The Aviation Supply Chain: Challenges And Responses
Testimony Before the U.S. Senate Committee on Commerce, Science, and Transportation

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Madam Chair Cantwell, Ranking Member Wicker, and Members of the Committee, thank you for asking for me to testify before your committee today. I am privileged to provide you with an overview of the aviation industry supplier base.

I am Vice President of Analysis at Teal Group, a leading aerospace market analysis consultancy based in Fairfax, VA. I manage consulting projects in the commercial and military aircraft field and analyze broader defense and aerospace trends. I have advised numerous aerospace companies, including most prime and many second- and third-tier contractors in the US, Europe, and Asia. I also advise numerous financial institutions on aerospace market conditions and industry dynamics. I have been in the industry since 1988. All my public writings and comments on the industry can be found at www.richardaboulafia.com.

Today, I would like to discuss three things with the Committee: (1) the structure and characteristics of the aviation industry supply chain; (2) the market, and other challenges to suppliers; (3) questions that should be asked by the Committee, along with my recommendations for future action. I am also happy to answer any questions you might have.

1. Industry Structure And Characteristics

The Supply Chain's Importance

The supply chain is the heart of the aviation industry, because of three factors: **Value, Innovation,** and **Vulnerability.**

First, the components, structures, systems, and technologies provided by the aviation supply chain represent the strong majority of the **Value** of any given aircraft. When Boeing sells a jetliner, or Lockheed Martin sells a fighter jet, suppliers, collectively, realize more revenue than the primes (Boeing and Lockheed Martin) do. There are almost no exceptions to this pattern, whether it is a transport, helicopter, business jet, or any other type of aircraft.

For a typical Boeing jetliner, 80% of the value gets added at the supplier level. Of course, employment, tax revenue, and other key metrics mirror this reality: the supply chain is of greater importance to the economy compared with the primes for many reasons.

Second, it is important to note that much (and often most) of the **Innovation** that takes place in aviation happens at the supplier level, and not at the prime level. Boeing's 737 jetliner, its F-15 fighter, Lockheed Martin's F-16 fighter, and many other platforms have been in production for around half a century. But the current models have very little in common, aside from exterior

shapes, with the original production versions. The rejuvenated jetliners use much less fuel and produce much fewer emissions. The rejuvenated combat aircraft are vastly more effective.

The successful transformation of these aircraft is because of the tremendous innovation that has taken place at the supplier level. Suppliers have created new and improved engines, avionics, systems, electronic warfare suites, materials, and more, which have been applied to these aircraft. Therefore, a steady flow of research and development (R&D) funding, for and by suppliers, is essential for the industry's future growth, industry competitiveness, and for the overall good of the aviation transportation system.

Third, as with most complex manufactured products, an aircraft production system is only as strong as its weakest link. That is, if a supplier company fails, somebody needs to step in to buy it, or to give it the capital or other resources needed to stay in business. Otherwise, the aircraft in question is not built.

The health of the supply chain, therefore, is critical to the aircraft industry. Given the enormous stresses experienced by the supply chain over the past two years, company failure, or inadequate resources for supplier capacity expansion and technology development, are some of the biggest risks faced by the industry. The supply chain, crucial to industry success, is also its greatest **Vulnerability.**

High Barriers to Entry and High Levels of Concentration

The aviation industry has very high entry barriers. Since World War 2, only one country (Brazil), and one company (Embraer) has successfully entered the jetliner industry. Very few companies – around five – have successfully entered the smaller jet industry. Worldwide, more companies have exited the jet industry than have entered it.

Entry barriers at the supplier level are also quite high. Most suppliers have been in business for 50 or 60 years, and while small, niche companies have been created, they are the exception. Very often, they are simply purchased by the larger, established suppliers.

There has also been a great degree of concentration in the industry. The aviation supply chain saw a series of mega-mergers over the past few decades. As a result, some supplier companies, such as Raytheon Technologies, General Electric, or Safran, are about as large, or larger, than some of the biggest aircraft primes.

Having said that, there are still a large number of suppliers at the Tier 2 or Tier 3 level that are small, and relatively fragile. While there's little risk from emerging competition (due to the high entry barriers), these smaller companies still face serious challenges in accessing capital and improving their products and processes.

