Notes

CONVERSATIONS WITH VLADIMIR PAVLECKA

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to
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The odd beginning of the modern metal airship.

"Carl B. Fritsche told me he was on a Great Lakes steamer, this was in the days when passenger ships made overnight trips between cities on the Great Lakes. It was a warm summer night with a beautiful full moon and rather than go down to bed in his cabin, Fritsche decided to spend the night up on deck. He was sitting there in the moonlight when an old man came up to him and they fell into conversation. The old man was talking about metal airships and his enthusiasm for the subject soon infected Fritsche. They discussed the subject for hours and when he finally went below decks to his cabin, Fritsche had made the decision to spend his life in the development of the type of metal dirigible they had been discussing. Then he realized that he had neglected to ask the old man his name. The steamer was docking in Cleveland early that morning and he decided to go up early by the gangway and watch the departing passengers so that he would be sure to see the man get off. He waited and waited until all the passengers had gone ashore but the old man did not appear. He was nowhere to be found and Fritsche never saw him again.

"His resolve remained, however, and at the first opportunity he went to Goodyear in Akron, Ohio, the only company in the United States that was then producing airships. He was introduced to Ralph Upson who was in charge of the Balloon Division. When Fritsche explained his newfound enthusiasm for metal airships to Upson, he found an enthusiastic listener for Upson had been considering the design problems of the metal airship for some time. This was the beginning of the modern metal airship in the United States.

"Fritsche told me this story while we were driving to Detroit one afternoon. I had to believe him for this type of story was very atypical of him. He was not this sort of person at all. He was a lawyer and this was so out of character for him that I believe it simply had to be true.

The selling of the ZMC-2.

"Carl B. Fritsche was a lawyer and a fund raiser for the Republican Party. He was around 33 when he and Upson formed the Aircraft Development Corporation. He got the money from his friends in the Detroit automobile industry including Edsel Ford, Charles Mott and Charles F. Kettering. When the development work was completed and they were ready to build their ship, Fritsche went to Senator Arthur Vandenberg, the senator from Michigan and Republican leader of the Senate. Once Fritsche convinced him of the value of the metal airship, Vandenberg added an appropriation for a metal ship to the Navy's budget request for that year. When the budget was voted on and approved, the Navy suddenly found itself with money it had never asked for to build a ship it didn't want and the only company capable of building it was, of course, the Aircraft Development Corporation of Detroit, Michigan.

Pavlecka joins the company.

"I came to Detroit and walked in and asked for a job at General Motors Research Laboratories. I was there because I was on my way West and had run out of money in Detroit. I had worked in a tractor factory and at Skoda during the summers in Czechoslovakia so with that background, they gave me a job as an engine designer. Oddly, they didn't have many engine designers at General Motors Research Laboratories. For my first job I laid out the first Buick Straight Eight engine. It wasn't a very good engine, the shaft was too long. The Metalclad airship group was in the same building and I met them and after six months at GM, I went with them when they moved to the fifth floor of the Detroit Terminal Warehouse.

The ZMC-2 construction.

"The ship was built by the Chicago Bridge Company at Grosse Isle, a beautiful island. It was wooded with only a few houses. Some were mansions and some were shacks. It was marshy on the southern part and there we made a circular airfield and built our construction hangar. It was 200 feet long, 100 feet high and 100 feet wide. The hangar was right in the woods. I would open the window of my laboratory and a tree branch would come in.

Ralph Upson's career.

"I joined the company in 1925. Originally it was called the Aircraft Development Corporation. After the ZMC-2 flew, they changed the name to the Metalclad Airship Corporation. Upson was there until 1928 when he was forced by Fritsche to leave the company. At first Upson and Fritsche got along well together although they were completely different types of personalities. But Fritsche brought in a shop superintendent from the Philadelphia Navy Yard where he had been a workman on the Shenandoah. This was mostly a public relations move to show that we had experienced airship people working for us though it had little practical value for us since the work we were doing was completely different from the type of work they had done in building the Shenandoah. Anyway, Upson and this fellow whose name was Hill never got along and as soon as the design work was completed, Hill persuaded Fritsche to get rid of Upson. Upson was not even invited by the company to participate in the ZMC-2's test flights although the Navy then insisted that he go along.

