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# Advances in Incremental Sheet Forming


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iDM Innovations in Design & Manufacturing

deLOGIC DeLineation of Object Geometry, Innovation, and Creation Lab

SoIn Social Innovation Lab

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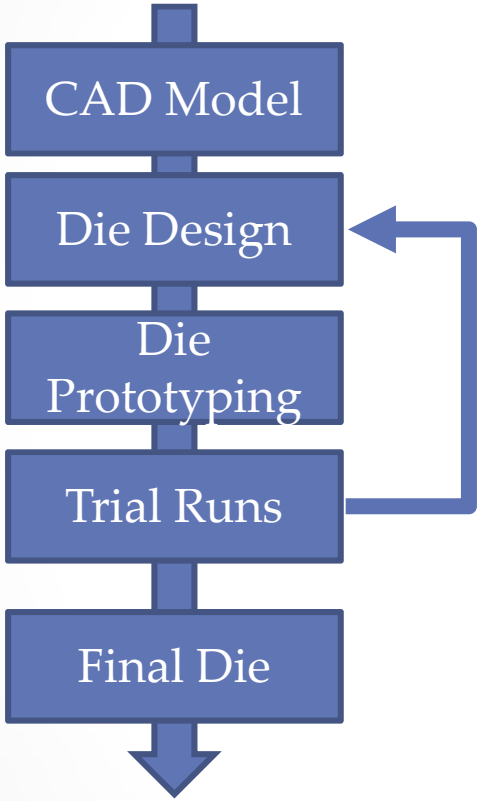
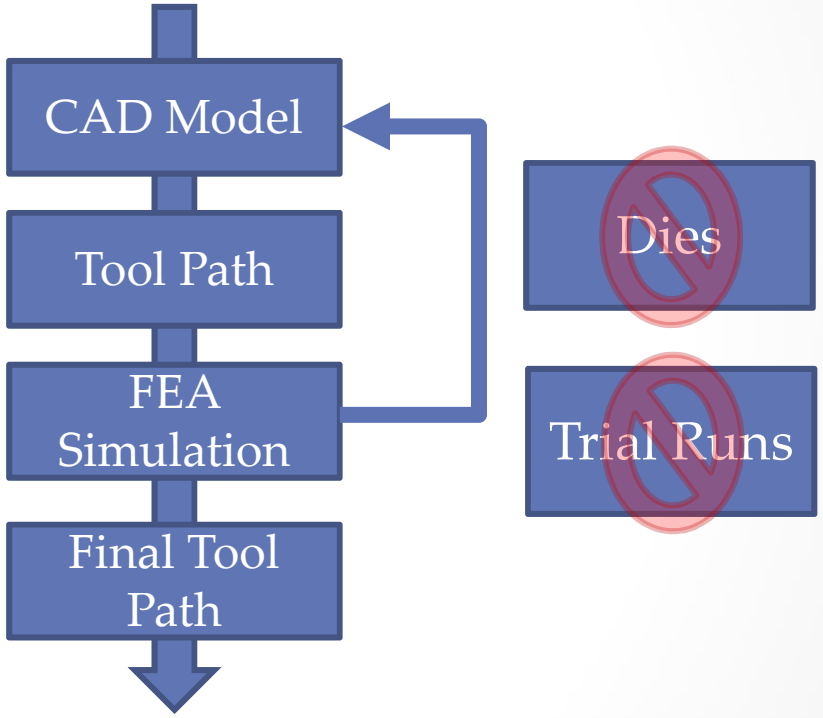
- Hybrid Manufacturing : Incremental Stretch Drawing (ISD)
- Hybrid Manufacturing : Deformation Machining

# Incremental Sheet Forming (ISF)

## Why Incremental Sheet Forming?

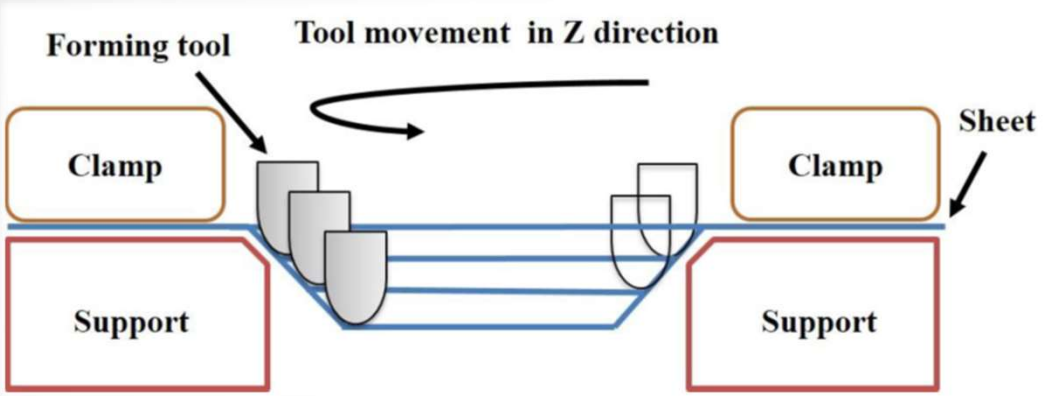



Work flow of Conventional Forming Process

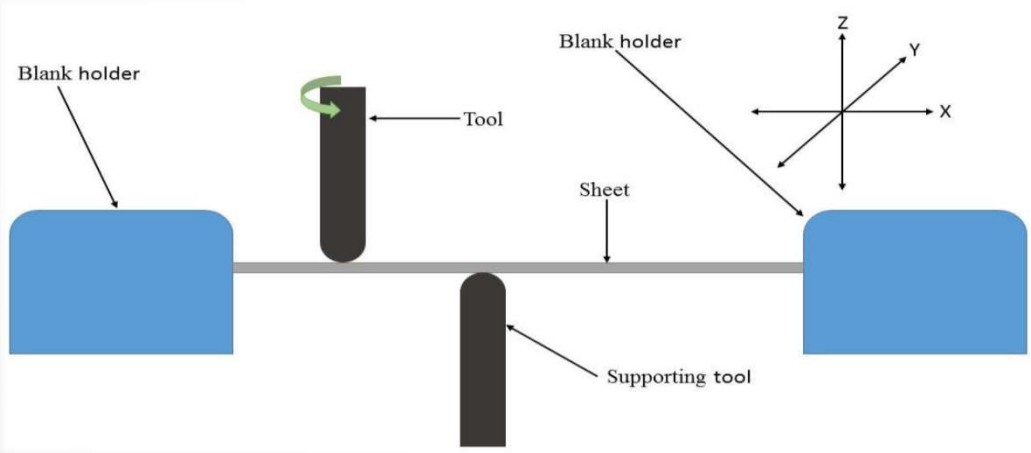



Work flow of Incremental Forming Process

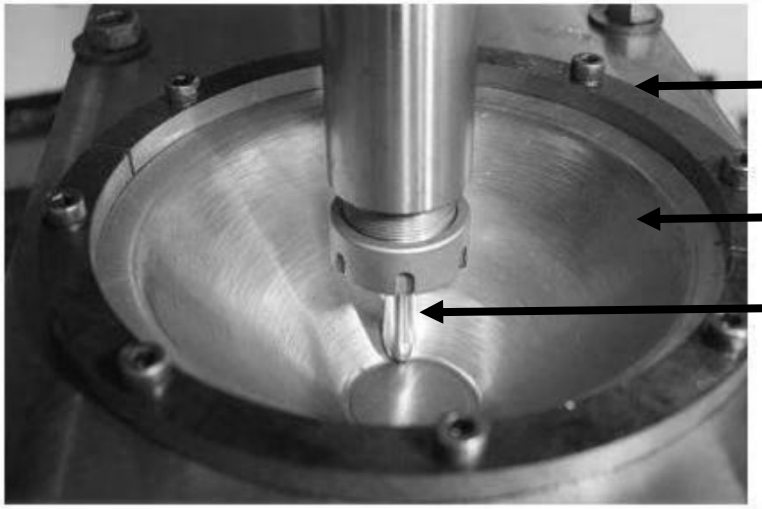
# Incremental Sheet Forming (ISF)