Impact of Globalization

The supply chain, like the rest of aviation and aerospace, is a highly globalized industry. Components built by U.S. suppliers find applications on platforms throughout the world. In fact,

one key U.S. supplier component, Pratt & Whitney's Geared TurboFan engine, has become quite successful purely on the basis of powering jets built by foreign aircraft companies.[1]

However, it isn't always an equal playing field in the world. Suppliers from allied countries, such as the U.K, France, or Italy can readily find applications on US aircraft, even military ones. But U.S. suppliers have a much harder time being sourced on European military aircraft.

Some of this problem results from U.S. International Traffic in Arms Regulations (ITAR) regulations. Aircraft designed with U.S. components are perceived to be problematic in international competitions, where U.S. Government decisions can prevent the sale of any aircraft that has U.S. components on board. Similarly, technology transfer restrictions have also resulted in US suppliers being disadvantaged on combat aircraft built in countries without their own supplier companies.

South Korea's KF-21 is a good example of that. U.S. Government reluctance to transfer data pertaining to U.S. technologies and systems, and to provide export licenses for these systems has resulted in significant competition losses. European companies, for example, have been tapped to provide this new fighter's radar, and other systems, largely because the U.S. did not want to provide the necessary data and licenses.

Also, government-funded R&D programs seldom cross borders (although companies do successfully cross borders with their own privately-funded R&D). When governments support their industry with commercial or military R&D development programs, the beneficiaries are almost always exclusively domestic firms. That is true in the U.S., and in other major aviation producer countries.

Some countries that only have an aviation supplier industry (as opposed to an in-country prime contractor) are more willing to make these programs accessible, since their own industry depends on global trade. The Netherlands is a good example of that. But most large aviation powers, such as France or Japan, have their own prime contractors, and do not make their much larger government R&D programs accessible to companies domiciled in other countries.

One unique characteristic of the aviation supplier industry is that globalization has not seen the rush to low-cost sourcing seen in many other industries. Rather, the overwhelming majority of foreign suppliers providing components for U.S. aircraft are from high skill, high wage countries. Japan, France, Canada, the U.K., and Mexico are the top sources for these components, but almost all of the components and structures shipped from Mexico are actually sourced from transplant factories owned by U.S., Canadian, or French supplier companies.

China, notably, is not a significant source of aircraft components, even from transplant factories. In fact, at the peak level of U.S.-China aerospace trade, the trade balance between the two countries was 17-1 in the U.S.'s favor.[2]

[1] https://www.forbes.com/sites/richardaboulafia/2017/07/30/a-stunning-u-s-industrial-success-shows-problems-with-trumps-made-in-america-push/?sh=3c9149997c0c
[2] https://dataweb.usitc.gov/

2. The Market and other Challenges

An Unprecedented Downturn

The entire aviation manufacturing industry has been impacted by the worst air transport downturn in history. The Covid-19 pandemic, and the associated lockdowns and travel restrictions, have resulted in numbers heretofore unseen in the aviation industry. Historically, in a bad year for the market, air travel typically falls by 2-3% year-over-year; in 2020 it fell by 66%. Only massive government intervention, in the U.S. and other countries, has staved off mass airline bankruptcies.

As of this writing, however, the situation is improving. The over-all economic picture is far better than feared. Domestic travel markets, particularly in the US and China, have come back strongly. The most recent traffic numbers show US domestic flights up 3% relative to the same period in 2019, the first time these numbers have turned positive since the pandemic began. Even European flights, which were down 62% in May (relative also to 2019) have started to make a strong recovery, with the most recent numbers down just 34%.[3]

