JUNE 2018

Aerospace Competitive Economics Study

(ACES)








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Prepared for: International Association of Machinists (IAM) District 751
Society of Professional Engineering Employees in Aerospace (SPEEA) on behalf of the Choose Washington New-Mid Market Airplane (NMA) Council

Prepared by: Teal Group Corporation

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Introduction

The findings of the Aerospace Competitive Economics Study (ACES) presented in this report address the competitive business environment that aerospace manufacturing and final assembly companies face when they consider locating in any of the 50 U.S. states or the District of Columbia. The results offer a comparative tool to help public and private interests evaluate the strengths and weaknesses of individual states as they look to attract new or expand existing aerospace manufacturing projects. While the results of this report should not be the only factor in determining a manufacturing location, they can provide significant assistance in understanding important underlying capabilities that can best support the aerospace sector.

The ACES report begins with a summary of the ACES rankings, followed by an industry analysis of aircraft markets and production site factors. The industry analysis section reviews the latest trends in the world aircraft market, commercial jetliner sales, the military market and competitive conditions in the market for midsize aircraft. Discussion and analysis from this industry section provides context for the ACES rankings.

The ACES rankings methodology is quantitative in nature; meaning that it is based on empirical measures of a state's economy and many of the associated factors that contribute to the ability of commercial enterprises to efficiently and profitably produce an aerospace-related product. While the focus is on empirical data, we recognize that there are other factors that cannot be measured, or for whatever reason have not been measured, that also contribute to a state's ability to positively support aerospace manufacturing. In this case, we make no attempt to include qualitative factors, such as political and labor relations, but we recognize their potential value in a fully comprehensive assessment.

The ranking methodology presented here uses forty-one metrics that are assigned to eight categories. Details on the individual metrics are included near the end of this report.

Individual metrics were chosen based on relevance, availability, consistency across states and potential impact to production and profitability. Wherever possible, and where relevant, metrics were chosen based on their ability to characterize the aerospace sector.

The eight categories included in ACES are presented in the table to the left. The assigned weights are based on an assessment of how impactful the category might be to the overall productivity and profitability of an aerospace company. The higher the likely impact to the income statement and profits, the higher the weight assigned. The metrics and categories chosen include elements that are directly or indirectly impactful. Direct impacts score a higher weight than indirect impacts. Additional discussion of the methodology is presented at the end of this document.

Category	Weight
Costs	20%
Labor & Education	17.5%
Taxes & Incentives	17.5%
Industry	15%
Infrastructure	15%
Economy	5%
Research & Innovation	5%
Risk to Operations	5%

The Costs category carries the greatest individual weight (twenty percent). The metrics included in this category (labor, material, energy and construction costs) are more directly related to a company's actual cost of operations than are metrics in other categories (i.e. education levels or spending on R&D). The Costs category is not intended to fully represent the actual cost of operations, but only aggregate measures that relate to operational costs, thereby impacting the overall competitive environment. A company's actual costs of operations are heavily dependent on its structure, requirements, supplier relationships and agreements, and numerous other factors.

It should be noted that labor and material cost metrics included in the study measure the cost of these inputs per dollar of output. This allows the study to incorporate the productivity of inputs, rather than simply measuring absolute labor and material costs.

Labor & Education and Taxes & Incentives have the same weight (17.5%), as do Industry and Infrastructure (15%), reflecting each category's slightly lower contribution to overall competitiveness. In total, these top five weighted categories comprise eighty-five percent of the overall rankings. Finally, Economy, Research & Innovation, and Risk to Operations fill out the remaining fifteen percent.

As the results show, some states are highly competitive across a number of the categories and individual metrics included in the categories, while other states are strong in a category or two, or not competitive in the least. The ACES analysis and findings focus on the aerospace sector, but some of the results for non-aerospace specific categories could apply to other sectors.

Additionally, state category rankings may change substantially from year-to-year. Tax metrics, for instance, are influenced by government policy which can change quickly within a legislative session, with rates adjusted and incentives increased, reduced or repealed. This year's ACES Rankings represent a quantitative snapshot of the current competitive landscape rather than an analysis of long term trends.

Finally, aerospace manufacturing encompasses a broad array of processes and products, and these different goods depend on different attributes in a production site. For example, manufacturing avionics or satellites involves a greater emphasis on a skilled engineering workforce, and relatively little emphasis on infrastructure. On the other hand, heavy manufacturing of large metal aerostructures involves greater emphasis on a skilled manufacturing workforce and physical infrastructure; composite structures would involve a greater emphasis on energy costs.

Given these diverse requirements, our criteria weightings and data reflect a balanced approach. In general, we have tried to look at the qualities most desirable for the manufacture or final assembly of large aerospace structures. ACES Rankings data for sales, exports, value added and other industry metrics are drawn from the aerospace product and parts manufacturing industry group (NAICS Code 3364), which includes "establishments primarily engaged in manufacturing aircraft, missiles, space vehicles and their engines, propulsion units, auxiliary equipment, and parts thereof." A manufacturer seeking to build, for example, missile engines or flight simulators, might apply alternative weighting to the various metrics and categories, or include a different set of industry data.

Summary of Findings

Based on the research conducted for this study, the states of Washington, Ohio, North Carolina, Kansas and Colorado offer the most competitive business environments for the manufacture of aerospace equipment. These states ranked high in a number of the evaluation categories and corresponding metrics.

Washington scored extremely well across all categories and was a top ten finisher in all but one. It ranked first in two categories: Economy and Industry, while finishing second in Labor & Education and Costs. It was ranked number five in Risk to Operations, Research & Innovation and Taxes & Incentives. Infrastructure was the only category where Washington fell outside the top ten.

Ohio had the second highest overall rank, with significant separation between it and the state of Washington. Demonstrating the substantial gap between first and second, Ohio finished in the top ten in only two categories, Labor & Education and Industry. It did finish in the second ten in a number of categories, thereby reinforcing its overall strong showing. These categories included: Economy, Risk to Operations, Infrastructure, Costs, and Taxes & Incentives.

North Carolina also had a strong showing in a number of categories and finished as the third highest ranked state. It finished first in the most important and highest weighted category, Costs. In addition, it had very strong rankings with two other top ten finishes in Taxes & Incentives and Industry. It had two second ten rankings in Research & Innovation and Risk to Operations.

Kansas came in fourth overall, with top ten category rankings for Industry, Labor & Education and Costs. It was at the bottom of the second ten for Infrastructure. Kansas was a poor performer in Risk to Operations, coming in at number fifty.

Colorado ranked fifth overall. It is particularly strong in Research & Innovation, Labor & Education and Taxes & Incentives, having top ten finishes in these three categories. The Economy and Industry categories came in second ten highest rankings. It did not score well in the important Costs category, thereby substantially limiting its ability to score even higher in the overall aerospace competitiveness ranking.

The remaining top ten is rounded out by **Georgia, Utah, Texas, Arizona and Alabama. Utah** was very strong in four categories: Research & Innovation, Economy, Taxes & Incentives and Risk to Operations. Georgia finished in the top ten in the Labor & Education category, while Alabama was very strong in Taxes & Incentives, and Industry.

Arizona ranked number one in the Risk to Operations category and finished top ten in two other categories: Industry and Labor & Education. Texas was highly ranked in the Taxes and Incentives category and scored well in Economy, Industry and Labor & Education.

State	Overall
Washington	1
Ohio	2
North Carolina	3
Kansas	4
Colorado	5
Georgia	6
Utah	7
Texas	8
Arizona	9
Alabama	10
Missouri	11
Virginia	12
Michigan	13
California	14
Oklahoma	15
Indiana	16
South Dakota	17
Florida	18
Wisconsin	19
North Dakota	20
Kentucky	21
South Carolina	22
Massachusetts	23
Connecticut	24
Pennsylvania	25
Wyoming	26
Oregon	27
Iowa	28
Arkansas	29
Minnesota	30
New Hampshire	31
West Virginia	32
Maryland	33
Idaho	34
Nevada	35
Delaware	36
Illinois	37
Hawaii	38
New Mexico	39
New York	40
Vermont	41
Nebraska	42
Tennessee	43
Alaska	44
Louisiana	45
Maine	46
Mississippi	47
District of Columbia	48
Montana	49
New Jersey	50
Rhode Island	51

Top 5 States for Each Category

Costs	Rank
North Carolina	1
Washington	2
Iowa	3
South Dakota	4
Missouri	5
Nevada	5

Labor & Education	Rank
Connecticut	1
Washington	2
Kansas	3
Colorado	4
Maryland	5

Industry	Rank
Washington	1
Kansas	2
Ohio	3
California	4
Florida	5

Infrastructure	
Massachusetts	1
Illinois	2
Vermont	3
District of Columbia	4
New York	5

Risk to Operations	Rank
Arizona	1
Oregon	2
Michigan	3
Utah	4
Washington	5

Economy	
Washington	1
Indiana	2
Iowa	3
Minnesota	4
Wisconsin	5

Research & Innovation	Rank
Massachusetts	1
California	2
Colorado	3
Utah	4
Washington	5

Taxes & Incentives	
South Dakota	1
Texas	2
Oklahoma	3
Alabama	4
Washington	5

Aircraft Markets & Production Site Factors

The World Aircraft Market: Best of Times

The competition for aerospace production work among US states and regions is intensifying for a simple reason: The outlook for the aircraft industry is now the best it has been for decades. Topline output continues at near record levels. Key segments look set for growth through the next three years, at least. There are areas of concern, and not all manufacturers will benefit equally, but overall the industry is in excellent shape.

