

STALL/SPIN/CRASH/BURN

UNDERSTANDING STALLS AND WORKING TO AVOID THEM THROUGH DESIGN AND/OR MODIFICATIONS

**PRESENTED BY: TOM HUNT
NORTHROP GRUMMAN AND
MODELAIR-TECH**



WHAT IS A STALL?

A STALL IS THE PARTIAL OR COMPLETE LOSS OF LIFT ON A FLYING SURFACE (WING, HORIZ/VERT TAIL, CANARD).

WHEN APPLIED TO A WING, A SIGNIFICANT, RAPID, LOSS OF ALTITUDE USUALLY FOLLOWS.

EXCESSIVE ANGLE OF ATTACK INDUCES THE STALL.

A SPIN CAN FOLLOW A STALL (ONE WING STALLS BEFORE THE OTHER)

RAPID CHANGES IN ANGLE OF ATTACK (AOA), EVEN WELL BELOW THE NORMAL STALL ANGLE, CAN CAUSE A STALL (WHIP OR HIGH SPEED STALL).

ONLY REDUCING THE AOA REDUCES THE CHANCE OF A STALL.



WHAT CAN WE DO TO POSTPONE A STALL?

DON'T FLY!

TAKE OFF AT MACH 1, FLY AT MACH 1, LAND AT MACH 1!!!

BALANCE THE MODEL IN RACING POSITION (VERY FAR FWD C.G.)

MAKE OUR WINGS SMARTER!

- (1) BUILD OR INDUCE TWIST INTO THE WING OR....**
- (2) ADD L.E. DROOP OR....**
- (3) INCREASE THE AIRFOIL PERCENT THICKNESS
OUT TO THE TIP OR....**
- (4) SHARPEN THE INBD LE OR....**
- (5) DON'T EXTEND THE AILERONS ALL THE WAY
TO THE TIP OR...**
- (6) ADD END PLATES TO THE WING TIPS.**

ABOVE ALL..... BUILD STRAIGHT AND TRUE WINGS!



MECHANISM OF A STALL

THE SHAPE OF THE WING (BOTH PLANFORM AND CROSS SECTION) INFLUENCES WHERE AND WHEN A WING WILL STALL.

GENERALLY, STRAIGHT OR AFT SWEPT WINGS WILL STALL AT THE TIP FIRST, THEN FLOW SEPARATION MOVES INWARD TOWARDS THE ROOT.

ON ANY STRAIGHT OR AFT SWEPT WING, THE EFFECTIVE AOA INCREASES FROM INBD TO OUTBD.

AIRFLOW OVER THE WING SEPARATES (LEAVES THE SURFACE) CAUSING A LOSS OF LIFT.

SEPARATION OF THE FLOW OCCURS AT THE WING T.E. FIRST AND WORKS FORWARD. THIS IS WHY AILERONS BECOME INEFFECTIVE EARLY IN THE STALL PROCESS. (SORT OF A WARNING!!)

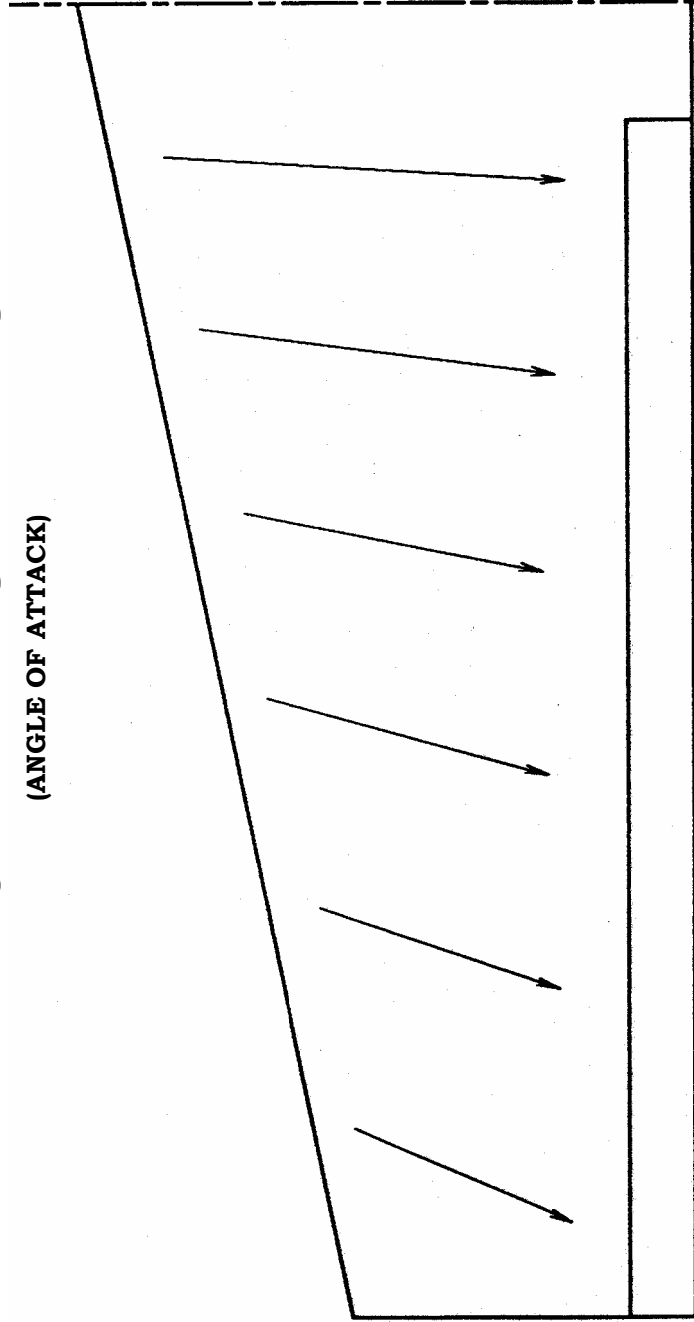
THE LONGER WE KEEP THIS AIRFLOW ATTACHED, THE HIGHER AOA THAT CAN BE OBTAINED, AND THE SLOWER THE MODEL CAN BE SAFELY FLOWN.