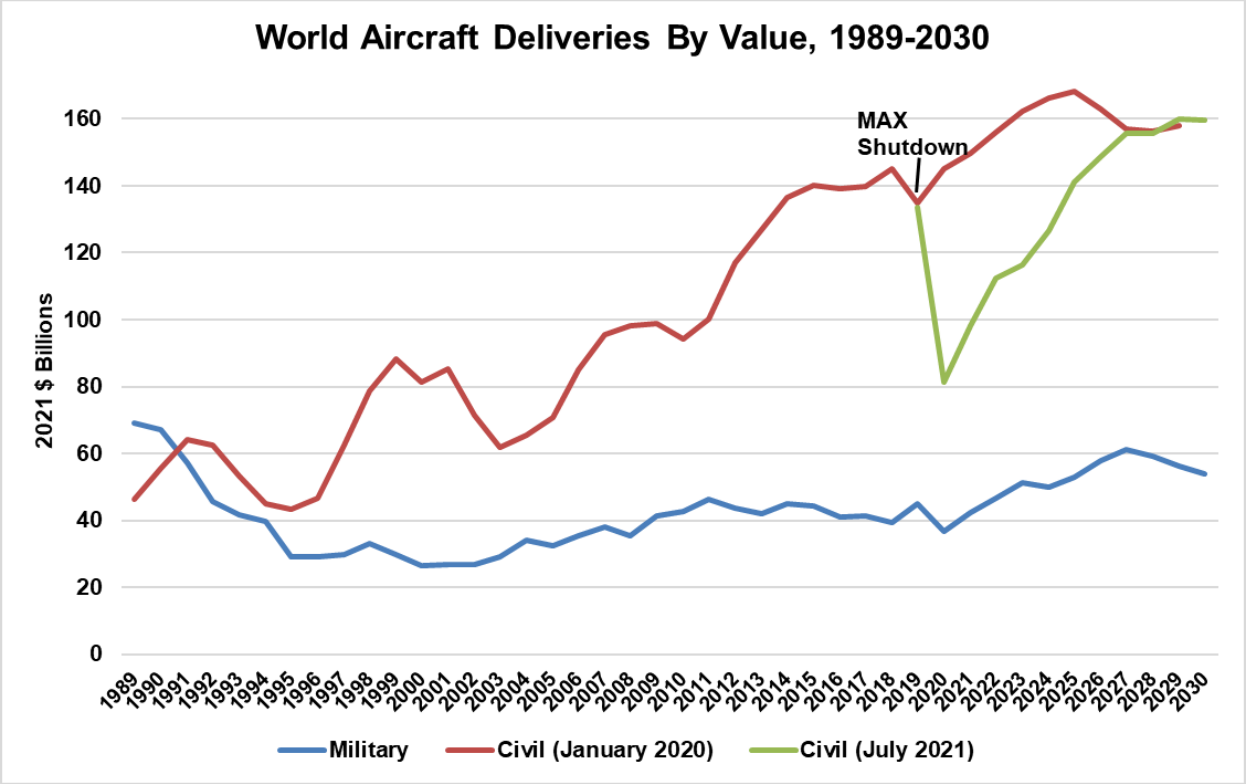
In fact, we now expect a return to the 2019 revenue passenger kilometer (RPK) travel peak in late 2022. And meanwhile, jetliner financing is inexpensive and readily available, and fuel is getting expensive again – the perfect formula for renewed jetliner orders (particularly single aisles).

The only area of serious concern, outside of Covid-19 itself, is China, the biggest single export market (and tied with the US for biggest single market). At the peak level of deliveries to China, 2018, the country took 23% of all jetliner deliveries worldwide. This has fallen precipitously, for both market reasons and due to geopolitical factors. This trade is under threat, due to slowing in-country growth rates, China's reluctance to recertify Boeing's 737MAX, and the U.S. Government's decision to put Western components for China's ambitious national aircraft programs on a possibly restrictive export list.

However, for the supplier base, the Covid-19 downturn came after another traumatic event: the grounding and production halt of Boeing's 737MAX. This is the second largest volume program in the world, and easily the largest in the U.S. Some supplier companies have a very high level of exposure. For fuselage provider Spirit AeroSystems, and many of its suppliers, this level of 737MAX dependence is in the 50% range.

The impact of the Covid-19 downturn on the civil aviation market can be seen in the chart below. The 2020 line (red) illustrates the market outlook as of right before the pandemic (with a MAX-related downturn in 2019-2020). The green line shows current projections, but also what happened to the market in 2020. Deliveries of commercial jetliners fell by 50% relative to 2019, and again, 2019 was already a weak year due to the 737MAX shutdown.

[3] Bank of America equities report, "Commercial Aerospace Tracker," July 13, 2021



The above chart also illustrates the relative sizes of the civil and military segments of the aviation industry. The civil side is simply much larger, if not always as profitable, compared with the military side of the business. Thus, while military revenue has helped stabilize the supply chain, it simply cannot compare to the volumes seen in the commercial sector.

