

Modelling the Avro Arrow

A beginner's guide to modelling in general, by Bill Zuk

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HTML'd By R. Kyle Schmidt

Titanium Desk Model

The Avro Company of Canada made a number of desk models for promotional purposes in the 1950's beside the usual wing-tunnel and testing models that were constructed. These models remain elusively intangible and their value, including the incredible cast-metal Arrow models would be fantastic. (A project to recover some of the rocket-borne test models from Lake Ontario is presently being considered.) There are five Avro Arrow models produced including two relatively new releases from Hobbycraft Canada.

Two of the kits are expensive and difficult to find vacuform 1/72 scale models from Astra and Victoria Products of Canada. The newest models to be released are injected molded Hobbycraft 1/72 and 1/48 scale Arrows that were introduced in 1987. The Hobbycraft kits are the ideal choice for the Arrow enthusiast although for years, the only Avro Arrow kit that was available to the modeller was the famous Aurora No. 124.

RL-202, the second of the Arrows was the subject of this model project. The Aurora kit scaled out to approximately 1/78 scale which was not untypical of the times, based on the record of the odd-ball scales issued by other North American model manufacturers.

Planned at the time of the Arrow test flights, the Arrow model, instead of being cancelled, as most observers would have assumed, was released and continued in production until about 1974. It likely was even re-issued or, at least, stocks of models were re-released, even after this period. Though its price of \$1.39 was steep for 1960, many thousands of kits found their way in to modeller's hands.

To expert modellers, the Aurora model represented a "start point" but since it was the only model of the Arrow, it remained a popular kit throughout its production life. Crude in some ways with its engraved markings, poorly registered decals and inaccurate contours, the Aurora model still became an instant collector's item when it went out of production. Commanding an average price of \$50.00 for an unbuilt kit and as much as \$400.00 for an expertly finished model, the Aurora Arrow became one of the most highly desirable kits in the black-market trade that has become part of the plastic model kit collector's headache. The introduction of the Hobbycraft models should bring prices of the Aurora kit back to reasonable levels.

The first step was in assessing what had to be done to the Aurora model. The request had been for a desk model which meant that constructing new landing gear, weighting the nose for the Arrow's unique nose-high stance and full detailing of the cockpit was not required. However, there was still a lot of preliminary work to be done.

Smaller parts were made and mounting holes were drilled for their fitting later. At this point, the rest of the project was planned out using an old IPMS CANADA RT detail page on building the Aurora model. A number of alterations had to be made to have the model conform to scale drawings provided by the Astra models' instruction sheet (drawn by Jan Strommenbergh) and photographs in the Boston Mills Press book, "The Arrow". The nose cone and tail were re-worked, the lower fin probe was removed and new panel lines were scribed using the Olfa P-cutter. The first stage of construction was completed with careful filling of all join lines at 15 hours.

RL-893-1986

The second stage turned out to be the longest and most involved operation, that being the painting stage. After grey primer, the colour scheme of RL- 202 was determined from colour photographs. It was decided to depict the aircraft as it looked on November 11, 1958 when the Avro Arrow suffered an accident- a gear failure on landing at its main base at Malton, Ontario. The main colour was the glossy anti-radiation white that was carried overall.

In order to achieve a deep, luxurious finish, Flecto Varethene liquid plastic was chosen. Painting took an extremely long time as each coat had to be masked, lightly sanded and painted. Over a day of drying was required between coats. After mastering the difficult medium which was prone to running and cracking, five coats of paint were applied to complete the white finish.

Other areas that were gloss or semi-gloss were painted next- including the nose cone (Tamiya flat black and gun metal mix), the heat exchanger outlets on the spine (Testors flat silver) and the air intake (Tamiya semi-gloss black). This last area was carefully masked because a Testors flat aluminum colour was chosen for the bleed inlets. The afterburner cans were painted a mix of Tamiya flat black and gun-metal to duplicate this area. An overall coat of Acrylic floor wax was sprayed to seal the paints and the second stage was over at 40 hours.

The final stage of construction involved detailing. Using the excellent Astra decal sheet and its accompanying instructions, RL-202 was depicted in its test markings. A further coat of wax was applied to seal the decals which had been applied using the Micro-Scale system. The flat finish of the anti-glare panel and fin tip were then painted using Tamiya Flat Black.

A display stand was obtained from another Aurora kit and the final operation of restoring the canopy with Kristal Klear solution and adding the pilot figure of "Spud" Potocki, completed the Avro Arrow project- two months and 50 hours of work later!

Building a 1/72 Astra Avro Arrow Vacuform

In 1982, the first new and accurate model of the Avro Arrow was released- as a vacuform. Astra Scale Models' Hugh Gilliland managed to get it right, and make it buildable. Despite its seemingly simple shape, the Arrow had quite a number of subtle shapes that made it very difficult to vacuform.

The kit comes complete with decals, and a five page instructional booklet including a bibliography. Apart from the major components, there is a complete undercarriage, bogies for the main wheels, nosewheel gear, inner and outer wheel door detail, separate splitter plates, and resin tail cone. Much thought has gone into the way the fuselage goes together. It is split horizontally, and the cockpit and nose assembly is added later.

