MACH TUCK CONTROL
(MACH TRIM)

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Net pressure distribution at low Mach number

Net pressure distribution at High Mach number
• At high subsonic speed range, increase in MACH number result in changes in the pressure distribution around the airfoil result in experience a nose down pitching moment known as “MACH TUCK”.

• This may result in flying quality problem such as reversal in stick-force-speed-gradients.

• It is experienced in Boeing 707 aircraft. As the speed increased there is a change in the pressure distribution over a typical airfoil (Mach number increases the center of pressure shift to aft result in airfoil tends to nose down)
• However, in the Boeing 707 there is a offset pitching moment generated by the horizontal tail which actually keeps the nose up as mach number increases.

• However, as the Mach number builds up the aft shift in cp will overcome the offsetting trend of the tail as a result airplane leads to nose down unless it is corrected by pilot or autopilot.

• At the mach number increases, the variation of the elevator control forces with mach number does tends to reverse up to Mach−0.82 as indicated in the above Figure.1 with the mach trim system inoperative.

• Note that the airplane is trimmed at M=0.82. if the pilot want to increase the aircraft speed without changing trim value. He has to push the control column with increasing force.
Figure 1 Variation of Elevator Control force with mach Number without mach Trim

Figure 2 Authority of Mach trim system over stabilizer
• Above $M=0.85$ the required control force become less and less sensitivity to increase the speed (up to mach of 0.87).

• Above $M=0.87$ a pull will be required instead of push for in order to increase the speed.

• To over the above reverse problem in column force a Mach trim system was installed in Boeing 707 aircraft.

• Mach trim system operating the elevator control force with respect to mach number as shown in Figure 2.

• Figure 3 shows the effect of Variation of Elevator Control force with mach Number with mach Trim.
Variation of Elevator Control force with mach Number with mach Trim

$\text{W} = 190,000 \text{ LBS}$

$\bar{X}_{c.a} = .275$

$h = 35,000 \text{ FT}$

$\text{MACH WARNING}$

$\text{BELL RINGS}$

$M_{no}$ $M_{ne}$ $M_0$

$.82$ $.84$ $.86$ $.88$ $.90$ $.92$ $.94$ $M$

$40$ $20$ $0$ $ELEVATOR \ CONTROL \ FORCE \ ~ LBS$

$60$ $PULL$

$40$ $PUSH$
• With modern and airfoils shapes and computation design analysis it is possible to produce airfoils with significantly less “tuck” behavior.

• Now a days most modern jets not uses Mach trim system.
Thank You