Basics of Giant Scale Design

by: David P. Andersen

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Are you ready to design?

- Have you mastered; Plan Building or Kit Bashing?
- Are you a good pilot?
- Do you understand basic principles of structure and flight?
- Will you enjoy every step in the process? »

"I don't have to be an aeronautical engineer. I start with a proven design."

- Wayne Siewert

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"An airplane is a group of compromises flying in close formation"

- Allen Penticoff

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Design Methods

Analytical

- Accurate and optimal
- Math intensive
- Requires super computer and wind tunnel
- For professional aeronautical engineers only

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Heuristic

- Derive from accumulated experience.
- Modest change from previous designs.
- Most applicable to modeling.

Six Steps in Scale Design

- Gather all the documentation that you'll ever need
- Decide on model size & purchase components
- Enlarge 3-views to model size
- Trace the 3-view & fill in structure
- Save the original, build from drawing copies
- Update the drawings as you build & fly »

Labor Required

10% Research
30% Design & Draw
5% Cut Wooden Parts
10% Make F/G, Plastic & Metal Parts
20% Build Airframe
25% Cover, Paint & Detail

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Build or Buy?

- Wheels
- Vacuum-Formed Canopy
- Struts
- Fiberglass Wheel Pants
- Fiberglass Cowl
- Decals
- Muffler

If you buy, fine tune model size to match available parts…

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Documentation

- 5-View Drawings w/Cross Sections
- Black & White Photos
- Color Drawings or Photos
- Color Proofs
- Paint Chips
- Plastic Models

Gather all documentation you'll ever need before proceeding …

Reconcile Differences!

When to Deviate From Scale

Never!

Well … except for compelling reason!

Examples:

- Washout – For low speed stability
- Wing thickness at root – to fit retracts
- Stab incidence – if too negative
- Wheel doors/pants – Cut high for grass

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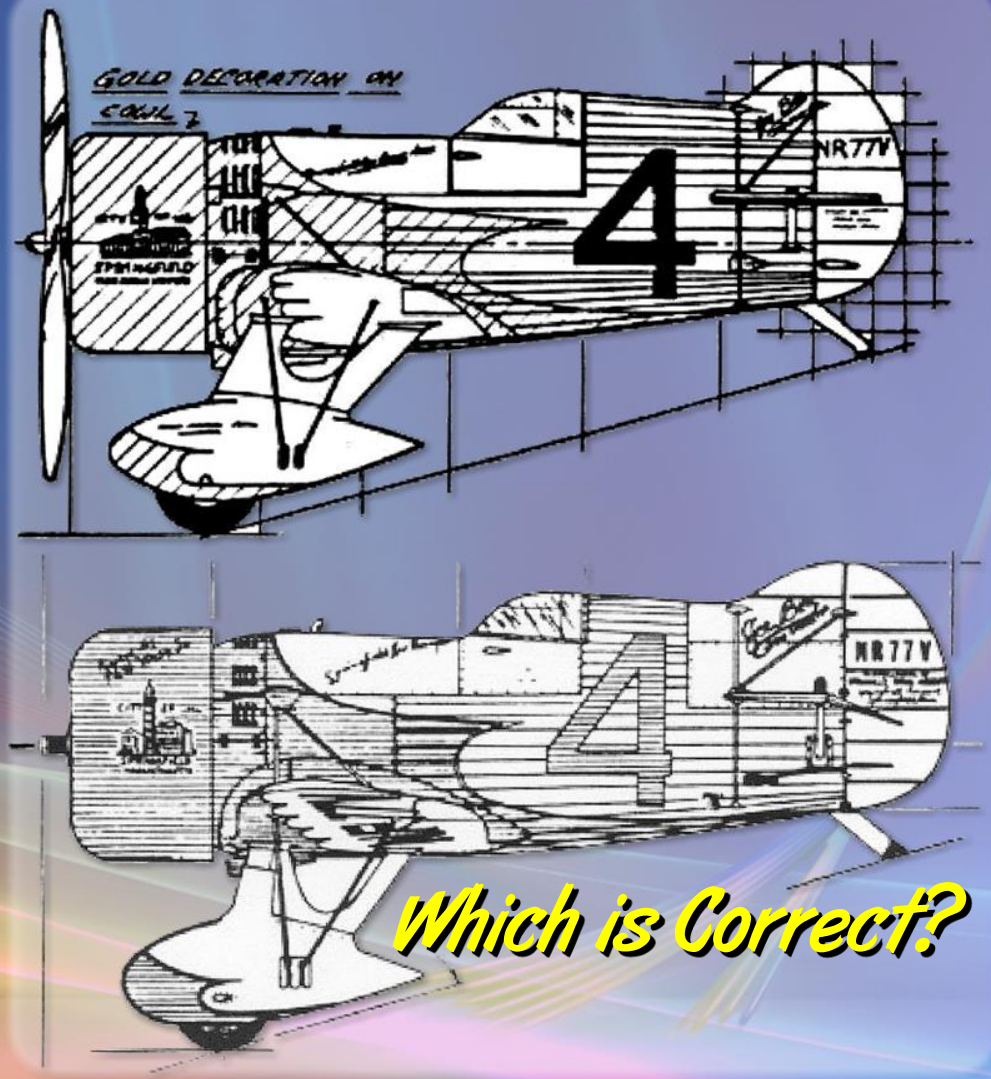
Don’t!