Sanding down the wings, fin and rudder and the upper and lower fuselage halves is the first step. A quick dry fit will show the excellent fit of all the parts including the nose section. Where the wings and fin join the fuselage, they are deliberately made oversize saving on filling later. The set of plans included in the kit are useful in obtaining the correct wing anhedral and the accurate "look" of the nose. Bulkheads to strengthen the interior also fit well. Be sure to build adequate mating areas in all subassemblies.

The first major piece to be assembled is the exhaust cone section. Glue in supports (the instruction sheet recommends a strengthening gusset in the centre) and place to one side until other subassemblies are ready. Then while the fuselage sections are still on the carrier sheet, cut out and install the fuselage bulkheads, noting that bulkhead D2 is on the bottom. Remove the upper and lower fuselage halves from the carrier. Glue the top and bottom fuselage together and add the exhaust section. Install the rear fuselage upper panel component that has the two raised portions that lead into the exhaust pipes and blend all the sections together. Install the tail cone stinger with epoxy or crazy glue.

Remove the nose sections, being careful to cut out the cockpit glass areas. If you are detailing the cockpit, you may consider cutting the front clamshell canopy apart. An interior floor and ejection seats could

improve the cockpit but would be hard to see if the canopy is closed. Paint the cockpit interior dark gray, fix enough weight to counteract taildragging, and glue the two pieces together.

The wing halves can then be cut out and rubbed down. Wheel wells are provided and can be used as a guide for cutting out the wells as the scored lines on the lower wing panel are not the same as the wells. Glue the wings together, and then install the wheel wells. Install the wings simply by gluing them to the fuselage. Check the plans to make sure that there is the correct 4 degree anhedral.

Glue the nose solidly into place then cut out the intake module along with the splitter plate in place and in line with the rest of the fuselage. Now cut out the spine, remove the rounded portion at the front, along the engraved line, and decide whether you want to open up the airconditioning outlet on the top. It is marked on the spine, with a light hatch area. Check the installation along the top of the wing and to the rear of the cockpit. Cut out and assemble the fin, cut off the excess plastic at the base, and file to fit the top of the spine.

Before installing the undercarriage, check the kit over for any filling that you might have missed. Spray it with a white or gray flat primer to show up any surface imperfections. Cut out the nosewheel bay area and install a box section for the nose gear. The highly detailed wheels and undercarriage legs are well done, and are sturdy enough not to require any wire or metal pins as supports, although axles for the wheels are useful additions.

The subject for the model was RL-201 on roll-out day at the Avro factory. Matching the photographs that appeared that day confirmed that it was a basically all-white scheme with a dark matt gray radome. Tamiya Gloss White that could be flattened a bit with a matt base or paint makes a close match. The black antiglare area was sprayed with Tamiya Matt Black. Intake shrouds, and sections of the spine were variations of semi-gloss black. The other colours included a light gray semi-gloss undercarriage and natural metal wheels and wheel wells. Using the Astra models decal sheet provides all the necessary other markings including the walk-ways and even a splitter decal to recreate the mesh area.

Another scheme that might be contemplated is that of RL-201 in day-glo. Day-glo orange bands were painted on RL-201 during the winter of 1958-59 in order to spot downed aircraft in the snow and for better observation during flight. This paint was next applied to the tail, nose and wing-tips. A mix of Metalizer day-glo orange and red can produce the unique colour. These were its colours on Thursday, February 19, 1959, when RL-201 completed its last test flight and the last flight of any Arrow.

Building a VP Products 1/72 Avro Arrow Vacuform

Victoria Products Arrow in Bag

The VP (Victoria Products) 1/72nd scale Avro Arrow kit from 1986 came vacuformed on five sheets of .030 inch styrene. The kit was vacuformed from female molds, with exceptional quality moldings. The surface detail rivals that of many injection molded kits.

The kit comes with a canopy molded in clear plastic and is also molded as part of the forward fuselage. You have a choice as to whether to open up the windows on the canopy molded to the fuselage and use clear sheet styrene, or cut out the canopy, and replace it with the clear canopy provided. Since the actual canopy was of the clamshell type, it has been molded in two halves to facilitate modelling it open. If you plan to do any superdetailing of the cockpit, plan to model the canopy open.

The kit comes with the gear doors molded closed, and on a separate sheet, a set of gear doors, and wheels are provided. Unlike some vacuform kits, the wheels can be used. Unfortunately, the landing struts are not provided. No decals were available with the first release, although a decal sheet is available through Astra Models which made a comparable vacuform Avro Arrow kit.

The instruction sheet is on two sheets, one 11" x 15" (both sides) and one 8" x 14" (one side), containing a three-view 1/72nd scale drawing, a three-quarter exploded view of the model assembly, of the main and nose gear, cockpit drawings, and colour scheme notes and some construction tips.

