FARO
Laser Line Probe
Laser ScanArm
Laser Line Probe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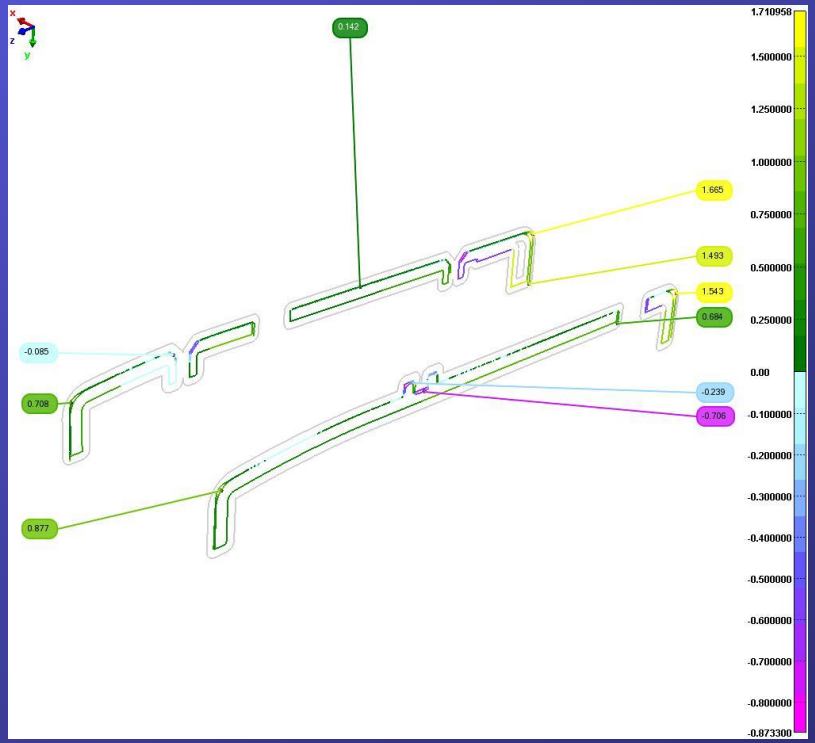
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-0.400000
-0.500000
-0.600000
-0.700000
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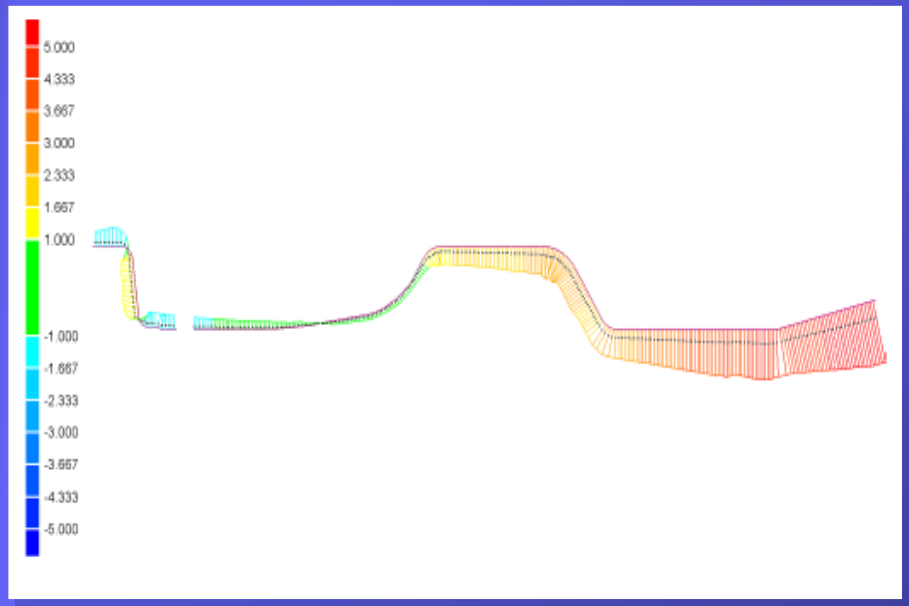
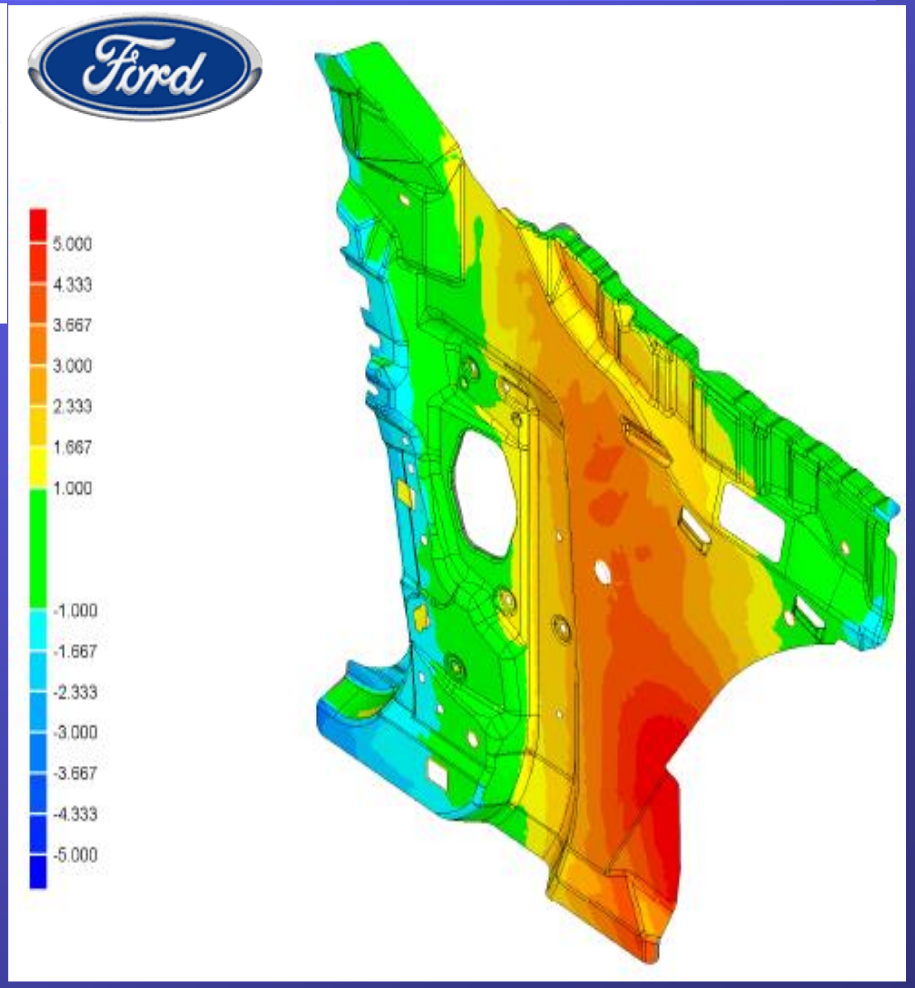
CAD-INSPEKCIJA
kod obrade deformisanjem

