

Scale Modeling: Strategy and Technique

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1. PROTOTYPE SELECTION

- A. Choose a prototype (full size "real" rocket) that you will enjoy modeling.
- B. Take stock of your building skills and pick a prototype that plays to your strengths, or allow extra time to develop new techniques.
- C. Simple prototypes, carefully built, will outscore attempts beyond your skill level (300 points for "Craftsmanship" vs only 100 for "Degree of Difficulty" in Sport Scale).
- D. Is the nose cone shape close to a commercially available one?
- E. Can you neatly reproduce the prototype's markings and detailing?
- F. Different rounds (flights) of the same prototype often have easier or harder paint patterns and markings: pick one you can handle with good craftsmanship, or tailor the data packet to omit or downplay those elements you don't want to attempt.
Note: While missing markings count against the "Accuracy of Color and Markings" score, omitted details don't specifically cost points, unless large enough to count against the "Similarity of Outline" score. (maybe a few points at most).
- G. Need at least minimal color data to have much hope of placing at NARAM. Note that a published color description allows the most latitude & least chance of a points deduction.
- H. If have no color data for a specific round or vehicle, can reference similar rounds or vehicles that you do have color data for (judge may decide not to deduct points if reasoning is sound).
- I. Flat white paint schemes show building flaws the least, while glossy finishes or silver show flaws the most (so it takes more effort to get the same Craftsmanship score).
- J. Look at how the particulars of the prototype will help with craftsmanship points (i.e. seam can be hidden by conduit) or hurt (i.e. detailing can't be neatly reproduced with the tools available).
- K. Craftsmanship is typically what determines the static points rankings for the trophy contenders, as serious entries mostly stay close in Outline and in F,C&M.
- L. Spectators notice large, "difficult" models with pretty colors. Judges notice craftsmanship and fidelity of the model to the data packet. When you see a "sure winner" that's in third or fourth after static judging, it probably didn't match the data very well. Why this happens with models scratch built for NARAM as often as for kits is a mystery to me.

2. MODEL SIZING

- A. Will the model be capable of a good flight on the planned motor(s)?
- B. Fly a boilerplate, a sport model of same weight & diameter, or a subscale model of similar impulse to weight ratio.
- C. Remember that weight more than doubles for a 50% size increase.
- D. Make size consistent with the amount of detailing (bigger model = more detail).
- E. Besides factors like available tubes and nose cones, size may be determined by such things as commercially available markings, parts such as tiny screws, or ability to fit the longest parts in a carry-on box for air travel.
- F. A smaller model should generally score higher for a given amount of time spent, as the craftsmanship on a smaller surface area should be better for the same time spent.
- G. A large model with too little detailing can look unfinished. A large model with bad detailing looks bad. Larger models also have a higher rate of crashes or flight point deductions.

3. STABILITY

- A. A small, quickly built "toss model" can be thrown around to get some idea as to where to locate the CG (and/or by how much to enlarge the fins if necessary). Remember to account for the weight of the motor(s).
- B. The above model can be converted for "stomp rocket" launching to gain additional insight. Swing testing, with the string tied such that the nose points downward about ten degrees, will usually be conservative.
- C. A BT-5 to BT-50 size mini-engine model will tell you more than either of the above.
- D. Models with significant-size upper stage fins will usually be stable with the CG near the trailing edge of the upper fins.
- E. Adding too much nose weight, especially to a long model, can cause pitch/roll coupling --roll causes a pitching motion, leading to a loss of flight points and possibly a crash.

- F. Except in the above case, a small rate of roll helps cure minor stability problems. Any roll from a model of a non-rolling prototype (e.g. space booster) could cost flight points.
- G. Increasing fin size by about 10% (20% area increase) may be imperceptible to the (Sport Scale) judge, or at least save more flight points than are lost from Similarity of Outline.

4. DATA COLLECTION

Online resources

- A. Try the Google.com search engine, including the "Images" option. Use variations on the keywords to maximize useful "hits". Selecting "Cached" highlights where the search words appear in the document.
- B. Try payload-related keywords for sounding rockets, e.g. "X-Ray Astronomy Rockets"
- C. Rocketry Online web site has links to scale sites, including some photos and color-keyed drawings by Peter Alway.
- D. University payload developers: Johns Hopkins, Penn State, USC, U of Vermont, etc.
- E. Space Agencies: NASA, NASDA, ISAS, CNES, ISRO
- F. Launch sites: White Sands, Wallops, ESRANGE, Woomera
- G. Corporations: Boeing, Lockheed-Martin, Swedish Space Corp, Arianespace, EADS, Raytheon, subcontractors
- H. To print a copy of a picture or drawing from the screen (Windows computer):

Move the cursor over the graphic and click the right-side mouse button.