- Enlarge the tail
- Use flat sheet instead of an airfoil in the tail
- Move the wheels forward
- Increase dihedral
- Thicken the wing
- Shorten the landing gear
- Add down thrust or side thrust
- Use horsepower to overcome excess weight

Choose 3-Views Carefully!



Which is Correct?

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- Weight is proportional to size^3
- Area is proportional to size^2
- Speed is proportional to $\sqrt{}$size

Example:

70" span 7Lb model scaled up to 100" will weigh 20Lbs, fly 20% faster and require twice the paint…

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Power is Proportional to Size $^{3.5}$

Note: Small change in size requires large change in power!

Example:

60 – sized model of 70" wing span, enlarged to 100" span requires 3.45 times the power

(Saito 180, Moki 2.1, Quadra 35 …)

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Start With The Propeller

What size propeller and RPM do I need to propel this airplane?

Then pick the engine!

Enlarging 3-Views to Model Size

1/3rd scale is 1/3rd bigger than ...

1/4 scale which is 1/4 bigger than ...

1/5th scale which is 1/5th bigger than ...

1/6th scale and so on ...

- Copy 3-views, check length & width
- Calculate enlargement factor = model span/3-view span
- Calculate drawing height = 36”/enlargement factor
- Cutup, rearrange 3-views, draw calibration lines
- Enlarge to 36” height max, any length
- Verify correct dimensions – length & width

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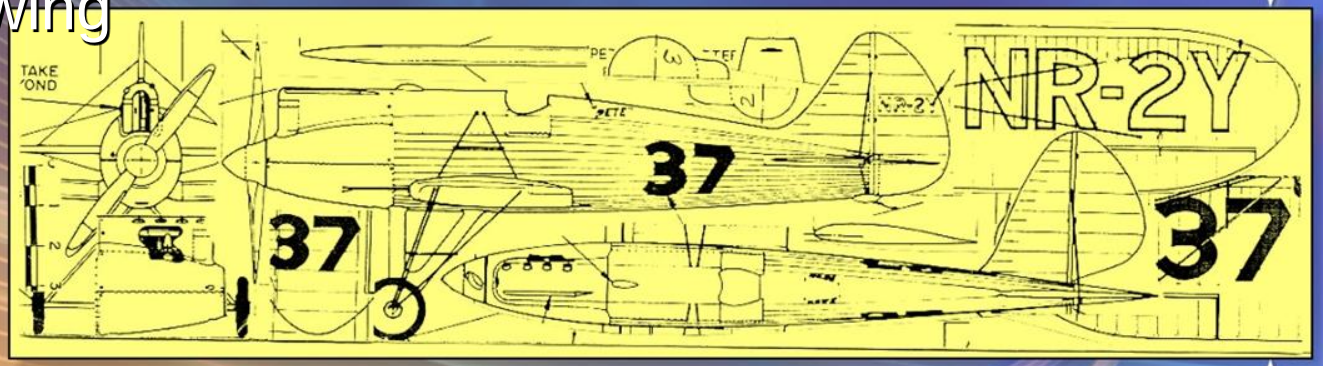
Enlarging Services

