

BETZ Optimum Prop Logic, Goldstein, Theodorsen Genius 3D Math, BGT!!!

GRASP THIS EASY CORE UNDERSTANDING of PROPS!

#1. EVERYONE KNOWS PROP TIPS ARE RIDICULOUSLY FAST!

Dynamic Pressure is a V^2 Phenomena, So Prop Tip Loading is Ridiculously² High!

That Creates Ridiculously² High Tip Drag, and Huge Torque Load on the Engine!

But FAR WORSE, Tip Lift or Thrust Must Fall To ZERO, into a TIP VORTEX!!!
Thus BIG COST AND LOSS, WITH -- THRUST LOSS, ZERO Right at the TIP!

✓
WOW!

SO What Does The 3D BGT Genius Math Do???

→ #1. It Just Tapers The Blade Tip, finally to ZERO BLADE CHORD
and Creates Optimum Half Teardrop Radial Blade Loading – a BGT Prop!!!

GENIUS!
EASY!

LOOK
GET IT!

DO!

Simply LOOK AT THE BOOK COVER, The PICTURES!
SEE The Half Teardrop Radial Loading, The Families of Tapered Blade Shapes!
Defined vs. Advance Ratio, The Actual Angle Of Advance Of The Prop Tip!
(See Inside Front Cover for a Picture Definition of that!)

#2. Newton Teaches us Thrust in Pounds = $M \cdot \Delta V$, $T\# = \dot{M} \Delta V$, SIMPLE
(pros learn Mass M is weight divided by the acceleration of Gravity, wildly called
slugs and \dot{M} is Flow rate in slugs per second. (Novices, See the Concept is EASY!)

#3. We Learn that Propellers like High Pitch, or High Advance Ratio, because that
correlates with FAST, Big Mass FLOW RATES, small ΔV speedups which takes
less energy cost, thus better efficiency. Novices: See Low Advance, p.48 II Terrible!!

LOOK
GET IT!

That is the SIMPLE CORE OF GENIUS OPTIMUM PROP DESIGN!!! Grasp the
Simple Horse Sense of that and you've Grasped The Simple Core Of Optimum Prop
Design Logic, Betz, Prandtl's sidekick, 1919 + Genius Goldstein, Theodorsen Math!

This is a Proper, Most Simple First Page Explanation of CORE Propeller Theory!

Now we'll Teach More than that in starting, but, That's The SIMPLE CORE!

INSIGHT: A Broad Tip can dig a big heavy Seaplane out onto the Step well, but costs big tip loss \$\$\$ for the hours
of Flight! A perfectly designed BGT Reno Formula 1 race prop immediately proved that it took off better than the
old broad tip standard, and increased it's race speed, then consistently beat all the other similar Cassett type racers.
All these Formula 1 props are right at their .9 Mach limit, unless helped by often warmer race day temperature!

It took 25 years to create a Single Page This COMPREHENSIVE, This SIMPLE, GET IT, GENIUS Insight!

GET IT
RIGHT ON
THE COVER!
A RARE GIFT!
RARE GENIUS INSIGHT
EASY ENOUGH
TO GRASP!

2015, A Little Insight On The Author, and Where We're Going!

When you write a Book, you're teaching the Subject, not about yourself! I've had a life most could only dream about, have a lot I can "Give Back" as time allows. This Prop Explanation can be valuable, never understood! The Good News is that you actually can be a Young 88! I got there Aug. 16, 2015. I've always been physically active, full mentally active, in good shape, diving into things, like props that needed to be nailed! Always an Airplane Kid, I got very good at it, was a quite knowledgeable airplane designer, won the National Senior Age model Championships twice in 1946 and 48 at the Nationals, 1947 was a laughable fiasco, luck in opposition!

Going through about 300 props, I actually had found these perfect shaped props by 1948, way north of 100 trophies etc. I still have the props, so no bunk, I have them, and won! I waited for a Half Century for someone else to adequately explain props technically, at the professional level, BUT UNDERSTANDABLE, AS LOGIC. I finally had to do all this with my pal, Dr. Andy Bauer, to add his Doctoral Insight and Check, great!!!

Young, I kept right on going, got a Great engineering education at Ohio State, a 5 year, 3 quarter system Bachelor and Masters program, 3 x 5, was 15 sets of subjects, not the usual 2 x 4 = 8. I think much more broadly across History, Economics, Psychology, even more, and by 88 that can teach a lot! It's really frustrating, politicians, Power Seekers, not learners, never understand that it was Science that created the productive middle class jobs, employed everyone, the \$17 Trillion economy that made the US Economy, Made it all work, that full stupid we gave it all away, still don't understand we gave away the leading edge too, because it's the manufactures that hire the engineers that create and take over, DUMB AS A STUMP, and "Zero Ability to Learn", the troops and the pols blind to easy economic insight! Jobs the core, you just don't give them away.