World industry output in 2017 came to just over $180 billion. Deliveries in 2014-2016 have all been at about this level in constant 2018 dollars (2015 was the all-time record, at $183.5 billion).

However, the industry has been stuck on this plateau not for market reasons, but rather for reasons relating to production ramp difficulties with key new programs. Single aisle jetliners represent 25% of the value of this industry, and difficulties in transitioning between the last generation and the next generation have resulted in the present level of stalled output. The F-35 Joint Strike Fighter's slow production ramp has contributed to this problem.

But these numbers represent only the value of deliveries; they exclude the broader footprint of the industry, which is about two to three times as large as the value of total new build aircraft. The numbers also exclude research and development funding, and the generally more lucrative aftermarket sustainment business.

Therefore, since the new aircraft market is worth $180-$210 billion per year, we reckon that the total aircraft industry contributes $700-900 billion annually to the world economy (that covers the broader industry footprint plus research and sustainment). And this figure excludes numerous related industries, such as airlines, air traffic control, and military air base support services.

As the chart to the right indicates, for the past 15 years, topline deliveries growth has come primarily from the civil markets, with a 3.7% compound annual growth rate (CAGR) by value. Military markets have grown at a 2% pace, but higher defense budgets will grow this in the coming few years.

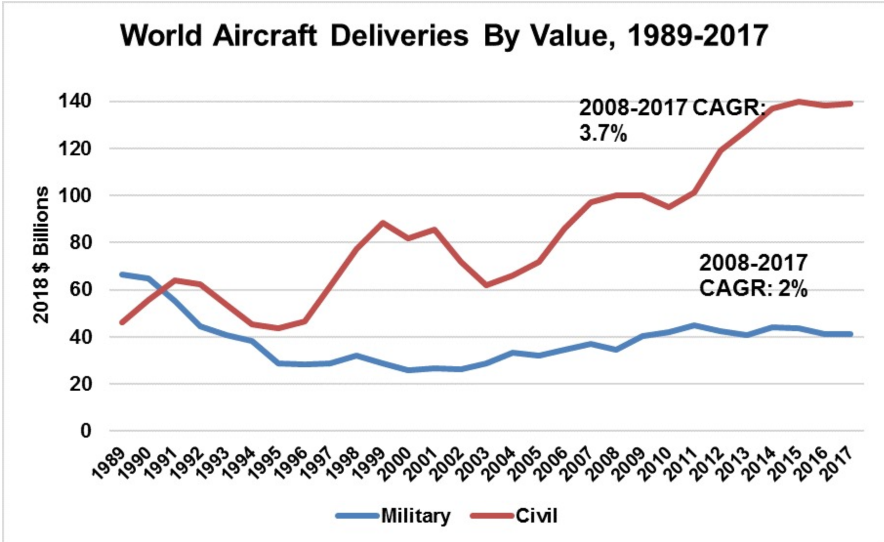


Chart 1

As chart 2 below indicates, US primes' share of this industry has remained relatively steady at just above 50% by value of deliveries for the last two decades. As the industry topline has grown, so has US output.

While this chart measures output solely at the prime level, US industry continues to do very well at the subcontractor level, exceeding the 50% mark in most key segments (engines, avionics, etc.) and equaling the 50% level in others (aerostructures, control systems, etc.).

The primary drivers of US industry at the prime level include Boeing jetliners and fighters, Lockheed Martin fighters, Gulfstream business jets, and rotorcraft from all three primes (Boeing, Textron/Bell, and Lockheed Martin/Sikorsky). Many other smaller manufacturers play a supporting role.

Given the relatively steady state nature of this industry, where there are few major disruptions and product life cycles are measured in decades, it isn't surprising that the US's aerospace trade surplus is relatively steady.

As chart 3 below indicates, the US has enjoyed a roughly 2.5-1 aerospace trade advantage by value with the rest of the world for decades. This higher ratio of recorded exports (compared with 1-1 output at the prime level, shown in the previous chart) reflects US industry's success at the subcontractor level, along with success in space systems, missiles, and in other markets.

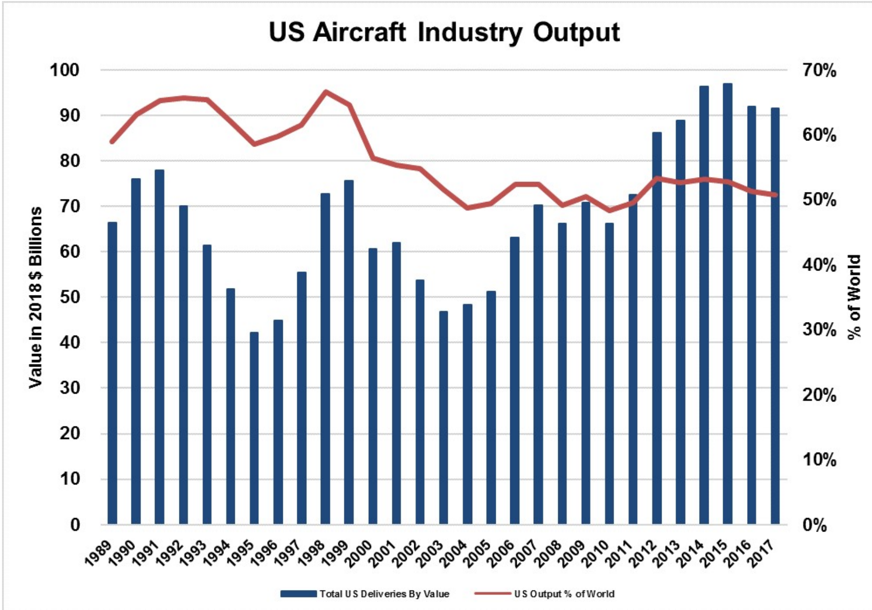


Chart 2

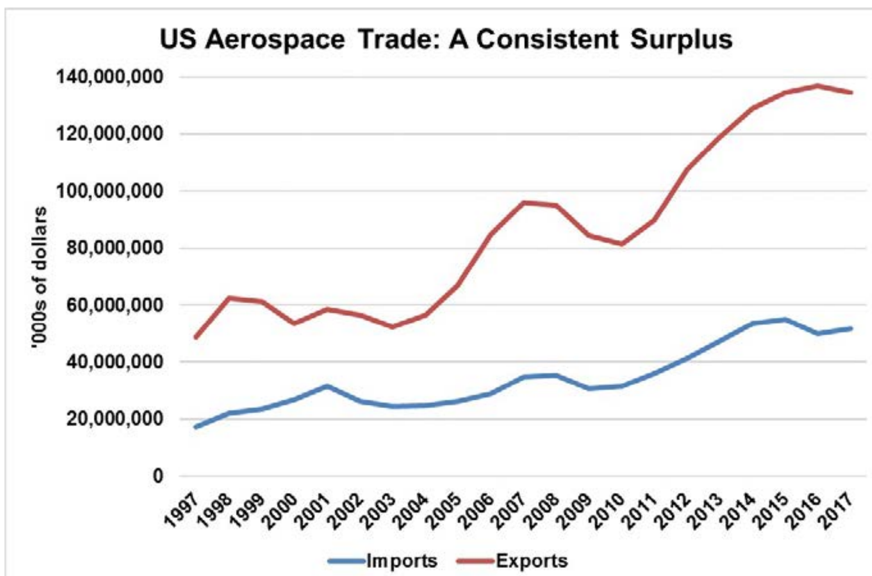


Chart 3

Jetliners Predominate

The world aircraft industry today is increasingly controlled by Airbus and Boeing. First, large commercial jets are now about 60% of total industry output by value, not just at the final delivery level but through most of the component and structures supply chain, too. The chart below indicates the relationship between commercial aircraft and the other segments.

