AERODYNAMIC SURFACE DESIGN METHODOLOGY

Transonic CFD Peer Review

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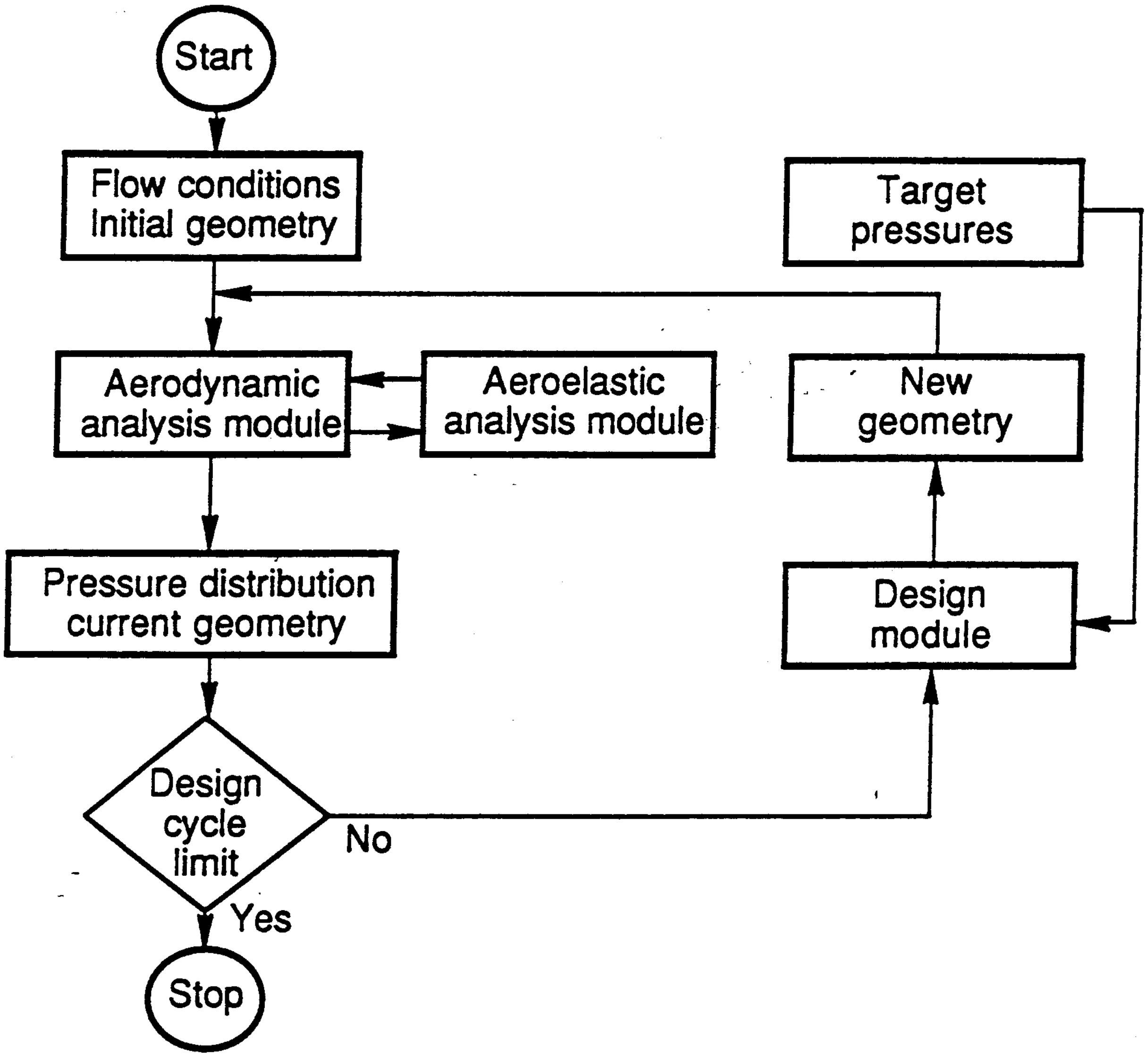
CURRENT TRANSONIC DESIGN METHODS