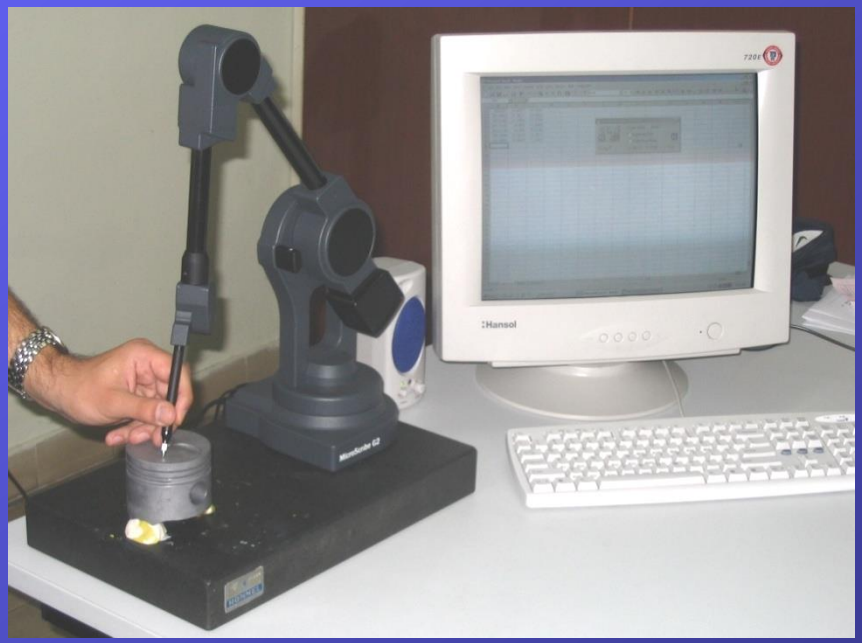
Qualify Report

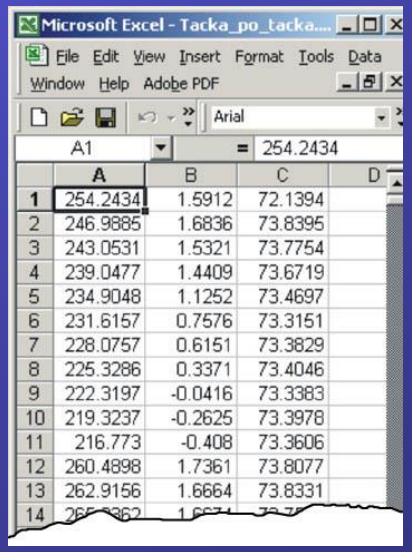
Title: Sheet Metal Example Report
Author: John Smith
Client: Ford Motor Co.
Part: SM-56G
Test: Sheet Metal - Scan
4/30/2003, 5:44 pm





CAD-INSPEKCIJA
klipa "FIAT ø80"- AD "MOTINS"