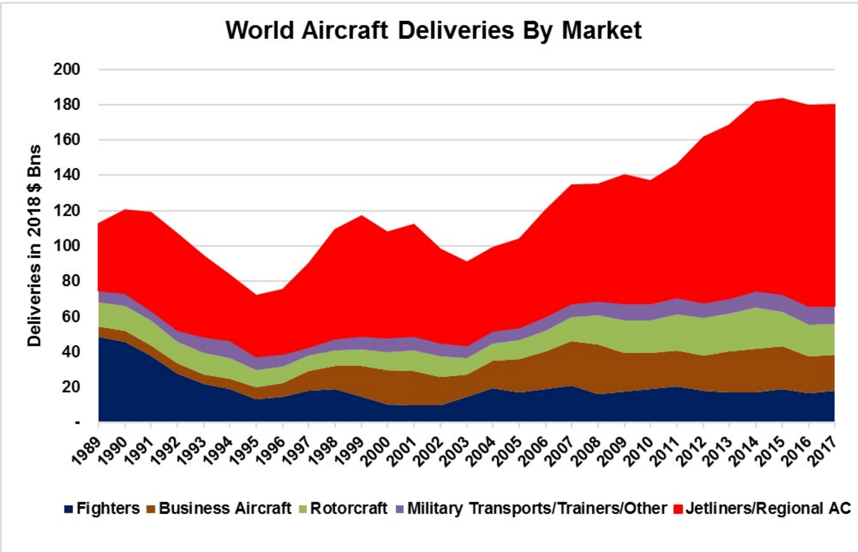


Chart 4

Second, Airbus and Boeing dominate because they are absorbing a greater share of the industry. The acquisition of Bombardier's CSeries – to be completed in the middle of 2018 – gives Airbus a new line of 110/130-seat jets, provisionally known as the A210 and A230. Meanwhile, Embraer and Boeing are moving towards creating a joint venture – to be controlled by Boeing – covering Embraer's E-Jet series, spanning 75-120 seats.

Therefore, in a year, the entire jet transport industry will be controlled by just two companies. And barriers to entry remain extremely high, as evidenced by China's multi-decade effort to break into the market, with few signs of success. Russia is trying to re-enter this industry, but aside from one money-losing regional jet it also faces a long and difficult road.

This industry is not just protected by high entry barriers; it also features extreme concentration at the top, in terms of major revenue-producers. Just a small number of jetliner models play a pivotal role in driving the market. The chart below shows revenue from deliveries over the past ten years and Teal Group's forecast for the next ten. The two major single aisle programs – Airbus's A320 series and Boeing's 737 family – constitute 25% of industry revenue.

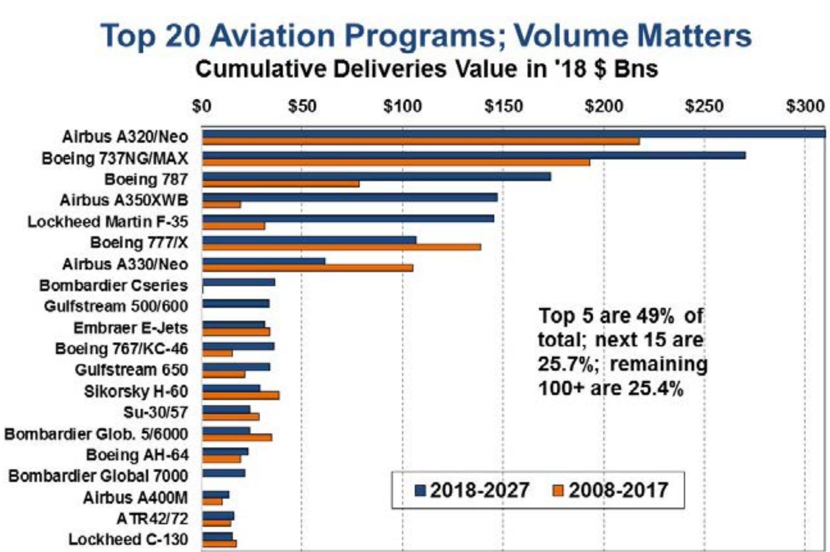


Chart 5

Of the top five programs (which represent half the aircraft industry in revenue) just one, Lockheed Martin's F-35 Joint Strike Fighter, is not a jetliner. Jetliners comprise eight of the top ten aviation manufacturing programs.

Today, the jetliner market is extremely strong. In fact, some are questioning whether the market has moved beyond cyclicality.

Since the jet age began, the market has seen a recurring pattern of roughly seven good years followed by three bad years, with deliveries in the bad years falling by 30-40%, or more, by value. Yet since 2004, the industry has enjoyed strong growth, with the exception of the 2016-2017 hiatus (due largely to the single aisle deliveries pause before A320neo and 737MAX deliveries ramp up).

With the exception of a few sluggish twin aisle programs, OEM plans call for continued growth through 2020, at least. The A320 family is on course for 60 planes per month, with the 737 headed for 57 per month. Boeing plans to raise 787 output from 12 to 14 per month in 2019.

If the current rumors are correct and Airbus and Boeing both go to 70 single aisles per month by 2023, the single aisle segment would have seen 450% growth (by value of deliveries) over 19 years, in constant year dollars. More single-aisle jets will have been delivered between 2010 and 2024 than were delivered in the first 51 years of the jet age, 1958-2009.

With over 12,000 jetliners on backlog at Airbus and Boeing alone, this momentum will continue through the end of the decade, largely due to those two new single aisle models. These single aisles represent 50% of industry output by value.
This means the jetliner market will have a 16-year growth cycle, and possibly longer. That's over twice as long as the usual seven-year boom, and this time, hopefully, we won't see an unpleasant bust cycle on the other side. The current Airbus and Boeing jetliner deliveries plan, and its relationship to the history of the market, is illustrated by the chart below.

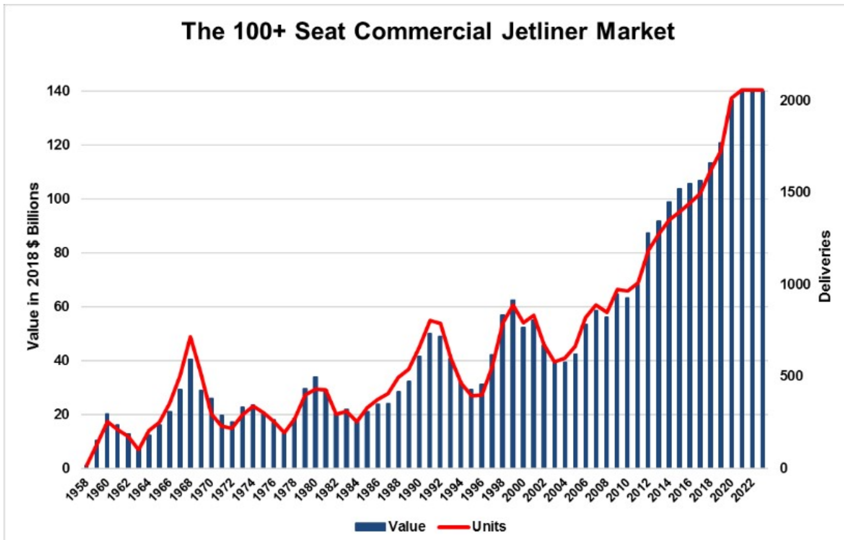


Chart 6

There have been three drivers behind this remarkable boom since 2004, and all of them are in very good shape.

One is the remarkable rise of China, both as an economy and as a jetliner market. In 2001, China accounted for just 3% of world jetliner output, scarcely higher than in 1991. By 2015, this had hit a record of 22%, making China the largest jetliner market in the world. In 2017 it reached 22.8%. This excludes leased jets delivered to China that year. And China's banks and lessors played an even larger role in world jetliner finance.

Two other key exogenous factors impacting jet demand are the price of fuel and the cost of capital. But it's the ratio between those two indicators that helps drive jetliner market health.

As of this writing, fuel is just above what might be termed the Goldilocks zone, $71/bbl for West Texas Intermediate. If fuel goes down, to $40 or below, airlines will be far less likely to re-equip with new, more efficient jets, and more likely to keep older equipment longer. If fuel goes up, to $80 or above, airlines will have a harder time making money, and as they raise fares to compensate travel demand will likely fall. But today's fuel prices are reasonably healthy for the industry.

Meanwhile, cash is still very cheap. The Federal Funds Effective Rate is just 1.5%, up from an extended period at around 0%. This is forecasted to get to 2.1% this year but considering that as recently as 2007 it was 5%, interest rates are still reasonably low.

The ratio between the cost of money and the cost of fuel plays a big role in airline thinking. A combination of 0% interest and $100 fuel effectively means that an airline should absolutely finance new jet purchases to replace older, less efficient jets. Today's ratio is still pretty good. By historical standards there's still a gap between these two metrics, even if it's far less profound than in 2009-2014. But 5% interest rates and $40 fuel would mean a lot of airlines simply hang on to older equipment.