Construction is divided into three main subassemblies, the tail cone subassembly, main fuselage, and nose section. Be careful with the main fuselage as the fuselage cross section templates (parts 11, 12, and 13) are not deep enough. There is no problem assembling the fuselage, but when the engine intakes are dry fitted to the fuselage, these are about two millimetres too large for the fuselage.

The solution is to begin by assembling the nose section. The engine intakes and splitter plates (parts 14-16 and 17-19) were assembled, and after the cockpit had been scratchbuilt and detailed, the forward fuselage (parts 1, 2, 3 and 6) can be assembled. In detailing the cockpit, consider a minimum of additional detail since almost no cockpit detail is visible through the small cockpit windows.

Assemble the nose section and engine intakes being careful to adjust for fit before the subassembly is set aside. The tail assembly (parts 31-33) and the tail cones (parts 27-30) can then be assembled. Using a No. 11 blade, the landing gear door panels on the wings can be carefully opened up with the pieces removed used to fabricate the wheel wells.

The outer wing panels can then be attached to the inner panels and backed with strip plastic before attaching upper and lower wing halves to gave the wing more strength, and kept the wing tips from drooping when the wings were attached to the fuselage. To maintain the correct wing cross section at the wing root, wing cross section templates may need to be constructed and attached. This may be necessary because cutting out the gear wells weakens the wing near the wing root.

The heat exchanger outlet on the spine should be opened up with a piece of scrap plastic attached on the inside to form a channel. The completed wing should then be attached to the fuselage. Almost no filling is required. After attaching the wing to the centre section, the nose and tail assemblies can then be attached.

The advantages to this approach include a perfect match of the engine intakes to the main fuselage, large bonding surfaces when the subassemblies were mated added strength and no alignment problems. Finally, the vertical stabilizer is assembled, and attached to the completed aircraft. A minimum of filling and sanding was required to achieve a smooth join.

Scratchbuilding the landing struts from aluminum tubing, scrap plastic, and bits from the spare parts box is needed. Before the aircraft is airbrushed, the gear is dry-fitted into position and holes marked and drilled with a pin vise.

After a light sanding the model requires a primer coat of light grey, to check for any rough spots. The paint scheme overall was Tamiya Gloss White. After allowing a couple of days to dry, the Day-Glo markings are then masked and airbrushed. The Day-Glo red/orange is a mixture of Tamiya gloss bright red and orange. Aluminum and Gunmetal can be used to airbrush the spine aft of the heat exchanger, and a mix of black and silver works for the exhaust burners.

After the areas to be painted gloss black have been masked and airbrushed, the model was ready for decaling. After the decals are applied and allowed to dry, a thin coat of Future floor wax can be applied to fix the decals. The tail pipes, nose probe, landing gear, and gear doors can then be attached.

The subject chosen was RL-203, because it was the only Arrow to sport both the Red Ensign and Day-Glo markings. The Astra decal sheet was used. The decal quality was quite good overall, and settled very well without use of any setting agents. One very nice touch was with the decals provided for the bleed inlets. If the splitter plates are first airbrushed natural metal, and the decals provided slid into place, a very fine mesh appears which simulates the bleed inlets very well.

No weathering is needed since RL-203 only accumulated 13 1/2 hours flight time before the Avro Arrow project was scrapped. All the tires on this aircraft were painted black and white on the outer edges, possibly for photo recognition. In the later test period, extended exhaust cones also appeared. Check references carefully for the exact details.

Building the Hobbycraft 1/72 Avro Arrow

Hobbycraft 1/72 Arrow Box (new style)

The newest injection kits of the Avro Arrow are the easiest to build. Hobbycraft Canada's kits are produced in both 1/72 and 1/48 scales. The smaller scale Avro Arrow model (HC 1392) was the first to be released in 1986 and subsequently reworked. Hobbycraft Canada is a marriage of a Canadian marketing firm and a Korean kit manufacturer.

The 1/72 scale CF-105 is molded in 52 white and one clear styrene part. The kit goes together fairly well but if you have one of the first series, you will notice a major error in the wings. The small teardrop-shaped hinges are molded on the top of the wings instead of the bottom. Cutting out the hinges may help but you may have to cut out the entire aileron and reverse them.

The moldings feature recessed panel lines and most of the detail that is missing in the Aurora version. However, finer detail can be found on the vacuforms. The outline shape is close to that of the earlier vacuforms but some modellers are still on the lookout for the Astra or VP kits because of their better accuracy. A large fold-out instruction sheet includes assembly drawings and hints along with a decal and painting guide.

The kit can be made with gear retracted or extended although no display stand is included for a flying version. A scribed location is made for the main undercarriage members on the inside of the wings. Sand off these areas if you are using an extended undercarriage.

Some other areas to be careful of include the cockpit. It is very basic with pilot figures, floor and simple ejection seats. Once installed not much can be seen through the tiny windows. The clear canopy also has to be carefully masked to get a good front windshield section and unfortunately no indication is made of the small windows that were used by the observer in the rear cockpit. Consult drawings and references to correct this as well as other detail areas as the undercarriage and wheel wells.