"Upson and Fritsche got back together in 1939 on their MC-23 proposal to the Navy but it was rejected. Upson went on to teach aerodynamics at the University of Minnesota and at the University of Washington. He died, while mountain climbing, I believe, in 1964 or 1965. I do not know if he continued to work on his metalclad ideas. He also was chief engineer for the Heinz Aircraft Company, of Heinz Soup fame, during World War II. They built gliders then in Pittsburg.

"Ralph Upson reminded me of Adali Stevenson. He was the same fort of man. He was an intellectual of the first magnitude. He seemed to see things much bigger than the rest of us saw them.

Pavlecka's first look at an airship.

"During World War I, German Zeppelins used to fly from Staaken near Berlin to their base in Romania and they would pass right over the town where I lived. Sometimes at school we would hear the sound of their engines but by the time we ran to the windows they would be far off on the horizon. They flew that fast. Then one day, one came over flying against a strong headwind that slowed him down quite a bit. He was not over 600 or 700 feet high. I ran along beneath it and could easily keep up with it. I could see the crewmen looking down at me and smiling as I ran along. I ran with it for miles and miles fascinated by the huge ship floating in the air over my head until finally it flew away and I found myself miles from home.

Pavlecka's meeting with Zeppelin Company president, Dr. Hugo Eckener.

"I met Eckener in his office in Germany in 1932. I was just a kid of 31 but we talked for a couple of hours. He had all sorts of questions on the Metalclad airship. He was very interested in what we had done but he never volunteered an opinion as to metal airships versus fabric ships. I had just been to France where they were very open and accommodating and showed me everything I wanted to see in their aircraft factories and Eckener was interested in all this too. He was very concerned and depressed by the Nazis. They were everywhere on the toads in large groups and I would just pull over to the side of the road and be very quiet until they passed, hoping they wouldn't tip the car over or anything.

Pressure strength in early Zeppelins.

"A Metalclad ship is stronger when inflated than when deflated. We have only recently learned that back in World War I, the German Zeppelins that bombed England, though they were high-altitude ships made as light as possible with special lightweight girders which should have made them quite fragile, were given considerable extra strength from interior gas pressure. Their cells were completely full of hydrogen at take-off, they rose from their bases in Germany and slowly gained altitude as they approached England, their cells were still full and under pressure. Only after they had dropped their bombs and were far from England, did they start their descent. The added strength from this positive gas pressure played a significant part in the ability of these fragile ships to carry out their missions.

Pavlecka's work at Douglas

"I started with Upson in 1925. I was 24 years old. I stayed with the company until 1933 and was part of the group that proposed the MC-72 to the Navy. This 7,200,000 cubic foot metal ship would have been the same size as the Hindenburg. It was turned down and I left the company and came to California in 1933 and got a job with Douglas Aircraft in Santa Monica as an engineer.

"I was hired by Douglas because of my work in light metal structures for the ZMC-2. Douglas had around 150 engineers which was a big operation in those days. I got the job because I knew light metals. There was no history of this in the United States. In Germany light metal planes also started from the airship. Both Claude Dornier and Dr. Claude Rohrbach at Staaken got their start at the Zeppelin Company.

"Rohrbach's flying boats were very advanced for their day and were licensed for manufacture in England, France, Czechoslovakia and to Heinkle in Germany. But Rohrbach was a jew and had no future in Germany despite his brilliance. He simply disappeared.

"There were many brilliant Jewish engineers in early aviation. One of the most brilliant, one whose role has been downplayed, was a professor of statics named Muller-Breslau. I forget his first name. He joined Count Zeppelin in 1902 or 1903 as his design expert. The jews in the Zeppelin Company were luckier than many. Dr. Eckener sent them to the United States to work for the Goodyear-Zeppelin Company. And I think that largely because of them, the Goodyear-Seppelin Company in the U.S. became more advanced even than the parent Zeppelin Company back in Germany.