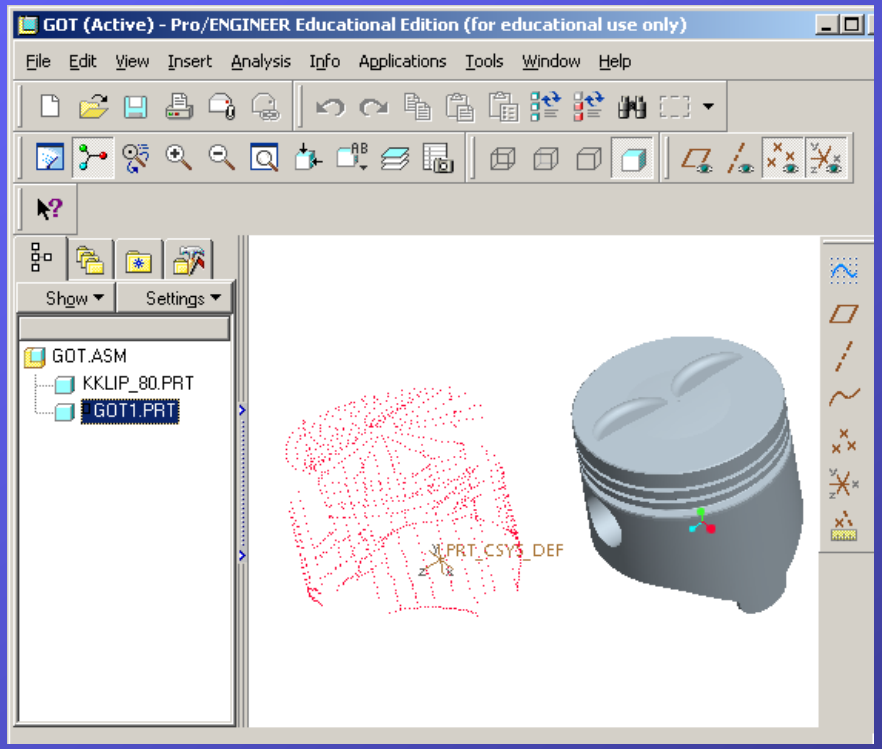


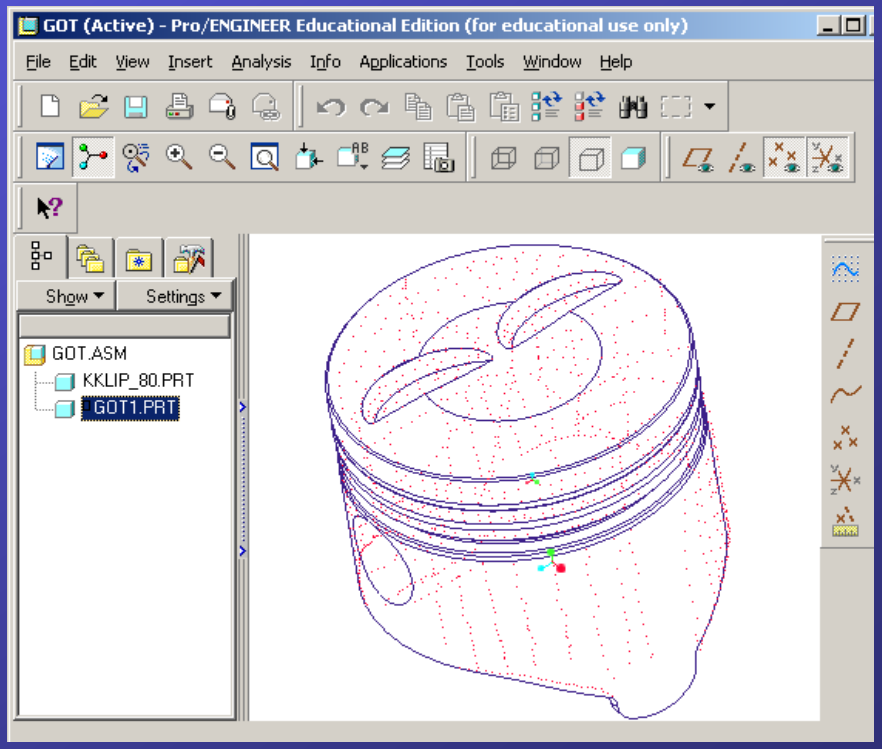


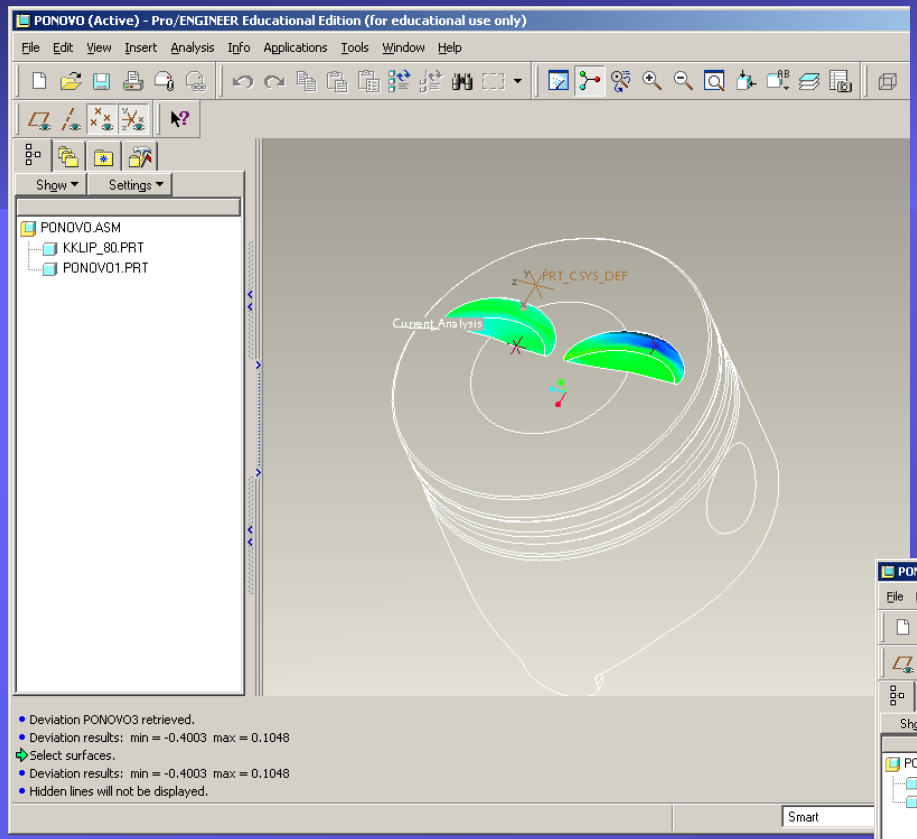
3D-digitalizacija na 3D-digitajzeru MicroScribe G2X (1093 tačke)

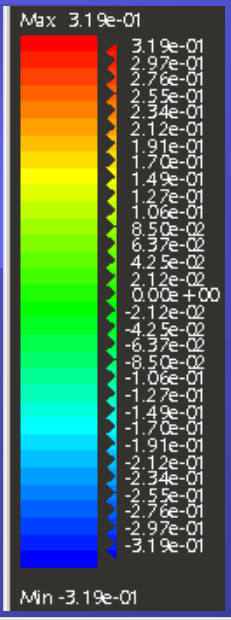
CAD-INSPEKCIJA
klipa "FIAT ø80"- AD "MOTINS"

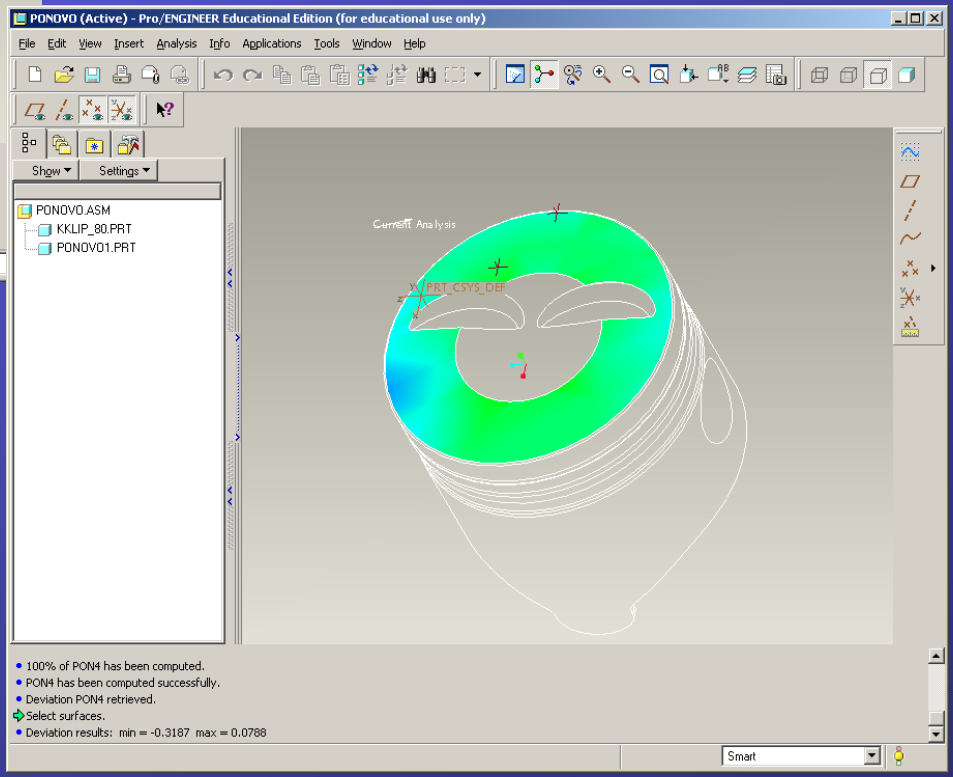
Provera odstupanja u Pro/E modulu Pro/VERIFY