- Shock-free design
  - Hodograph
  - Fictitious gas

- General transonic design
  - Inverse
  - Direct iterative

DIRECT ITERATIVE SURFACE CURVATURE (DISC) DESIGN METHOD



HYBRID DESIGN ALGORITHM

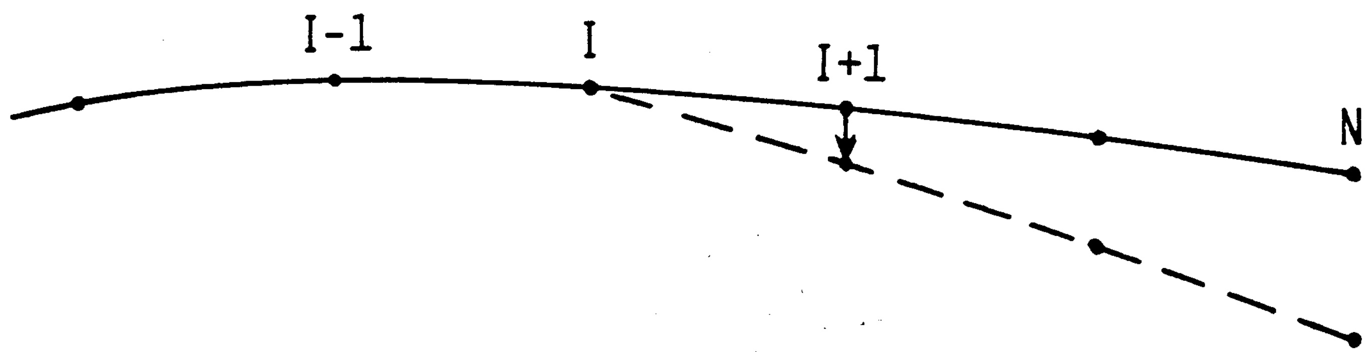
- Subsonic regions

  $$\Delta C = \Delta C_P \; A \left(1 + C^2\right)^B$$

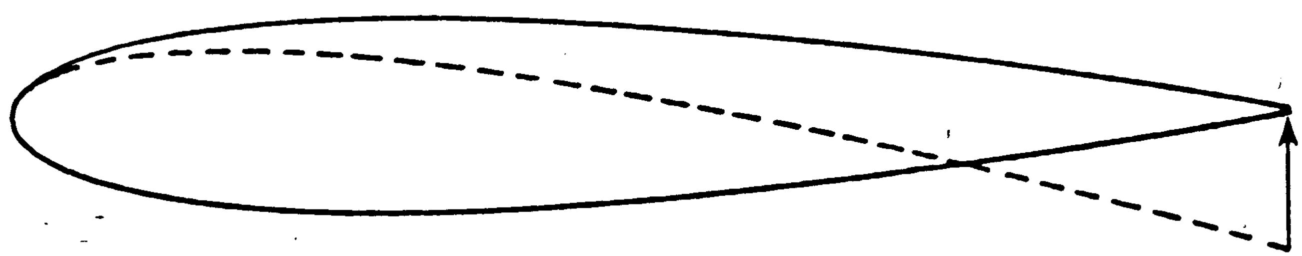
- Supersonic regions (M > 1.15)

  $$\Delta C = \frac{0.05\,A}{\left(1 + (y')^2\right)^{1.5}} \frac{d}{dx} \left(\Delta C_P\right)$$