- Look in Yellow Pages for Engineering copying services, OZLID copying, etc… for architects, engineers, surveyors, etc…
- Copy size standard is 36” max height, any length
- Photocopy enlargement cost is about $40 for one ¼ scale drawing



36” Max After Enlargement

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Copy structural details from a proven design of similar size & construction.

For Example:

- To design a 95” span Nakajima Ki 27 Nate, refer to plans of a Ziroli P-47
- Same rib spacing, ply thickness, sheeting, stringers, mounts etc
- Same washout, incidence angles, throws, C.G., weight etc…

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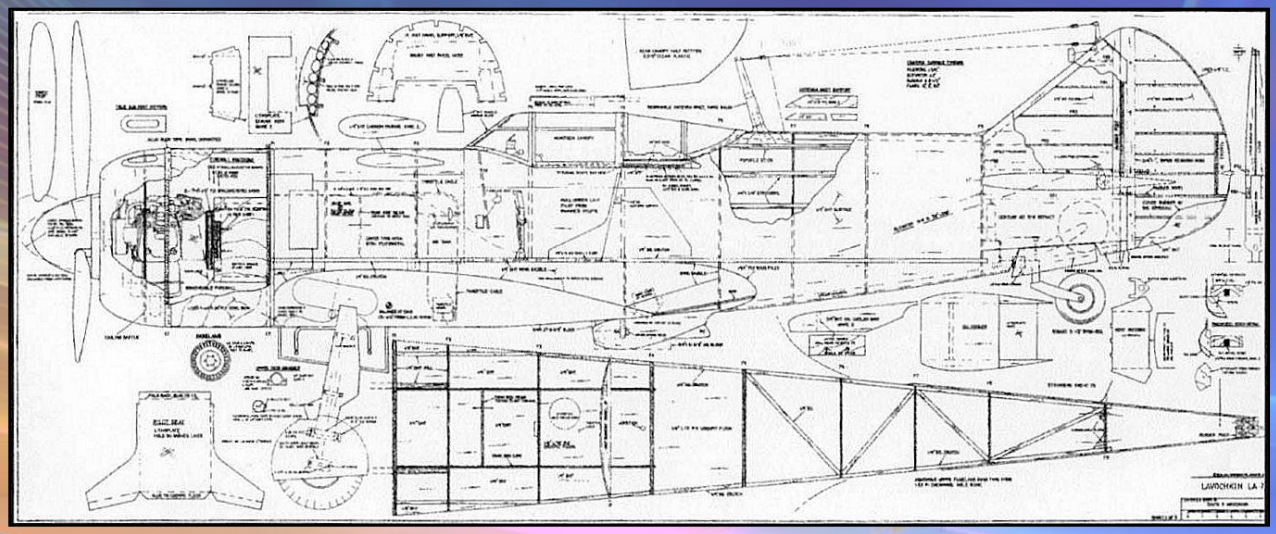
Drawing the Plans

- Draw master w/0.5 HB pencil on 1/8” quadrille-rule vellum
- Let wide paper hang over left & right edges of table
- White table works better for tracing
- Build from copy of master drawing
- Update the master as you build! »



