

## Daniel Raymer Answers Some Questions

Dan Raymer here. You may know me from my crazy aircraft and spacecraft designs, like the tailless airliner or the vertical takeoff jet fighter with the engine installed backwards. In his Flying Magazine article, Peter Garrison once described me as having a “complete lack of preconceptions about how an airplane ought to look.” Thanks – I think.

Or maybe you took one of my short courses on how to design aircraft and spacecraft, or you bought my big fat aircraft design textbook or my skinnier “dummies” design book for homebuilders. Or maybe you just saw my ads or my website. I may not be the most famous guy in the small world of aircraft designers, but at least I’m on the list.

Sometimes I get asked questions like “how did you become an aircraft designer?” or “who were your influences?” or “if you are so famous, why aren’t you rich?”

I still can’t answer the last question, but I had a go at the others, not once but twice. Years ago the AIAA asked me similar questions and published it in their column “Editorial Echoes” (see [www.aircraftdesign.com/spotlighton.html](http://www.aircraftdesign.com/spotlighton.html)). A decade later I wrote an autobiography called “Living in the Future: The Education and Adventures of an Advanced Aircraft Designer.” This exercise in egotism actually sells fairly well considering the subject matter and the limited likely audience ([www.aircraftdesign.com/livingfuture.html](http://www.aircraftdesign.com/livingfuture.html)).

Now I’ve been asked to put together a few updated pages about my career. I’m told that “people will be inspired and fascinated by you,” and “their eyes will be wide-open to see that the AIAA has someone amazing like you.”

Really? Get a life, folks! But here goes:

You could almost say that I went into the family business. My father was a Navy test pilot and aeronautical engineer. An uncle, a cousin, and a brother are all airline pilots. I started with model airplanes and Tom Swift books at age eight, and wasted half my childhood designing and flying model aircraft. I started working on my pilot’s license at 16, washing a plane for my first lesson.

I went to Purdue University which is known for producing practical, get-it-done engineers. I got pretty good grades (A’s, some B’s, and let’s not talk about that theoretical class on differential equations). In my last year I worked in the Purdue wind tunnel where I learned more than in most of my classes. I joined the AIAA student chapter and was lucky enough to win the AIAA Midwest Region Student Paper Competition, with a paper about my wind tunnel work on a Greyhound bus, of all things. But I lost at the national level, at least partly because I brought the wrong set of slides. Stupid, stupid. Now I’m an AIAA Fellow. Go figure.

After college I got my dream job - a drafting table in the advanced design department of North American Aviation (Rockwell). My first boss designed the X-15. In our small design office were the guys who designed the Space Shuttle, B-1, HiMat, B-70, and others. That’s where I really learned how to design airplanes. Later I wrote my big textbook to share what I had learned at the feet of these “masters.”

I had several early projects that taught me a lot and gave me a chance to develop some reputation. Shortly after starting at Rockwell I was put in charge of developing computer-aided design capabilities for the advanced design department. I got the job mostly because the rest of the group were older guys who didn’t want anything to do with computers. Defining the system specifications forced me to really think about the design process, so I asked a lot of questions and

learned a lot. The CAD system we developed worked out pretty well, being used for over 25 years. The X-31 and B-1B were both designed on my system, and it earned me Rockwell Engineer of the Year.

Another project I'll always remember was the Innovative Strategic Aircraft Design Study, looking at new bombers to follow the B-1. I'd long been interested in flying wings and thought that a clean flying wing design, like the Horten flying wings of the 1940s, would offer a good stealth capability. This was long before the B-2 program. I put together a triangular-shaped flying wing design which we studied for four years, including wind tunnel and radar cross section testing. I really thought it would get built, but we were told to stop work on short notice. Later we learned that others had started working on stealth flying wings in the "black" world, while we at Rockwell were supposed to focus on getting the B-1 into production. Darn.