Over the past two years, a third factor driving jetliner demand has kicked in. Airline traffic demand has been unusually strong. Revenue Passenger Kilometers (RPKs) grew 7.6% in 2017, well above the 5.5% average rate of the last ten years, according to the International Air Transport Association (IATA). Even the long-depressed air cargo market is back; Freight Ton Kilometers (FTKs) grew by 9% last year, the strongest numbers since the 2010 recovery. Airline industry profits have been strong, too, with $35.6 billion earned in 2016, and IATA now forecasting $31.4 billion in 2017.

This traffic growth (and industry health) far exceeds the pace of world economic growth. There's a long-established link between GDP and traffic, and traffic is now outperforming the usual GDP multipliers by a healthy margin. It's hard to say whether this will continue, but even if RPK growth falls to 2016's 6.3% level, that's sufficient to keep jetliner demand strong. While traffic is outperforming economic growth, the latter is also quite strong. The U.S. economy has now been expanding for nine straight years, with no signs of a slowdown. The IMF and OECD are both forecasting global growth of 3.9% this year, up from 3.7% in 2017. All the major regions of the world are enjoying this growth, and China, again the biggest single market for jetliners, is still growing at around 6.5%.

There are many things that could go wrong. In addition to a decline in passenger traffic and economic growth, a trade war with China or a slowdown in China's economy, and changes to the fuel prices/interest rates ratio, there's always the risk of an exogenous shock, such as a war or a terror attack. But our baseline scenario calls for growth through 2020. At that point, jetliner industry output, in real dollars, will be worth three times the level in 2004, when this super-cycle began.

The jetliner industry's remarkable growth is accompanied by a strong military aircraft market. However, as the chart to the right indicates, the US part of this market is increasingly dominated by Lockheed Martin's F-35. Also, there are even fewer new product launches in the military market than there are in the civil markets.

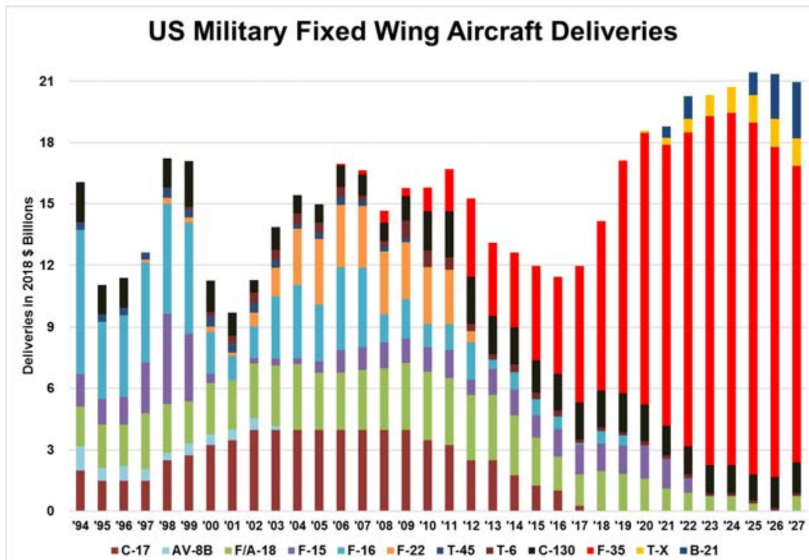


Chart 7

Despite its current good fortunes, Boeing faces a few challenges in the future. The military market outlook described above is clearly not in its favor. It's one of the biggest curiosities that the world's largest military aviation program is a US program, but the US's biggest aerospace company is one of the very few companies in the world without any kind of role in that program (the F-35). Northrop Grumman has won the B-21 bomber contract.

While the T-X trainer is still up for grabs, there are three competitors, and even if Boeing wins it would not provide much growth.

Also, as discussed above, even the current remarkable jetliner market will run out of growth in the next few years. Clearly, if Boeing wants to keep growing its revenue and profits, it will need to try new approaches. This explains why the company has established a separate aftermarket division, to pursue sustainment opportunities. It also explains why the company is establishing new capabilities in propulsion, actuation, and avionics, to pursue vertical integration opportunities.

But a third approach will be to look at where the company is weakest against Airbus, and to see what can be done to regain lost market share in that segment. The New Midsize Airplane (NMA) is a response to that middle market weakness.

Boeing & the Middle Market

In most segments, Boeing is ahead of Airbus in deliveries and backlog. Yet in aggregate, as indicated in our backlog comparison chart, Airbus is ahead by value of backlog. This is because Airbus enjoys a commanding lead in exactly one segment: the 190/250-seat middle market.

	1h 1997	1h 2001	End 2004	End 2006	End 2008	End 2009	End 2010	End 2011	End 2012	End 2013	End 2014	End 2015	End 2016	End 2017
Boeing	130.0	107.8	79.5	199.1	300.4	271.1	270.0	300.1	316.8	365.3	421.9	413.8	399.7	403.1
Airbus	48.6	112.9	115.5	173.0	281.8	268.2	277.6	309.5	321.6	397.4	436.3	456.7	463.0	436.8
Bombardier	—	—	—	—	—	2.0	3.5	5.2	5.8	7.1	9.5	9.5	9.2	13.1

Chart 8

Just below the middle market, the 737MAX8 and A320neo look evenly matched. Just above the middle market, in twin aisles, the 787-9/10 are generally doing better than the A350-900 and A330-900. Above that, the 777X is well ahead of the A350-1000. The 747-8 and A380 have ceased to be major factors in the market.

But in between the first two of these two segments, the largest 737MAXs – 9 and 10 – are being outgunned by the A321neo. The latter has about 2,000 orders, while there are just over 500 known MAX 9/10 orders (more may come from the "undetermined" group of MAX orders, but this would be at the expense of the MAX8).
The current state of 190/250-seat backlogs can be seen in our chart, which clearly shows that if it weren't for this segment Boeing's overall backlog would be well ahead.

Boeing's response to this challenge is the proposed NMA, a clean-sheet twin aisle design which will seat 220-260 passengers with 5,000-5,500-nm range. Air Lease Corp. Executive Chairman Steven Udvar-Hazy even gave it a proper Boeing designation: the 797.

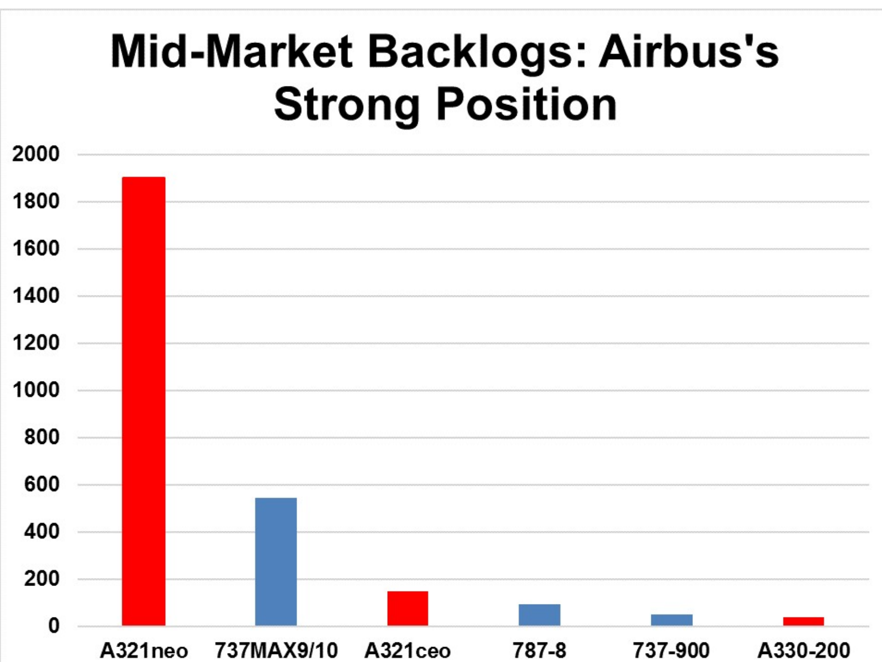


Chart 9

There are two possible problems with Boeing's NMA concept. First, there's the market. Any projection of trends over the past 30 years—airliner fleets, orders and deliveries—clearly shows that single-aisle middle-market jets have enjoyed stronger growth than twin-aisle middle market jets. The mid-market demand ratio is now at least 3:1 in favor of single-aisles.

This middle market preference for single aisles explains the very large A321neo order book. It also may explain why orders for 250-seat twin-aisles—particularly the 787-8 and A330-800 – have been eclipsed by orders for larger 300-seat variants.
Norwegian's plans to start transatlantic service with 737 MAXs, along with the increased number of other transatlantic single-aisle routes, suggest that, if anything, some twin aisle midsize demand will migrate downward to the single aisle segment.

Second, there are the higher costs associated with twin-aisles.
A glance at operating and production economics (block hour cost per seat and realized price per seat, respectively, illustrated in our chart) clearly shows that there's a significant gap between single- and twin-aisle jets. A single-aisle product is inherently cheaper to buy, build and fly. Low-cost carriers seeking fast turnaround times may like the idea of two aisles, in theory. But if twin-aisle operating economics remain distinctly higher than single-aisles', it is unlikely that faster turnaround times will actually trump lower operating costs.