Single Point Incremental Sheet Forming

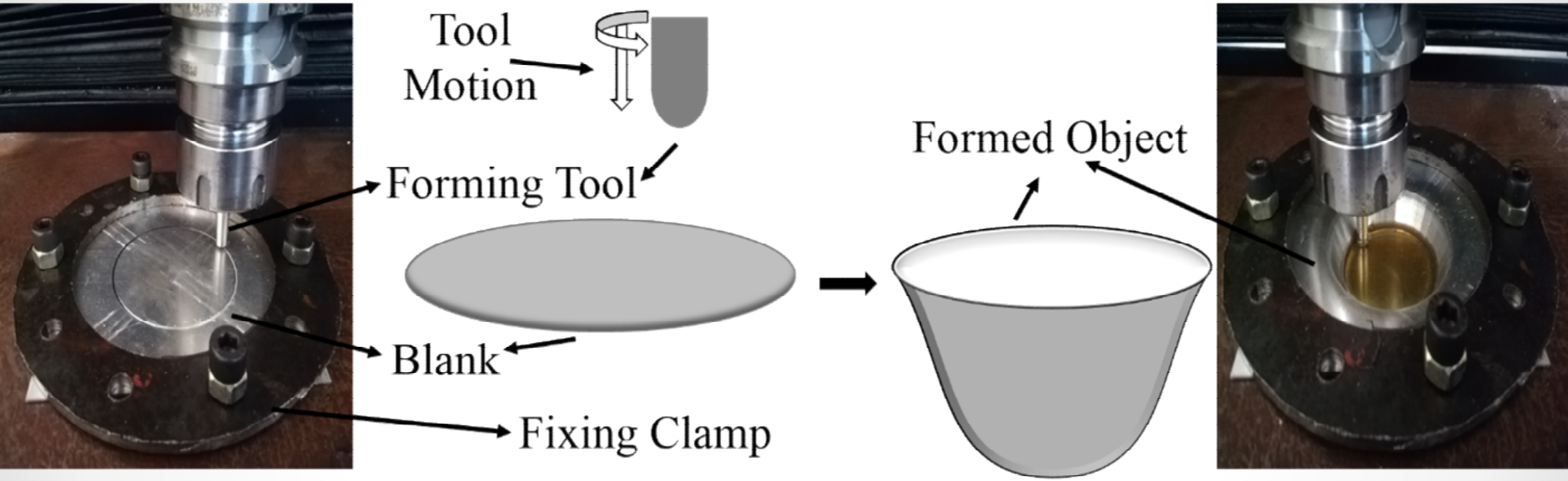



Double-sided Incremental Sheet Forming




Experimental Setup Parts

# Incremental Sheet Forming (ISF)



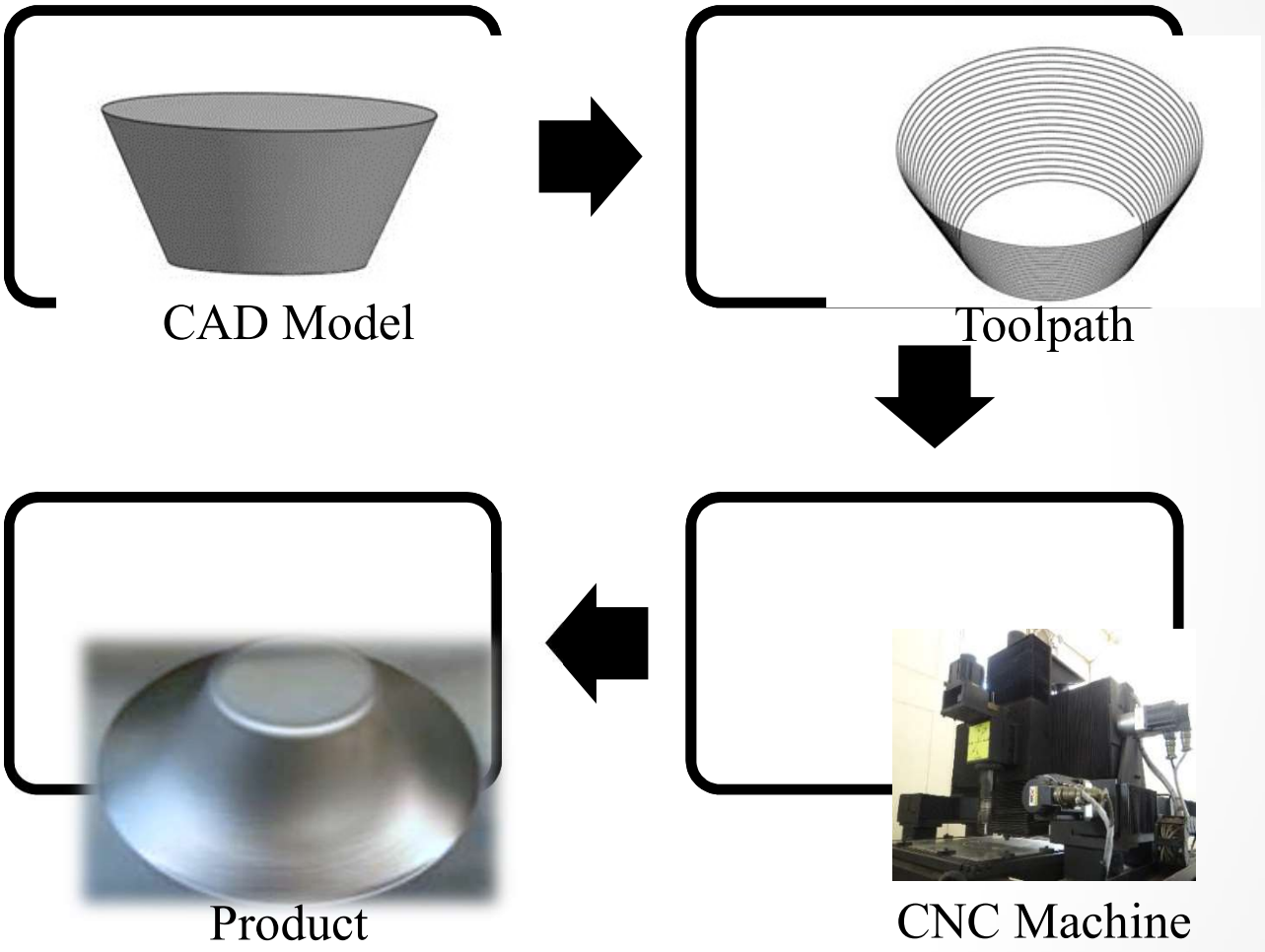

Incremental Forming (IF) process

# Incremental Sheet Forming (ISF)

SPISF in action (Video)

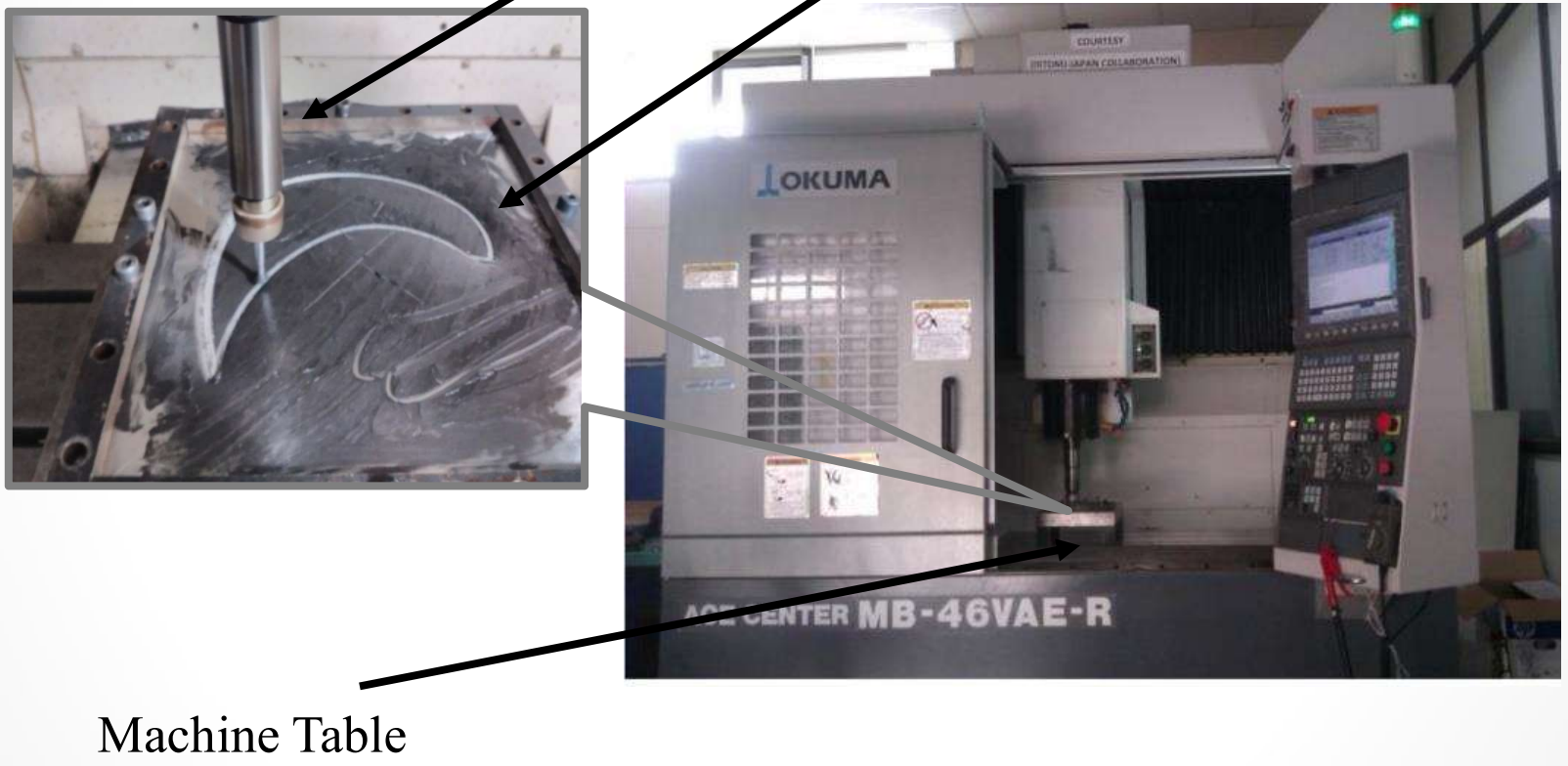
# Incremental Sheet Forming (ISF)

