ULTIMATE JET FIGHTER ????

Trying to compare aircraft that were designed as little as five years apart can be an exercise in absurdity.... or an exercise in dishonesty. Pre-World War II, a five year gap between the design of two aircraft could result in trying to compare a four gun bi-plane barely capable of exceeding 250 mph with an eight gun monoplane capable of 350 mph.

Another five year gap, would have the 350 mph monoplane compared to 450+ mph monoplanes armed with four 20 mm cannon. The comparison exercise is commonly patently dishonest.

But occasionally interesting.....

Efforts to compare the early 1950's Avro ARROW design with the late 1950's North American F-108 Rapier, lack a certain.... integrity.

As well as a certain acknowledgment of reality. The Avro ARROW marks 1, 2 and 2a, were actual aircraft that flew(mk 1) or would have been the result of a routine set of upgrades [it intended engine (mk 2), and increased internal fuel (mk 2a)], that are quite ordinary, with virtually *NO* controversy or risk (the PS 13 was proving to be an excellent design). The Rapier F-108, never made it past mock-up, and after going through several drastic re-designs, ran into very serious technical problems.

Both Avro Canada and N.A. were examining various means of enhancing aircraft performance (range and speed). Avro was examining a series of upgrades to the basic ARROW configuration (a noticeable leap in technology and performance in its own right), while North American were trying an even more drastic leap in technology and performance in one fell swoop. There are interesting parallels in certain areas both firms were examining. And in most cases, Avro seemed better at making the correct choice, at a lower price.

The best example of divergent approach favouring Avro, would be in a area of zip-fuel. Both firms gave consideration to its use, Avro as a future enhancement, and NA as a cornerstone of the most ambitious aspects of the Rapier's performance. Avro had concluded that a high energy fuel (ethyl borane) would be best suited to use only in the afterburner, due to various byproducts ("sludge") that formed when it was burned. After spending a massive amount of money (reported as anything from 100 to 220 million dollars), the Americans found that these fuels were hard to make, dangerous to handle, and the solids produced during burning caused erosion of the engine. Hardly a practical fuel, it has never been used as primary fuel in any aircraft in the intervening 40 years.

Since the Rapier (which I freely acknowledge was a beautiful machine in its final form) would have needed such an enhanced fuel to meet it's very high levels of hoped for performance, the failure of this aspect of the project, tends to throw the entire project into doubt. (This statement is based on the amount of fuel the Rapier was intended to carry. It was not sufficient to give the Rapier its hoped for performance. Period. The only

machine that parallels the *hoped for* performance of the Rapier, the Lockheed A11/SR-71 family, carries about 1 1/2 times the Rapier's fuel capacity.)

A point to be born in mind with very high speed (Mach 2.5 and above) aircraft, is that afterburners become more efficient at higher speeds... The SR-71 is more fuel efficient above Mach 3, than it is below Mach 2.5 (which is part of the reason Kelly Johnson found he exceeded his expected range). This is due to the duel cycle nature of the engines and inlet/afterburner combination in the Habu. At its highest speeds, the engine does not supply most of the thrust.... instead, the "afterburner" becomes a "ram-jet", the actual engine being bypassed by most of the airflow. The programming for the intake spike and bleed/inlet doors was a very long (and occasionally frightening) project, and was ***necessary*** for the success of this program. Without this unique system, the Habu would not be a functional Mach 3 aircraft. The only other Mach 3 aircraft to make it to squadron service, the Russian Mig-25, has an inlet configuration occasionally referred to as "identical" to the Rapier. And the Mig pilot is usually prohibited from flying at over Mach 2.5. At speeds higher than this, engine/afterburner control is extremely delicate, with the possibility that the power plants will run out of control. When the Mig was flown at Mach 3, the engines were often reduced to scrap. It isn't just a case of the engine running out of control. The entire system, from inlet to afterburner, must be very carefully integrated. The Rapier gives no indication that it was sophisticated enough for its hoped for performance envelope. The higher speed ARROWs would have had a vastly more sophisticated (and frankly sexier) inlet configuration.

The Rapier was to use two of the same engines as the XB-70. Unlike the Rapier, the massive XB-70 had an intake system (which besides setting a record for length.....) that did succeed in controlling airflow into the engines. Unlike the Rapier, the XB-70 was able to take advantage of compression lift, which would have drastically increased its performance. The features of the XB-70 that gave it the ability to "surf" it's own shock wave, were not part of the Rapier's design.