I've had more fun and satisfaction than anyone, set the leading edge 17 times across multiple fields, financially independent, 3 1/2 Billion passengers have SAFELY Flown My Boeing Jet Hydraulically Powered Flight Controls, All the early Astronauts, because I *Created* the Company that Designed and Manufactured the very dangerous Hypergolic Fuel, Oxidizer, and 5000 psi Pressurization Gas Valves, for the Maneuvering Rockets on the Mercury Gemini and Apollo. 107 of my products were central to those birds in the Milestones of Flight Gallery, The Central Hall of the Smithsonian National Air and Space Museum, Nuclear plant Seismic Isolation, teaching the Nuclear Sub Navy why their Prop Shaft Seals Leaked 47 GPM, wild, how to easily fix it all, with Insightful Design! No, I'm not one of those pompous guys who thinks he's smarter than everyone!!! Actually understanding, being deeply careful, being a guy people can like is the real key, everyone helping creates success!

✓
D.O.
THE CORE KEY HERE IS GRASPING THAT OVERALL PROPULSIVE EFFICIENCY IS TERRIBLE, except on the Slick BEST PLANES THAT CAN GO 200 MPH+, the RV's and UP! Catch on Right NOW, Gus Raspet taught us in the 50's that the nice Bellanca Cruisair, glided Great, but Under Power, at 58% Propulsive Efficiency, that took the reciprocal, 178 % MORE POWER to do the same speed!!!! TERRIBLE, DISASTEROUS, and THE PROS NEVER WOKE UP, CAUGHT ON -- That That is The Most Important Factual Insight in Aerodynamics – and the Pros Never Caught On – Never Did Anything!!! Never WOKE UP!!! Gus needed to give us more of his data and numbers, for everyone to understand better, not just single point insight, but that's ours to nail! Look at p. 109 and 113II RIGHT NOW AND START TO CATCH ON TO THE FIRST REAL FACTS AND TRUTH!!! I wanted to do more for this year, but a family health problem stopped me! I'll do more as I can get more facts for us all, some real insight on present planes, nailing facts!

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Understand a key core that we didn't fully understand until the Book was finished and Published. In hindsight Theodore Theodoreson, NACA's WW II Math Genius, assumed a particular solution for Heavy Loading, that assumed and covered essentially an old inefficient plane with too much Pitch, and loss, throwing extra air! But with essentially Perfect, Heavily Loaded 3 D Math, he got essentially exact Solutions, could teach us truly how everything worked in 3D. The Great Planes can simply fly with less Pitch, less Loss. We Have a way to teach you truly correctly, BIG Radial Losses Feeding Huge Tip Loss, The Real Truth Everyone Has Missed for Decades, because no one had used 3D Math, as BGT do, pages of 3D Partial Differential Equations, Genius Work!!! Mother Nature, Orderly and Logical, we can teach the SIMPLE INSIGHT and teach you correctly!!!

Dense Summary Notes on Propeller Logic.
Reference the Book, The Logic of Flight, The Thinking Man's Way to Fly*
Propellers, The First and Final Explanation

Eleven Basic Insights that allow us to Understand the Secret Logic of Propellers!!!

(ΔV Delta V)

NEWTON
ROTATING WING
AIRSCREW
BETZ
G-T MATH
B-G-T
Low Rn Drag
Design Calcs
Gearing
Slowdown
Off Spec.
Insights