Process Flow



# Incremental Sheet Forming (ISF)

## Experimental Setup




Initial Setup: CNC Okuma MB-46VAE-R

# Parts Fabricated using ISF

Cranial Plate

Back seat orthosis form

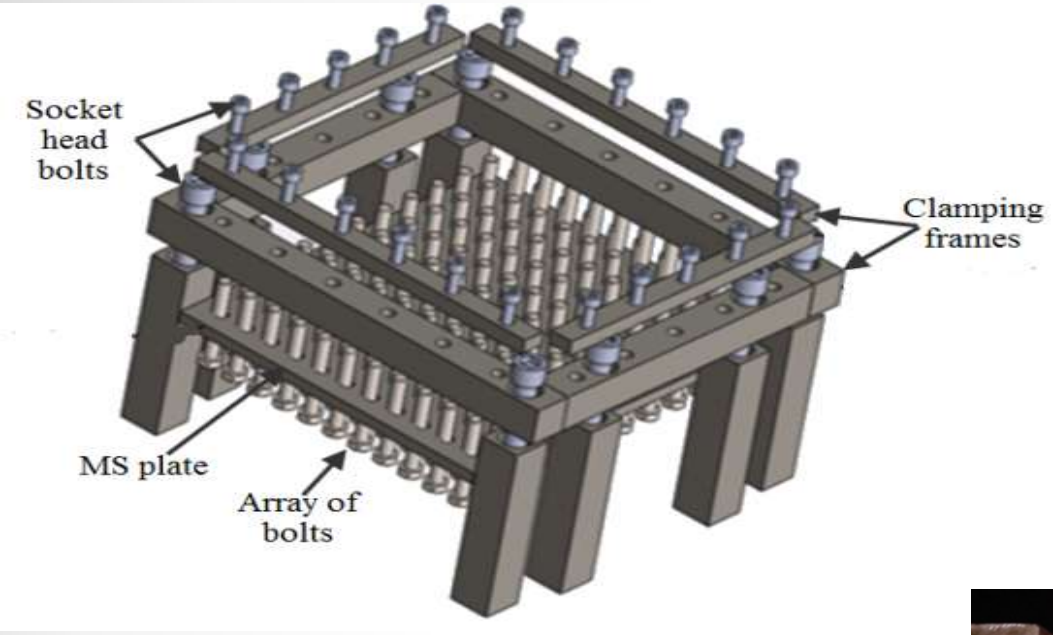
Some of the Complex Geometries Formed @ deLOGIC Lab, IIITDM Jabalpur

# Incremental Sheet Forming (ISF)

- Not applicable for materials having low formability (hard to form)
- Due to springback, dimensional accuracy of the parts prepared by IF is not up to the mark

Defects in objects formed by Incremental Forming Process

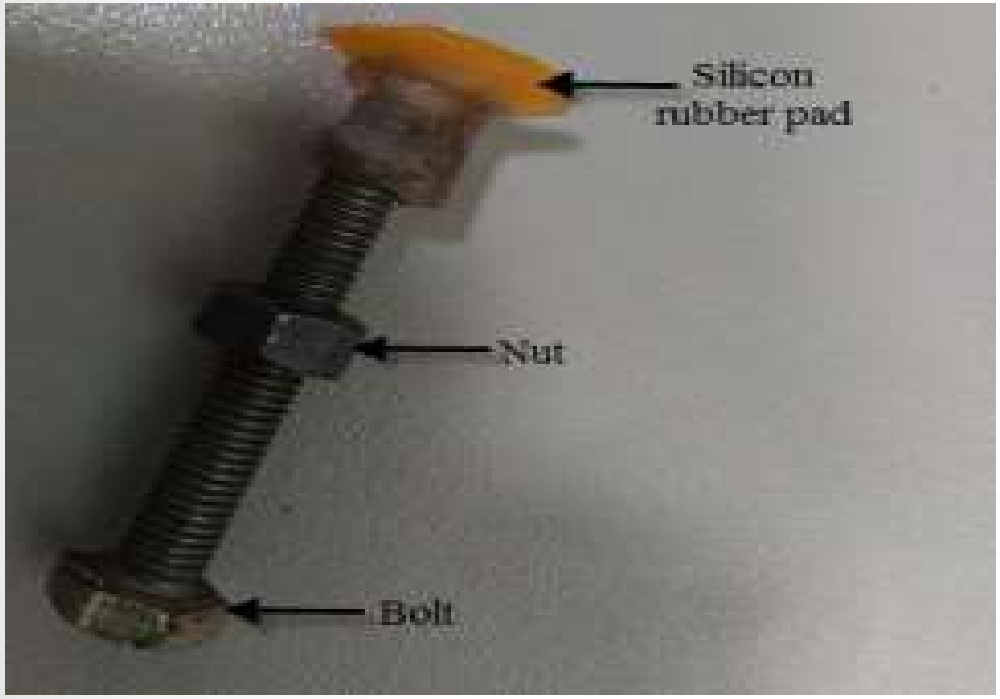
# Flexible Die using Bolt Support




CAD model of bolt support

Actual bolt support setup

# Flexible Die using Bolt Support

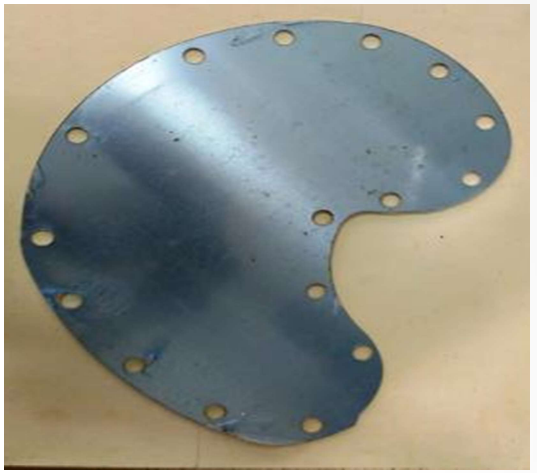



Bolt assembly

Bolt support setup with grid of bolts

# Custom Cut Blanks

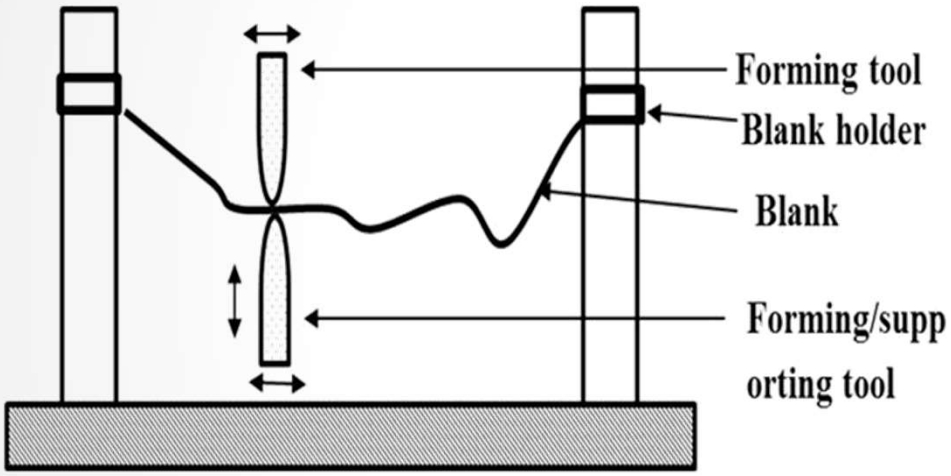
Customized clamping for custom cut blanks