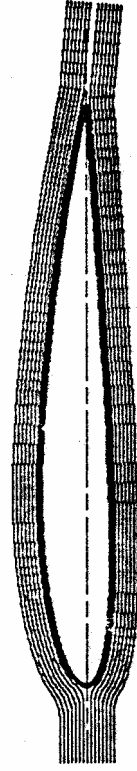
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WING AT LOW AOA

(ANGLE OF ATTACK)



AIRFLOW TRAVELS SLIGHTLY OUTBD OVER A WING IN FLIGHT
RELATIVE AOA THE WING "SEES" ALSO INCREASES MOVING
OUTBD



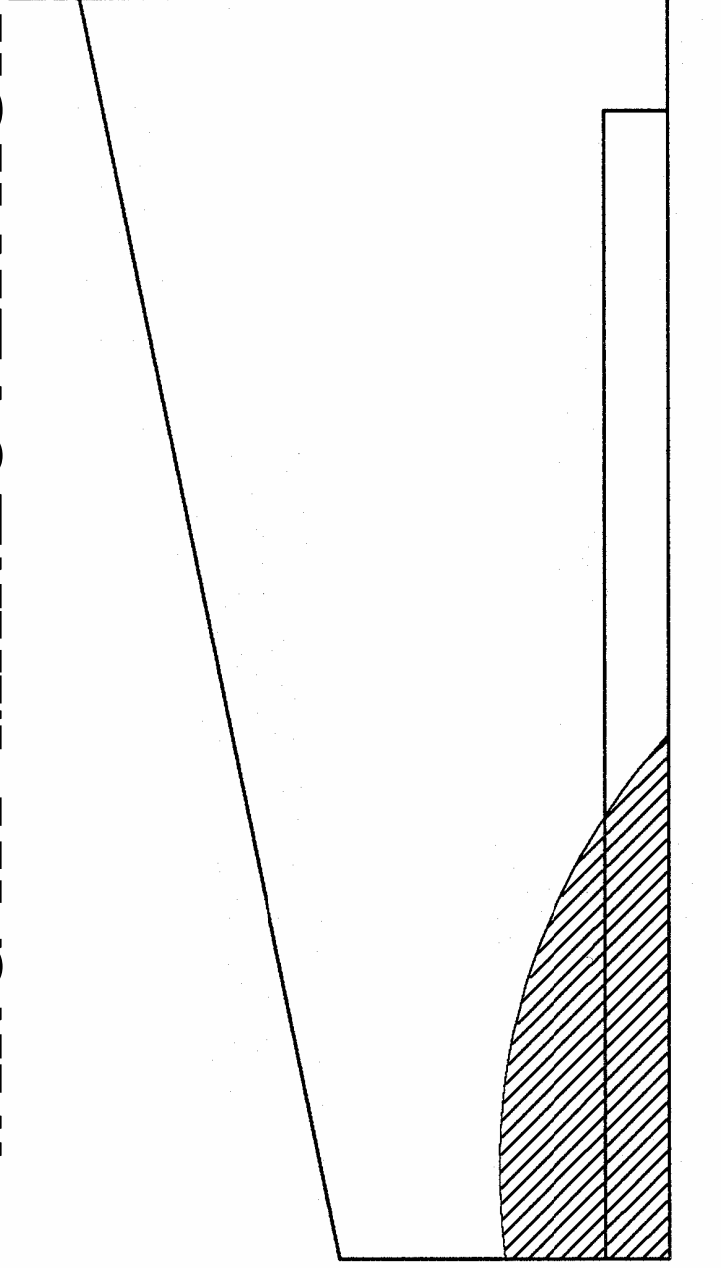
AOA INBD

AOA OUTBD

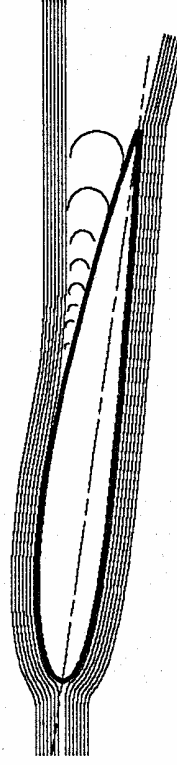