The main landing gear can be modified by mainly shaping the elements from the model's original square section to the required round and diamond profiles. The nose gear well is the wrong shape and is too shallow. I made the well profile rectangular (it narrows on the model) and deepened the well to provide reasonable space. The intake ramps on the model are also poor. The profile is close to correct, but the back side (the side facing the fuselage) is hollow, and this is not the case on the aircraft. It needs to be filled with putty and sanded to shape. With the addition of some narrow styrene strip, the duct that allows entry of the air conditioning air is added. This is between the ramp and the fuselage. Another error in the model is the shape of the airconditioning hot air outlet. This is shown as having the top part of an octagon shape on the model. In fact, the sides are rounded, with the top not flat but angled. The shape of the exhausts is incorrect for all but the first few weeks of RL201. The later exhausts did not curve in, rather they were larger and had a straight profile.

The decals are not very useful and should be replaced by the Arrow Graphics (RR No. 1, York, Ont. NOA 1 RO) Decal Sheet (D1-72) which is available. There are complete markings for all the Avro Arrow Mk.1s which not only have letters, tail markings, inlet mesh, wing-walk areas but also stencil details. Modelling RL-204 as it appeared at CFB Trenton makes a different Avro Arrow subject. A minor landing accident by an Air Canada airliner had closed the Arrow's home base down at Malton and RL-204 diverted to Trenton. It flew in day-glow markings on the tail and nose that day.

Building the Hobbycraft 1/48 Avro Arrow

Hobbycraft Kit No. HC 1651, the 1/48 scale CF-105 is molded in 62 white and clear styrene parts. Looking like a scaled up version of the 1/72 scale Arrow, there are recessed panel lines, but there is too little detail in this scale. In addition, drop tanks and rockets are included which reflect later developments of the Arrow.

The nine-step instructions have a couple of errors. The installation of the main gear struts is shown incorrectly as the main strut should be attached to the outboard edge of the gear well and the retraction struts go inboard, not rearward. Also the painting guides for the fluorescent red markings are inaccurate for some aircraft.

Although it is a straightforward, simple kit to build, there are fit problems. The nose, wing, and stabilizer areas go together quickly, but the upper and lower main fuselage halves require a lot of careful fitting. Before gluing the upper and lower pieces together plastic strips along the interior joint area were added to provide support and prevent the joint from cracking during cleanup. This long joint line still requires much careful filling and a stretched plastic sprue piece may have to be inserted. Other problems exist in the rear exhaust area and with the main wheel halves.

The rest of the assembly is better with fit of the wings to the fuselage being right on and requiring little sanding.

A light gray primer coat first showed any areas of concern especially around the fuselage joins. Although the decals offer markings for RL-201, the Canadian flag was only used by RL-203. The decals were out of register and are best replaced by other decals. Arrow Graphics Decal Sheet (D2-48) has markings for tail markings, inlet mesh and stencil details. New decals can be used to make another Avro Arrow subject come to life. RL-205 was the last trial aircraft and looked like the other Arrows that flew with day-glo markings. It flew only once.

The photograph referred to as "Death Row" in the "Arrow" book shows the 5 completed Mk. 1's with #202 on the outside right side. It appears in overall white with no red markings. (It never was painted in day-glo.) All of the other Arrows wore red day-glo at the end of their life. After the cancellation of the project and the destruction of the aircraft. #202 seems to be the first to be hacked up. Although it had not flown since its accident on Nov. 11, 1958, it had been scheduled for flight testing of the Hughes MA-1 fire control electronic system in mid-May, 1959.

#206 and other Arrows on the production line were destroyed as workers moved up and down the line, cutting up the airframes. Originally the plan was to use a wrecker's ball but when the ball bounced off the aircraft according to one worker I spoke to, they resorted to axes and torches. All 37 Arrow Mk. IIs and the 5 Mk. 1's were destroyed in that way.

Only pieces of RL-206, the first Mk. II (nose and front landing gear as well as an Iroquois engine) are preserved at the National Aerospace Collection in Ottawa (a landing gear section is also found at the Transportation Museum, also in Ottawa).

AVRO ARROW DRAWINGS

Drawings of the Avro Arrow in 1/72 and 1/48 scale are available from Howard McLean, RR No. 1, York, Ont. NOA 1 RO. Also available are similar type drawings of the CF-100 in either Mark 4 or 5 variants.

AVRO ARROW by the Arrowheads

This is an excellent reference source on the Avro Arrow for both modellers and historians. The 180 page hard cover book covers the development of the Avro Arrow, right from the initial design to the final cancellation of the project. The focus of the material is mainly technical but there are many useful black and white and colour photographs. Line drawings include colour profile drawings of RL-201- RL-206. Other illustrations of landing gear, gear wells, cockpit and weapons systems provide valuable references for the serious modeller.

A Response to Modelling the Avro Arrow

From: R. Kyle Schmidt
Subject: Avro Arrow model articles
To: Bill Zuk

Bill,

Thanks for sending the model articles directly to me, it saved grabbing them from r.m.s. I will be including them in my next revision to the page (coming within the next week, I hope). this revision will be a major change in structure, with some new stuff added. In particular, a modelling section. I am currently working on a 1/72 Hobbycraft Arrow (a later version). I would have been done months ago, but I have made numerous changes that are still in the works.