AIRFOIL GEOMETRY MODIFICATION PROCEDURE



a) CHANGE CURVATURE AT A POINT

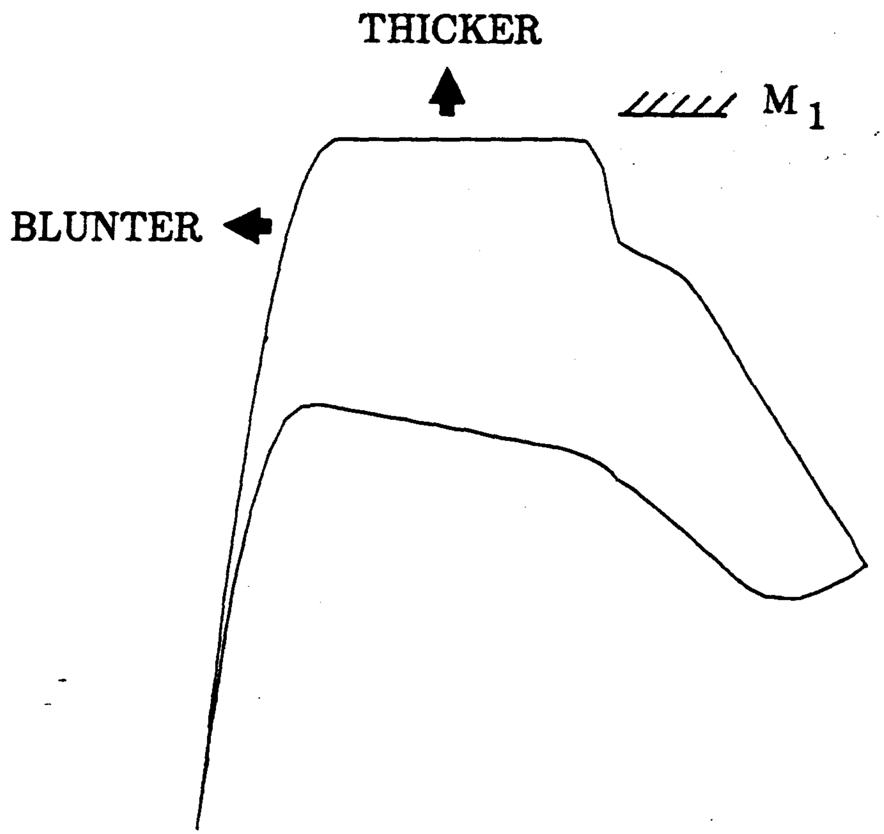


b) ROTATE ABOUT LEADING EDGE

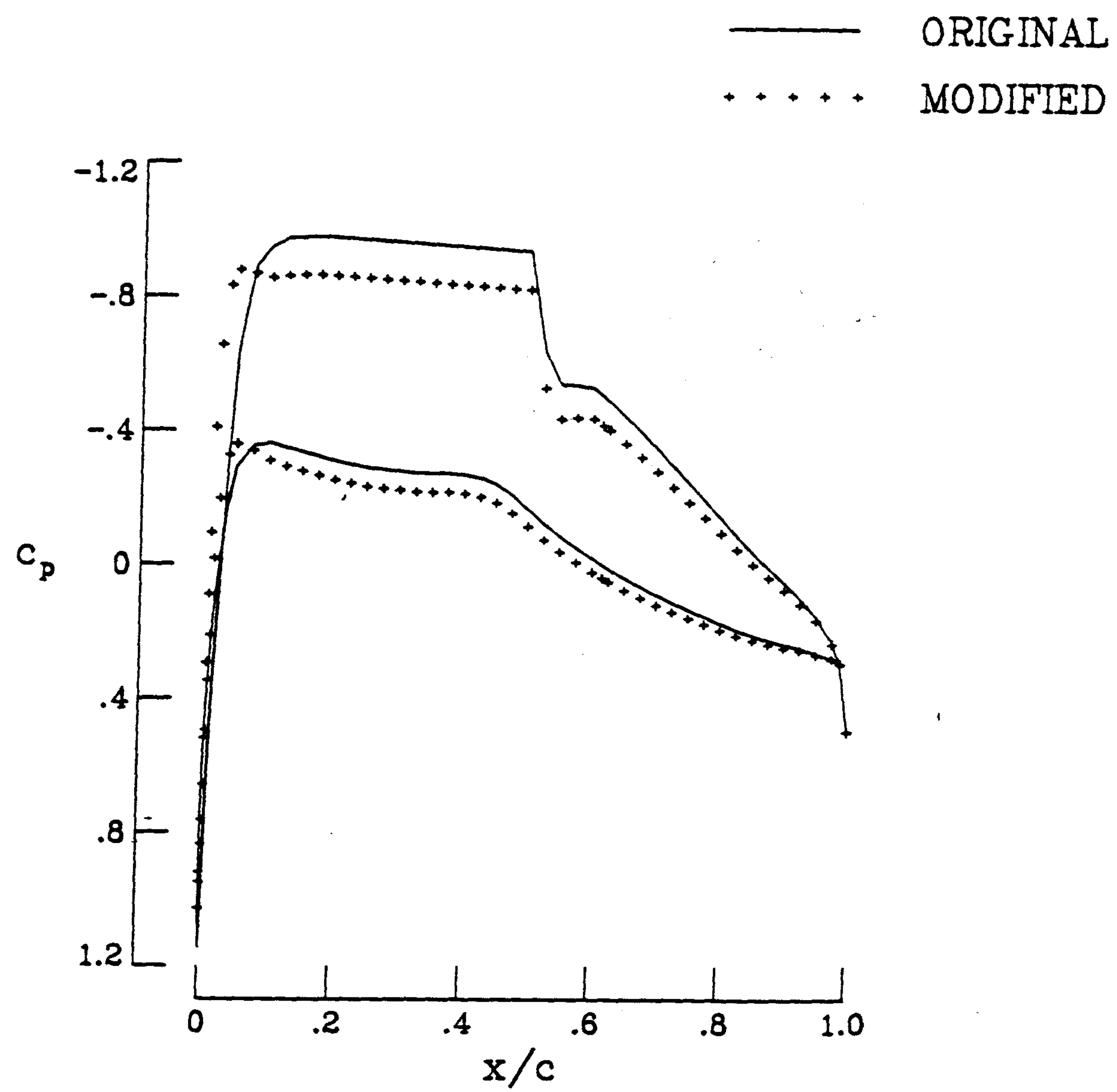
DESIGN CONSTRAINT OPTIONS

- Limit extent of design region
- Constrain surface curvature
- Specify airfoil thickness
- Modify flow characteristics