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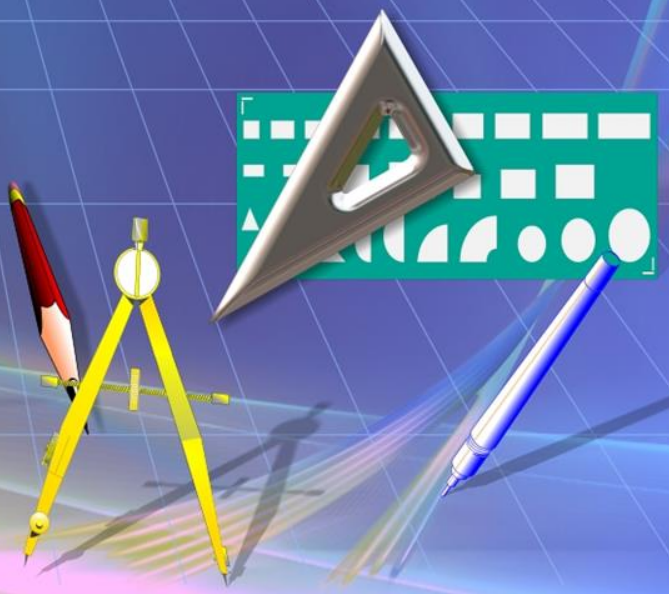
Drawing Tools

- 0.5mm HB Mechanical Pencil
- Eraser & Thin Metal Shield
- 45°-90° Plastic Triangle
- 30°-60°-90° Plastic Triangle
- 12” Ruler
- Long Straight Edge
- Compass
- Circle Template
- French Curve
- Ships Curve
- 36” White Drawing Table
- Bright Shadow-Less Lighting



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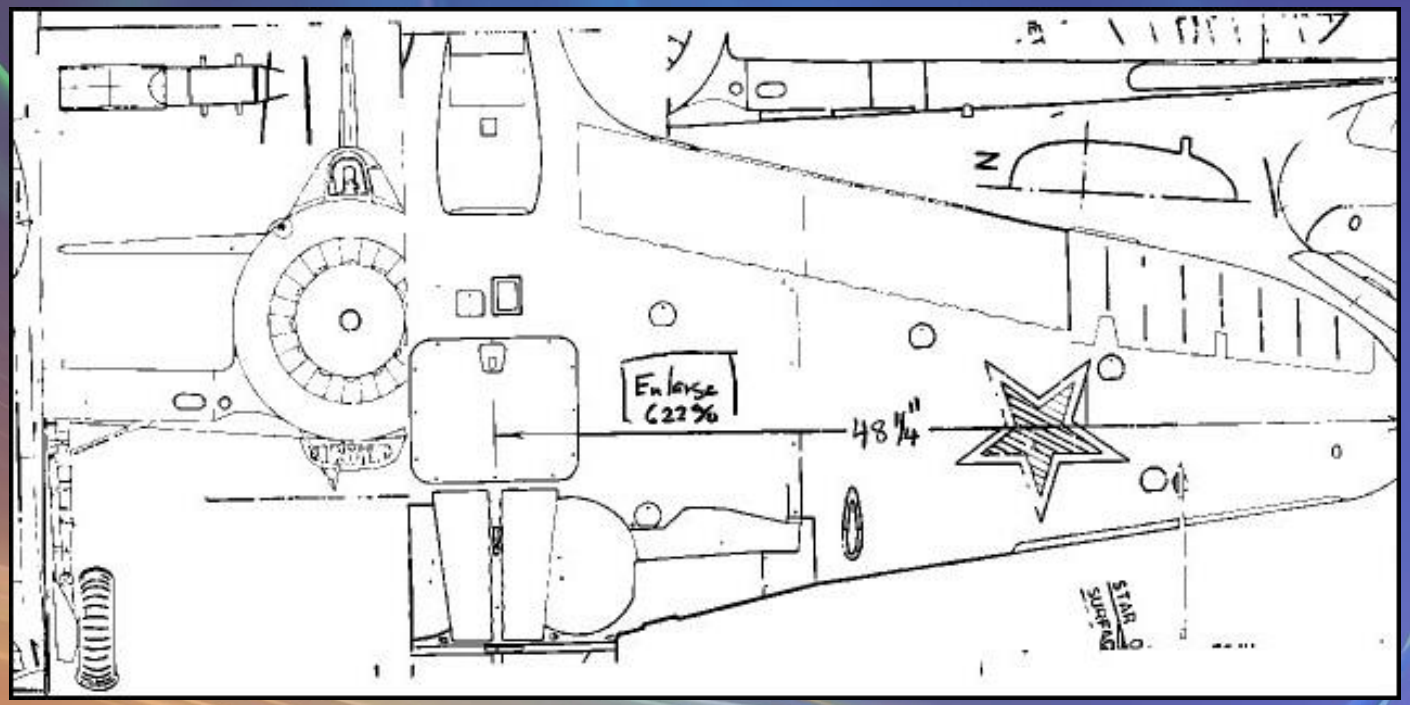
Enlarged Wing View Ready For Tracing