NATURAL LAMINAR FLOW



WING AT MANEUVER AOA



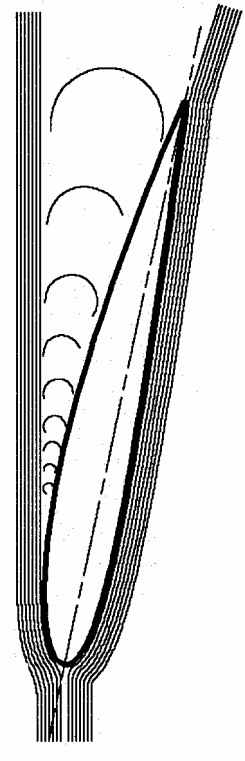
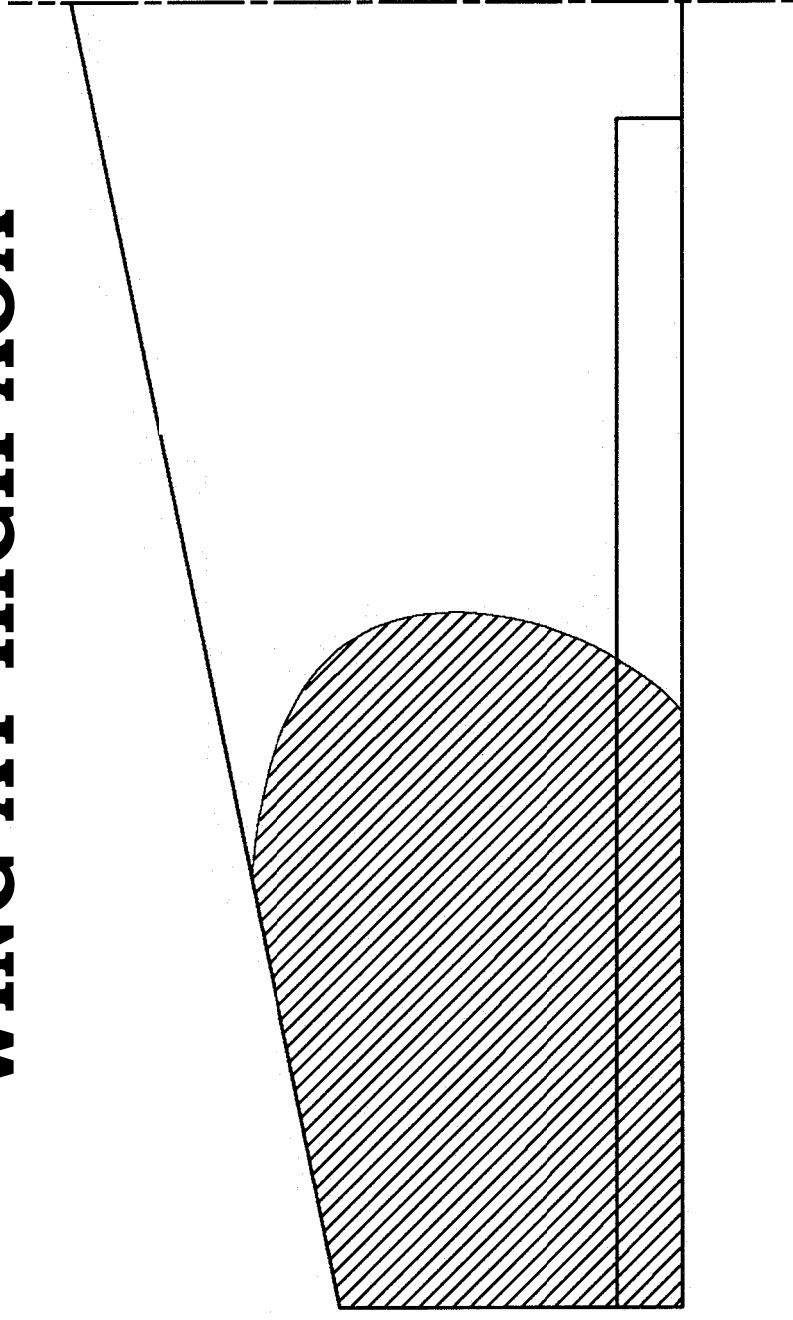
AREA OF EARLY FLOW SEPARATION



THE BEGINNING OF FLOW SEPARATION



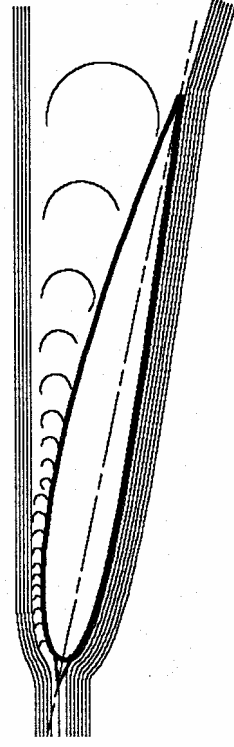
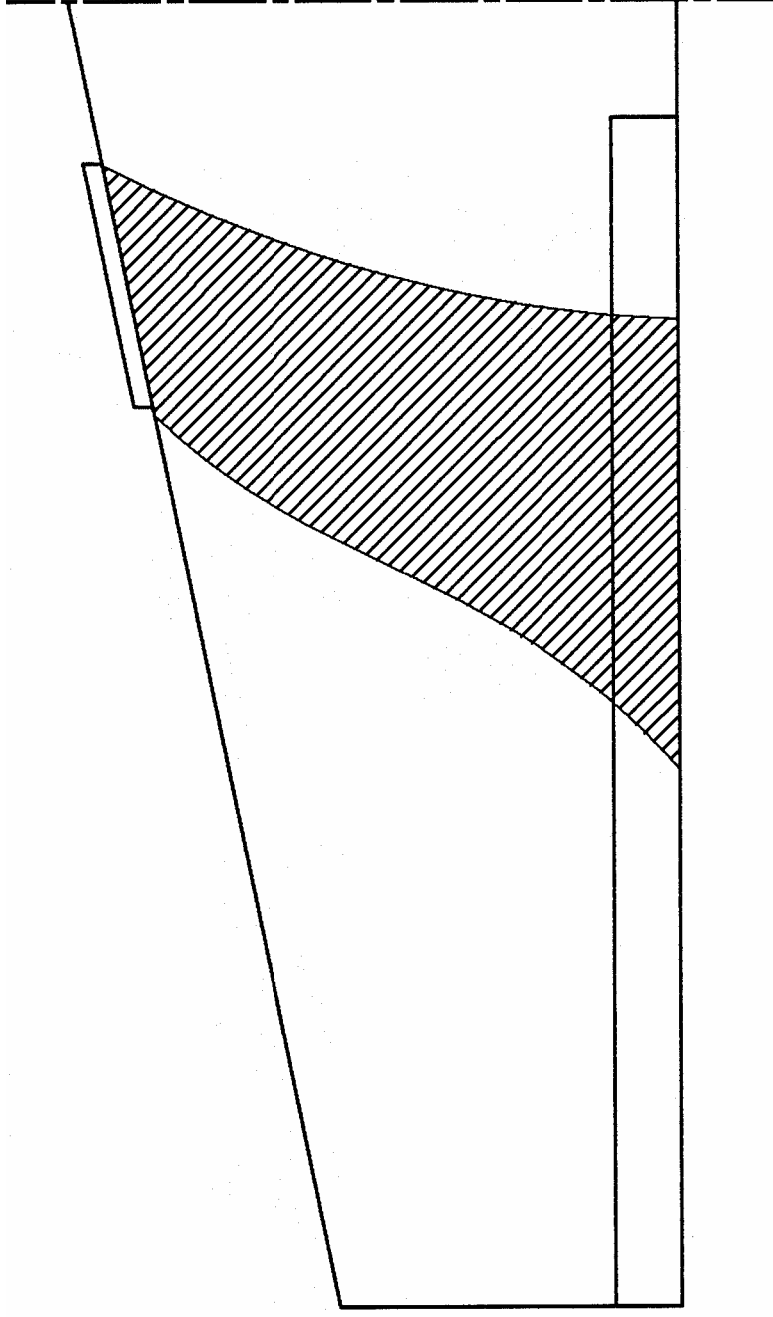
STALL/SPIN/CRASH/BURN WING AT HIGH AOA