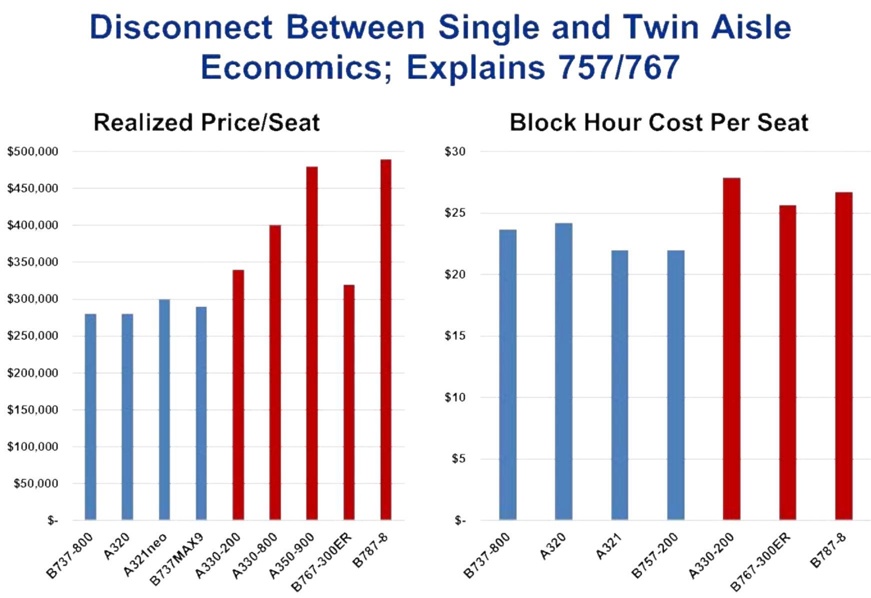


Chart 10

Boeing is aware of this problem. Company representatives have made it clear that the NMA needs to offer twin-aisle capabilities—range, comfort, capacity, and faster turnaround time—with single-aisle economics.

If Boeing is successful with this, they will have a product that likely stimulates demand in the mid-market twin-aisle segment. This is a reasonable goal.
One big reason that orders for the 787 and Airbus A330neo series have migrated to the larger members of these families is that these aircraft are built with the structures and systems needed for longer routes and larger models.
A plane that's optimized for the shorter and lighter routes, like the NMA, should convince airlines to fly new thinner routes between new city pairs.

But there are no guarantees that Boeing will be able to bridge the cost gap between single- and twin-aisle jets with the NMA. And new technologies developed for the NMA—particularly new engine technologies—could be used to help lower single-aisle operating costs, too, keeping the gap in place.

Boeing has been in this position before. In the late 1970s, it bifurcated its middle market product launch decision, creating the single-/twin-aisle 757/767 family. This was seen as a necessary response to the clear line between single and twin aisle market requirements, and ultimately both products succeeded. But these are different times in terms of new product development spending levels and company tolerance for risk.

As a result, Boeing is now leaning towards a twin aisle NMA, with the 737MAX10 filling some of the 757 roles. Again, the company needs to do everything it can to make the NMA competitive with single aisle jets.

Production Site Factors

Boeing's need for an ironclad NMA business case relies on many factors on the supply side. Supplier costs, aftermarket rights, and technology and materials decisions all play key roles. But the economics associated with site selection will play a role too, both for final assembly and any separate fuselage or wing manufacturing location.

An aerospace company's need to looking at production site options as part of establishing a business case for a new program is a relatively recent development in the jetliner industry. Historically, most jetliners have been built at legacy production sites. Given very high barriers to entry in this business, and given very long product life cycles (the 737 last year set a record at 50 years in production), this is not surprising.

This means aircraft have been produced where successful companies were established themselves, usually many decades ago. Sometimes, these companies were established in places for relatively arbitrary reasons, such as Boeing's original start in a wooden shipyard in Seattle, and its utility for wooden seaplanes. Often, aerospace companies were located in places far from an enemy threat, such as Russia's Siberian-based aircraft factories, or almost all of France's aerospace industry.

Until the 1990s, this reliance on legacy manufacturing sites didn't change very much. Successful companies turned their legacy sites into industrial powerhouses; unsuccessful companies reduced their legacy sites to museums. In 2016, the last C-17 rolled off the line in Long Beach. This represented the last jet built in California, the last of thousands of aircraft.

Today, state and regional competitiveness matters, but in the first decades of the jet age success was determined by company success or failure and the attributes of the sites themselves seldom played much of a role. McDonnell Douglas failed as a jetliner prime not because Long Beach was a terrible place to build planes; rather, it just systematically underinvested in new technology and products. If Boeing had been located in Long Beach, and McDonnell Douglas had been located in the Puget Sound, it's quite likely that the fortunes of these two regions as aerospace manufacturing centers would have been reversed. But Boeing invested in the future, which helped create and maintain a skilled workforce, and many other attributes that make the Puget Sound a great place to build aircraft.

While manufacturers generally stayed in their legacy regions, two other trends had a material impact on the evolution of aircraft production. The first was outsourcing. While Boeing regrets going too far in outsourcing design and integration work on the 787, the idea of spreading production to risk-sharing partners has been around for half a century, or longer. The entire body of the 747 was outsourced to Northrop in the 1960s.

Increasingly, this outsourcing went global, largely as a result of much broader macroeconomic trends. As borders and governments gave ground to multinational enterprises and economic liberalization, international trade grew at a record pace. Container boxes and ships, air cargo, CAD/CAM, the internet and logistical software provided tools to accelerate globalization. Distance became less relevant. Manufacturing became less vertical, creating global supply chains and industrial arrangements. US manufacturers have been transformed by this new paradigm, enjoying remarkable profitability over the past few decades.

Meanwhile, as noted above, Boeing is pursuing vertical integration opportunities. In the case of the 777X wing, this work will indeed be located near the final assembly line. But in the case of other systems, most notably propulsion systems, the work will be placed away from final production. For example, Boeing's propulsion unit is building 737MAX engine nacelles in South Carolina, across the country from Renton. It might be part of Boeing, yet it still represents distributed manufacturing.

The idea of a “supersite,” where all components and structures for a given aircraft are built in the same region, is generally not regarded as a valid approach. In good times, such a supersite would see very high wage inflation for engineers and manufacturing workers, with Boeing and its contractors all poaching employees from each other. And in a bust cycle, the region would be hit hard by very high unemployment rates.

The second aircraft industry trend over the past few decades has been the establishment of secondary final assembly lines, or, as they are sometimes termed today, Final Assembly and Check Out (FACO) lines. Military programs have relied upon FACOs since before World War One. But with its China facility constructed to build MD-80s, McDonnell Douglas extended the concept to jetliners.

Airbus has further led the way in adapting this idea for jetliners. At first, the European company used the concept to establish a secondary single aisle line, in Germany, at a member company facility. But today, it has transplant lines in Mobile, Alabama, and Tianjin, China. It will also use its Mobile facility to build the CSeries in a secondary line when that acquisition is completed.

This second trend, of secondary assembly lines, was enabled by the first trend. Basically, with sections of the aircraft built elsewhere, it became less expensive to establish secondary final assembly lines, because they didn’t need to have a heavy level of local production.

Inevitably, this led to a move away from legacy sites for final assembly lines on new programs. One of the first abortive instances of this took place on the MD-95, later designated the Boeing 717. In November 1994 McDonnell Douglas announced that it had signed up Dalfort Aviation, a Texas-based overhaul company, to handle final assembly of the aircraft. However, this was later cancelled, and the 717 was built at Long Beach.

The 787 was the first Boeing aircraft which involved a very active manufacturing site selection process. After surveying numerous alternatives in the US, including South Carolina, Texas, and Alabama, Boeing selected Everett, Washington in December 2003. However, Boeing later decided to establish a second production line in Charleston, South Carolina.

The 787 was followed by the 737MAX. As a derivative rather than a clean-sheet design, the incumbent 737 production site had an advantage. Even though Boeing executives said they would look at alternative sites, Boeing management worked with labor and other parties, under Project Pegasus, to come to mutually agreeable terms to keep the line in Washington.
This was followed by the 777X site selection process, which also involved a derivative jet. While this was a far more contentious process, which, in theory, involved a much closer look at alternative sites, Boeing kept the line in Everett.