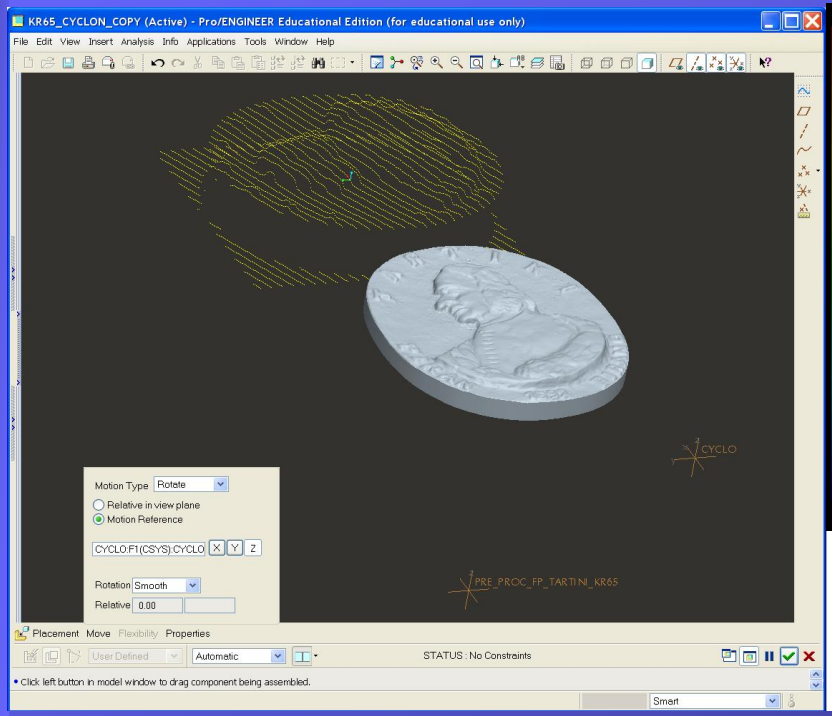






CAD-INSPEKCIJA
klipa "FIAT ø80"- AD "MOTINS"

Rezultat odstupanja
u Pro/VERIFY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Motion Type Rotate
Relative in view plane
Motion Reference
CYCLO.F1(CSYS):CYCLO
X Y Z
Rotation Smooth
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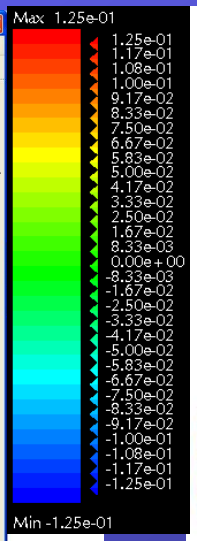
Placement Move Flexibility Properties
User Defined
Automatic
STATUS : No Constraints
• Click left button in model window to drag component being assembled.
Smart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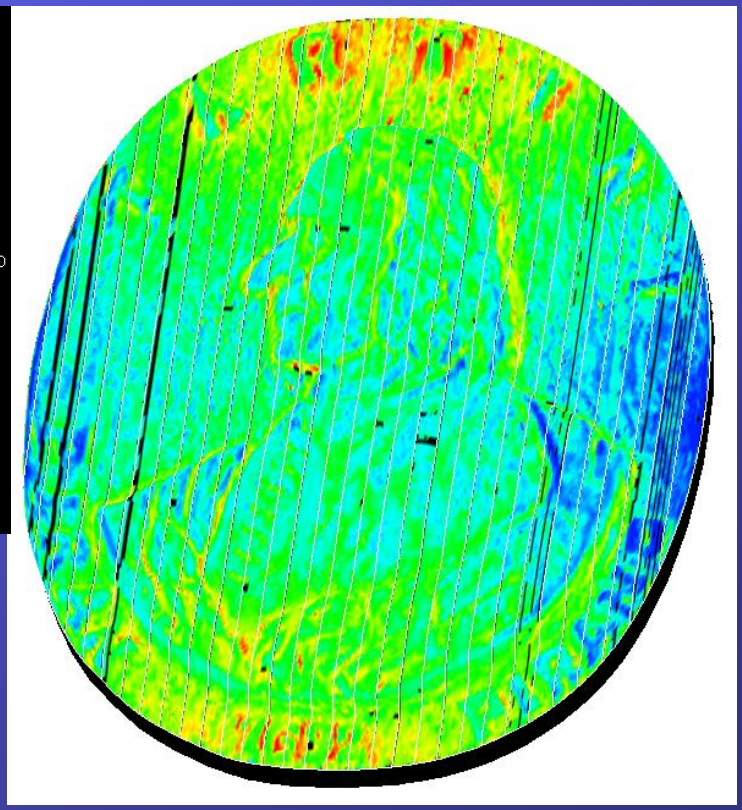