A third memorable project was our early work on Advanced Tactical Fighter (ATF), which eventually led to the F-22 program. When I was made Chief Engineer for ATF at Rockwell, it was not considered possible to have stealth and supersonic cruise in the same aircraft. Besides, most people thought that supersonic cruise was a waste of time for a fighter since you "slow down to dogfight." I tried anyway, and came up with a design with really low supersonic drag that also permitted fairly good stealth by the standards of the day. According to analysis and extensive sub- and supersonic wind tunnel testing, the design would indeed supercruise – at Mach 1.80. This design was studied intensively for 3-4 years. After I'd left Rockwell, the top management decided not to put a billion dollars of company money into the program as required by the Air Force to get a contract. So my design didn't get built.... again.

There have been dozens of other projects, ranging from a hybrid-electric hybrid airship to a Mars rover airplane to an otherwise-normal but tailless commercial airliner to an Air Force reusable launch vehicle to an optionally-manned modular UAV for DARPA to a rocket designed to fling a whole squad of marines halfway around the world, land them in a remote site, and get them out when their mission is done. Recently there have been several exciting launch vehicle projects about which I can say nothing – they have grim and powerful lawyers. One or both may fly. Hopefully when that happens, they'll finally let me say "I did that."

Right now, I'm heading a DARPA contract which my company just won called the "Flying Missile Rail." It's described on the DARPA website but the aircraft concept shown there isn't the real one. Mine is much cooler!

Oh right – what about my influences? I should start with my father since he was a Navy Test Pilot (Pax River). He didn't really push me towards aviation but I saw a lot of airplanes as a kid, and I read his old Navy pilot training books and copies of Aviation Week. But as I said in "Living in the Future," he just went to work like other dads. It's not like he took me up in his P-2. I didn't learn until decades later some of the things he did, like teaching the Black Bats how to fly their spy planes over mainland China (he's in that book). RIP, Dad – love you.

Other influences? As a kid I wanted to be the next Kelly Johnson. I read all about Kelly, the Lockheed Skunkworks, and the planes he designed there. I was thrilled years later when they made me Director of Advanced Design at Lockheed, with corresponding title inside the Skunkworks, but most of my work was on the "outside." A big regret of mine is that I didn't somehow arrange to meet Kelly. He was retired and frail, and I didn't want to be a pushy jerk fanboy. I should have, anyway.

I've always admired the simplicity and directness of the design work by Ed Heineman of the Douglas Aircraft Company, especially his A-4 ("Heineman's Hot Rod"). I was lucky enough to meet him at an AIAA meeting early in my career – fanboy again.

Howard Hughes was a hero of mine, as a pioneering race pilot and aviation entrepreneur. He didn't really design airplanes but he paid for their development and pushed his designers to do great and innovative things. I was lucky enough to go inside his H-4 (Spruce Goose) before it was opened to the public. Hughes was dead by this time but I got to meet his Chief Engineer, William Berry, who had been brought out of retirement to prepare the H-4 for public display. Berry gave us an hour-long technical talk on the design including the pioneering work that he and his team had done on molded structures and full-authority hydraulic flight control systems. It was fascinating, and miles ahead of others at that time. For the full story see my autobiography. Later I learned that William Berry was actually the father of singer/songwriter Jan Berry, of 1960's surf band Jan and Dean. I still love their stuff.

Wilbur and Orville Wright were heroes of mine from an early age. I read a child's biography of them when I was about eight, and have been their fan ever since. I still hate it when books or talking heads describe them as "lucky bicycle mechanics." They were true aviation scientists using theory and experiment to, one by one, solve the problems of flight.

I was most influenced by the designers who taught me how "real" aircraft design is done, in my early years at NAA-Rockwell. My main mentor was Lester Hendrix, the designer of the B-1 and HiMat. Harry Scott, one of the main configuration designers of the Space Shuttle, taught me a lot and still does. While long since retired, I occasionally take him to lunch and pepper him with questions. My first boss, Loui Hecq, taught me many things including the importance of getting the landing gear right. George Owl, a Cherokee Native American and the key layout designer of the B-70 and designer of the Formula One Owl Racers, quietly educated me about conics and mechanisms. There were many more – thanks to you all!

Well, that's about it. See you at the airport, or the next AIAA meeting!

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