Andersen Designs

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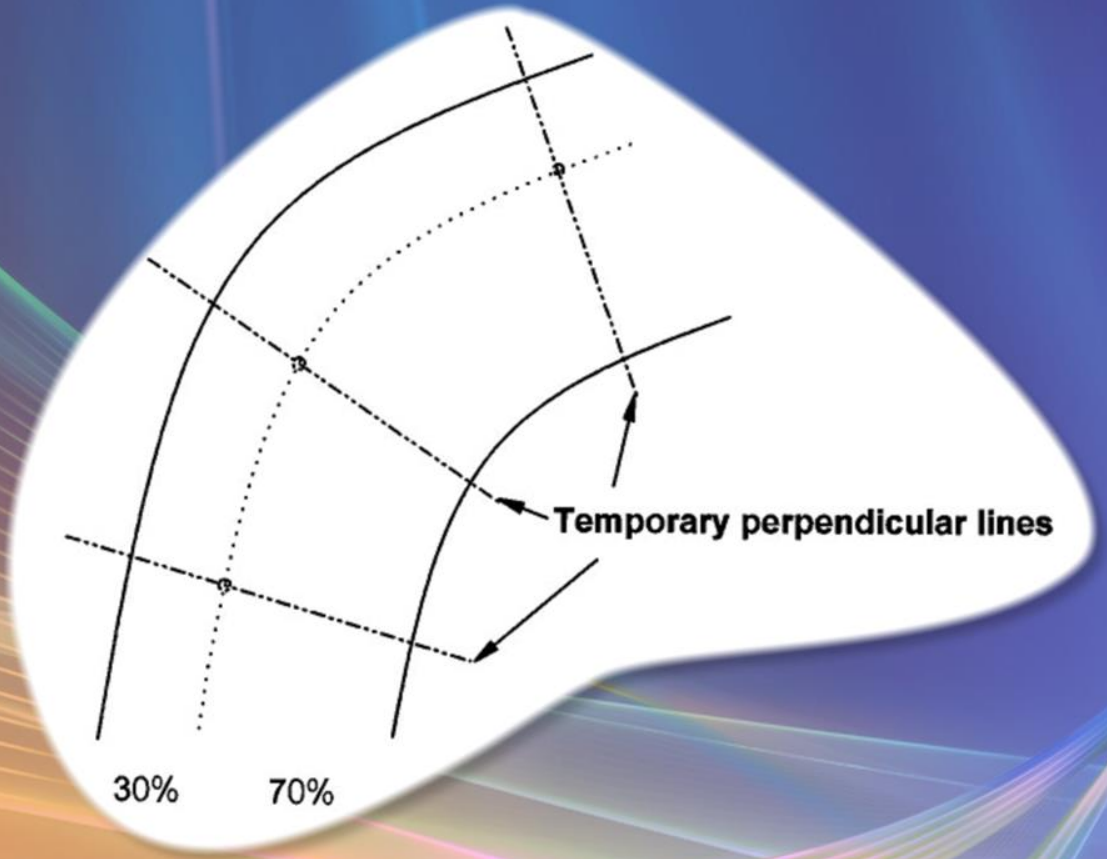
Lofting a Line Between Two Other Lines