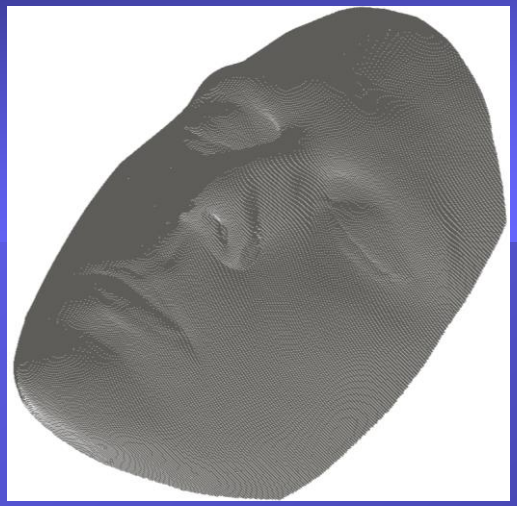

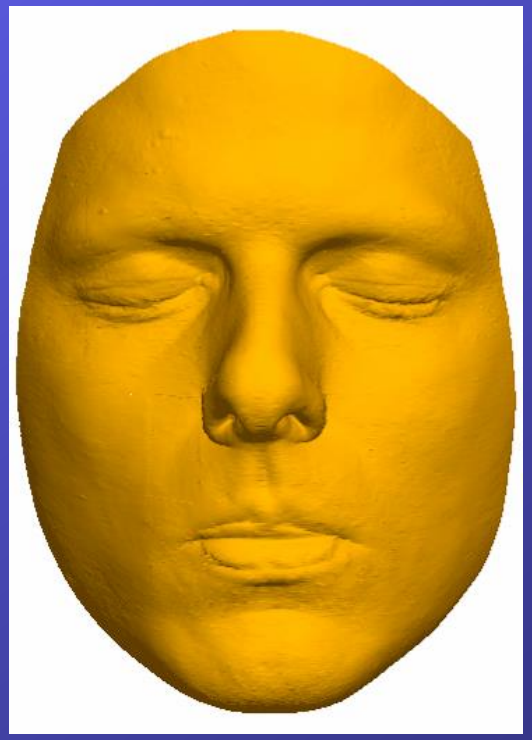

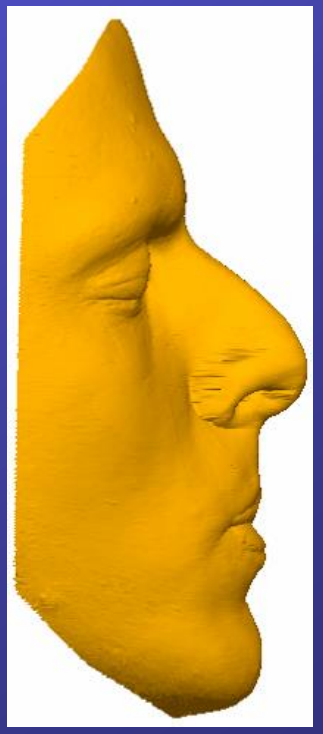

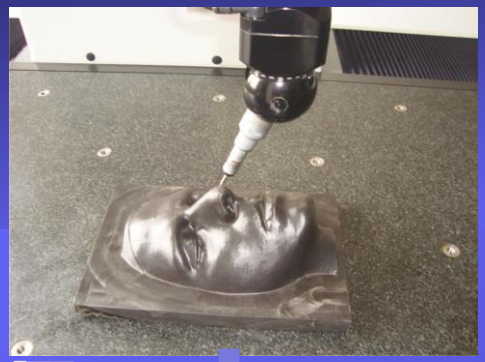

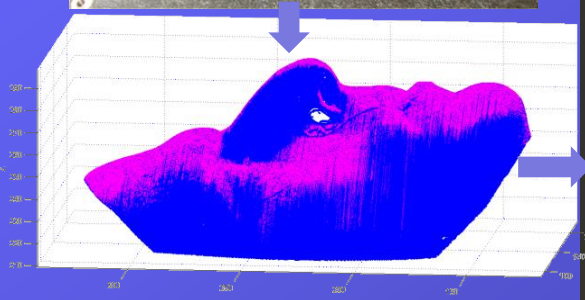

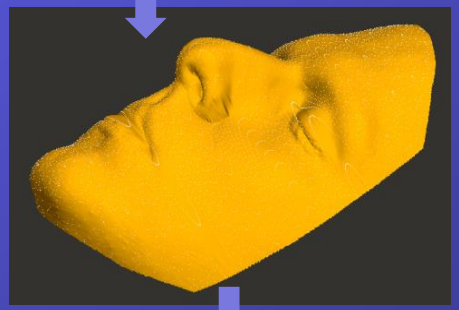

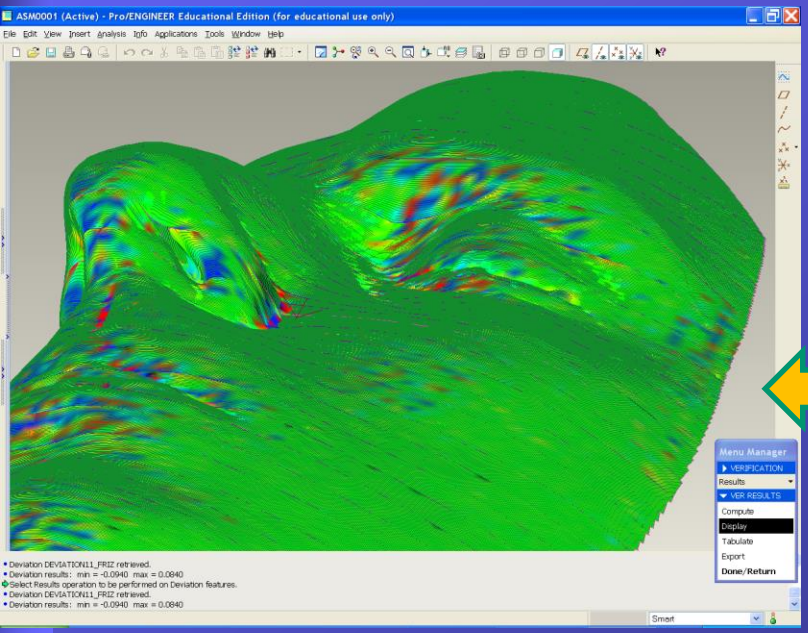
ASM0001 (Active) - Pro/ENGINEER Educational Edition (for educational use only)
File Edit View Insert Analysis Info Applications Tools Window Help
Menu Manager
VERIFICATION
Results
VER RESULTS
Compute
Display
Tabulate
Export
Done/Return
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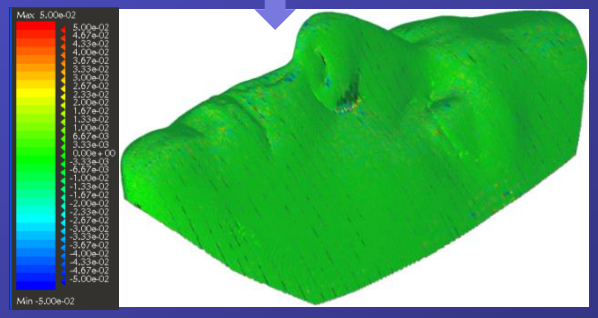
Deviation results: min = -0.0940 max = 0.0840
Select Results operation to be performed on Deviation features.
Deviation DEVIATION11_FRIZ retrieved.
Deviation results: min = -0.0940 max = 0.0840
Smart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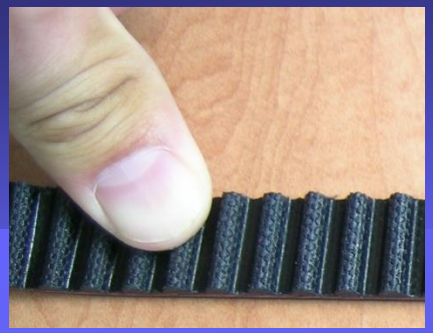