OUTBD SECTION FULLY SEPARATED



EFFECT OF STALL STRIP NEAR STALL

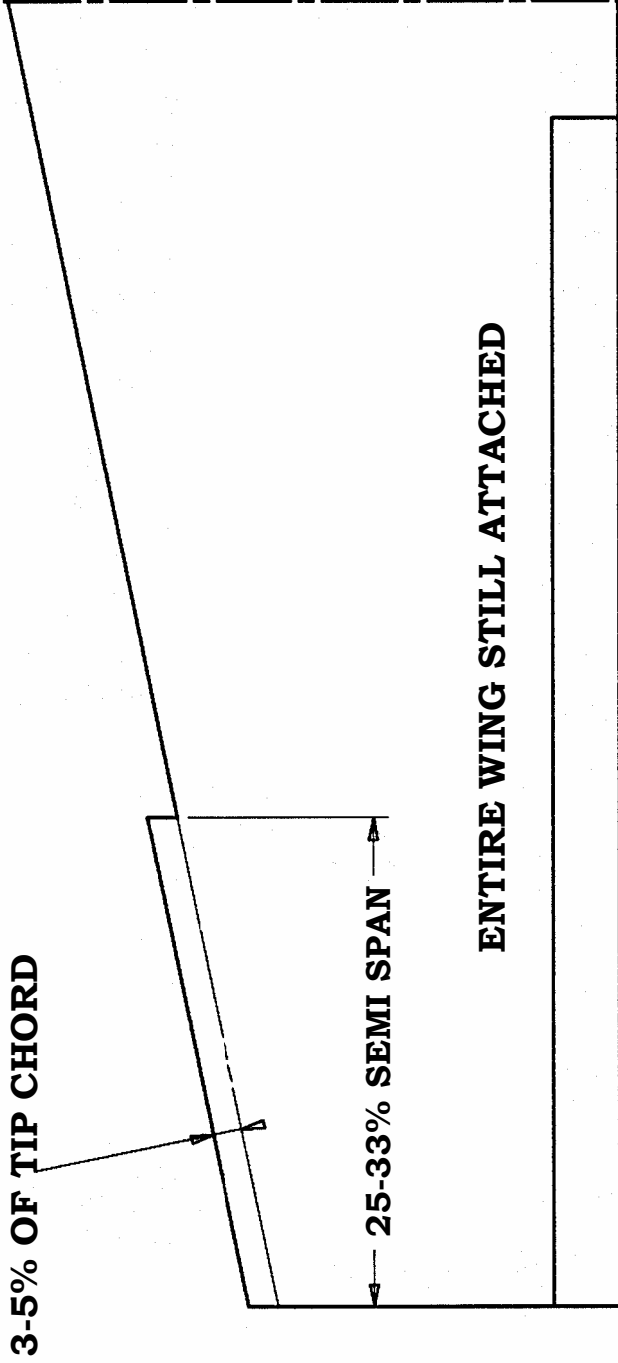


SHARP LE CAUSES EARLY STALL
OF INBD SECTION BEHIND STRIP

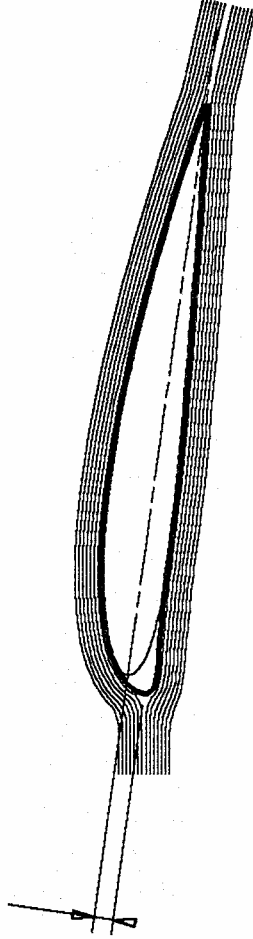


WING AT MANEUVER AOA

EFFECT OF LEADING EDGE DROOP(EXTENSION)