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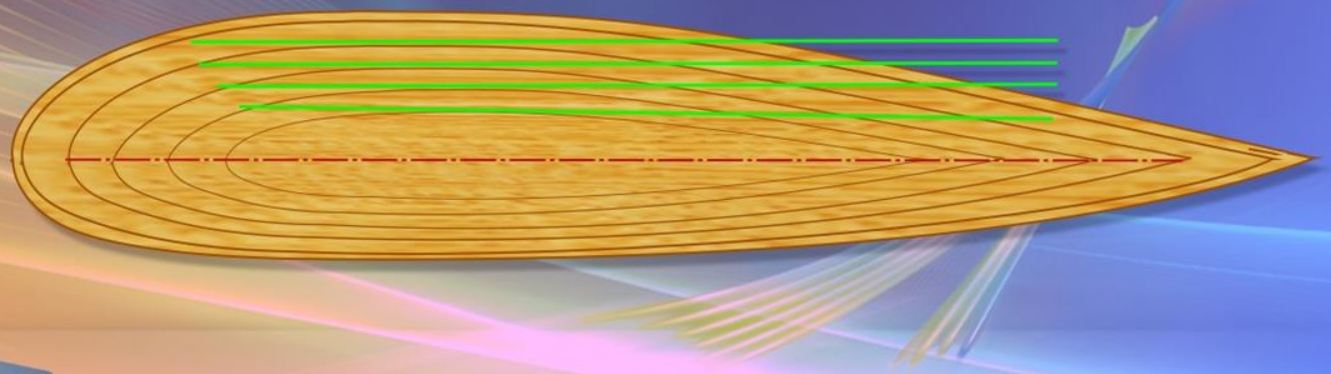
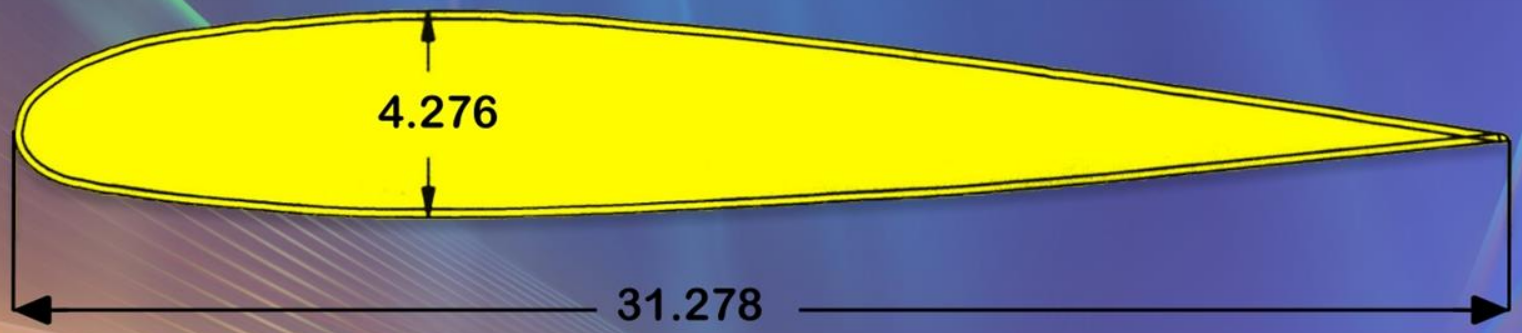
Lofting Wing Ribs