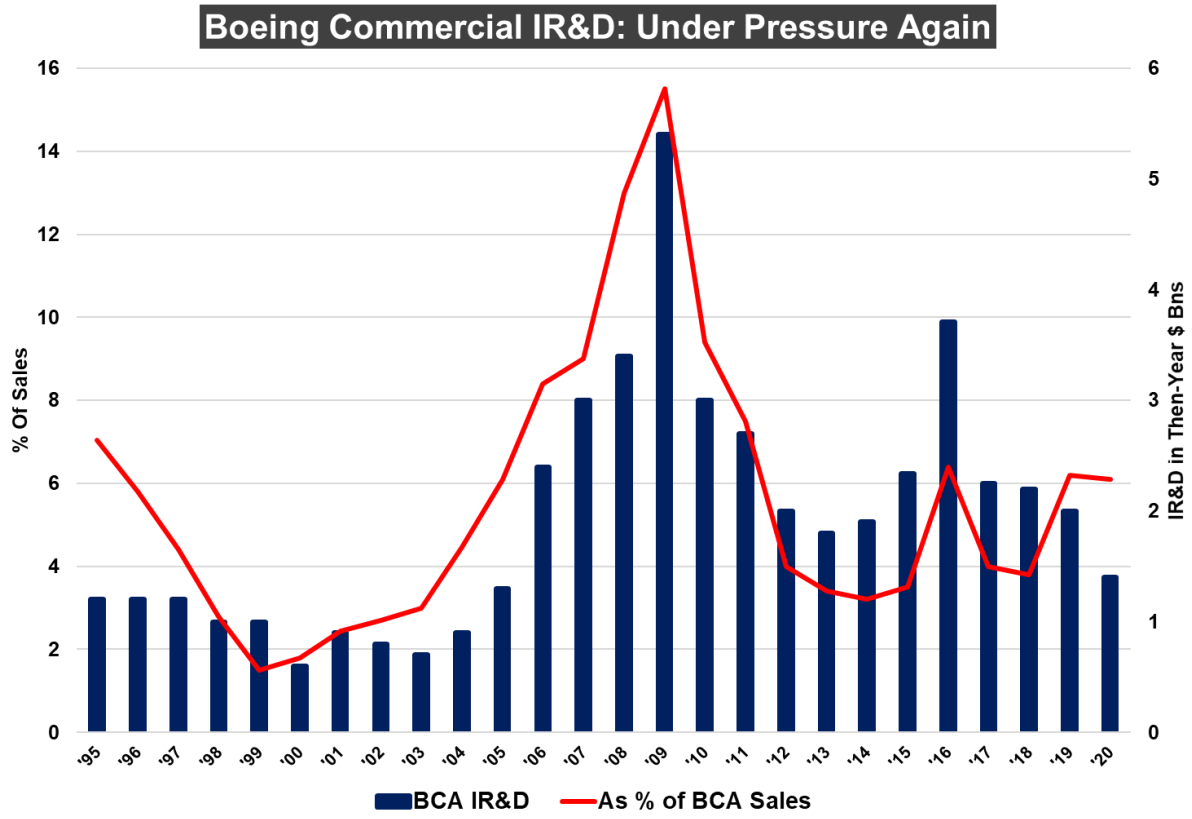
For aviation suppliers with a heavy exposure to the aftermarket, or maintenance, repair, and overhaul (MRO) part of the industry, the unprecedented falloff in utilization has resulted in a revenue decline even worse than that seen with new-build aircraft. Even for supplier companies that don't rely on the aftermarket for the majority of their business, this decline has been painful, since aftermarket work tends to be more profitable than new-build production.

Boeing's market position

Another challenge faced by the supply chain concerns Boeing's market position. Despite the industry's globalization, U.S. supplier companies, in aggregate, are more exposed to Boeing relative to its rival, Airbus. Right now, however, Boeing seems prepared to cede market share to Airbus. This may change as the market recovers, and Boeing is clearly under a great deal of financial pressure as a consequence of both the 737MAX shutdown and the industry downturn, but right now the outlook for the company's future product development efforts is a serious concern for the industry.[4]

[4] See, for example, https://aviationweek.com/aerospace/program-management/opinion-will-boeing-become-next-mcdonnell-douglas