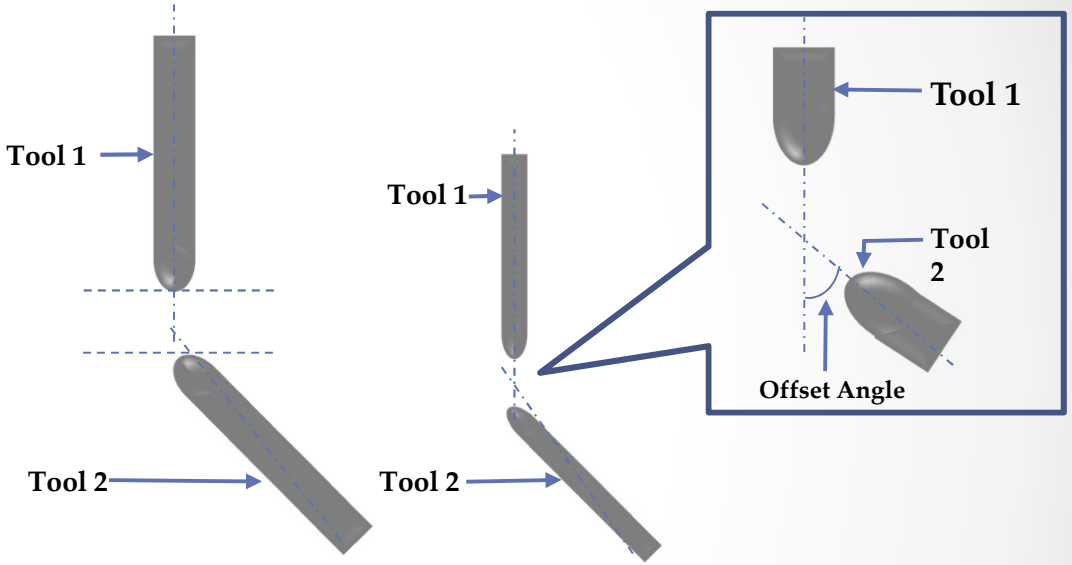
Custom Cut blank for Free form geometry

End component

# Double Sided Incremental Forming

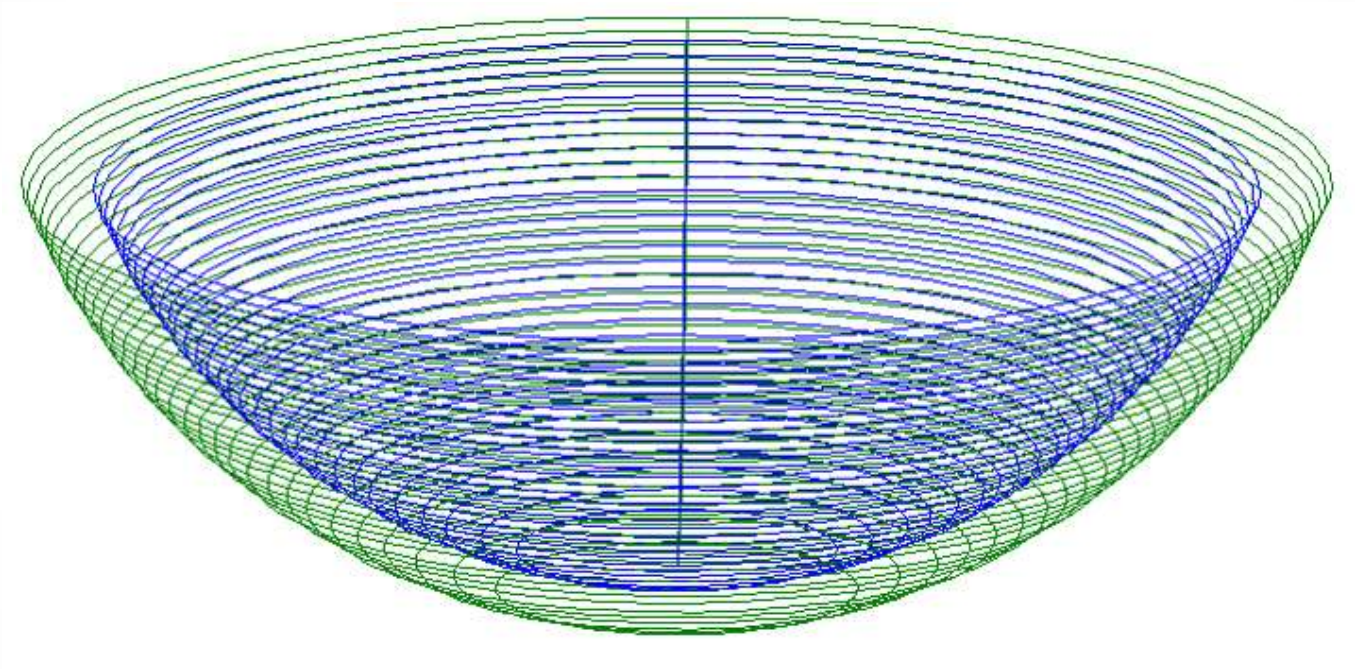



Double Sided Incremental Forming




Schematics of Double Sided Incremental Forming

# Double Sided Incremental Forming

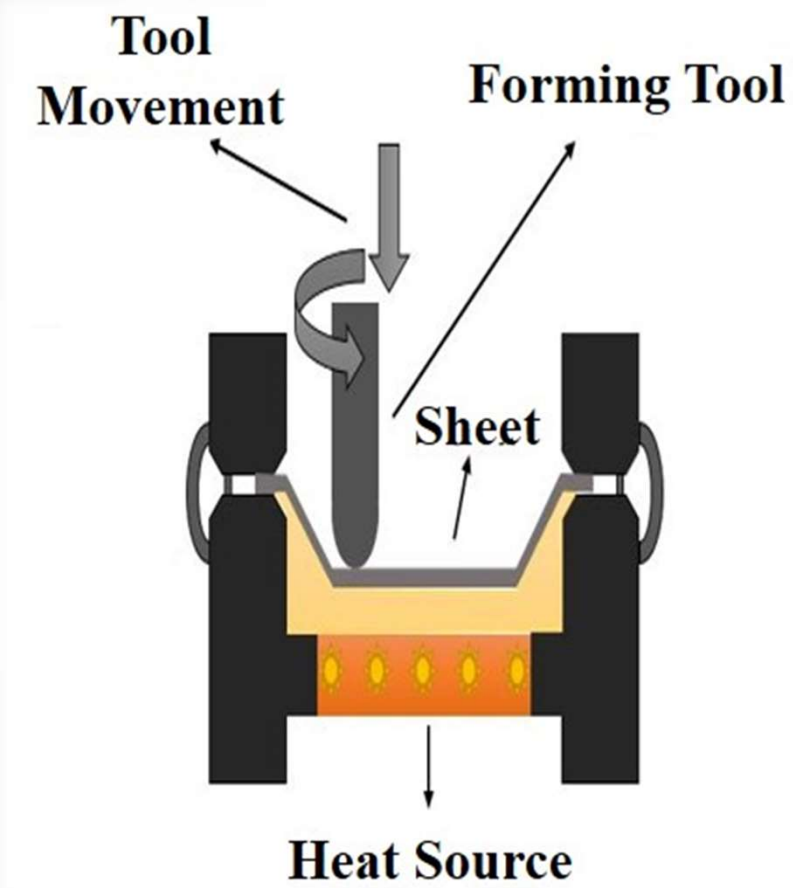


DSIF Toolpath: Forming tool (blue), Supporting tool (green)