For instance, I have opened the canopy (both front and rear) and this necessitated the installation of a cockpit. I am not a huge fan of 1/72 but I persevered and now have a completed cockpit (from scratch but with resin ejection seats). The seats are for a T-33, and are not correct (They are too thin) but they look good in the cockpit. Styrene sheet and strip formed the rest of the cockpit.

I have a fascination with landing gear, and the HC models are terrible in this respect. With the help of the Arrowheads book and about 40 pictures I took at the NAM, I was able to modify the mains and the nose gear to adequately model the real thing. The nose was a tricky problem, and I originally tried to model the gear with brass tube, but gave up and sliced and diced the original styrene. The mains were modified by mainly shaping the elements from the model's original square section to the required round and diamond profiles. With the addition of some bare metal foil and some string, I now have reasonable looking gear. The nose gear well is the wrong shape and is WAY too shallow (a common fault on many models). I made the well profile rectangular (it narrows on the model) and deepened the well to provide reasonable space. I have yet to detail the well, but I do have several pictures of the area. The intake ramps on the 1/72 HC model are also poor. The profile is close to correct, but the back side (the side facing the fuselage) is hollow, and this is not the case on the aircraft. This I filled with putty and sanded to shape. With the addition of some narrow styrene strip, I added the duct that allows entry of the air conditioning air. This is between the ramp and the fuselage. The shape of the exhausts is incorrect for all but the first few weeks of RL201. The later exhausts did not curve in, rather they were larger and straighter (this is shown to good detail in the Arrowheads book).

I would probably be done now if not for the fact that I was ambitious and cut out the weapons pack. Since I have chosen to model RL201 near rollout time, I plan to fill the pack with telemetry equipment. This is not the problem. The problem lies in detailing the cutout in the fuselage. I am currently working on that, with the addition of rounded air ducts. I plan to add the stringers and piping/electrical runs soon.

Oh, I almost forgot. Another error in the model is the shape of the airconditioning hot air outlet. This is shown as having the top part of an octagon shape on the model. In fact, the sides are rounded, with the top not flat but angled.

That is about all I can remember right now, but I plan to display it in a diorama with a tractor, ladder, weapons carriage dolly, Iroquois engine (I know that doesn't fit with the period, but I will tell why in a

minute) and an engine dolly. Most of these components are modified versions from the Revell Germany F-16 that comes with tractor / ladder / engine and dolly.

The reason for the Iroquois is that the F-16 engine is more readily transformed into an Iroquois than a J75.

Also, regarding your comment about desk models of the Arrow, I have a Titanium Arrow on a marble base with a brass dedication to the maiden flight of the Arrow. This is one of my most treasured possessions.

Thanks again for the articles, keep in touch, and let me know if you have any problem with me using them on the page (you get the credit of course).

Kyle

R. Kyle Schmidt
Homepage

Update to modelling the Avro Arrow:

Arrow Graphics Decals

Decal sheets are available for the Mk.1 Avro Arrow in both 1/72 (D-1-72) and 1/48 (D-2-48) scales from Arrow Graphics (Howard and Sandra McLean, @@ N0,1, York, Ontario, N0A 1R0). The smaller sheet includes all the code letters to build any of the first series Arrows as well as stencil markings, inlet mesh, wing-walk areas and tail markings. The 1/48 decals only include stencils, tail markings and mesh decals. Each of the sheets is accompanied by an extensive black and white set of plans to assist the modeller in placement of the decals.

Bill... in my other life, a meek and mild librarian... Zuk

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RC Modelling the Avro Arrow

Bob Parkinson Arrow

There was one available kit of the Avro Arrow for ducted fan flight. This was the Bob Parkinson Model Kit. Although it is rumoured that Bob still exists, he has evidently moved to the United States, and is no longer the Home of the Arrow. Don Britton writes that Bob does still exist. These are his words:

I am an avid ducted fan flier. I have some information on Bob Parkinson. Yes, he has moved to the U.S. Here is the address...

Bob Parkinson Flying Models
1140 Early Drive NW
Palm Bay, Florida
32907
(407) 726-8401

He offers the ducted fan Aero for less than \$200.00 U.S. Hope this helps you out.

Arrow airfoil and description

The following description is the HTML'd version of a message sent to a gentleman working on a 1/6th Arrow powered by two 40lb thrust jets. Good Luck. I'll keep you posted, and they are working on a web page

OK, You asked so here it is....

You are right the Arrow did use a NACA 0004-6-3.7mod airfoil (according to Arrow, by the Arrowheads anyways).

The ultimate reference on this stuff is Theory of Wing Sections, by Abbott and von Doenhoff. (its about \$21 at your friendly neighbourhood bookstore).

So, I looked it up, because I have always been interested. Here's the breakdown.