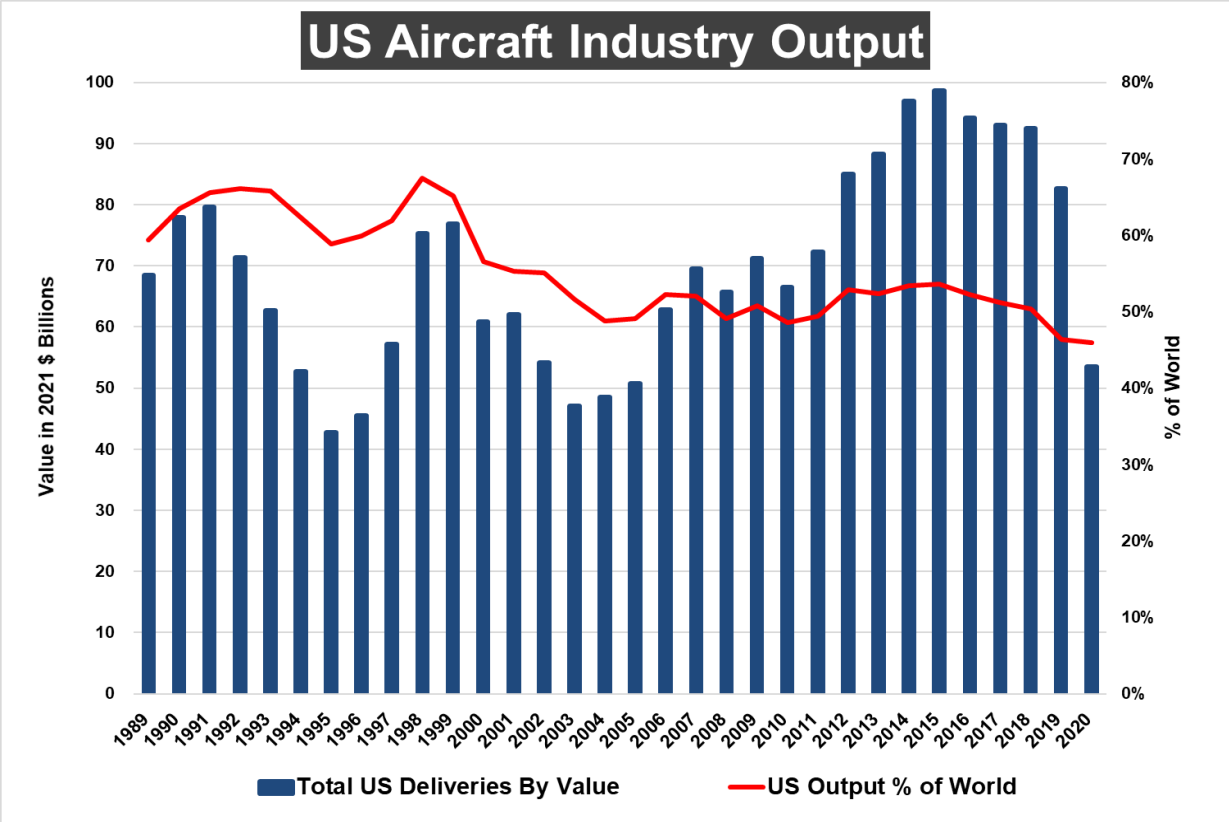
The European company's A321neo is a very strong performer in the mid-market segment. Boeing, by contrast, has cancelled plans for its own new mid-market jetliner. It hasn't launched a completely new jet in 17 years. It continues to cut its engineering team. As the chart below indicates, it has slashed R&D, with a further 27% cut last year alone.



Assuming Boeing does nothing new, and the duopoly goes from a 50%-50% market share balance to a 60%-40% one in Airbus's favor (this is our projection), then on balance, U.S. aviation supplier companies will face a similar decline. The companies with substantial Airbus exposure will be immune from this, but again, many U.S. suppliers are heavily reliant on Boeing.

Boeing has also been quite aggressive with its supply chain in terms of contract terms. Boeing programs such as Partnering For Success (PFS) were designed to pressure suppliers on prices, intellectual property, aftermarket access, and other terms. It isn't clear whether Boeing will begin to take a softer approach, now that much of its supply chain faces very different circumstances (relative to the good years before the MAX shutdown, when the supply chain was healthy enough to withstand these contractual changes and pressures).