From the menu that opens up, select COPY.

Click FILE at the top of the screen, followed by NEW to open a new file.

Click on EDIT at the top of the screen followed by PASTE to insert the graphic image in the new file (or paste to a program such as Windows "Paint" to crop or scale image). Add a caption, or text copied from the web site, along with the web site address copied from the input line at the top of your web browser screen. Print it, or give it a descriptive name and store on your hard drive.

I. Other web sites worth a look:

- 1. www.skomer.u-net.com/projects/start.htm (lots of UK programs)
- 2. www.univ-perp.fr/fuseurop/index_e.htm (Rockets in Europe)
- 3. www.skyrocket.de/space/ (many "rare" color photos)
- 4. www.astronautix.com/ (Mark Wade' s Encyclopedia Astronautica):
Click on "Graphics" to see indices of the pictures with thumbnails

J. Public Libraries

Aviation Week back issues, Jane' s "All the World' s Aircraft" annuals.

K. University Libraries

Besides the above, look for bound back issues of Journal of the British Interplanetary Society, Interavia, Flight, Flight International, Journal of Spacecraft and Rockets, Aerospace America, and various no-longer-published trade journals similar to AvWeek (e.g. Technology Week).

L. Aerospace Museums and Military Base Displays

Quite a bit on the web as to what is displayed where.

5. TOOLS & MATERIALS

- A. Sanding blocks of various grits / fine grades such as Flexi-grit or Testors assortment.
- B. Keep a sharp blade in one X-Acto knife for fine work and a "used" one in another for more routine tasks (engine mount construction, etc).
- C. Thick odorless (saves lungs and eyes) cyanoacrylate "super glue" from the hobby shop.
- D. Accurate (not all are) ruler with a millimeter scale.
- E. Low-stick scotch tape (blue-color packaging vs green) for masking paint lines.
- F. Muffler tape for just about everything, including lining inside of tube for recessed engines.
- G. Pen vise drill with assorted bits (can purchase individually) for tiny holes (such as screw holes in a payload section) and building internal mechanisms.

6. BUILDING PRINCIPLES

- A. A boilerplate model will provide building practice, good weight and stability data, and a backup to fly if the competition model cato' s.Try different construction and finishing approaches on repetitive parts or similar sections to see what works best.
- B. "The biggest flaw should be smaller than largest detail".
- C. Build the model to match the data -- select data that matches what you built.

- D. Put bad stuff at back of model (Monokote seams, launch lugs, flaws you couldn't dispatch).
- E. Use a plastic nose cone when possible, or for test models.
 - 1. Remove mold line by scraping with X-Acto knife and sanding smooth with wet 400 grit.
 - 2. Tip can usually be made more pointy with X-Acto knife plus sandpaper.
- F. Use a shallow light angle to look for flaws in surfaces being sanded (e.g. styrene fin surface).
- G. Work in millimeters when possible.
- H. Thick CA is good for most parts, except the engine mount. Use sparingly.
- I. No exposed balsa anywhere on the model = no balsa grain.

7. FINISHING

- A. Test new paints and techniques on boilerplate models or scrap parts.
- B. More drying time (e.g. weeks) means more durability for masking and better compatibility.
- C. Recommended Spray Paints
 - 1. Krylon: Good for covering large areas with basic colors. Very fast drying.
 - 2. Testor's Model Master: Many "scale" colors, including specific metals and olive drab.
- D. Tube Finishing
 - 1. Fill tube seams with putty & sand. And/or...
 - 2. Use many coats of auto primer spray, sanding between each coat with fine sandpaper (smelly, takes days, very smooth). Or...
 - 3. Cover the tube with self-adhesive trim Monokote film.
 - a. Good enough at most NARAMs for A/B Division, or C/Team 3rd place and lower.
 - b. Mark a pencil line (in same way as you would for fins) along entire length of the tube.
 - c. Cut Monokote (similar to final color) longer and wider than needed.
 - d. Align a straight edge of the film with the pencil line.
 - e. Let film hang below horizontally held tube as you rub your finger back and forth along the tube's length, advancing circumferentially in VERY small increments.
 - f. Run a fingernail along the overlapping film at the seam to define it, then trim the excess with a sharp X-Acto knife.
 - g. Trim film from ends with sharp X-Acto knife held nearly perpendicular to the tube.
 - h. If desired, clean up the edge by coating inside of tube end sparingly with thin CA and then, when dry, rotate the tube end against a fine-grit sanding block.
 - i. Sand tube with 400 grit for better paint adhesion.
 - j. Spray on thin coats of paint (silver Monokote may look good unpainted).
 - 4. Fin Covering