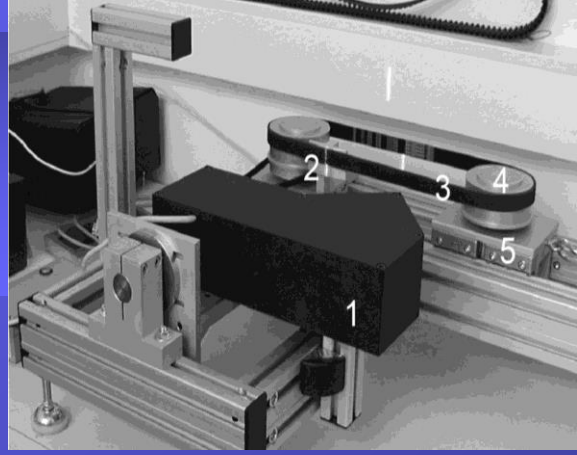
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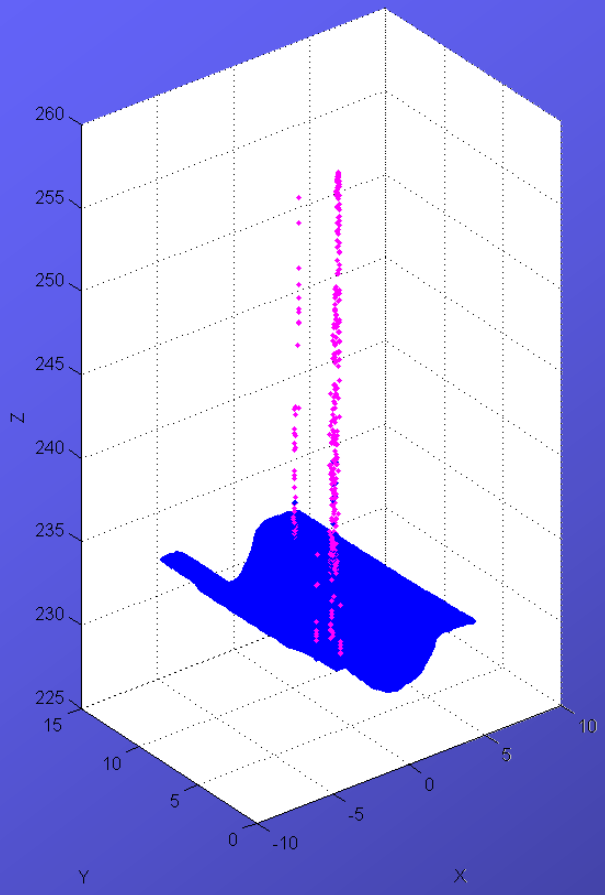
2
3
4
5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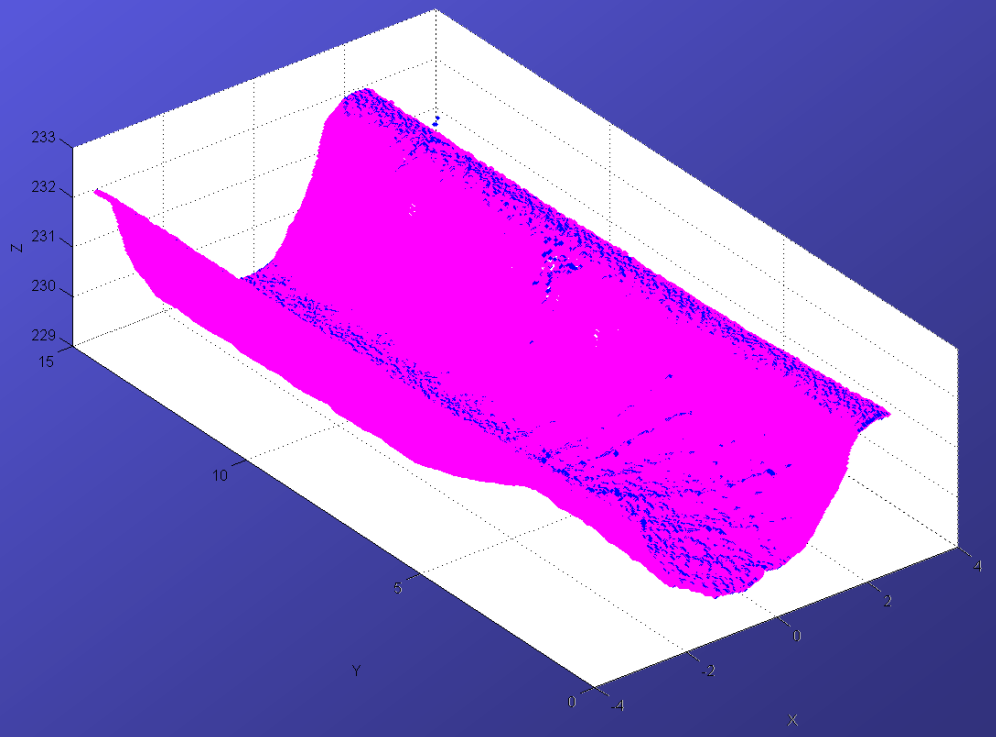
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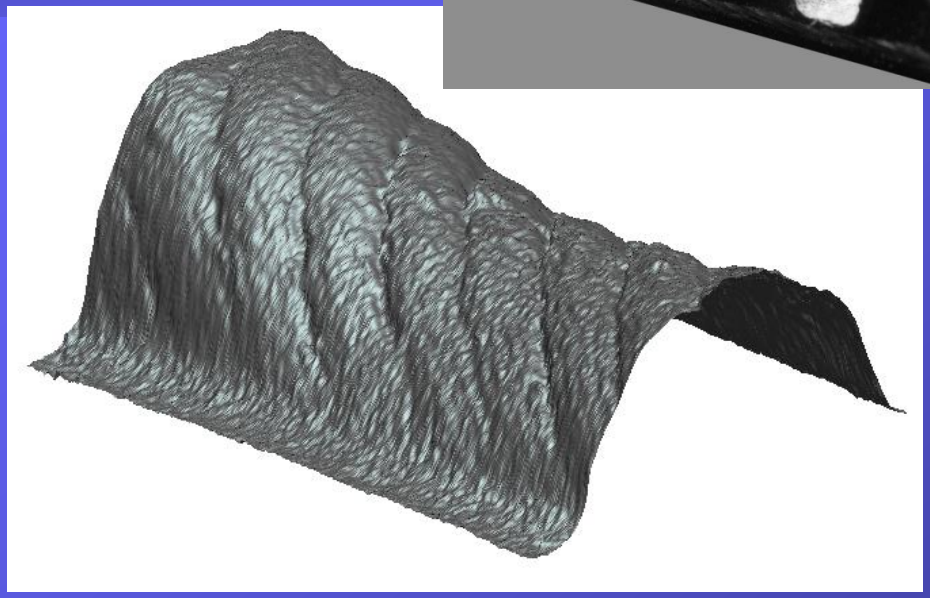