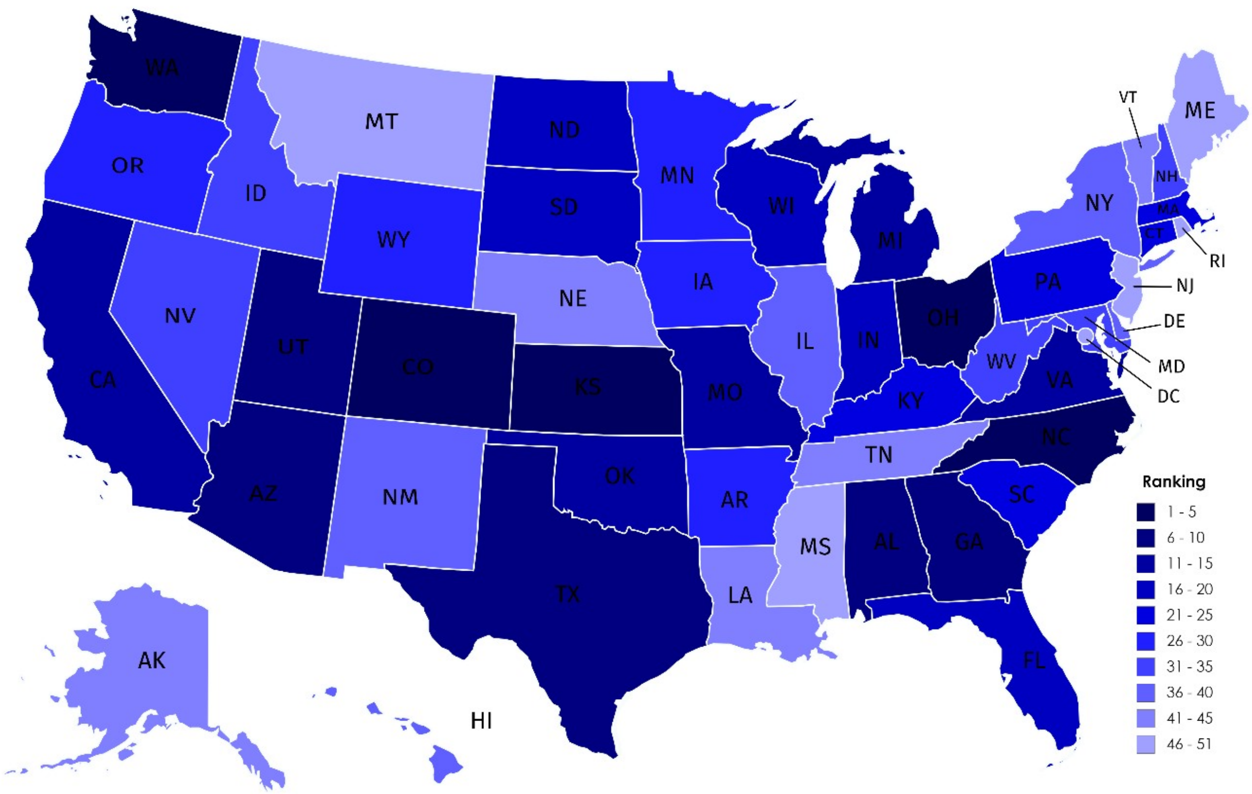
So far, Airbus has yet to look at alternatives to Toulouse and Hamburg for its primary jetliner final assembly lines, and Embraer has not looked outside of Sao Jose Dos Campos. However, Embraer has moved business jet production lines to Florida. But Bombardier did investigate alternatives to Mirabel for CSeries jetliner production, at the start of the program. Boeing, of course, will continue its stated policy of examining many alternatives for future jetliner programs. And to summarize, the success of Boeing’s NMA will depend on choosing the optimal site, or sites, for manufacturing and final assembly.

The changing nature of aviation manufacturing means that this plane could be built anywhere, but top states maintain competitive advantages outlined in the ACES rankings below.

Most Competitive Overall

The top performing states are presented in the chart and table below. Based on the various measures included in ACES, these states represent the most competitive business environments for the manufacture or final assembly of large aerospace structures. Each of these ten states incorporates multiple factors that contribute to its competitiveness ranking.

ACES Ranking

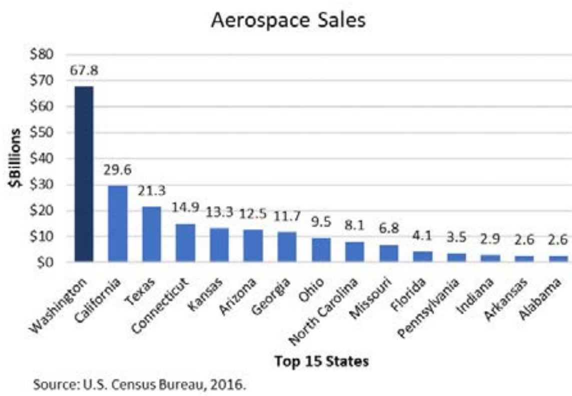


Rank	State	Costs	Labor & Education	Industry	Infrastructure	Risk to Operations	Economy	Research & Innovation	Taxes & Incentives
1	Washington	2	2	1	14	5	1	5	5
2	Ohio	14	10	3	16	12	14	24	16
3	North Carolina	1	45	6	28	16	28	19	12
4	Kansas	9	3	2	20	50	26	23	30
5	Colorado	32	4	14	44	28	17	3	9
6	Georgia	19	9	15	23	19	23	29	10
7	Utah	13	14	18	50	4	6	4	6
8	Texas	22	20	11	35	22	9	21	2
9	Arizona	12	8	7	51	1	38	10	14
10	Alabama	30	12	7	36	23	16	34	4

1. Washington

The State of Washington is a strong first place finisher as the most competitive place for aerospace manufacturing operations. It scores high in nearly all the evaluation categories and many of the individual metrics.

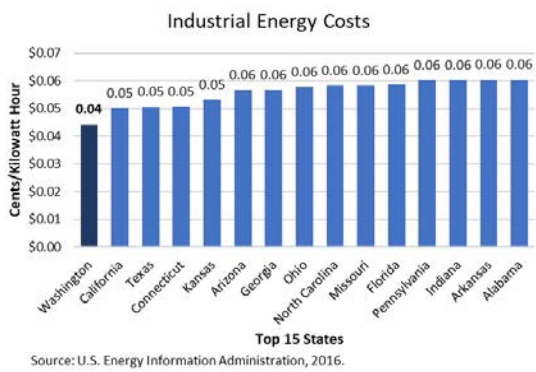
In terms of Costs (#2), Labor & Education (#2), Industry (#1), and Economy (#1), it performs at or near the very top. Washington is also rated in Taxes &Incentives (#5), Risk to Operations (#5), and Research & Innovation (#5). Only the Infrastructure category (#14) presents a modest constraint on its dominant position.



Source: U.S. Census Bureau, 2016.

Washington has a large aerospace presence led by The Boeing Company. Many other suppliers, manufactures and vendors support the aerospace industry as well, evidenced by the #3 Supplier Density ranking. Washington ranks high in many of the metrics that closely relate to aerospace.

What makes it especially competitive is its advantages beyond aerospace experience, namely low Energy Costs (#1), which are increasingly important due to the growing use of energy-intensive composite structures manufacturing in aircraft, high Port Volume (#4), low Insurance Losses (#2), high Patents per Capita (#3), high Private R&D (#5), and lower Individual Income Tax (#1) and Manufacturing Taxes (#4).



Source: U.S. Energy Information Administration, 2016.

- **At Boeing's Composite Wing Center in Everett, workers on the autoclave began producing the carbon fiber stringers that will form the long single-piece composite spars for the 777x, set to enter service in 2020. Boeing's facility has attracted new suppliers as well.**

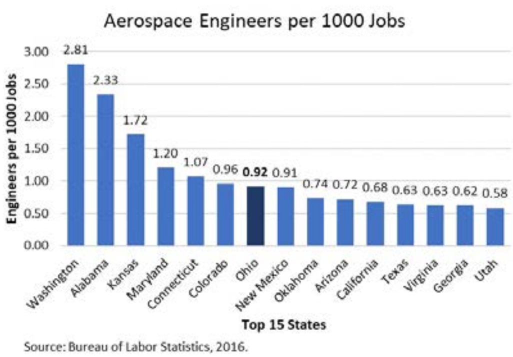
- **Héroux-Devtek's Everett facility, opened in 2016, began producing 100 shipsets of landing gear for the Boeing 777/777X under a contract that runs through 2024.**

- **In December, Spanish engineering firm MTorres opened a new plant near the Composite Wing Center to produce advanced manufacturing robots used in the 777x carbon-fiber spars production process.**