DROP LE HIGHLIGHT 5% OF TIP CHORD



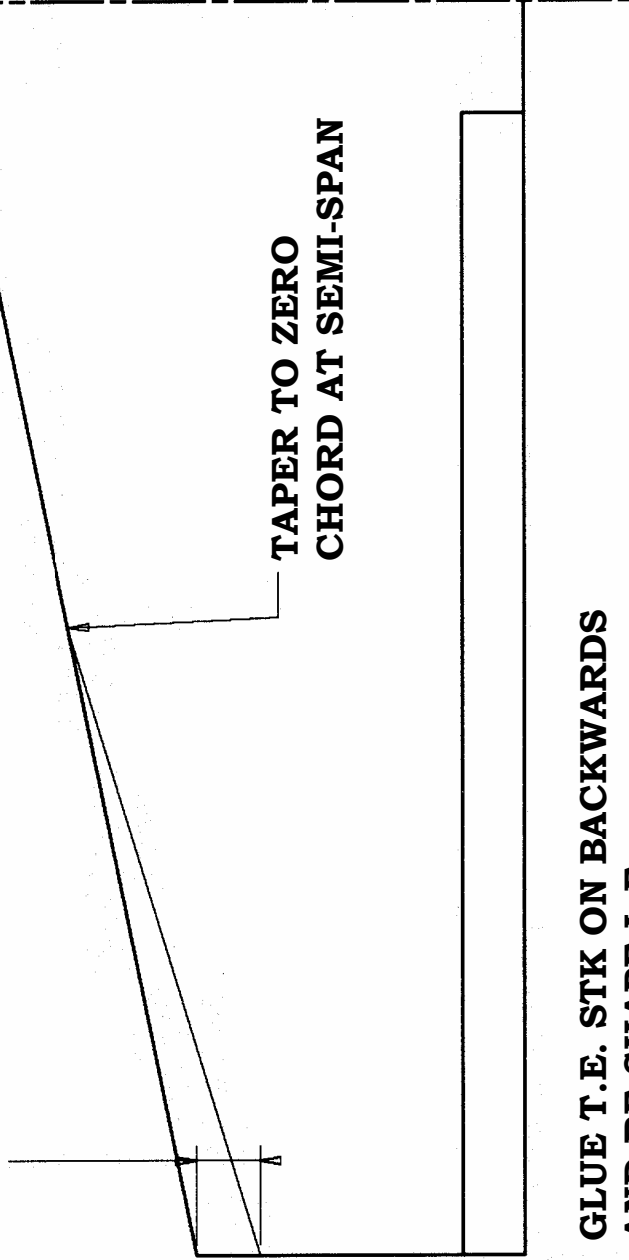
LEADING EDGE DROOP HELPS UPPER SURFACE REMAIN ATTACHED NEAR STALL



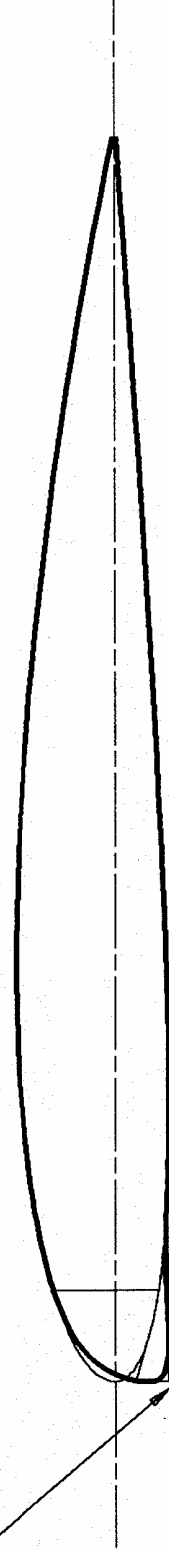
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ADDING DROOP WITH EXTENSION