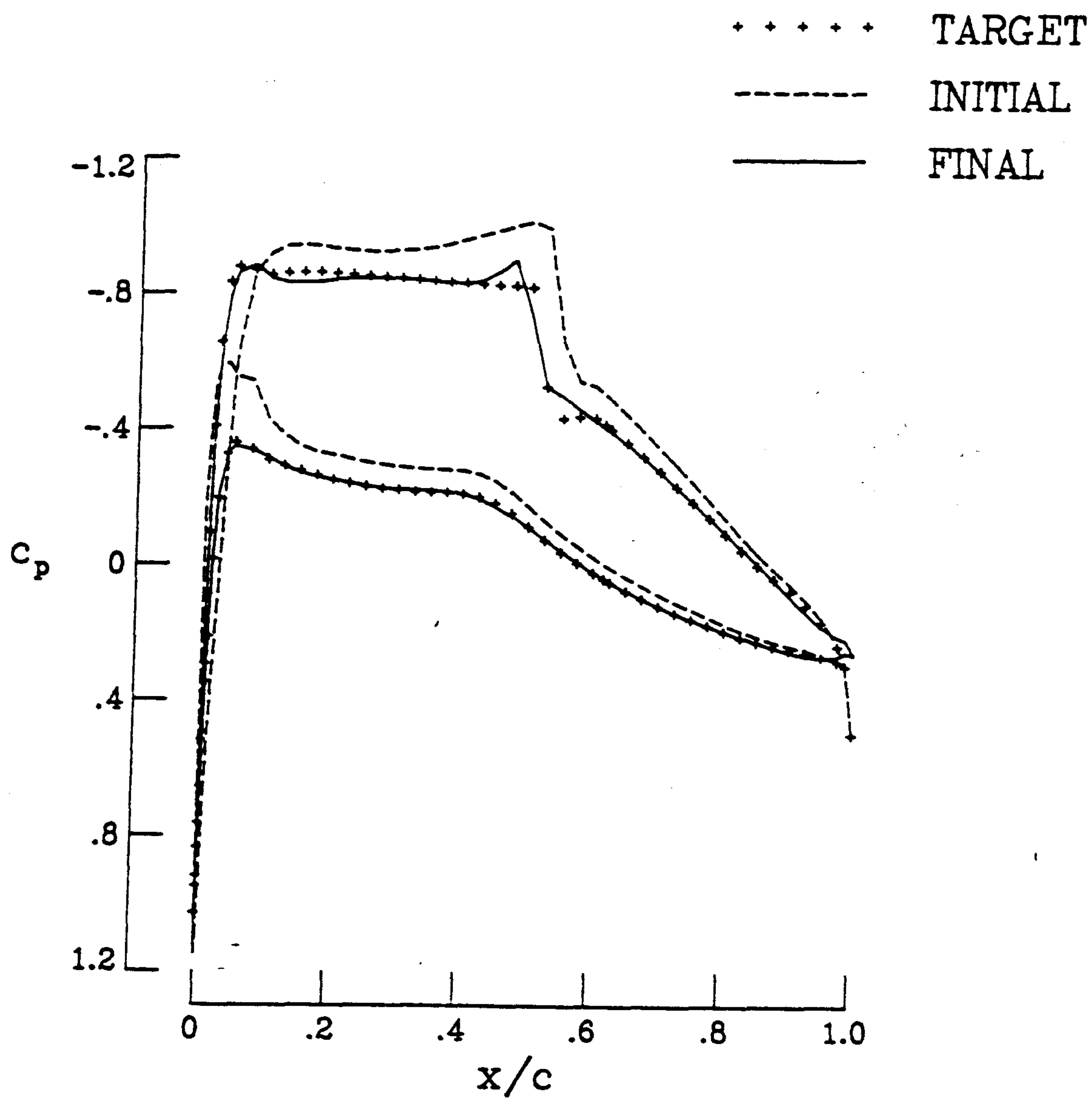
AIRFOIL PRESSURE-GEOMETRY RELATIONSHIPS



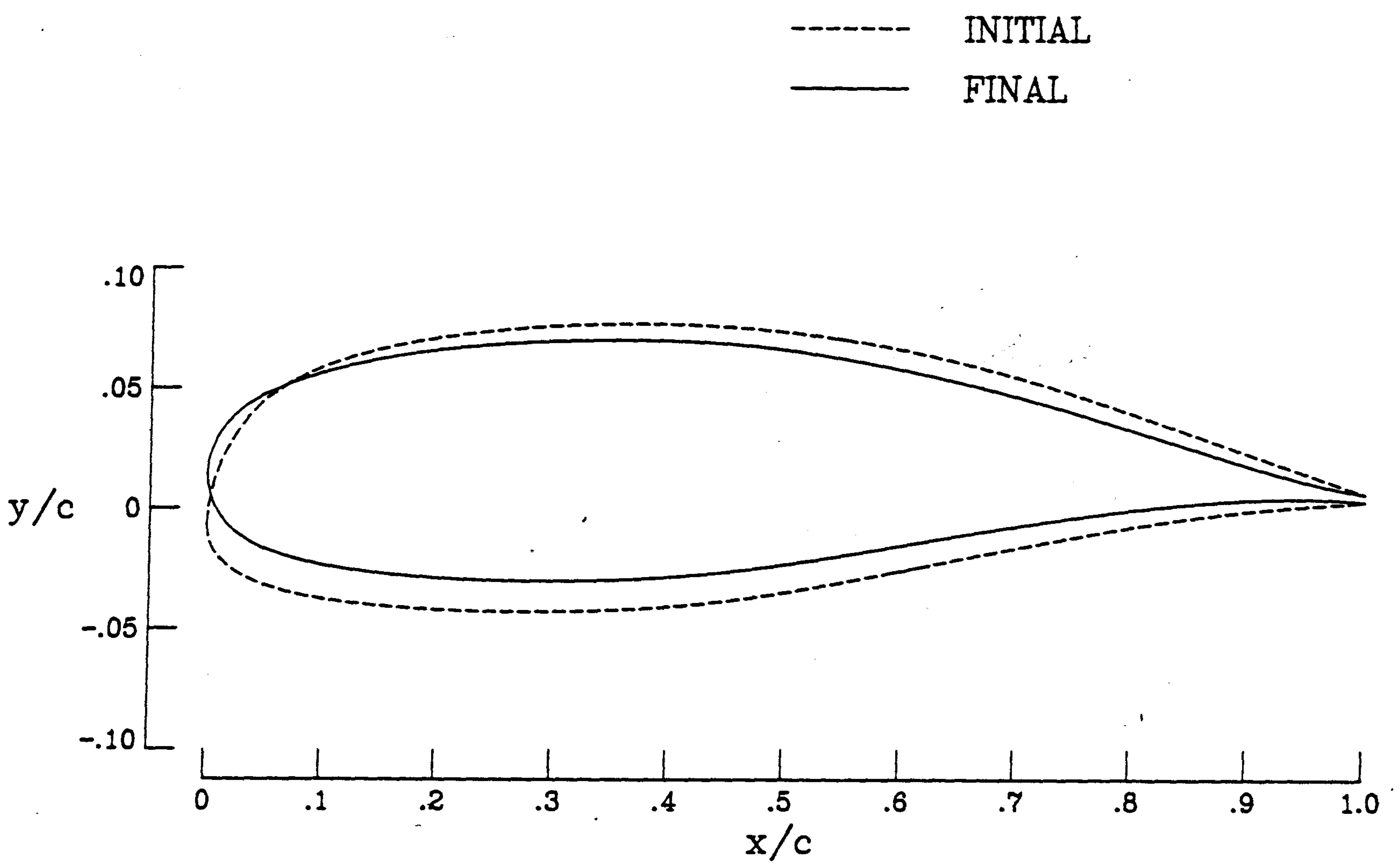
CONSTRAINED DESIGN TARGET PRESSURES