One of the points not usually referred to in regards to the Rapier, would have been its construction materials. They varied over different configurations, but the highest performance suggested for the F-108 would have required extensive or total use of stainless steel or titanium for its exposed surface, and some structural members. NA opted not to use much titanium, but was working on SS, in a honeycomb form to save weight, as used in the XB-70. If the same material was used in actual (as opposed to paper) Rapiers, it would have proven interesting. The original XB-70, first flew in 1964, and the honeycomb was found to be deficient... breaking away from the airframe. If solid SS had to be used for the Rapier, as opposed to a lighter honeycomb, would its structural weight have been increased over estimates???

Which leads to another point about the Rapier:
The poor and conflicting quality of the information available about it. One of the points that seems to be *very* consistent, is that Mach 3 was to have been its Vmax. While it *may* have had impressive *zoom* climb, it is rarely suggested that its climb rate would have

exceeded 18,000 fpm. The dimensions of the final configuration (this being the mock-up form) are *NOT* agreed upon by all sources. Most sources will give wing spans differing by about 5 feet..... length varies, as does wing area (by over 450 square feet).... yet most sources give the same weights, for two wildly different aircraft. Machines of a similar configuration, but with considerable differences in all dimensions and wing area, seldom share the same empty, loaded, and maximum weights. And more importantly, if there is drastic disagreement over basic dimensions, what type of confidence can be placed in performance figures?? (Variations in the length quoted for the ARROW Mk2 are based on variations on expected radar package. Hardly the same thing.)

The radar and armament that were intended for inclusion in the Rapier, would have had a similar performance to those carried on the F-14 Tomcat.... If they actually worked, and were not again just a paper project or failure, why were they not used on another machine???? (They were to have been used in the F-12a, and were tested in the few actually built..... supposedly with notable success. Several years after the Rapier was to enter service. If they were a working item, why were they not used???) The ARROW would have been as capable of accomodating this weapons package as the Rapier, so a comparison of weapons systems, is altogether a red herring.

The Rapier never made it past mock-up. It should be compared to (if you wish to make an honest comparison) Avro projects that were being developed at the same time as the paper Rapier.... advanced ARROW projects, up to and including the PS 2. I will ***NOT*** make such a comparison here. I would rather have those who denigrate the first generations of the ARROW do so, which should be adequate to demonstrate that they do ***NOT*** know enough about the ARROW to comment on it. They have already demonstrated that they know nothing about the Rapier.

A FINAL NOTE AND COMPARISON

The current top long range interceptors in the world would be the America F-15, the Russian SU-27 family, and the Mig-31 Foxhound .

They first two are both capable of Mach 2.2, or higher (2.5 for the Eagle) for at least short term. Both are capable of a RADIUS of action (the Eagle with conformal fuel tanks, the Flanker on internal fuel) approaching 1,000 stat miles. Both can carry variable air defence weapon loads, from 4 (Flanker) to 8 (Eagle) missiles. In the case of the Eagle this does bring the top speed down to *below* Mach 2. Both machines have (at combat weight), excellent thrust to weight ratios and good wing loading, which would make for excellent dog fight potential.

If this sounds familiar to you, it would be no suprise. These are the same performance specifications of the aircraft that Canada should have been putting into squadron service, 45 years ago(with relaxed stability, the ARROW would have been able to overcome the major drawback to a delta in a dogfight... and it had an excellent TWR, as well as a freakishly low wing loading.... which combined would have given any version of the ARROW better altitude performance than the Rapier)..

The Foxhound is a higher speed machine (Mach 2.83), but relies on external fuel tanks for its excellent range. It shares an interesting trait with many Russian jets: the addition of external stores does not diminish its speed capability. With some of the changes planned for advanced ARROW's (changes to the material used in structure and surface), the ARROW would have matched or exceeded the performance of the Mig-31 as well).

When you compare ANY aircraft, have the integrity to compare machines that actually flew with machines that actually flew within a few years of each other, and paper airplanes to paper airplanes. *Don't* compare a machine that flew, and exceeded performance requirements with a machine that never made it past mockup, and due to a failure to develop a major component (zip fuel), would have failed to meet its performance requirements.