1-2" T.E. STK

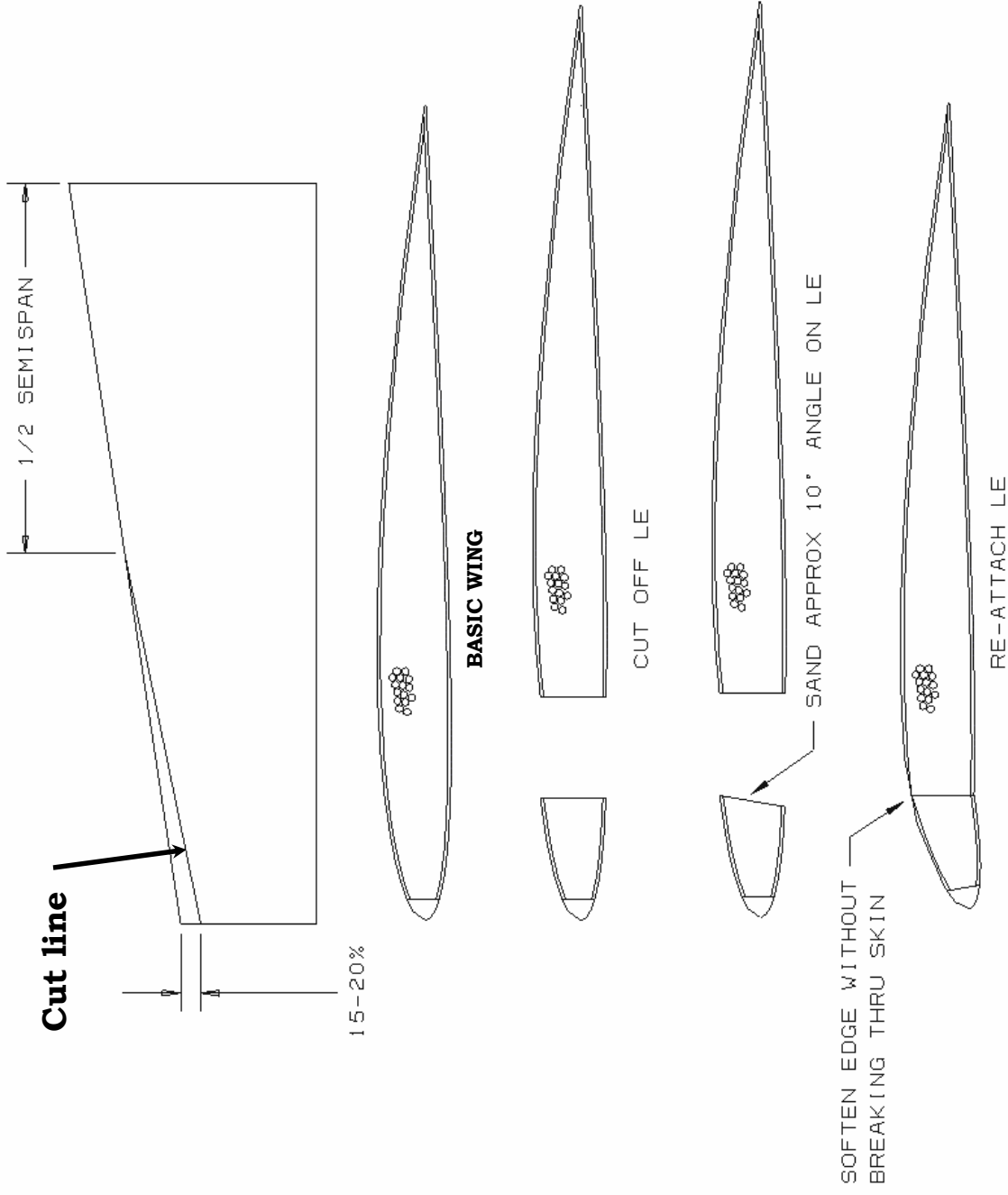


GLUE T.E. STK ON BACKWARDS
AND RE-SHAPE L.E.



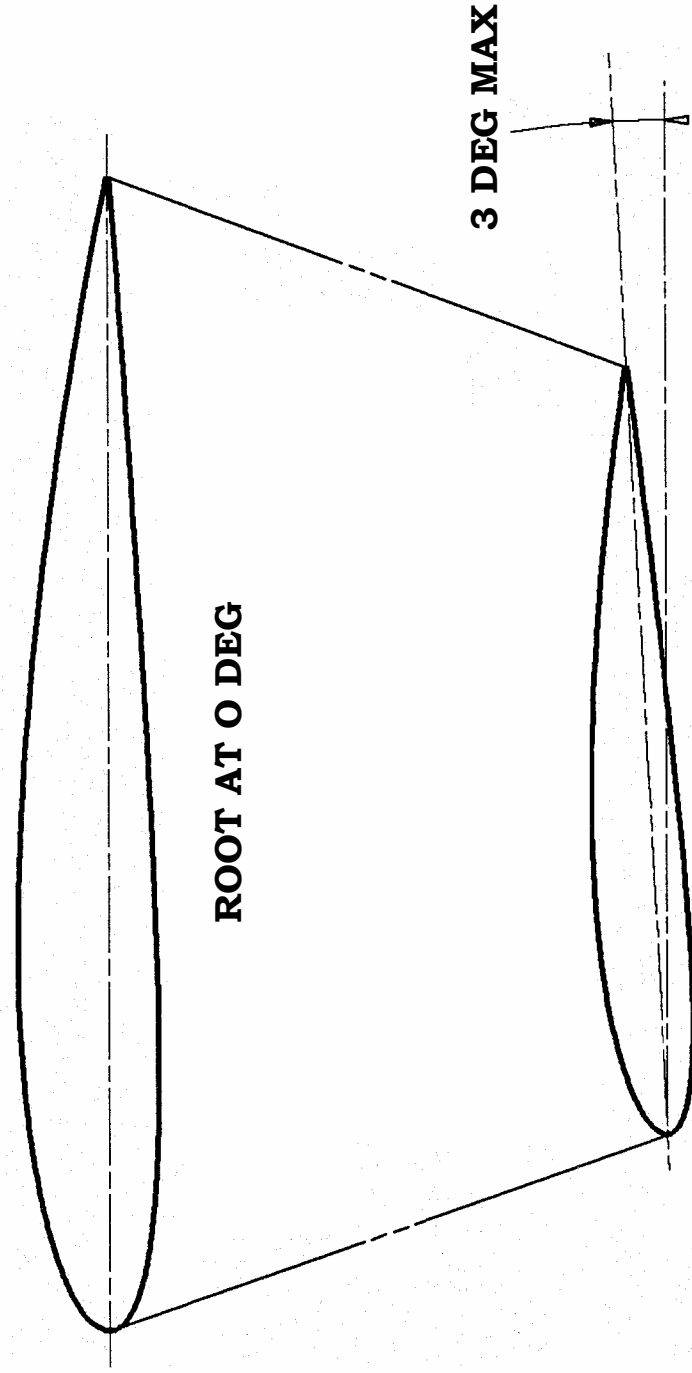
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ADDING LE DROOP TO A FOAM CORE WING