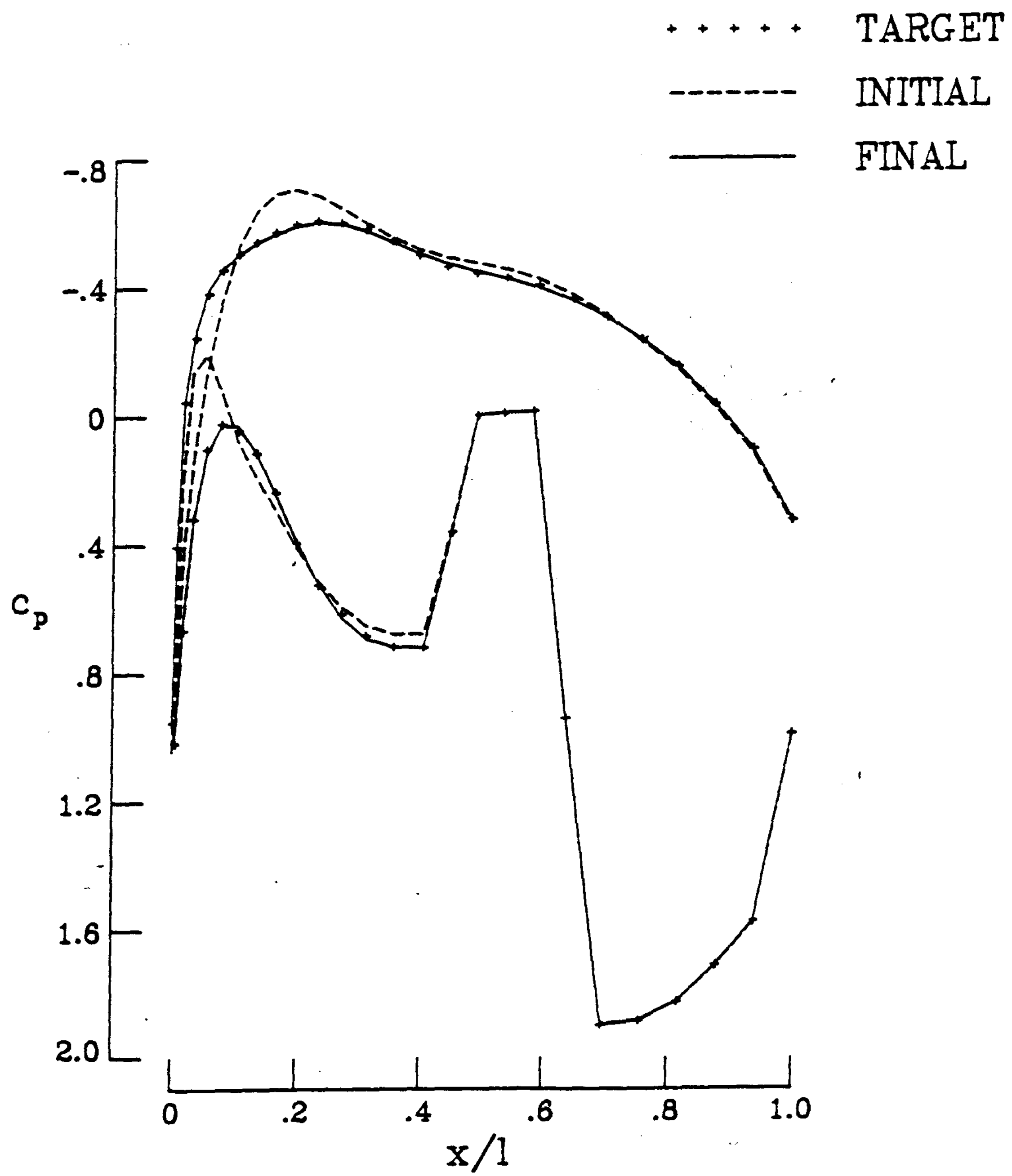
CONSTRAINED DESIGN RESULTS - PRESSURES



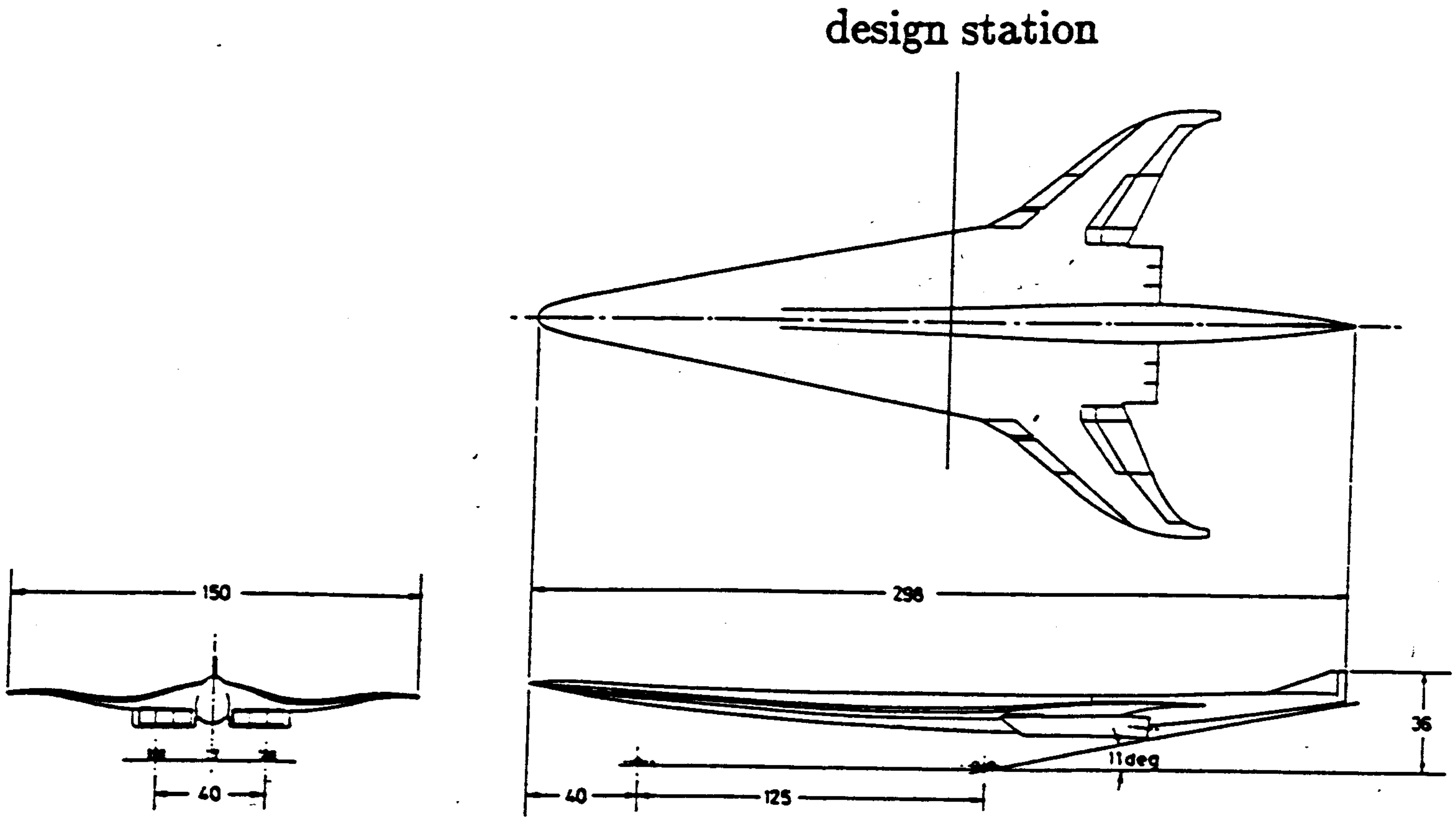
CONSTRAINED DESIGN RESULTS - AIRFOILS