The airfoil is a NACA 4 series (that means 4 digits in its designator). So, the airfoil starts life as a NACA 0004. The first two zeros means its symmetrical, the 04 indicates the section thickness as a percentage of the chord. There is a formula in the book to generate the ordinates (and there are several on the 'net). Now comes the interesting part. As best as I can tell, the designator should be NACA 0004-63.7mod, without the extra dashes. The first digit after the dash indicates the leading edge radius. A six is the normal leading edge radius. For information, a sharp leading edge would be a 0, a fat an 8. The leading edge radius varies as the square of this number through this range. The second number (Theory of Wing Sections only recognizes it as an integer, but we can squint) indicates the position of the maximum thickness in tenths of the chord. So, in our case we have a NACA 0004 airfoil with normal leading edge radius and a maximum thickness at .37*chord length.

Boy, that was fun, eh? Now. The mod indicates the drooped leading edge. This is not work documented in the book I have, and most likely indicates the Avro engineers took some liberties. The section shape is shown in the 3 views in Arrow by the Arrowheads.

I have some further information from Design Progress, May 1959. The article indicates that the leading edge was drooped by 8 degrees inboard of the notch and by 4 degrees outboard of the notch. The notch is

'about a 5% notch at about midspan' and the outboard leading edge has ' a 10% increase' I presume they mean in chord. This chord increase is to cure pitch up. For information, the notch creates a vortex that limits spanwise flow. (Originally tried by English Electric, if I remember correctly). It was found that the depth of the notch was the most critical parameter.

Now, to add some more information to the pile. There is a BASIC source code program available that will produce this airfoil section. I haven't tried it extensively (been too busy), but it is available at The UIUC Airfoil Data Site. This is an incredible site that has thousands of airfoil sections in files, as well as utilities to view and manipulate them.

The file to look for on this page is David Lednicer's NACA.BAS program. It will compile nicely in QuickBASIC 4.5, and will run in QBASIC that comes with MS-DOS.

I also have a program available to view airfoil files, and it is a quick and dirty attempt (I wrote it to be able to sort through the numerous files around). Right now it is quite picky about its file format (most of them are), but the next revision will make it able to read a multitude of file formats. The ViewFoil program is available compiled to run on MS-DOS computers. Instructions are included.

A New Ducted Fan Arrow!

John and Michael Houghton have been working on an RC ducted fan Arrow that sounds splendid. I have included here the full text of their letter to me. Since these letters were written to me, the Houghton's have created their own page. See it for more Arrow Model Details

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EMail: houghton@georgian.net

R. K. Schmidt:

We're new to the Net and have just recently found your page re the Arrow. Michael, my son, and I fly radio controlled model aircraft and we wanted to go faster. Michael got turned onto ducted fans or jets but, like me, wanted something different to the standard F-16, 18 etc. He somehow saw the Arrow and we both knew that it was for us. This past two years we have been building a scale model of the Arrow and last fall we had two successful flights.

I don't know how much you know about model jets and how they are powered but we use a Ducted Fan setup. A small 2 cycle internal combustion engine turns a 9 blade prop inside a duct. These motors are high precision as they are revving at 20,000 rpm. The duct is 5 inches in diameter and with proper ductwork, the powerplant can produce 10-12 lbs. static thrust. Many jets are getting bigger and depending on the size and wing loading, guys are getting 15-20 lb. aircraft into the air and have them fly very well.

The Arrow that we are building is 1/12th scale. Length of 78 inches, wingspan of 50 inches. Fuselage is of moulded fiberglass and the wings are made of a blue foam core with balsa wood and fiberglass skin. Unpainted weight is 13.5 lbs and it flies like a dream. This is a typical building method for jets nowadays. I made a plug of the Arrow, a static master shape, and then made a fiberglass mould from the plug. I then laid fiberglass into the mould and when it was dry, I pulled it out and there is my fuselage. With the mould I am able to make as many fuselages as the mould will hold up to. After talking to some enthusiasts, I feel that I will be able to go into production and sell the kits to other modelers.

To produce the plans that we used, we relied on the Arrow Book by the Arrowheads. Photocopy enlarged the plans in the book until they really fell apart and then measured the drawings. Then Michael took these measurements and created our AutoCad plans. We are about 90% scale. At 1/12th the fuselage needed a slight bulge in the middle to take the powerplant. Also the wing is so thin that in order to give me some room to put in the retractable undercarriage, I had to increase the thickness about 10%. The undercarriage is home made from aircraft aluminium and aircraft steel. Air operated cylinders raise and lower the mechanism as it twists to fit into the wing, as the real one.

This project started out as a 'lets see if the model will fly and can I do the project'. Usually, when an aircraft is scaled down so accurately it has trouble flying, due to the difference in airspeeds, scale effects and reynolds numbers of smaller and slower wings. My goal from the start was - if it worked we would go to a larger twin engine version. Well this version works so well, that it looks like I have to sell the kit so that others can enjoy the Arrow as I go onto building the next size up. A 1/10th true scale with twin ducted fans, or if I had the money, I would power it with real turbine engines.