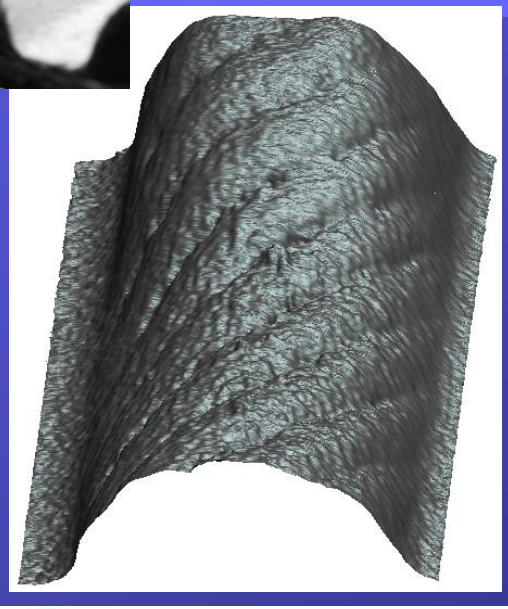

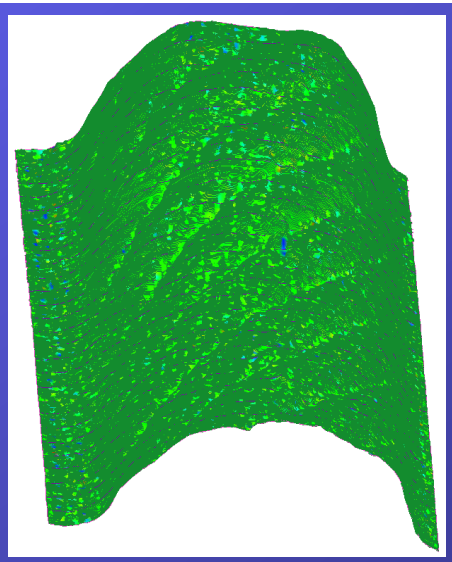

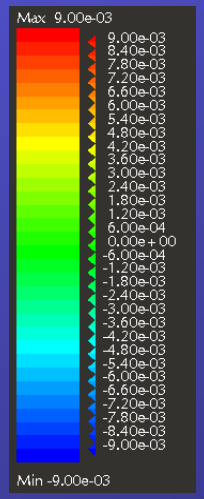
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4.80e-03
4.20e-03
3.60e-03
3.00e-03
2.40e-03
1.80e-03
1.20e-03
6.00e-04
0.00e+00
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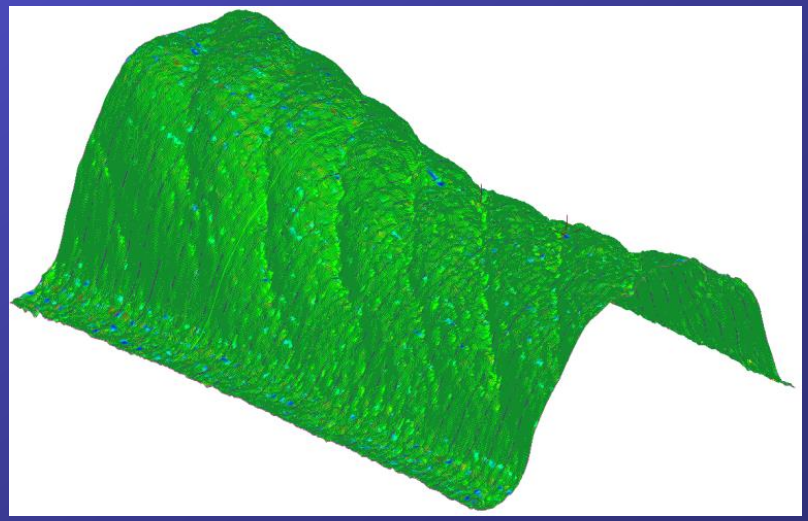