Rank	Metric
1	**Overall Rank**
2	**Costs Rank**
4	Unit Labor Cost
6	Unit Material Cost
1	Energy Cost
31	Construction Cost
2	**Labor & Education Rank**
1	Aerospace Engineers
2	Aerospace Production Workers
2	Engineering BAs
12	Graduate Degrees
15	High School Degree or More
28	Education Spending
1	**Industry Rank**
1	Aerospace Sales
1	Aerospace Value Added
1	Aerospace Exports
19	Workforce Growth
3	Supplier Density
33	Crowding Out
14	**Infrastructure Rank**
22	Airports
32	Freight Railroad
4	Port Volume
39	Road Condition
11	Transportation Funding
5	**Risk to Operations Rank**
2	Insurance Losses
8	Insurance Premiums
48	Earthquake Premiums
7	Extreme Weather
1	**Economy Rank**
10	GDP Per Capita
3	GDP Per Capita Growth
11	Manufacturing
3	Global Manufacturing Connectivity
37	Unemployment Rate
5	**Research & Innovation Rank**
3	Patents per Capita
16	Public R&D
5	Private R&D
18	High Tech Establishments
5	**Taxes & Incentives Rank**
12	Total Taxes/GDP
37	Workers' Compensation
6	Corporate Income Tax
1	Individual Income Tax
4	Manufacturing Tax
18	Property Tax
41	Sales Tax

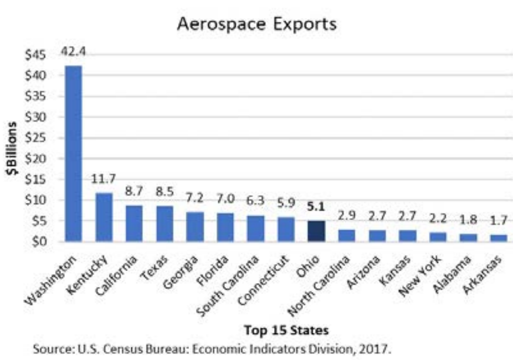
2. Ohio

Finishing as the second most competitive state is Ohio.



It has a well-established aerospace industry and ranks number three in that category. Key measures contributing to its position include attractive Unit Labor Costs (which reflect productivity in the ACES methodology), modest Risk to Operations and competitively configured Taxes & Incentives.

Ohio ranks just at the bottom of the top ten in the Labor & Education category with the 7th highest density of Aerospace Engineers in the nation.



Reflecting its aerospace experience, Ohio ranks high in Aerospace Sales, Aerospace Value-Added, Aerospace Exports and Supplier Density. It has a solid infrastructure ranking and scores high in Airports and Freight Railroad.

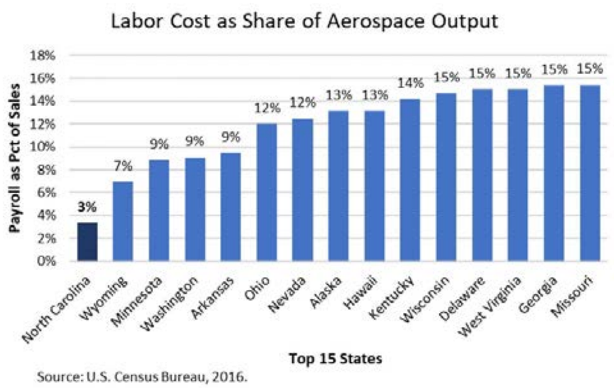
It falls within the highest quarter in Risk to Operations which is highly competitive with top ten rankings in Insurance Losses and Insurance Premiums.

- **Much of Ohio's Aerospace industry is anchored by Wright-Patterson Air Force Base in Dayton. The base directly and indirectly generates $3.7 billion in wage income and 51,000 jobs in the area. Fully 19% of all of Ohio's aerospace and aviation industry jobs are in the Dayton area.**
- **GE Aviation employs 7,400 manufacturing workers in Greater Cincinnati. It's one of the world's largest jet engine production site.**
- **In November 2017, GE Aviation inked a $600 million contract with Chile's Sky Airline to provide maintenance for the airline's LEAP-1A engines. The engines are built in Cincinnati by CFM International, a joint venture between GE and Safran Aircraft Engines.**

Rank	Metric
2	**Overall Rank**
14	**Costs Rank**
6	Unit Labor Cost
17	Unit Material Cost
26	Energy Cost
31	Construction Cost
10	**Labor & Education Rank**
7	Aerospace Engineers
20	Aerospace Production Workers
29	Engineering BAs
32	Graduate Degrees
26	High School Degree or More
20	Education Spending
3	**Industry Rank**
8	Aerospace Sales
9	Aerospace Value Added
9	Aerospace Exports
20	Workforce Growth
9	Supplier Density
28	Crowding Out
16	**Infrastructure Rank**
6	Airports
3	Freight Railroad
22	Port Volume
30	Road Condition
42	Transportation Funding
12	**Risk to Operations Rank**
3	Insurance Losses
9	Insurance Premiums
29	Earthquake Premiums
39	Extreme Weather
14	**Economy Rank**
25	GDP Per Capita
14	GDP Per Capita Growth
9	Manufacturing
13	Global Manufacturing Connectivity
45	Unemployment Rate
24	**Research & Innovation Rank**
21	Patents per Capita
21	Public R&D
21	Private R&D
28	High Tech Establishments
16	**Taxes & Incentives Rank**
24	Total Taxes/GDP
12	Workers' Compensation
5	Corporate Income Tax
17	Individual Income Tax
37	Manufacturing Tax
21	Property Tax
24	Sales Tax

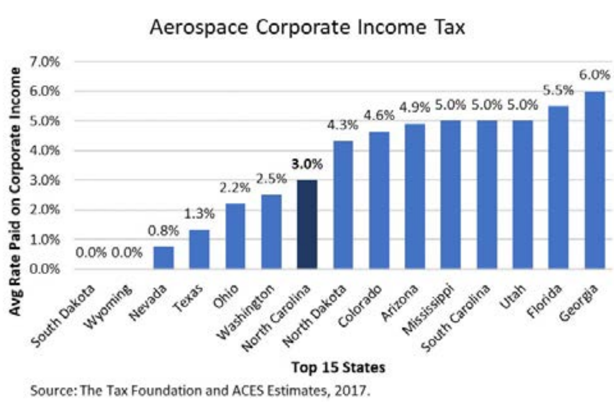
3. North Carolina

Cost competitiveness plays a key role in making North Carolina an attractive state for aerospace companies.



It scores #1 in Labor Cost and #2 in Material Cost, thereby propelling it to #1 in Overall Costs. It also ranks within the top twenty in the other two cost metrics, Energy Cost and Construction Cost. Costs were a key factor in HondaJet's decision to launch a new production program in North Carolina, the first successful new jet startup in decades.

North Carolina also does very well with respect to the Industry category at #6, scoring top ten finishes in Aerospace Employee Growth, Aerospace Value Added, Aerospace Sales and Crowding Out.



A competitive tax environment contributes to North Carolina's strong ranking and places it near the top ten in the Tax & Incentives category. It ranks as the #7 state in terms of Corporate Income Tax.

Other metrics that help propel North Carolina to #3 in the overall ranking are low Insurance Losses and solid Research & Innovation scores, with top ten finishes in Private R&D, High Tech Establishments and Patents Per Capita.

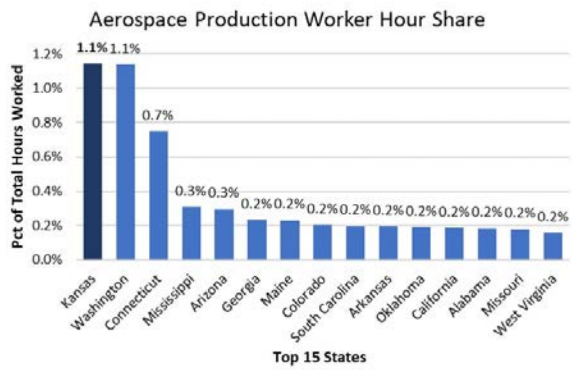
- **HondaJet deliveries began In December 2015, giving the state its first jet production line.**
- **North Carolina has a number of aerospace clusters, including facilities centered around Union County and Monroe near Charlotte and production located at the Global Transpark in Kinston, NC.**
- **Several major international aerospace firms have facilities in North Carolina, including GE Aviation, Honda Aircraft Co., BAE Systems, Honeywell, B/E Aerospace, Spirit Aerosystems, Curtiss-Wright Corp., LORD and HAECO.**
- **In December 2017, Spirit Aerosystems announced it would be investing more than $55.7 million to expand its Kinston, NC site.**

Rank	Metric
3	**Overall Rank**
1	**Costs Rank**
1	Unit Labor Cost
2	Unit Material Cost
15	Energy Cost
12	Construction Cost
45	**Labor & Education Rank**
34	Aerospace Engineers
34	Aerospace Production Workers
28	Engineering BAs
25	Graduate Degrees
36	High School Degree or More
45	Education Spending
6	**Industry Rank**
9	Aerospace Sales
8	Aerospace Value Added
10	Aerospace Exports
8	Workforce Growth
35	Supplier Density
9	Crowding Out
28	**Infrastructure Rank**
16	Airports
18	Freight Railroad
15	Port Volume
21	Road Condition
45	Transportation Funding
16	**Risk to Operations Rank**
9	Insurance Losses
26	Insurance Premiums
14	Earthquake Premiums
32	Extreme Weather
28	**Economy Rank**
32	GDP Per Capita
26	GDP Per Capita Growth
15	Manufacturing
31	Global Manufacturing Connectivity
30	Unemployment Rate
19	**Research & Innovation Rank**
20	Patents per Capita
25	Public R&D
17	Private R&D
20	High Tech Establishments
12	**Taxes & Incentives Rank**
14	Total Taxes/GDP
30	Workers' Compensation
7	Corporate Income Tax
25	Individual Income Tax
20	Manufacturing Tax
13	Property Tax
15	Sales Tax

4. Kansas

Kansas finishes as the fourth most competitive state for aerospace manufacturing operations. It ranks near the top in two key categories, Industry and Labor & Education, coming in at #2 and #3, respectively.