Yes that is right, there are now model size turbine jet engines and they are truly awesome. Some are propane powered, some are jet fuel powered. They are about 4-5 inches in diameter and 12-18 inches long. Produce anywhere from 8 to 40 lb. thrust, depending on which one of about 7 different versions you buy that are now on the market. Prices start at about \$3000.00 U.S. up to \$5000.00 U.S. Know any rich sponsors that would like to fund a Twin-Turbine powered Arrow Project????!!

Next step the CF-100 or how about a Jetliner???

I have seen the Bob Parkinson Arrow, in fact it was photo featured in a recent model magazine as it appeared at a Jet Rally in Texas last September. It is not to scale, what is jokingly called 'Stand Way Off Scale'. Fuselage is short compared to the wing and it is not a scale wing, no notch, no undercamber and not to scale undercarriage. But it is available, he lives in Florida and does advertise under Bob Parkinson Models. Best bet for interest is to look up recent issues of Model Airplane News or R.C. Modeler, available at your friendly neighbourhood Hobby Shop.

There is also RL-206 hanging in a Hobby Shop in Orleans in Ottawa, Shop name of Discount Hobby. Again Ducted Fan about 1/12th Scale. It is sort of scale and the trained eye can see many variants. Apparently the builder got too happy with the fiberglass resin and the thing is too heavy. Never been flown although the powerplant, and all is in the model.

I have heard rumour that a chap in either Winnipeg or Calgary, they are so close together, is trying to produce a kit of the Arrow. Don't know much more than that, other than I think his business name is Celler Dweller Hobby's. I heard this at a big Hobby Show that happens every April in Toledo, Ohio. It is THE show to attend either as a modeller or a supplier of Hobby equipment. I was telling lots of people down at the show that I was building an Arrow and to my surprise some of the Americans actually knew about the plane.

I can't get into too deep a conversation about the Arrow with anybody as it makes my blood boil at how stupid our government is when it comes to the aircraft industry in this country. The loss of the Arrow is only a small piece of the puzzle that is gone for ever, when you think of how good an industry was there in Canada and our Government 'LEADERS????!!' have over the years just killed the whole industry.

Well I think that this might be enough rambling. We really enjoy your page and would like to thank you for taking the time to put it together for others to see.

This may be too much to send to you but I have appended a newsletter to this note to you. I have collected a list of names of people that have expressed an interest in purchasing a kit from me when it finally becomes available. I forwarded this newsletter to those people last fall, after the flights. Some of the info is repeat of

what I said to you above. Some of it is directed to model jet flyers so if it makes no sense to you I hope you are tolerant of me.

Thanks again

John & Michael Houghton

Dear Arrow Enthusiast:

THE ARROW HAS LANDED!!!

We were at Quinte 1995 with our Avro Arrow CF-105, and you had expressed an interest in our jet at that time. We promised to keep in contact as thing progressed and until now, not much of news worthiness has occurred. It has taken all of the summer to bring what you saw at Belleville into flyable shape. This project has been bigger than anticipated.

Taxi trials occurred on Sunday afternoon August 27, 1995. Plenty of power and the fan picked up revs as the plane accelerated. Good ducting design I am told.

Monday September 4, 1995 was maiden flight day. Good static thrust lead me to believe that liftoff would easily occur. Was going to try a couple of taxis but when throttled up, the jet responded so well within the first 50 feet that I decided to go for broke. Held it on for a good 200 feet on paved runway then pulled back and crossed my toes. Observers said that it "Leapt" into the air. There was some left roll that needed trimming out and some tense moments to adjust to the extreme sensitivity on the ailerons but it flew and flew beautifully. Both high and low speed passes were very stable. The Arrow penetrates the wind very capably and will perform to the max. 6 minutes of flying and time to setup for a landing. Approached fairly high and what I thought was slow enough for a jet. Handling at medium-slow was very stable at about 30 % power, nose was not too high and had a good sink rate that could be easily controlled. On a go-around it came back up on the power very quickly. Reset for second approach and downwind was stable and level. Brought it in slower but not a high enough angle of attack as on flair it ballooned and stalled and pranged in from about 6 feet. The right main bogie arm bent and jammed the tires thus applying a full right wheel braking effect. This swerved the aircraft right and the 20 m.p.h. breeze got under the left wing and flipped the Arrow on its back. Some damage to the fin, right wing upper surface and the fuselage but all was repaired easily.

Saturday, September 23, 1995 second flight day. Mechanically reduced the aileron throw to 12 degrees and put in a low rate on the radio of 8 degrees with lots of exponential (-38 and -44 on my Futaba Super 7). Reduced the elevator to 15 degrees high and 10 degrees low with moderate exponential. Stupidly I didn't mechanically reduce the rudder throw but left it at 20 and 15 degrees. A heavy duty five cell battery was installed which moved the C. of G. about 3/8" forward. Take off was smooth as I pulled back on the stick sooner and it flew into the air. Climb was very good and all the erratic behaviour of over sensitive aileron was gone. However, because I left the rudder with too much throw, it not only yaws the plane to great authority, it also severely rolls the plane. This could have added to my problems on first flight as I am used to flying with rudder and instinctively correct with both sticks. Rudder is now mechanically fixed at 12 degrees high rate and I am sure this will be enough. Forcing myself to fly only aileron/elevator the jet is very smooth, goes where you point it and does what you tell it to do.