STALL/SPIN/CRASH/BURN

DESIGN TWIST INTO THE WING

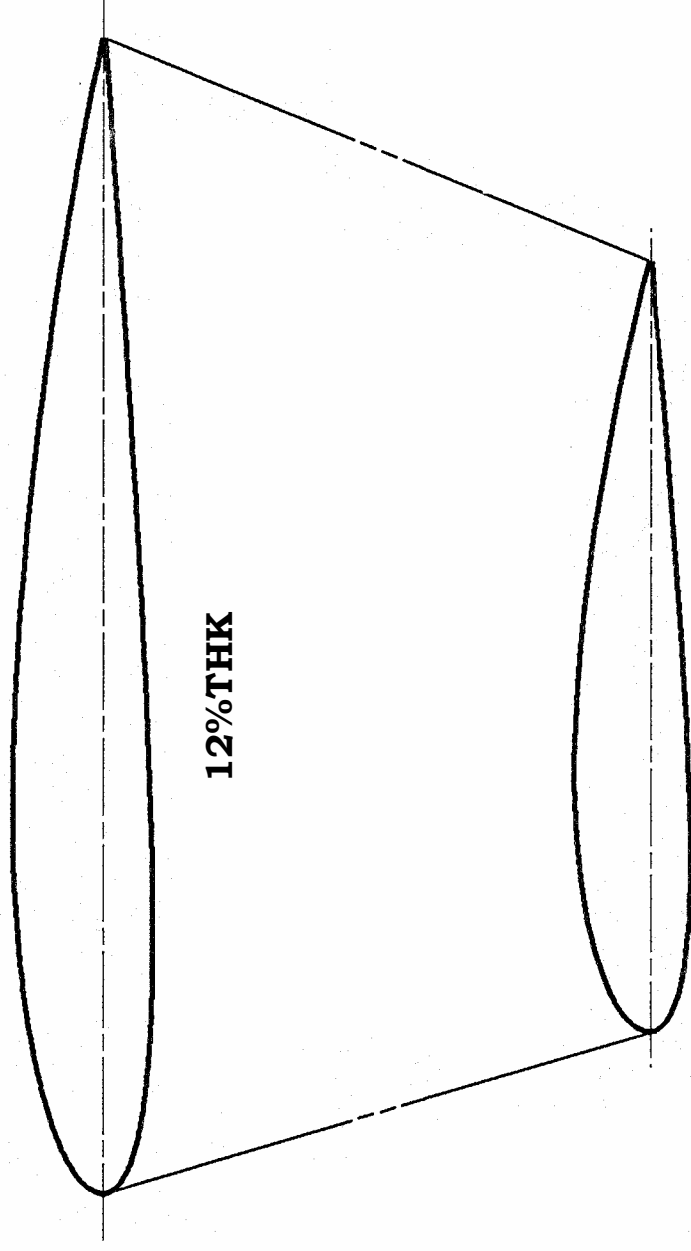


TIP AT 3 DEG OF WASHOUT



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INCREASE AIRFOIL PERCENTAGE AT TIP