"Ed Burton was the Chief Designer of the DC-3. He was a good engineer but served here mainly as an administrator. In the DC-3 was where the work on the ZMC-2 really paid off; in making the structures both light and strong. The pilots were scared to death of the first DC-3's because the wings flexed, they weren't rigid. I had to give seminars to the United Airlines pilots but they didn't believe me and only experience allayed their fears.

"At Douglas too, they were very tight with money. I had a list of 80 subjects that should be worked on. I went to management and asked for the money to do some of these projects. I got none. I had my own lab so I simply started working on various projects and charging it to approved projects. When I took the results to management they were delighted. One such result was the self-sealing gas tank for the B-19 using sheets of aluminum foil. It was used until synthetic polymers came along several years later.

Pavlecka's development of the pressurized fuselage for the DC-4.

"The first written notice of the idea of a pressurized fuselage appeared in articles by a Russian whose name I have forgotten. He was the head of the Edo company which was then located on Long Island and is now headquartered in Denver. These articles appeared between 1922 and 1924 in the magazine, Aviation Monthly. The Russian was a very advanced aviation thinker. He wrote that transport planes would have to be pressurized in order to achieve higher altitudes where lower air resistance would result in higher speeds.

"Experiments were subsequently carried out in France and in Germany. Both the United States Army and Navy also experimented with small pressurized planes at high altitudes. By 1936 the development of the 18-cylinder Wright engine promised good power at higher altitudes due to its new two-stage supercharger and Douglas Aircraft decided to pressurize the DC-4 which was then on the drawing boards. Douglas' Chief Engineer, Arthur Raymond, gave the job to me and my staff.

"I did all the design work. The DC-4 was already designed and under construction when they brought the problem to me. The new supercharged engines would allow them to raise the DC-4's ceiling from 8,000 feet to around 14,500 feet. I found that the fuselage was not being built in a true cross section. It appeared round to the eye but the port and starboard sides were up to half an inch off being symmetrical. Rather than redesign it and do it right, they insisted on going ahead with it as it was. And rather than pressurize the whole fuselage as I wanted them to, they would only pressurize it down to the floor, and the program resolved itself into doing a proper floor design.

The development of the tricycle landing gear for large airplanes.

"Originally developed in France in 1911 by Louis Breguet, the tricycle landing gear was used for years on small airplanes. Eventually someone realized that planes with this type of gear never seemed to ground loop and the Army Air Corps determined to see if this would also be the case with large airplanes.

"The Army gave the problem to Douglas and there, Chief Engineer, Art Raymond, turned the investigation over to me and my staff. We built a three-wheeled wagon with an adjustable front wheel, loaded it with sand bags and towed it by truck on the runway at Clover Field in Santa Monica. We would tow it at speeds up to 45 miles per hour, disconnect the three-wheeled wagon and film it as it coasted to a stop.

"Once we proved that the concept was practical and could carry sufficient weight, the project was turned over to Dick Goldstein who set up flying tests in a Douglas Dolphin amphibian fitted with a tricycle landing gear. The Dolphin tests proved that the tricycle landing never ground looped.

"When Douglas got the contract for the B-19, which was to be at that time the world's largest airplane, our Chief Designer, Ed Burton, told me to put it on a tricycle landing gear. I prepared the stress analysis and the loading layouts and they assigned me a dozen engineers to help complete the work. From that day to this, the tricycle landing gear is the standard on large airplanes.

Wing folding for naval aircraft.

"Lee Atwood, Douglas' Head of Preliminary Design, came to me with the Navy's request for wing folding. He brought with him a preliminary sketch that he had made and asked me to design and develop it, which I did. When the time came to apply for the patent, Lee Atwood had already left Douglas to become Chief Engineer at North American Aircraft, but I put both our names on that patent application. He went on to become president of North American.

Flush riveting

"There had been many attempts to achieve flush riveting, primarily in Germany where they led in the early development of the sheet metal airplane. Hot, cold and spin riveting were attempted, susally using a separate tool to make the indentation into which the rivet was seated. The idea of using the rivet itself as the tool was original with me, as was the structure of the 100 degree rivet, now in use all over the world.