Both high and low speed passes were rock stable in the 15-20 m.p.h. breeze. The plane wants to fly. 40-50% power and pull up slightly to slow the plane down and all it does is climb.

After rereading all the Jet International articles on landing deltas I thought I knew what to do on landing but not so. First attempt was far too hot with too much power left on, about 30% after turn to final at 100 feet up. The Arrow didn't want to sink. Chopped to idle too late to really slow down enough. Flair was nose very

high (about 20 degrees up) and I applied power from idle. The Arrow climbed into the air with no hesitation ready for another attempt. However, I wasn't ready, and I repeated the approach the same way just a little lower. Still too hot and too much power left on for too long. I did get it down ... hard, but not too badly hurt. We did have it on video tape though, and watching the film after, the landing procedure is obvious. On the down wind, trim for level at 50 % power. The power is needed to get you through the turns as sink is pretty quick if there is not enough. (Power, not necessarily speed.) Stay high and after the turn to final, immediately chop to idle. Pull the nose high to slow way down and then adjust the glide with power. The video shows that once I got to idle, I could pull the nose up without the chance of ballooning, and still maintain control. Touchdown will be nose high (20 degrees ??) and surprisingly slow once the proper technique is accomplished.

Flight configuration:

Ramtech Fan, O.S. 91 DFVR and J.H.H. twin tuned pipe. Fixed wire undercarriage, fuselage unpainted weight 13 lbs. Estimated high pass speed 90- 100 m.p.h. This is with big open wheel wells in wing and undercarriage down. With retracts, doors and all cleaned up should hit 150 m.p.h.??? I'd like to paint it before next test flights as visibility in epoxy beige is pretty low but I also want to get in as much flying this year as possible so that I can really know what to adjust for next year and for the kit. (2nd flight had a dayglow red vertical fin and it helped alot.)

Over the winter the retractable undercarriage will be finished and some changes need to be made to some moulds. While the ducting seems to perform well, it is a bit of a bear to assemble so work on a splittable mould is needed. I am also seriously considering moulding the wings rather than sheeted foam. The profile is very difficult to cut and assembly of the wing is complicated. Moulded wings could be honey-combed, allowing for an undercarriage support spar, and a great deal more strength.

This has been a richly rewarding experience for both Michael and myself. We thank you for expressing an interest in our project. You will probably get one more letter in the spring to let you know how the winter fine tuning has gone then we hope to meet you again at Quinte 1996. Until then, have a constructive winter.

John & Michael Houghton

A Bit More Info...

Kyle,

1. Yes we have fiberglass shells available. The idea is to sell the entire aircraft structure as a kit complete with fiberglass fuselage (2 halves to be joined), foam-core wings and fin, custom undercarriage (perhaps optional for the modeller not wishing to spend the extra money for custom retracts), complete ply-wood formers, ductwork, and blue-prints, photos, etc, for finishing details. We are currently at the stage where we need to fly the aircraft in order to determine if any changes need to be made for production. We already have a few in mind and it is just a matter of time before a kit will actually be available.

How much you ask? That's a good question. Moulded fiberglass models can sell for anywhere between \$400 and \$1200. There is of course some fluctuation in scale looks, and kit completeness and complexity to mirror the fluctuation in price. The final price of our Arrow has not yet been determined but we have estimated that a price of about \$800 for the kit would be fair. The cost of the materials alone is fairly high when you consider the fiberglass, carbon fibre, epoxy resin and woods that go into it. Again, this price is not finalised. We still have to take into account the price of the custom undercarriage. It is common for companies to charge in excess of \$400 for a set of undercarriage given the many hours required to cut the pieces out on a mill or lathe. Our undercarriage has been designed to keep the time required to build at a minimum and they should not cost more than \$400. The undercarriage price may also indirectly effect the

price of the airframe kit. It is intended to sell the airframe separate from the undercarriage so that if a modeller wishes to stay with a fixed undercarriage, it is still possible to do so.

Kyle's Note: Be advised that these prices are very inaccurate. As with any product currently in development, it is difficult to set a final price

Arrow 2000 and CBC Movie Model

Doug Hyslip of R/C Hangar in Calgary has created and flown an eighth scale Arrow for the upcoming CBC movie The Arrow. Pictures are available at the Arrow 2000 site. This is what Greg Greene has to say:

Just to let you know that Doug Hyslip of R/C Hangar in Calgary has been flying his 1/8 scale model for a few months now in preparation of the CBC filming. It uses 2 K&B 100 ducted fans for power and weighs approx 40 lbs. Its quite a sight and I am going to be trying to put some video clips on for down loading. The model flies well and at a deceptive speed due to its size. It is built from fiberglass molds and foam wings, any one interested should contact Doug at arrow@quenet.com

If you have further information about references, or just want to comment, mail me:
R. Kyle Schmidt... Thanks.

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