The extent to which U.S. industry relies on Boeing can be seen in the following chart, which shows U.S. aviation industry output in both absolute and relative (to the rest of the world) terms. As a percentage of world deliveries, U.S. output has been fairly stable at just over 50% for several decades. However, in 2019 and 2020, this shifted below 50%. Obviously, the serious decline in 2020 (in absolute terms) was due to the pandemic. But the decline as a percentage in 2019 and 2020 was purely due to the 737MAX production halt.



Consequences

Despite the severity of the aviation market downturn, the aviation supply chain has generally weathered the storm rather well. Several smaller companies have gone bankrupt, but these represent well under 1% of supplier capacity. For almost all companies, relative health has depended upon portfolio: those with the most defense work have done best. Those with the most exposure to twin aisle jets (the single most impacted part of the aviation business) or to the 737MAX, have generally been hit hardest. But again, there have been very few outright bankruptcies.

However, there are many concerns for the future of the aviation supply chain, for two reasons:

First, it is important to consider the reasons that almost all aviation suppliers have come through the crisis intact. Government support is one of the biggest reasons, particularly with paycheck protection programs. Similarly, defense spending, while not as large as commercial market numbers, is relatively strong, particularly compared with the last commercial jetliner market downturn (in 2002-2003). The Department of Defense's accelerated payments program, aimed at stabilizing the aerospace industrial base, has been very helpful.

Supplier companies have also taken almost every possible defensive action. They have sold assets, fired or furloughed workers, burned down work-in-progress, and conserved cash any way they can. These were tough calls, particularly with headcount reduction; but, when topline

revenue falls drastically, the only way to avert financial disaster is to cut variable costs, which, for the most part, means cutting payroll.

Also, financing, so far, has been available to suppliers. Banks and other lenders have been patient, and have provided new financing. Interest rates are low, which helps with debt servicing.

Yet all of these measures have run their course. Debt has been increased, capacity and workforce cuts have been made, non-core businesses have been shed, and the Pentagon has done all it can. Defense budget growth has halted in real terms, and accelerated payments, inevitable, have run their course.

Second, it is important to consider the challenges ahead. When jetliner production rates rise again, many supplier companies may have a difficult time raising the capital needed to make capacity investments. Labor costs increases and other inflationary pressures could exacerbate these capacity expansion challenges.

In short, these survival tactics have resulted in a rather brittle supplier base. These companies have shed assets and taken on a great deal of debt. Inevitably, R&D funding for new technologies has been slashed too, endangering future competitiveness.

Finally, given the concerning development of Covid-19 variants, such as the Delta variant, there are valid reasons for concern regarding the recovery's trajectory. If anything were to disrupt the market recovery, such as another round of pandemic-induced lockdowns, the resulting production cuts would endanger the health of a very fragile supply chain. Concerns about its health would range from short-term financial viability worries, to long-term R&D funding questions.

3. Questions and Recommendations

Questions

In my opinion, the Committee might want to ask the following ten questions about the health of U.S. aviation supplier industry:

1. Is the market crisis over? Or, will the industry face another downturn, possibly one induced by a broader economic stumble as current government aid programs expire?

2. Will financial weakness in the supply chain impact the production ramp-up that will hopefully be associated with a market recovery?

3. Human capital is a major possible bottleneck; can suppliers bring back skilled employees after deep cutbacks?

4. In addition to labor, what other inflationary pressures (energy, materials) do suppliers face? Do their contracts allow for pass-throughs of these inflated costs? How badly did

prices fall for jetliners, and are suppliers further subject to declining revenue here as well?

5. Will private equity and other financing sources be available to help suppliers with capital (or to buy them) in the next few years?

6. Are U.S. suppliers at risk of acquisition by non-allied countries?

7. Are current ITAR reforms sufficient to enhance the competitiveness of U.S. suppliers on the military export market?

8. What is the status of U.S. components on the Military End User (MEU) list? The Trump Administration put many of the constituent companies of China's COMAC (their aspiring state-owned jetliner company) on a list that may, or may not, prohibit component exports. Since China's jetliners will be much more difficult (and perhaps impossible) to develop without these inputs,[5] this was a very aggressive move, and the Biden Administration has continued this ambiguous policy. Is this part of an effort to negotiate a grand trade bargain (perhaps one including Boeing jet sales) to China?