"My staff and I were given the order to produce a flush riveting system by Ed Burton, Douglas' Chief Designer. We tried to use a tool but abandoned this because it didn't give a good rivet seat. I did not even consider hot riveting as there were too many variables. When you do something like this you imagine all the possibilities and try them all. Some are dismissed out of hand as completely unworkable. Others you find out won't work by experiment.

"The standard rivet was then 86 degrees. It didn't produce a good flush rivet as it had too much metal in the head so we had considerable redesigning to do to get the particular form of the 100 degree rivet that is the standard in the industry today.

"When the patent for the riveting tool was applied for, I put the names of myself and five of my staff on it. The patent examiner responded that six people could not invent anything. I asked him, well how many people can invent something? He said three is the greatest number of people who can invent something so the patent is in my name and the names of only two of my assistants.

Conversion of Douglas to sheet metal profiles.

"I think that this was probably one of the most important contributions that I made during my six years as Head of Structural Reserach at Douglas. I developed a system of fuselage construction using rolled section longerons from sheet strip metal to replace what was then the industry standard, the use of extruded sections.

"In 1937 I persuaded Douglas to change over to this stronger, more efficient and less expensive method of construction. With the outbreak of World War II with its sudden increase in demand for military aircraft, the industry found itself unable to respond due to a shortage of extrusion presses, except for us at Douglas, for we were by then using rolled sections.

"Today, all the major aircraft companies except Lockheed use rolled sections, even Boeing. It is one of the few things Boeing ever picked up from Douglas.

Pavlecka's development of the jet engine.

"When in 1930 we started designing the MC-38, we found that there was no really suitable power plant to drive it and I started thinking about a turbine, a steam turbine. We could use the heat to add superheat to the helium and the airship could carry the bulky and heavy elements of the engine easily. But my associates were skeptical and they didn't dare even suggest the idea to the Navy.

"In 1933 when I came to California I gave the steam turbine idea up and turned instead to the gas turbine as a candidate to fill the gap in available engines that I felt existed not only in airships but in other areas of aviation as well. The gas turbine had a very bad reputation among engineers. One had been made in France in 1906. It worked but only had a three percent efficiency. Even so, the company made a fortune with it. All torpedos at the time were driven by steam turbines. It is an interesting fact that no company has ever lost money building turbines. I collected all the information I could find on gas turbines and determined that, despite its bad reputation, it could be used as an efficient aircraft power plant.

"I presented my findings to Douglas management and they turned my proposals over to pratt & Whitney who sent it to their consultants at MIT. And they decided it wouldn't work. I knew they were wrong and I assembled a lecture with 87 slides. I still have them. And I gave this presentation to various groups in hopes of finding someone to back the jet engine.

"Northrop asked me to come to his home to give my presentation. He had about 40 people there and when I was through giving this illustrated lecture on the feasibility of the jet engine, he came up to me and asked when we would be able to start. This was in 1939 and I left Douglas and started with Northrop. I think it was two months later at the beginning of 1940.

"We went to the Navy and they said we had to change it to a turboprop to keep it from burning the wooden decks of their carriers. The Air Force was not interested in the jet engine at all, until General Arnold saw the Gloster Meteor fly in England powered by the I-40 Whittle engine. He had two of them flown directly back to General Electric to copy. The Air Force thought since GE made electric generators, they could make jet turbines. Actually they work exactly the reverse of each other and GE didn't want to get involved with it but the Air Force insisted.

"Meanwhile we at Northrop got nothing from the Air Force until June 1941 when we got the go-ahead to build our 40,000 hp compressor for this 10,000 hp turbine that General Arnold had brought back to GE a year earlier. Not until 1943 did we get the go-ahead on the engine which was completed in 1945. It was designed for the Flying Wing but was never used in it. Our engine, the Turbodyne project, was finally purchased by GE.

"Actually the British could have had the jet in 1929 but nobody would listen to Frank Whittle as he was a difficult man to get along with. Dallenbach and I developed our theory in this country and at the end of the war we found out that two men in England had done the same work and gotten the same results. Everyone, of course, during the war was working alone. We had no information at all on what the Germans, the British or even the fellow in the U.S. working for the forerunner of NASA, the National Advisory Committee for Aeronautics, was doing.

Comments on John Northrop.