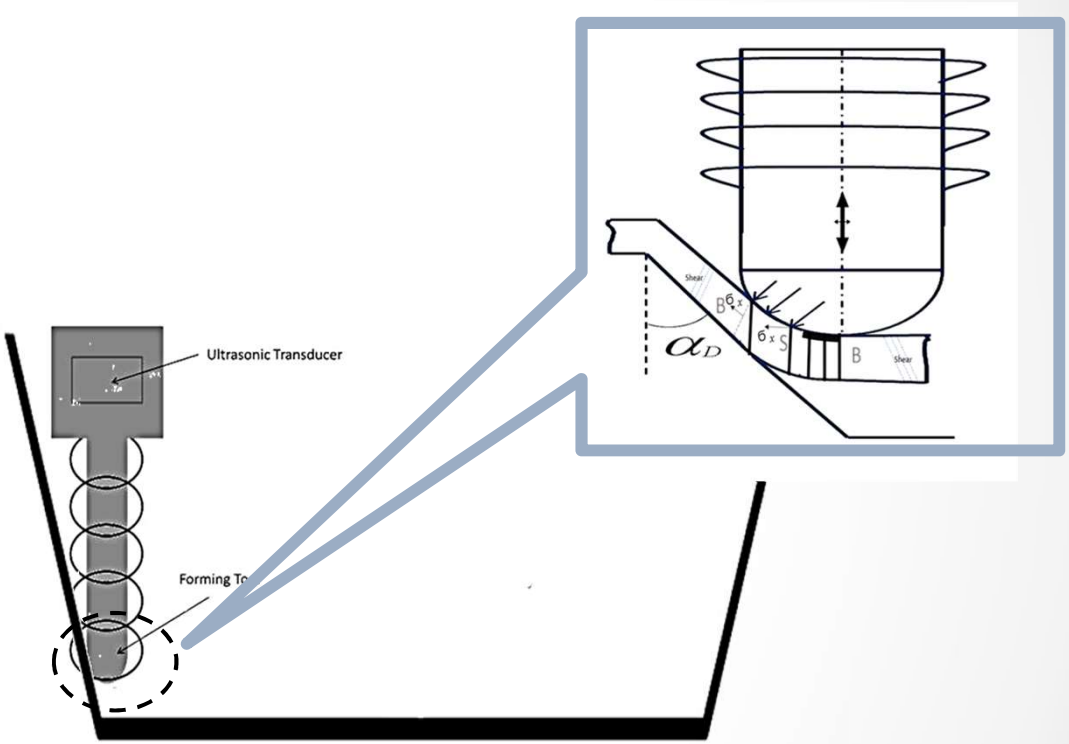
# Double Sided Incremental Forming

Courtesy: BRNS/DAE, Grant No. 2012/36/27

# ISF Variants – ET-IST and UVaISF

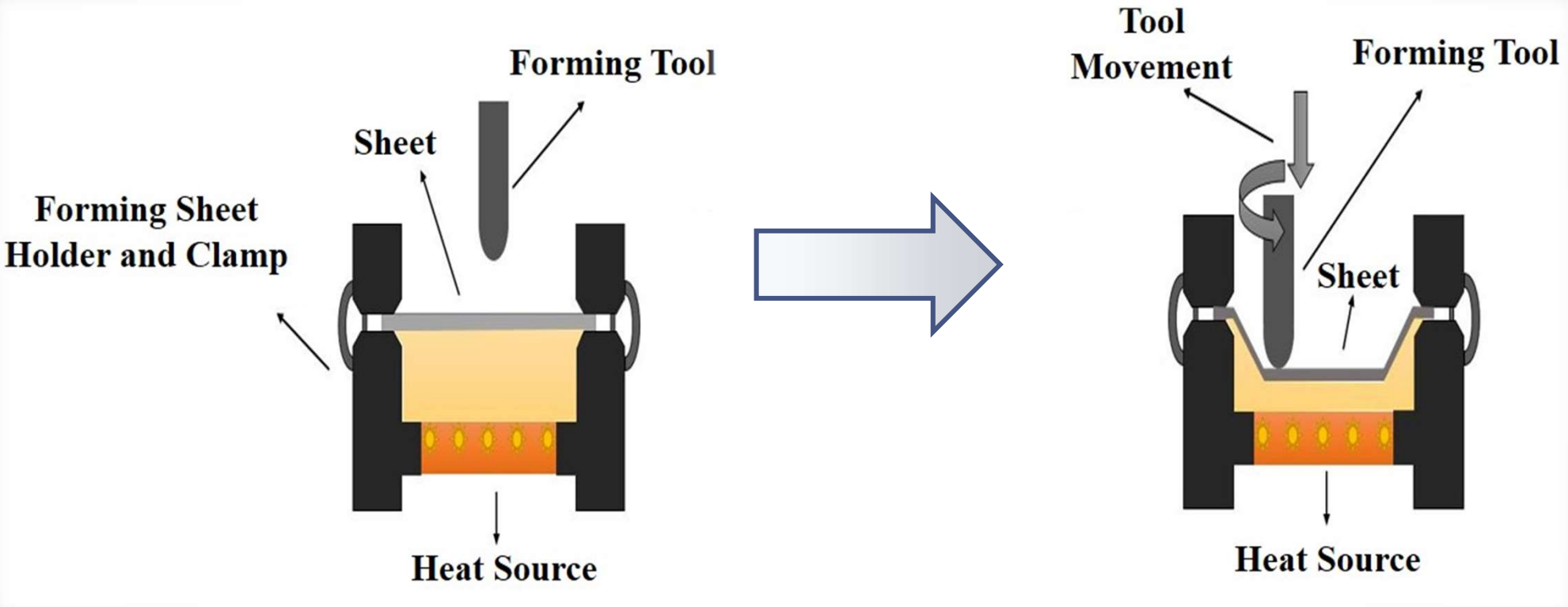



Incremental Sheet Forming at Elevated Temperature



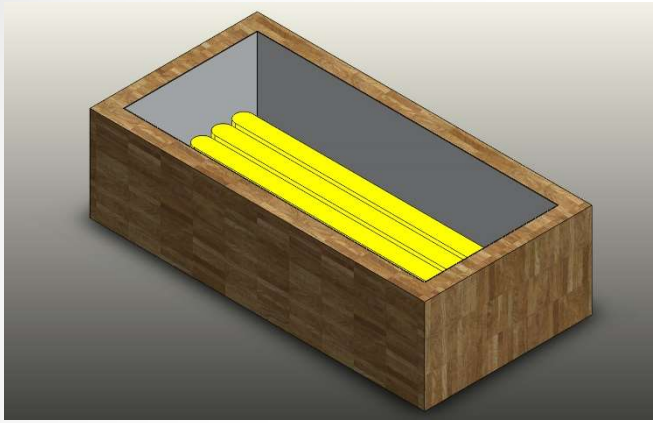

Incremental Forming with Ultrasonic vibration

# Incremental Forming at Elevated Temperature (ET-IF)

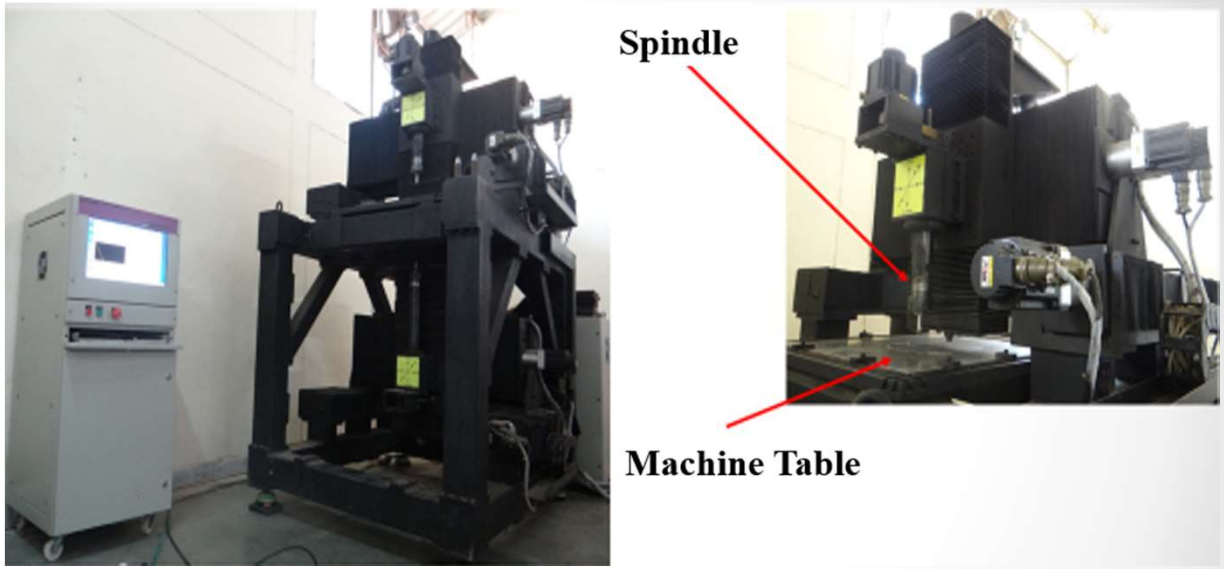



Working Principle of Incremental Sheet Forming at Elevated Temperature

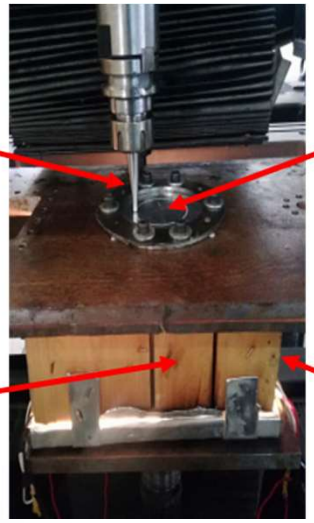
# Experimental Setup



CAD Model of Heating Setup




Incremental Sheet Forming Setup




ET-IF Setup


Tools for ET-IF Process