9. Will US allies stay on the same page regarding China? The Biden Administration has made working with allies on China a priority. Calling a ceasefire on the WTO complaint against Airbus is part of that, with the objective of working with the Airbus countries on a united front against China's efforts to distort the jetliner market. Will those European countries say with the U.S. in this united front?

10. Will Boeing launch a new aircraft to effectively compete with Airbus in the mid-sized jetliner market?

Recommendations

I would offer the following seven recommendations to the Committee for actions that would be useful in securing the future of the U.S. aviation industry supplier base:

1. Initiate a government R&D "Sustainable Aviation" or "U.S. Clean Skies" program for aviation suppliers. Europe has moved aggressively to establish Zero Emissions targets for aviation, and is funding a wide variety of technologies under "Clean Skies" and other programs. The U.S. should consider the same for its supplier companies, particularly since the majority of EU country-funded research is not accessible to them.

The emphasis might be on sustainable aviation fuel (SAF) and other related technologies. This initiative would echo similar work begun in France, Germany, and the European Union, the latter with its ReFuelEU legislation to boost SAF. SAF and other research programs might be coupled with airline usage mandates designed to increase the guaranteed market for the new technologies.

[5] https://foreignpolicy.com/2021/02/16/china-aviation-industry-washington-trump-biden/

This clean skies initiative would also serve to employ engineers and technical workers at suppliers, who might otherwise be at risk of headcount reductions due to company-funded R&D cuts.

2. Move a greater share of government R&D dollars from basic to applied research. The composition of R&D is a serious issue because the U.S. Government is good at funding basic research but not as good at applied research. It would be good to consider a migration of Federal R&D dollars toward applied level projects to help out with U.S. competitiveness. This would also help to get technologies to market faster, and of course with supplier workforce issues. This migration would involve working with supplier companies to identify what is in the pipeline now, what the prospects are for acceleration, and how government money can help.

3. Clarify the China MEU list. For many suppliers, there is considerable uncertainty about this list: are component shipments for China's indigenous jetliner programs prohibited or not? If this uncertainty isn't a deliberate effort aimed at crafting a trade agreement with China, the terms and conditions of the MEU list should be clarified, so U.S. suppliers can again sell into this important export market without fear of legal ramifications at home.

4. Work to enhance coordination with Europe on China aviation policy. China is able to demand technology transfer from U.S. supplier companies, in large part, because it plays Europe and the U.S. off against each other for jetliner orders from Airbus and Boeing. If both sides agreed that jetliner orders would not come with pre-conditions like these (that is, if China adhered to the terms outlined in the WTO's Agreement on Trade in Civil Aircraft[6]), this would not be a problem. Eliminating technology transfer risk would help supplier companies sell into the crucial China market without fear of creating long-term competitors.

5. Continue to work on labor-centric assistance packages. Paycheck protection programs have been remarkably successful in helping the supply chain maintain its workforce during the downturn, and this will be crucial in maintaining the increased pace of output we will hopefully see as the market recovers. But if another round of PPP is needed, it would be better to have the terms and conditions lined up in advance. Also, U.S. companies continue to face a demographic "bathtub": there is a gap between many older, more experienced workers, and the younger next-generation, due to low levels of employee intake during the 1990s and early 2000s. There may be ways for the government to help with mentoring and training programs.

6. Direct the Department of Defense to provide greater clarity on its spare parts order patterns and inventory levels. Several suppliers report that they benefitted from a significant run-up in components orders at several times over the last year, but then, suddenly, orders fell to nothing. It's possible that DoD was increasing its orders as a way of helping supply chain companies during the crisis, but, inevitably, this resulted in filled warehouses, so orders have fallen off. Either way, guidance for industry on these patterns would be very helpful.

7. Accelerate and improve ITAR reform. It might be best to go back to the commitment made in the Export Control Reform (ECR) during the Obama Administration to review the Munitions List on the ITAR to see what might be added or removed. This would involve looking carefully

[6] https://www.wto.org/english/tratop_e/civair_e/civair_e.htm

at what technologies are now more widely available from competitors, in which case our controls were simply closing the market to U.S. industry, not keeping them from potential adversaries. Also, this means looking at what new and emerging technologies might have significant military applications and should be controlled, preferably in concert with our allies.

Again, thank you very much for asking me to provide testimony to the Committee. I will now be happy to answer any questions.