"John Northrop was a strange man. I was at Northrop Aircraft for only two years. We had been at Douglas together though we did not know each other well. But when he started his own company, he started with several second-rate designers. We started in Hawthorne. Our engineering offices were in a former bordello. I'm sure he didn't intend it to be this way but the people he had around him would report to him all the plant gossip in order to curry his favor. Then they began spying on each other and reporting to him. It got quite out of hand and became a very bad atmosphere. In 1945 or 1946 he came to work as usual one morning, left the plant at lunchtime and never came back; just walked away and left it.

The Heliarc and Argonarc welding processes

"Jack Northrop wanted to build his airplanes out of magnesium. He knew that I had worked with magnesium at Douglas and this was the main reason that he asked me to come with him when he started his own company.

"Eventually the experiment proved to be unsuccessful as we found that magnesium was more prone to corrosion than other metals. But in the meantime we made considerable progress in building a pursuit plane of magnesium alloy. I had immediately discovered that magnesium structures could not be properly welded by the normal oxy-acetylene process. We tried to make it work and didn't succeed.

"I told Jack Northrop that it wouldn't work but I would like to try to shield the eweling arc with an inert gas like helium or argon to protect it from impurities in the air. I had worked with helium in lighter-than-air and I thought it could work. I knew General Electric had just developed atomic arc welding and though they hadn't been able to sell the process to anyone yet, some of the equipment they had developed could be used for our purposes.

"I wrote to them to ask if they had ever used helium to protect the electric arc. For six months they didn't answer. Then five GE engineers came to see us. I showed them what we were trying to do and they said they'd get back to us. Six more months went by and finally we got a letter from them. No, they said, they had never tried shielding the arc with inert gas.

"By that time, I had designed the torch and was convinced it would work. But Jack was getting nervious. One day in February 1941, he called me into his office. I'll never forget that meeting. Mr. Cohu, the Chairman of the Board, was there. Claude Munson, the Controller, was there. And Jack Northrop was there.

'Pavi,' Jack said, 'you're getting nowhere with this welding process and you're spending entirely too much money on it. We've got to drop it.'

I couldn't believe it. 'How much have we spent?' I asked.

Munson had the figures. It was $3,400. The welding department had been charging all their mistakes to my account. In reality, my department had spent only about $300 on the project. I convinced them of this and explained that we were still waiting for the refractory electrodes that GE had been promising to send us for over a year. Jack said that if we didn't get results by the end of the month, we would have to drop it.

"Well, the electrodes did arrive and the process worked perfectly. I patented the torch but we found that GE had taken out a patent on gas shielding of the arc some 13 years earlier. In 1942 the Lincoln Arc Welding Foundation gave me their First Prize for the development of the Heliarc and Argonarc welding processes. Northrop sold the patents to the Linde Company and today, Fortune magazine estimates Heliarc welding is a $10 billion worldwide industry. Pretty good for a $300 investment.

The MC-7

"The MC-7 is the smallest ship that can still do a job that can make money, the smallest ship that can perform a commercial function. Yet even though small, it can still prove the three design concepts that will make it unique. These are its Metalclad hull, hull rigidity under positive gas pressure and thruster control. After these three we will be concerned with boundary layer control and hydrogen fuel engines.

"The MC-7 will use air valves rather than rudders and elevators. Larger Metalclads will use thrusters rather than air valves.

"It should cost just under $100 million to build the MC-7. It will have four interior gas cells so if one is deflated, the ship will still fly. The cell partitions are of bonded Mylar, very light but strong and long-lasting since they are inside the hull and never see the sunlight which is harmful to them.

"The hull will be a new alloy of lithium and aluminum recently developed by Alcoa, far stronger and lighter than the old Alclad hull of the ZMC-2.

"I believe there is a world market for 300 to 400 ships of the MC-7 type including three ships for each of the forty maritime nations simply as patrol ships to enforce their new 200-mile sea frontiers.

Pavlecka's personal feelings about the modern airship.

"I am the only one surviving from those days, from the ZMC-2 design team. If I don't do this, it won't be done. Everyone else would have to start from scratch. I feel a great responsibility to pass my knowledge on.