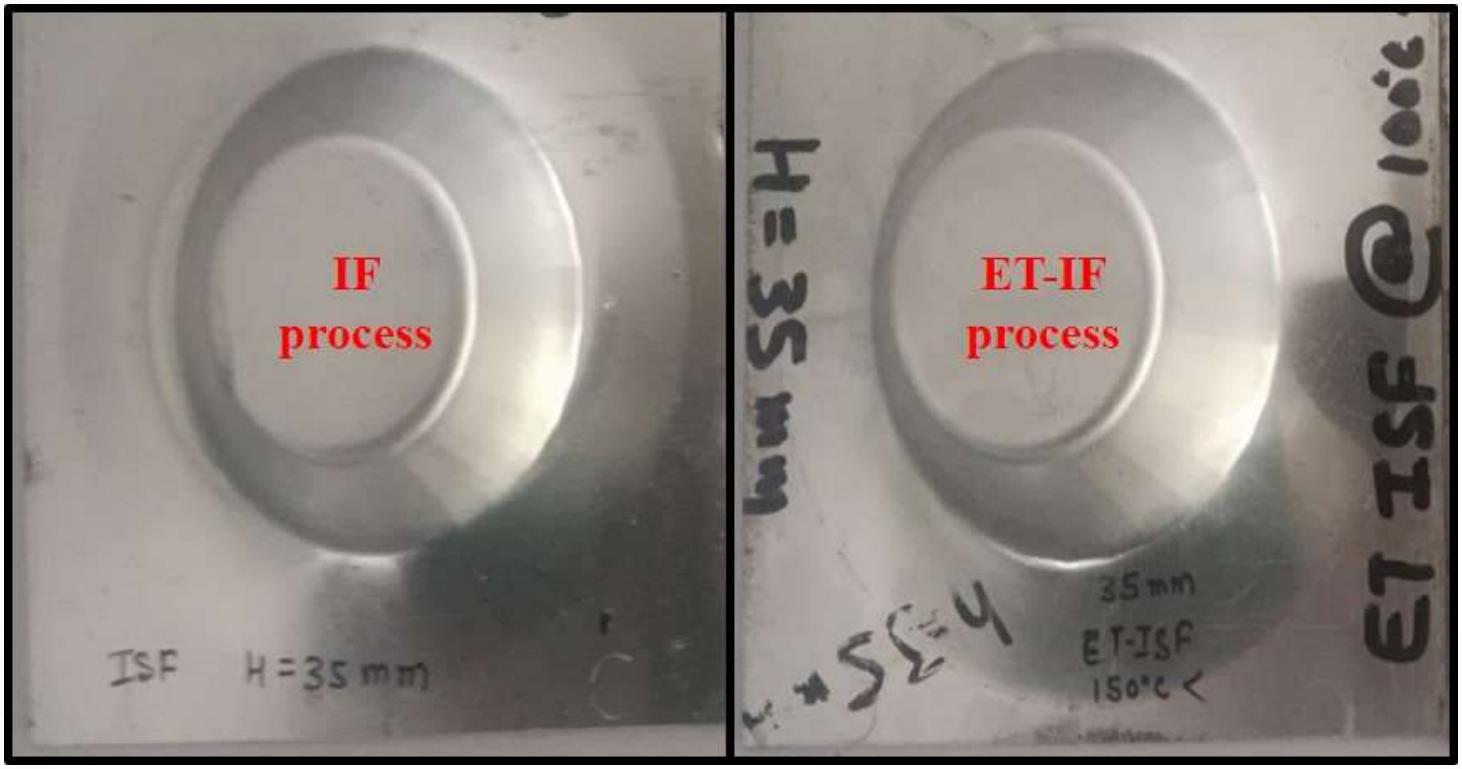
# ET-IF using Lubrication

ET-IF Process with different Lubricants

# Advantages of ET-IF

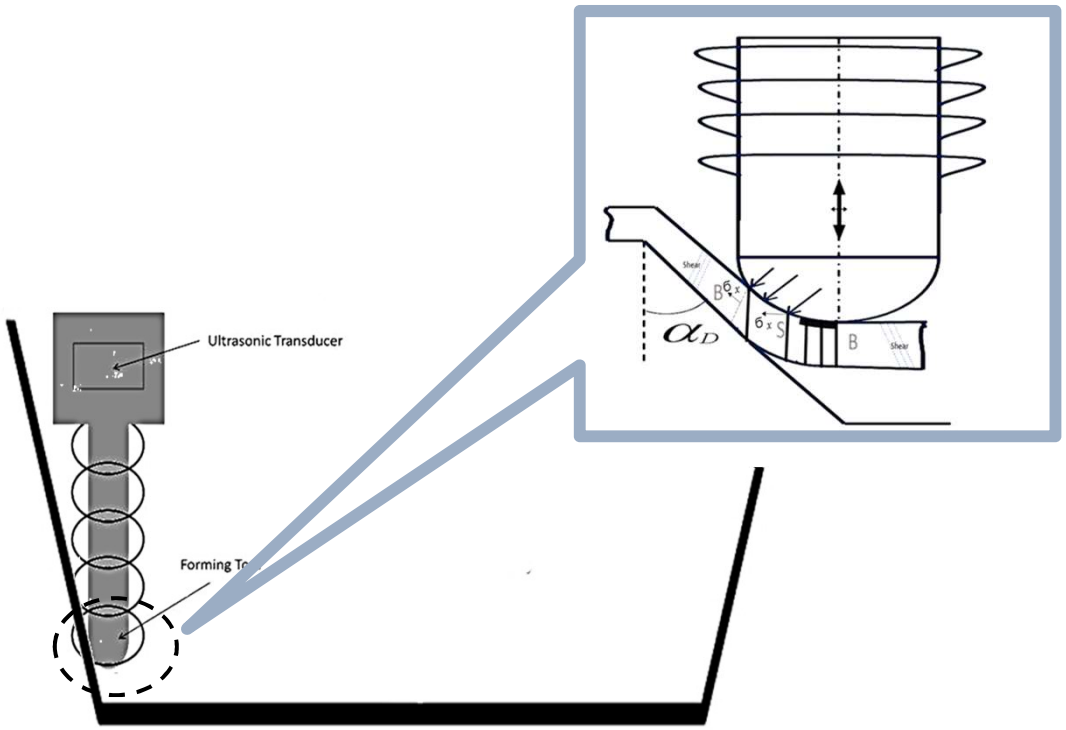
- Improves the dimensional accuracy
- Decreases processing time
- Improve the workability
- Easy to form geometries that are not easily formed at room temperature

# Output




Formed Parts by IF and ET-IF process

# Ultrasonic Vibration assisted Incremental Sheet Forming (UVaISF)

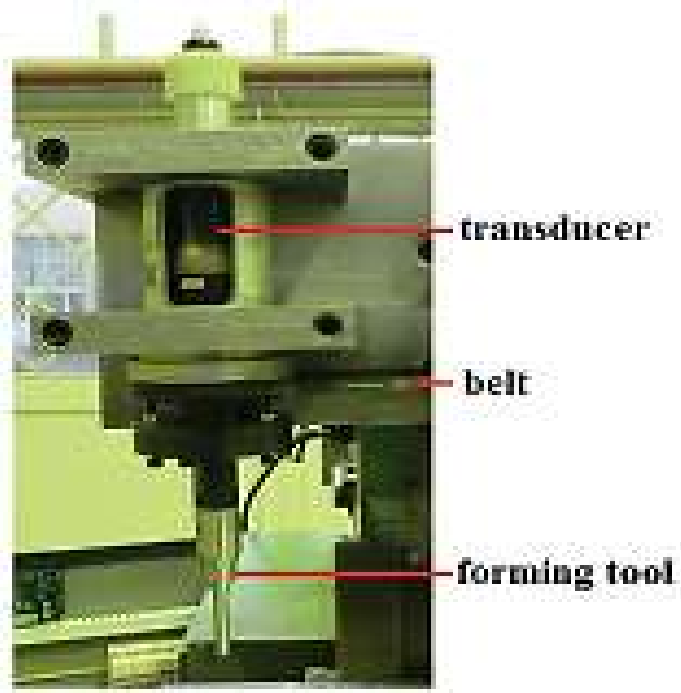



Incremental Forming with Ultrasonic vibration

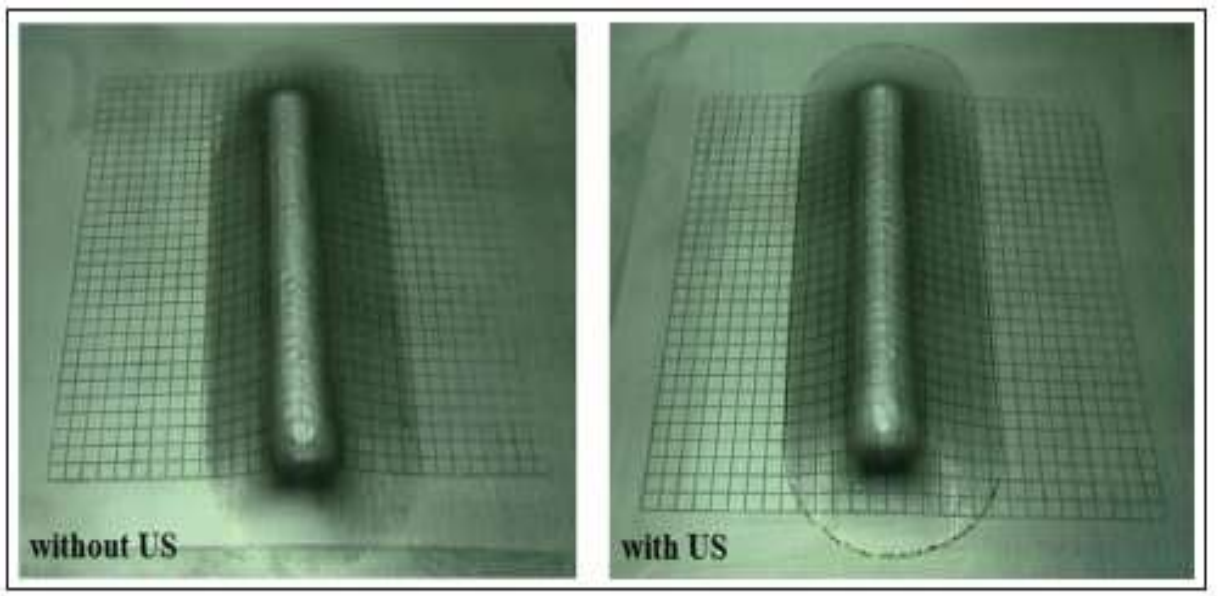
# Ultrasonic Vibration assisted Double Sided Incremental Sheet Forming (UVaISF)