POWERED NACELLE DESIGN RESULTS

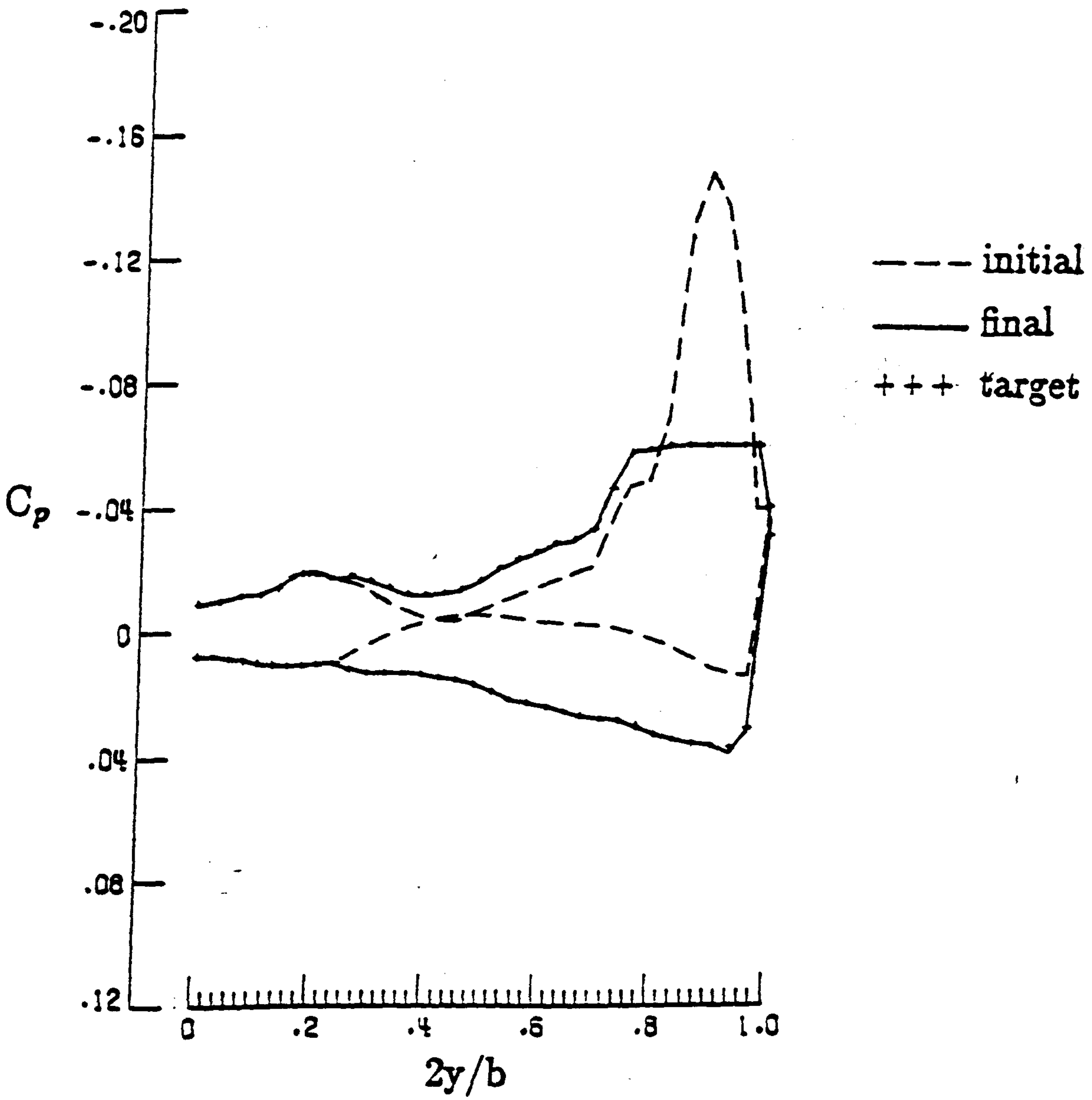


HSCT Geometry



Supersonic Wing Design Results

Mach = 3.0 $\alpha = 1.5$



CONCLUDING REMARKS

- DISC method developed for design to specified pressures
- Design module is easily coupled with analysis codes
- Constrained design capability has been added
- Method has been applied to several aircraft components
- Approach is valid for attached flows, subsonic - supersonic