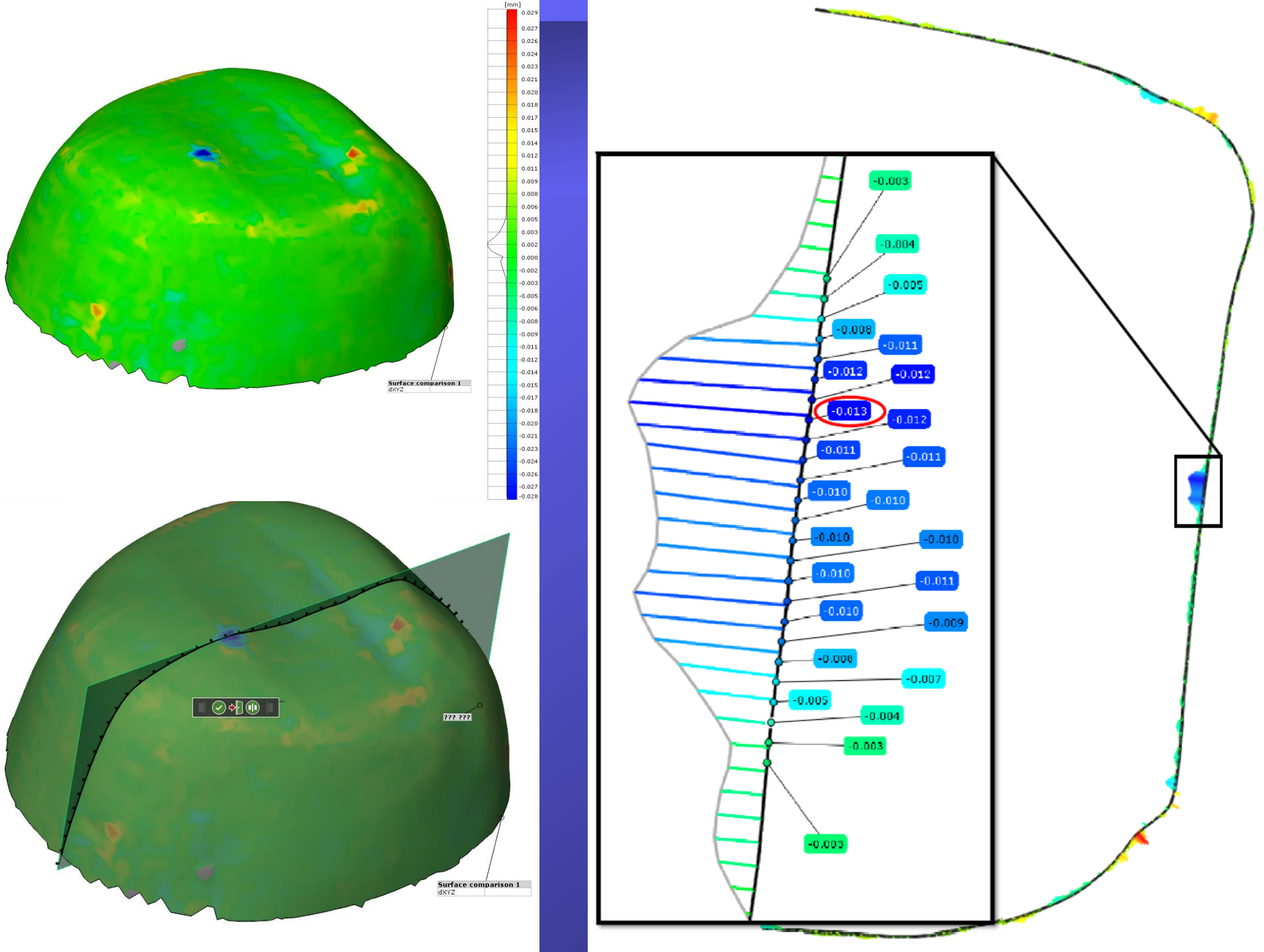
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0.011
0.009
0.008
0.006
0.005
0.003
0.002
0.000
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Surface comparison 1
dXYZ
??? ???
Surface comparison 1
dXYZ
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-0.004
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-0.012
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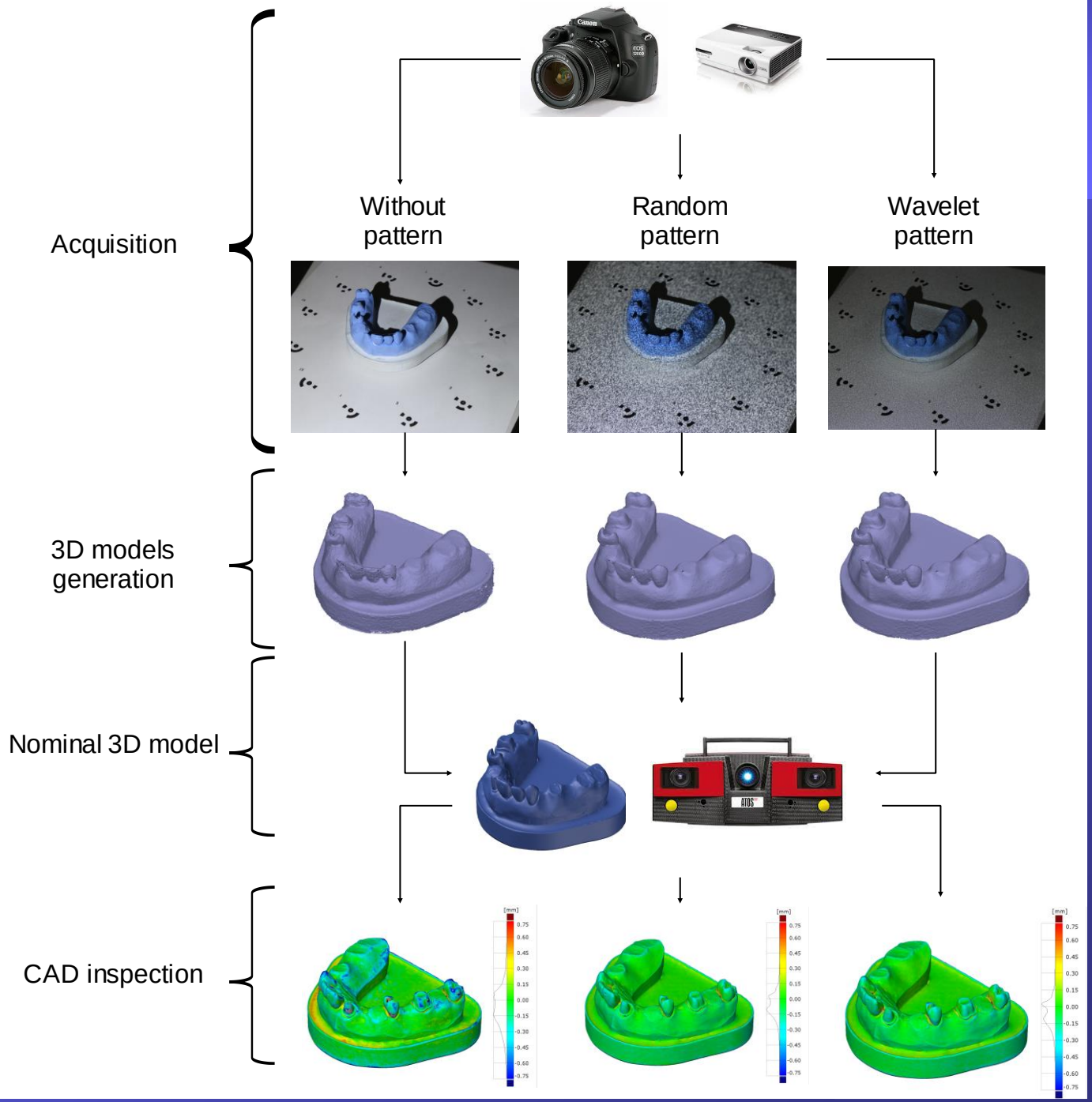
Acquisition
Without pattern
Random pattern
Wavelet pattern
3D models generation
Nominal 3D model
CAD inspection

Pitanja, komentari, diskusija...