Start with a balsa or basswood (harder than balsa) fin sanded to the airfoil shape.
- E. Covering with self-adhesive Monokote
 - 1. Cut the Monokote so that it folds over the leading edge of the fin (i.e. the whole fin will be covered by a single piece) and allow at least a 1/4 inch excess along each edge.
 - 2. Apply to one side and trim away the excess before covering the next.
 - 3. Cut part way through the film along the edges to help it go around corner without pulling up.
- F. Covering with sheet styrene
 - 1. Start with a balsa fin sanded to the approximate airfoil shape, minus several millimeters of the planform at the leading and trailing edges.
 - 2. Use 10-20 thousandths thick styrene, depending on fin size.
 - 3. To achieve sharp panel edges or bevels on the fin surface, score the bevel line on the styrene from the inside with an X-Acto knife, cutting part way through and then bending at the bevel line.
 - 4. For extreme bend angles (e.g. leading edge), hold knife perpendicular to scored line and use scraping technique to create a V-shaped trough only a few thousandths of an inch thick at the bottom.
 - 5. Glue to the balsa core with thick CA, spread fairly evenly around the inside of the styrene.
 - 6. Gently scrape with X-Acto to remove glue smudges after they dry -- final sand with 400 grit.
- G. DETAILING
 - 1. Styrene strips, rods, channels etc are found in model train stores and some hobby shops. Evergreen is the most commonly found brand. Plastruct has some unique parts (e.g. hex rods, flexible corrugated sheet, longer lengths).
 - 2. Roughly shape the part with an X-Acto knife (protect fingers), then sand with finer and finer grades of sandpaper, such as Flexigrit Wet & Dry.
 - 3. If the part needs to conform to a tube, wrap sandpaper around slightly smaller tube and stroke the part in one direction only until no gap is visible on either side.

4. Paint small parts before attaching (with SMALL amount of thick CA).
 5. Remove paint from the middle of the area on the model that will be covered by the part, and roughen the bottom of the part with fine grit sandpaper.
8. MARKINGS OPTIONS (low-tech but presentable)
- A. Cut similar-color trim Monokote to shape, fine sand & spray paint before applying it to model.
 - B. Use low-stick Scotch tape or Frisket (art supply store item) to mask lines for painting.
 - C. Decal trim film of appropriate color.
 - D. Dry transfer lettering (rub-ons). Apply to clear decal film or directly to the model. Clear coat.
9. SCALE DATA PACKET
- A. Identify with NAR or Team number (name optional) on the front.
 - B. Be concise. Start with an overview, such as drawings and photos of the overall vehicle, followed by any details. Reference the source of the data whenever possible.
 - C. Include any documentation for planned mission points operations.
 - D. For a simple prototype, a single sheet of paper with everything the judge needs is... everything the judge needs.
 - E. Packets often include data that hurts the static score (e.g. omitted markings in closeup photo).
10. MISSION POINTS
- A. May move up a place in the event just by remembering to say "The prototype spins".
 - B. The flight judge may not be the static judge (i.e. hasn't seen your data packet and whatever it may say about mission points).
 - C. The amount awarded is completely up to the judge -- there are no official guidelines, but inexperienced judges tend to award more.
 - D. MY rough guidelines:
 1. Scale (non-vertical) launch angle: 10 pts.
 2. Spinning: 10 pts any -- 15 pts "scale-like" amount, e.g. fast.
 3. Clustering: 10 pts per additional motor, adjusted for difficulty (clustered prototype only).
 4. Staging: 25 pts easy direct staging -- up to 50 hard (e.g. a long booster requiring special techniques, delayed ignition, etc).
 5. Gliding: 40 pts and up.
11. RECOVERY
- A. For a soft landing, parachute area should be in the range of 100-200 square inches per ounce of recovered weight.
 - B. Use nylon parachutes for weight of more than several ounces (fabric stores have thin nylon, including bright orange, for compact chutes).
 - C. Use elastic 1/4" wide or greater for the shock cord.
 - D. Use separate parachutes and recovery for upper and lower sections.
 - E. Have model touch down on least delicate area if possible.
 - F. Rear ejection system lessens damage at chute opening.
12. CONTEST TACTICS
- A. Fly the model in its simplest configuration first to get a qualified flight.
 - B. Have a backup model prepped, or at least extra motors available.
 - C. Look at whether catching the model (invokes max damage points) will cost you a place or not hard to say unless the leaders have flown).
 - D. Take touchup paint, paint pens or markers to the contest for emergency fixes.
 - E. Put the minimum required data in car or suitcase (wherever it will definitely arrive at the meet) as soon as building starts