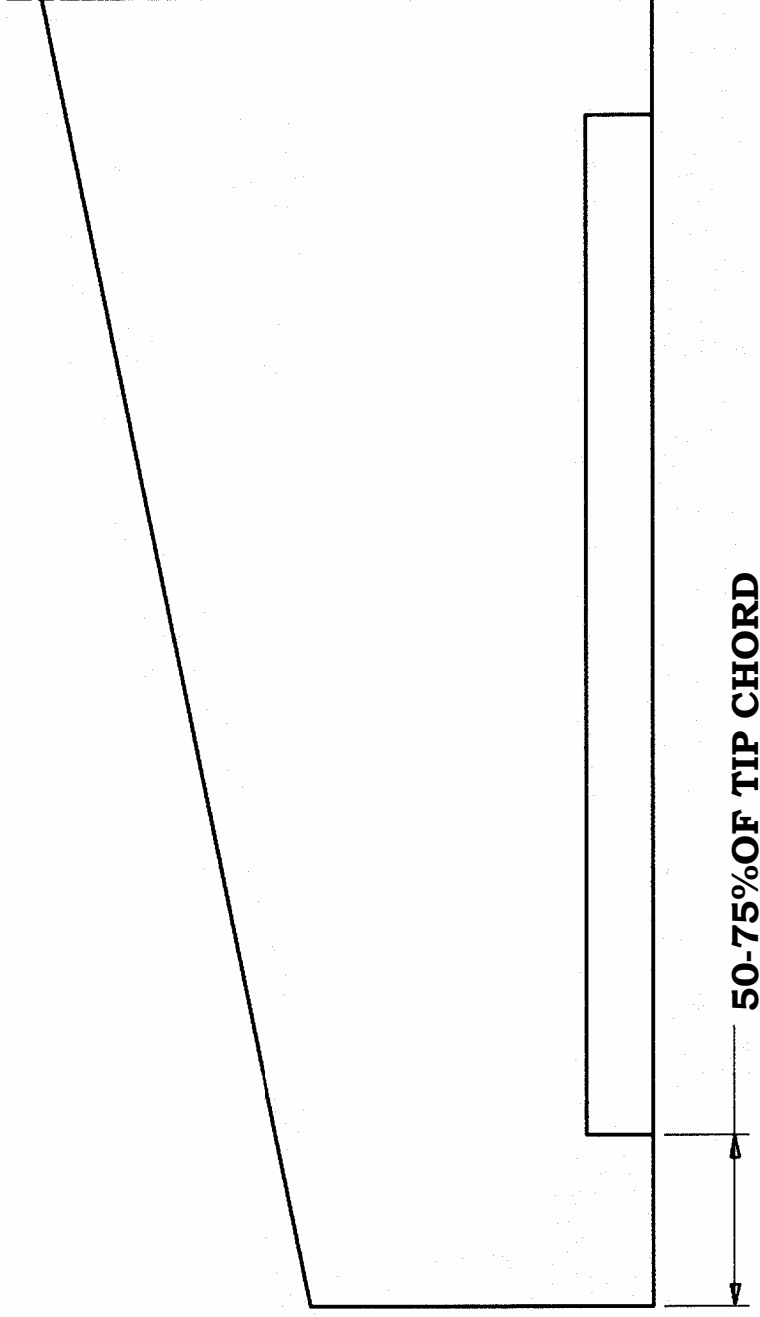


**GOOD FOR R/E MODELS, BUT MIGHT MAKE AILERON EQUIPPED MODELS
A BIT SLUGGISH, OR PRONE TO ADVERSE YAW.**



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STOP AILERON SHORT OF THE TIP

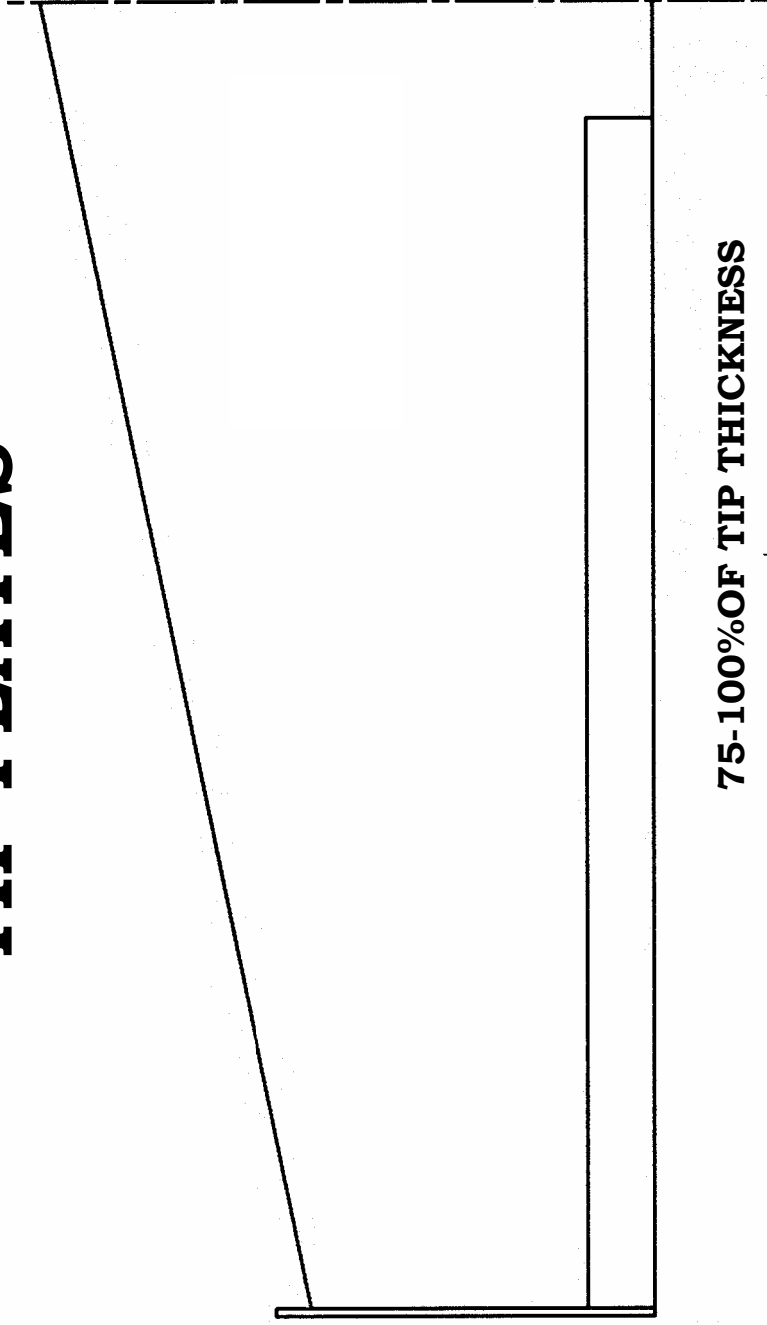


THE DOWN AILERON, WHILE MANEUVERING AT SLOW SPEEDS, CAN CAUSE A PRE-MATURE STALL OF THAT TIP.

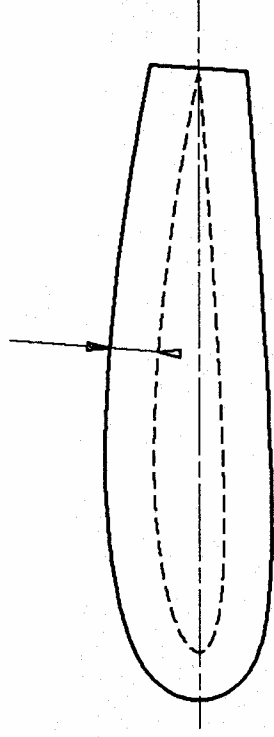


STALL/SPIN/CRASH/BURN

TIP PLATES



75-100% OF TIP THICKNESS



TIP PLATES MAKE THE WING "THINK" IT'S LONGER IN SPAN