- 1. Propellers Pull in and Throw Back Air to Make Thrust**, a Reaction Force, Newton's 3d Law Throwing Air to make Lift, or Thrust is what creates Induced Loss, minimize it, low ΔV . $T\# = \dot{M}\Delta V$ A big \dot{M} , big Diameter, or just Fast, allows a small ΔV , for any required Thrust. Fast is better, a *twice smaller* $\Delta V/2V$, axial efficiency loss, a smaller $\Delta V/2$, divided by a big V . 3D LOSS, a bigger %: Axial teaches the tricky logic, Rotational, bigger inboard, Radial feeding tip vortices. Props are seen as kind of a Rotating Wing, but nobody ever tells you the next step!!!
- 2. High vector Tip Speeds**, Much Higher Tip Dynamic Pressure, $q: V^2$, greatly overloads tips. Props work Inside Out, Very Wrong vs. wing Logic, Max Drag and Thrust at Tip, where Thrust must fall to Zero! Props beg for the good Horse Sense to highly taper Tips, counteract, pull back excess tip loading, reduce loss. **** Tapered Tips** prevents making excess tip induced loss, excess drag at max lever arm, less RPM, thus HP, loss of T#. Wide Tips Lose 4 Ways, Beg for Intelligent Correction with Tapered Tips!
- 3. Props must be Understood as Airscrews**, not just producing Thrust, but need to screw home efficiently. Only High Pitch, High P/D, High Advance per Revolution, can be most efficient.
• High Pitch Simply, the Shortest Spiral Path to the destination, least Profile Drag Energy Loss.
• High Pitch, Faster, big \dot{M} , lower $\Delta V/2V$, lower Axial and total 3D induced Loss also.
It is the Perfect Screw Insight and Math that Validates, proves Steep Inboard Blades have constant dT/dQ .
- 4. Betz Constant Helical Pitch Air Inflow**, stretched outflow gives Constant Slip, Min Induced. Ideal Loading of Blade vs. Radius, controlled by Ideal Shape, with matching Twist. Constant dT/dQ , Thrust to Torque Ratio, constant efficiency, all radii - if initially drag free. Actually achieving constant Ideal α and C_L gets Triple Ideal Prop, Min Profile, Induced, Torque. Min Area Precisely Placed, min Profile, Torque. Can also get Pure Helical Inflow, Outflow, min. Induced.
- 5. Goldstein-Theodorsen gives essentially Exact 3D Math Solution** for a Betz Propeller. All accomplished from a simple Chart of Kx Blade Loading, Circulation, vs. Radius, Advance Ratio. Heavy Loading, High Advance Ratio Solution nails what other math does not, correct Pitch, Thrust. Solution gives precise Shaping, Twist, Loading, Pitch to 1%, better than required .1 degree. Accuracy Required: If 1 degree error is .1 C_L , a 20% error on .5 C_L Prop, 1 degree required for +/- 2%.
- 6. Low Reynolds number Drag and Early Stall** --- added concurrently by Computer. Private plane Props have the Speed of Jets, but the Chords of Model Planes, R_n 200K, 1 Meg+. Super Airfoils cannot create super props with poorer Low Rn Drag. Metal props allow Thin Airfoils, maximizing L/D, especially fast, at tips, especially near .9 Mach.
- 7. Prop Calculations**; 3 Spec Items: Speed, RPM, Alt. p, 3 Choice Items: C_L , C_D , AR, 3 Calcs: Size, Twist, Pitch = 9. Diameter, Area, Shape cannot be separated with highly variable q, but AR Scales each up or down! Must Know how to pick required Thrust, (# 10), if a poor Interference Efficiency is Involved.
- 8. Gearing Down Slow**, High RPM, Low Pitch, low η Props, Gives High Pitch, Big Dia. High Eff. Gearing Down Fast Prop can hold Tip Speed Below .9 Mach, Restrain D, More Blades, Hurts η .
- 9. • Must Correct Ideal Theoretical Prop for Nose Velocity Profile**, Slowdown, Source, Sink
- 10. • Must Understand Program of how to calculate "Off Spec Conditions"**, Speed, RPM, Alt. 800# Gorillas of Prop Design: Speed V, RPM - C_L vs. Diameter - Pitch, A.R. - Shape vs. Twist = Ideal Loading.
- 11. • Must Understand a wealth of important basic insights** on Variables, Conditions, Conclusions. Ideal C_L , .5 to .55, (Higher, Lower vs. Diameter. The Interchange of Induced vs. Profile loss) --- also Weight vs. D^3 . Variation of C_D and Stall vs. Reynolds Number. High Drag C_D and early stall at low R_n . Hi V, but narrow chords. Advance Ratio Curve of Max Potential Efficiency of Any Prop, usually 85% to 91%, but also affected by Aspect Ratio. Super Magic Graph, variation of all Parameters vs. Speed --- a feel for how everything varies vs. Speed. The variation of the Characteristic Planform Shape of Ideal, Constant C_L , Betz Props vs. Advance Ratio. ref Book p.147. The Location of the Max Chord vs. Advance Ratio; also the location of the Ideal 45° Blade Angle vs. Advance Ratio. p.146. Vibration very complex. Desirable Hi Aspect Ratio lowers Natural Frequencies, more vulnerable to Engine frequencies.

\dot{M} = Mass Flow Rate

This page took a lifetime! — Jack Novis 12/17/03
LINDBERGH'S 1927 to the — WRIGHT'S 100th ANNIVERSARY of FLIGHT

If you come to understand all the incisive insights here, you have a very good grasp of prop basics.