- Draw wing top-view & front view w/rib positions
- Superimpose root, mid & tip airfoils … no washout yet!
- Adjust chords & thickness per wing top & front views
- Mark L.E., T.E., top, bottom of airfoils
- Interpolate curves of remaining airfoils
- Trace each airfoil, subtracting sheeting & add spar notches
- Rotate rib for washout, add alignment tabs
- Add details to each rib for ailerons, flaps, retracts, etc…



ModelCAD Intermediate Drawing of a Wing Rib



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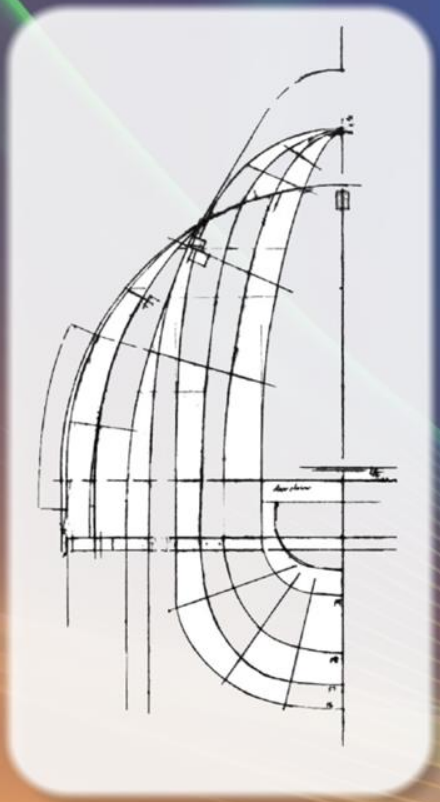
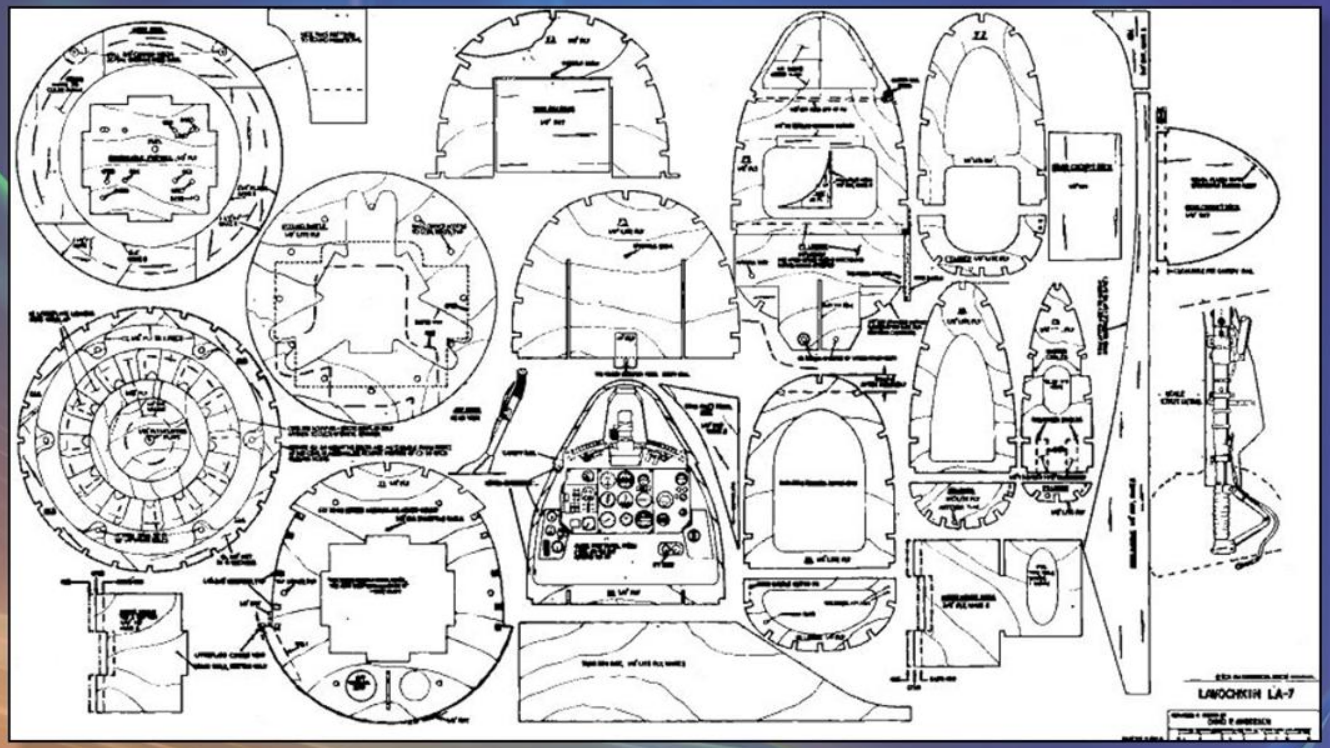
Lofting Fuselage Formers