Courtesy: IMPRINT India, Grant No. 5506

# Ultrasonic Vibration assisted Incremental Sheet Forming (UVaISF)




Ultrasonic vibration assisted forming setup



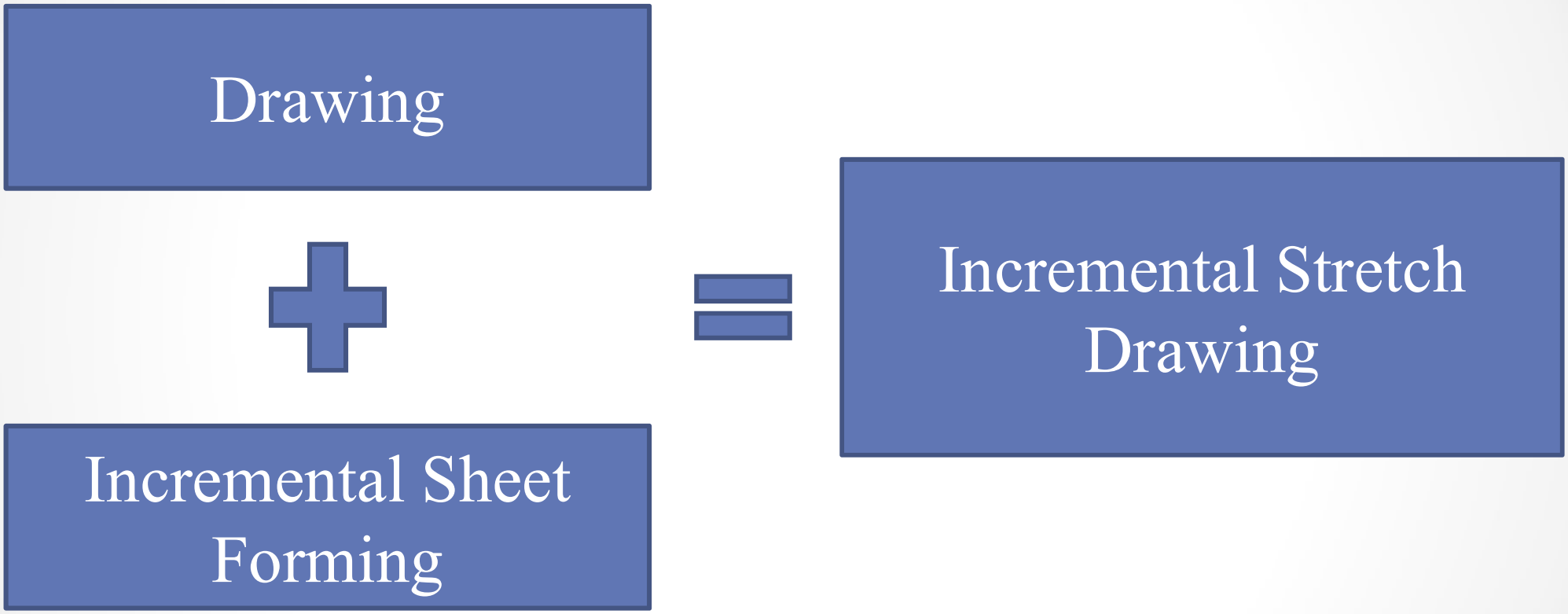

Samples produced

# Ultrasonic Vibration assisted Incremental Sheet Forming (UVaISF)

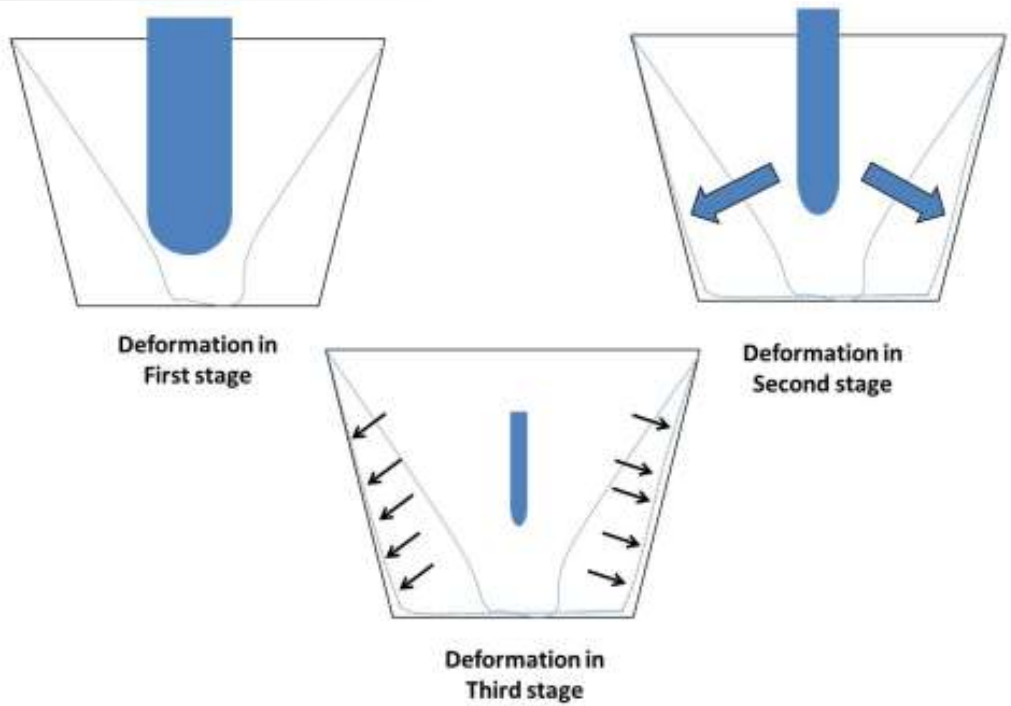
Advantages:

- Better material flow
- Better surface quality
- Enhanced formability
- Forming at higher feed rates possible

# Incremental Stretch Drawing (ISD)



# Incremental Stretch Drawing (ISD)



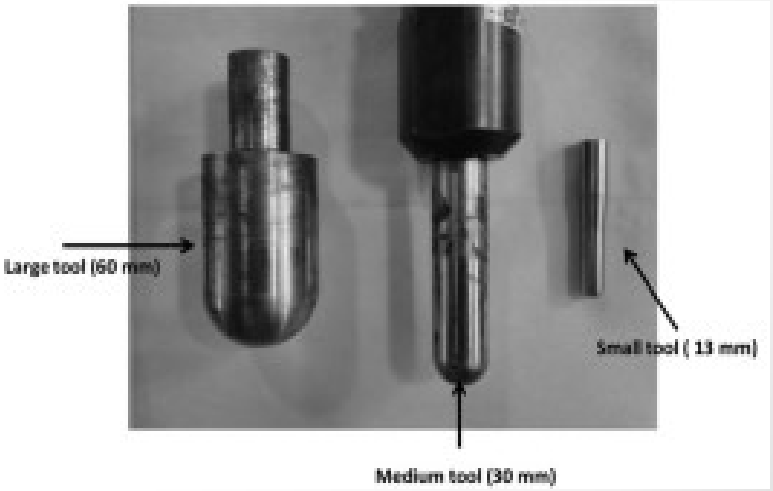

Deformation in ISD

- Drawing with large sized tool
- Drawing and ISF with medium sized tool (inside out toolpath)
- ISF with small sized tool (outside in toolpath)

# Incremental Stretch Drawing (ISD)

Blank in ISD

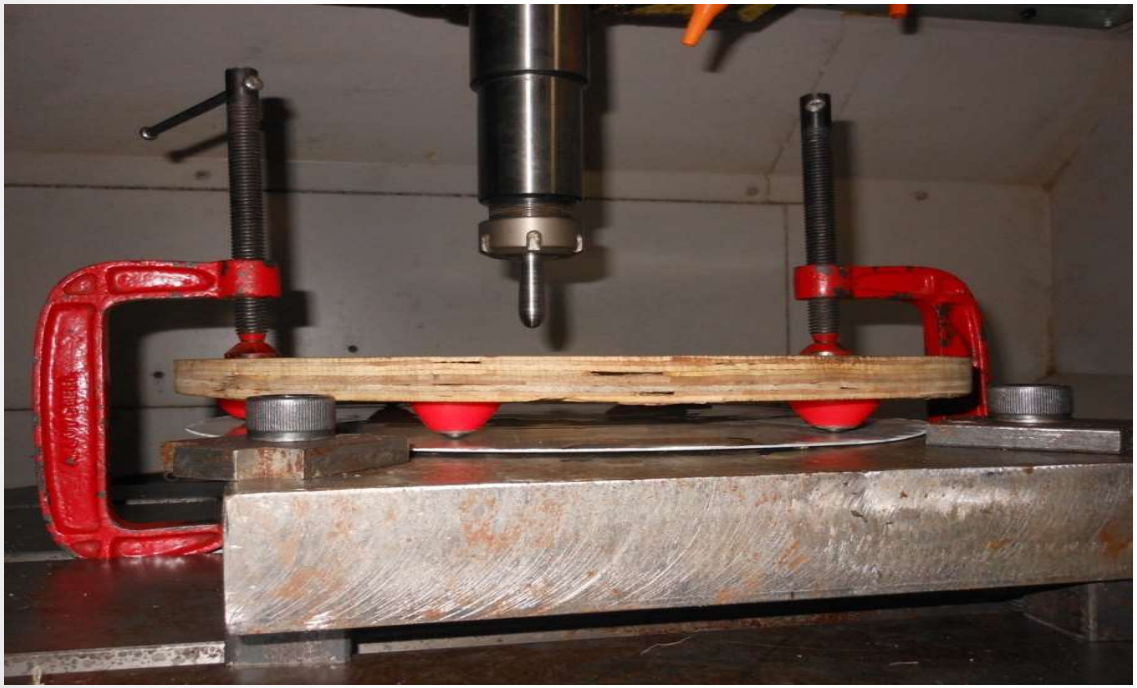
Fixture in ISD




Tool in ISD

# Incremental Stretch Drawing (ISD)

- Development of set up for achieving incremental stretch drawing
  - Ball point metal caster wheels / Rollers – Reducing Friction