- Draw fuselage top view & side views w/ former positions
- Superimpose known former halves
- Adjust height and width per fuselage top & side views
- Mark width & height of remaining formers
- Interpolate curves of remaining formers
- Trace each former half, subtract sheeting, add stringer notches
- Reverse the drawing, trace the other half

Fuselage Formers



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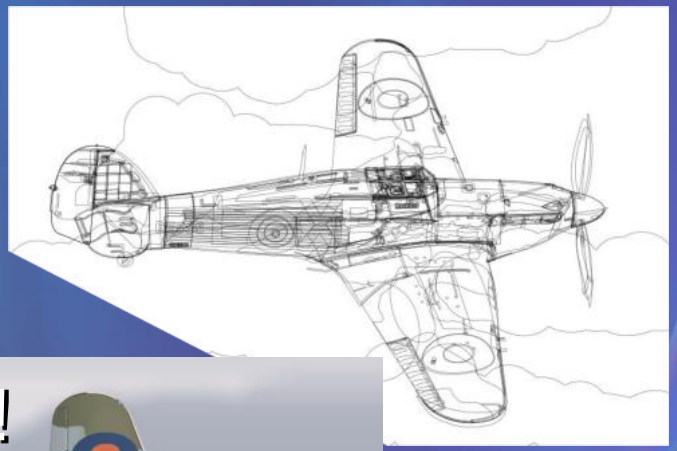
Draw The Master

- Draw the master copy on vellum or Mylar ®
- Build the airplane from copies of the *Master!*
- Update the Master as you build & fly, not later!



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Enjoy Your Next Scale Project!

Resources …

HighFlight Spring 2010

Simplified Scale Design – Article

www.MNBigBirds.com

- *Free!* Scale Plan Downloads, 3-Views, Documentation, Fiberglass Parts, Scale Wheels, Retracts etc …
- Scale Flyers of Minnesota – News Letters, Events, Meetings Info etc …
- *Contact Information;* Andersen Designs, Micko Aircraft & Accessories
- Additional Resources & Building Tools!

Additional Resources

- Shindin Machine - Custom Landing Gear, Shindinmachine.com
- SAC Midwest - Custom Instrument Panels, Sacmidwest.com
- Axel's Pilots - Custom Pilot Figures, Axels-scale-pilots.de
- Pro-Mark – Dry-Transfer Decals & paint masks, Pro-Mark.com
- TnT Landing Gear - Struts, TnTLandingGear.com
- Abell Hobbies - Sheet Metal Struts, AbellRC.com
- Bisson Custom Mufflers - BissonMufflers.com
- Bob Banka's Aircraft Documentation – Photos & 3Views, Bobsairdoc.com
- "*Vacuum Forming for the Hobbyist*" - Book on Home Vacuum Forming, RCM Plans, RCMPlans.com
- ModelCAD 3000 - Free Download; Modelcad-3000.uptodown.com/en/
- Clearprint Drafting & Design Fade-Out Vellum, 1000H-8, 36" x 20 yds

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