# Incremental Stretch Drawing (ISD)

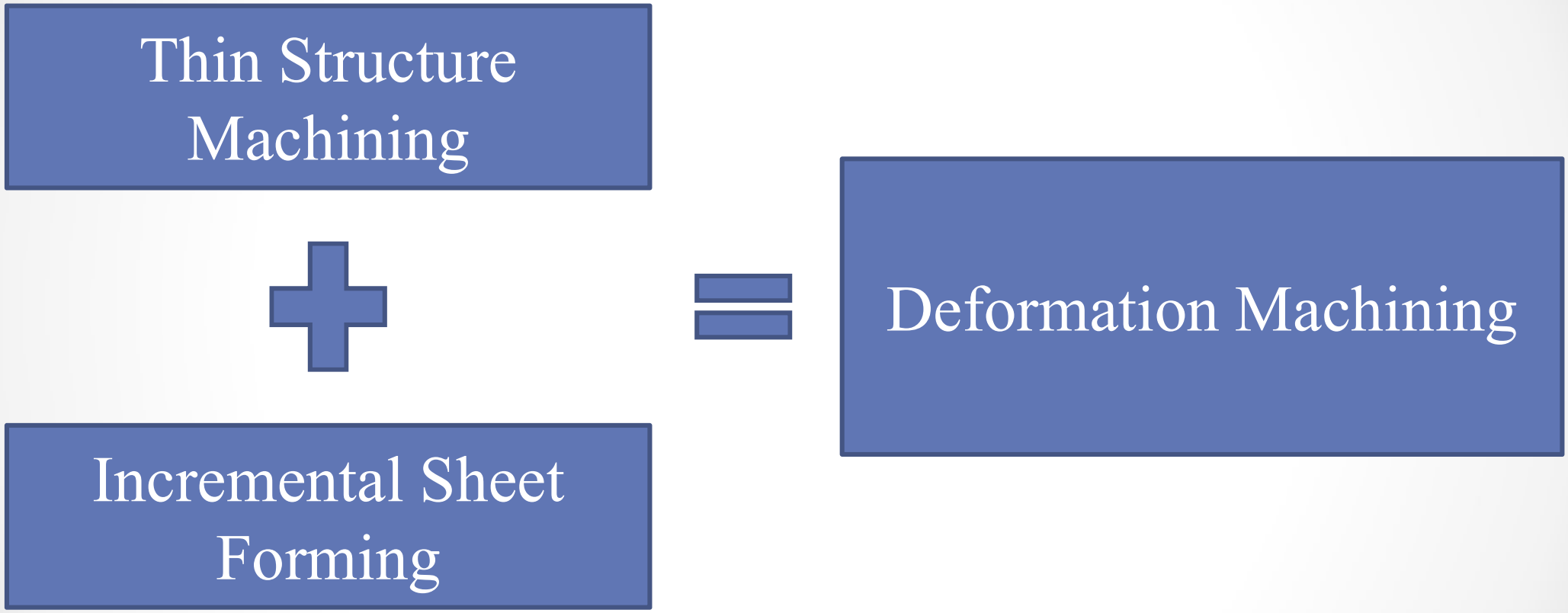
- Ball point tool

# Incremental Stretch Drawing (ISD)

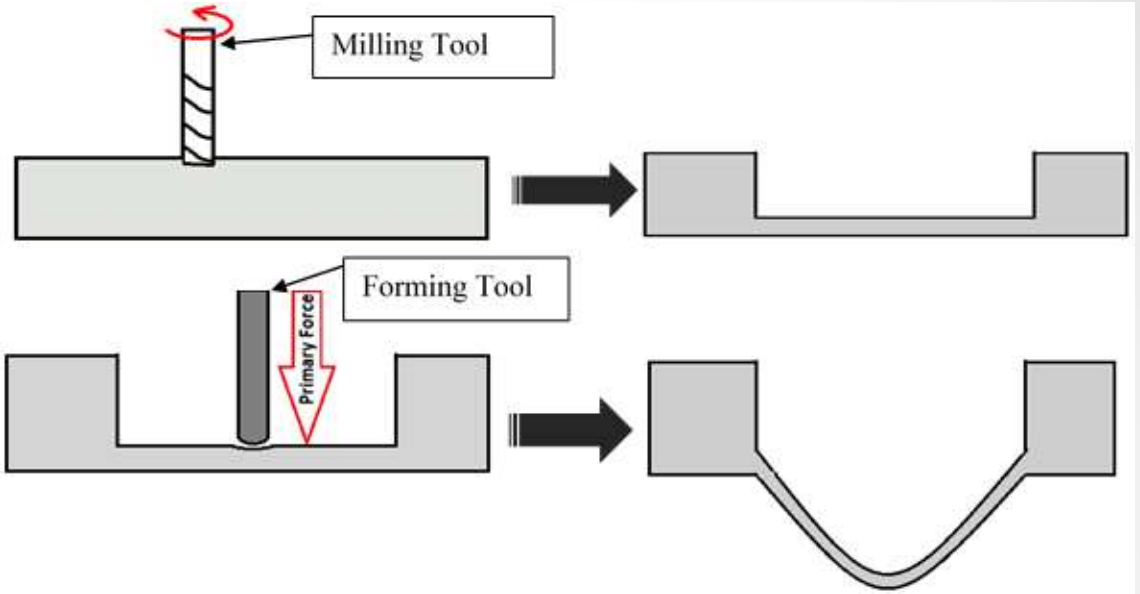
Advantages:

- Better material flow
- Controlled wrinkling of the sheet
- Reduction in thinning due to enhanced forming zone
- Better formability than conventional ISF

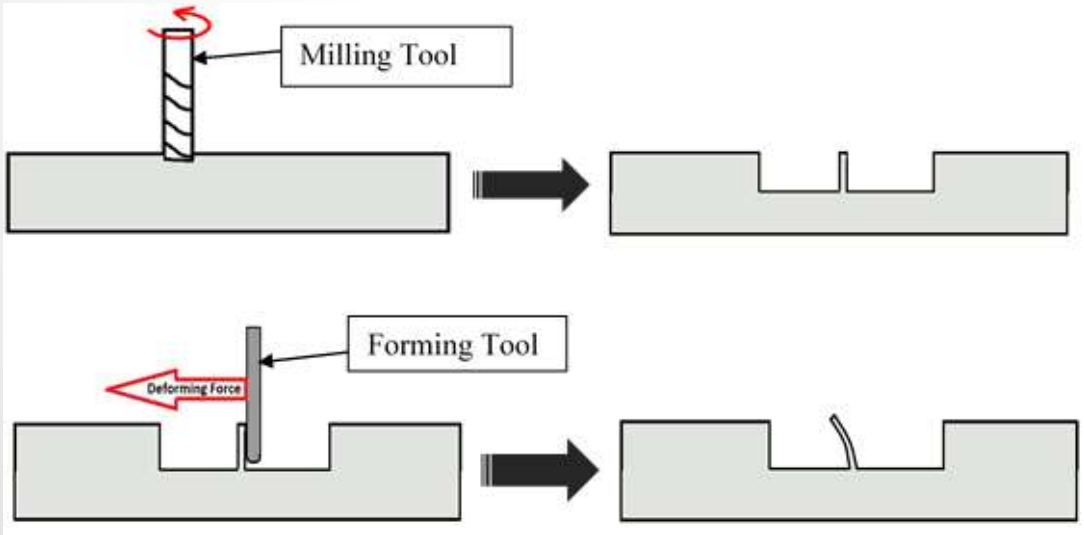
# Deformation Machining



# Deformation Machining

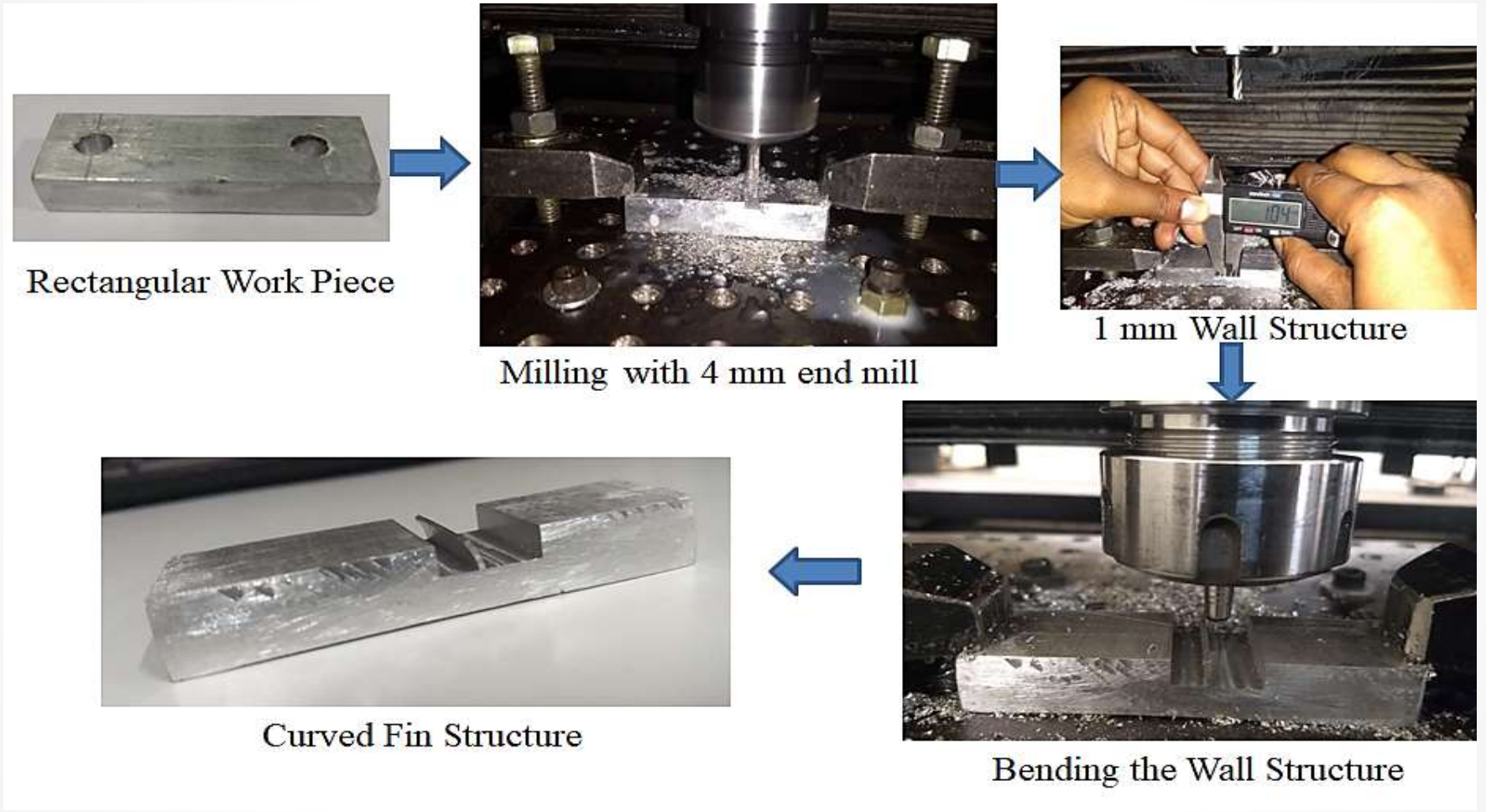



Deformation Machining process in stretching mode



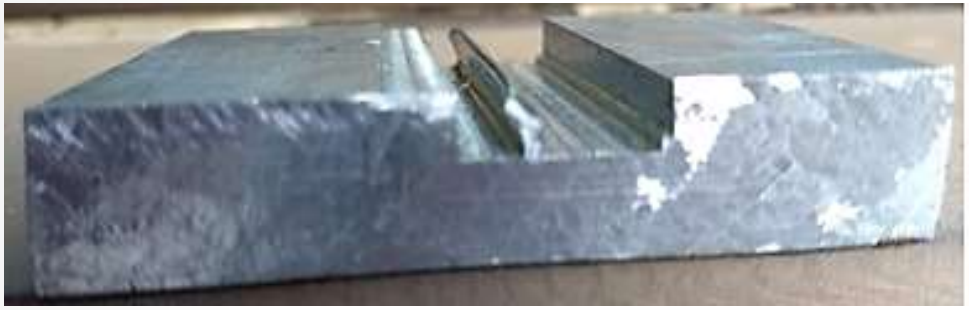

Deformation Machining process in bending mode

# Deformation Machining




Deformation Machining – Process Flow

# Deformation Machining



(a)

(b)

Parts Fabricated using Deformation Machining
(a) Bent Wall (b) Curved Wall

# Deformation Machining


Parts Fabricated using Deformation Machining
@deLOGIC Lab

# Deformation Machining

Advantages:

- Monolithic complex shapes can be produced
- Provides better control over properties of the formed components
- Cost and weight reduction in components when compared to conventionally produced parts
- Controlled thinning in the walls
- Better formability than conventional ISF

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# Thank You