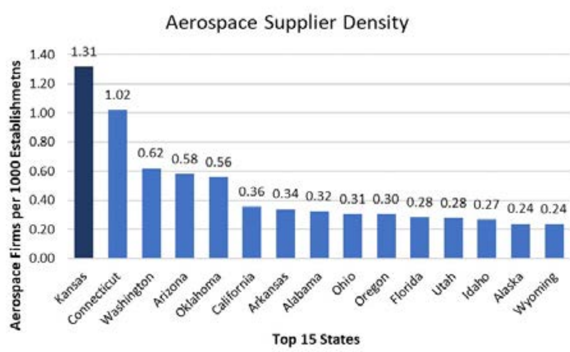
With respect to its high Industry category ranking, there are four individual metrics that contribute to its strong performance: Supplier Density (#1 among all states), Aerospace Value Added (#4), Aerospace Sales (#5) and Aerospace Exports (#12).



Source: Bureau of Labor Statistics and ACES Estimates, 2016.

Within the Labor & Education category, Kansas does very well with respect to Aerospace Production Workers (#1) and Aerospace Engineers (#3). Also contributing to its high ranking are top twenty finishes in Graduate Degrees and High School Degree or More.

Kansas is also the ninth highest ranked state in the Costs category and is highly competitive with respect to Material Cost (#9). Other key contributing metrics include Road Conditions at #1, which helps Kansas finish with a top twenty ranking in Infrastructure.



Source: U.S. Census Bureau, 2016.

- **Kansas boasts the top-ranked aerospace supplier density in the nation, hosting firms like Spirit AeroSystems, Honeywell and Garmin. Wichita, the "air capital of the world", leads in small planes, thanks to Textron/Cessna and Bombardier/Learjet.**

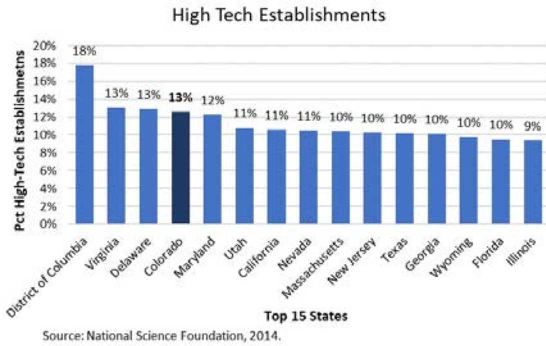
- **In September 2017, Orizon Aerostructures Inc. a manufacturer of complex subassemblies for the aerospace industry, announced it was moving production from Missouri to a new 205,000-square-foot plant in Olathe, KS.**

- **In December 2017, Spirit AeroSystems announced it would invest $1 billion in its Wichita factory and add 1,000 jobs, including many union machinist and engineering positions. The company followed that up in February 2018 with an announcement of bonuses equal to more than 10% for Society of Professional Engineering Employees in Aerospace ("SPEEA") union engineers and other Spirit workers.**

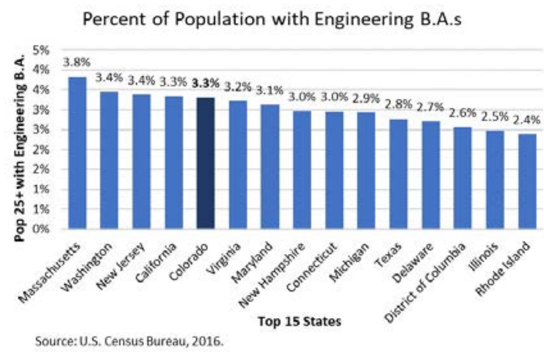
Rank	Metric
4	**Overall Rank**
9	**Costs Rank**
19	Unit Labor Cost
9	Unit Material Cost
28	Energy Cost
18	Construction Cost
3	**Labor & Education Rank**
3	Aerospace Engineers
1	Aerospace Production Workers
27	Engineering BAs
17	Graduate Degrees
17	High School Degree or More
32	Education Spending
2	**Industry Rank**
5	Aerospace Sales
4	Aerospace Value Added
12	Aerospace Exports
22	Workforce Growth
1	Supplier Density
19	Crowding Out
20	**Infrastructure Rank**
31	Airports
25	Freight Railroad
22	Port Volume
7	Road Condition
30	Transportation Funding
50	**Risk to Operations Rank**
45	Insurance Losses
47	Insurance Premiums
28	Earthquake Premiums
31	Extreme Weather
26	**Economy Rank**
29	GDP Per Capita
43	GDP Per Capita Growth
18	Manufacturing
26	Global Manufacturing Connectivity
16	Unemployment Rate
23	**Research & Innovation Rank**
27	Patents per Capita
13	Public R&D
24	Private R&D
22	High Tech Establishments
30	**Taxes & Incentives Rank**
28	Total Taxes/GDP
11	Workers' Compensation
30	Corporate Income Tax
14	Individual Income Tax
31	Manufacturing Tax
35	Property Tax
41	Sales Tax

5. Colorado

Colorado ranks as the fifth most competitive state. It has a fast-growing aerospace sector and ranks #2 in Aerospace Employee Growth. Other key measures contributing to its position include highly competitive rankings for Labor & Education (#4), Research & Innovation (#3) and Taxes & Incentives (#9).



Colorado ranks #4 in the Labor & Education category, with a number of high performing metrics. It is #5 in Engineering BAs, #6 in Aerospace Engineers, #8 in Aerospace Production Workers and #8 in Graduate Degrees.



Equally impressive is the state's #3 ranking as the most competitive state in terms of Research & Innovation. Coupled with its strong position in Labor & Education, this gives Colorado a strong stake in future aerospace sector development. With respect to Research & Innovation it performs well in all four metrics, with especially impressive rankings for High Tech Establishments (#4) and Public R&D (#7).

- **The University of Colorado receives more NASA research funding than any other public university in the nation, and overall, CU faculty received over $1 billion in federal, state and local research grants.**
- **In October 2017, CU Boulder doubled-down on that success, announcing construction of an $83 million, 139,000-square-foot aerospace engineering building that will open in 2019.**
- **Colorado's space industry continues to rapidly develop. Colorado-based United Launch Alliance beat out SpaceX for an Air Force satellite launch contract worth $191 million in 2017 and Denver-based Lockheed Martin Space Systems holds the contract to build the Orion spacecraft, an important component of NASA's multi-billion dollar deep-space exploration program.**

Rank	Metric
5	**Overall Rank**
32	**Costs Rank**
26	Unit Labor Cost
21	Unit Material Cost
30	Energy Cost
35	Construction Cost
4	**Labor & Education Rank**
6	Aerospace Engineers
8	Aerospace Production Workers
5	Engineering BAs
8	Graduate Degrees
13	High School Degree or More
39	Education Spending
14	**Industry Rank**
16	Aerospace Sales
15	Aerospace Value Added
37	Aerospace Exports
2	Workforce Growth
29	Supplier Density
7	Crowding Out
44	**Infrastructure Rank**
43	Airports
39	Freight Railroad
22	Port Volume
45	Road Condition
14	Transportation Funding
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43	Insurance Premiums
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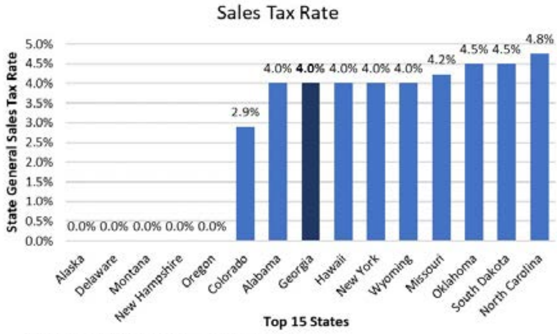
14	Extreme Weather
17	**Economy Rank**
17	GDP Per Capita
10	GDP Per Capita Growth
35	Manufacturing
43	Global Manufacturing Connectivity
7	Unemployment Rate
3	**Research & Innovation Rank**
10	Patents per Capita
7	Public R&D
19	Private R&D
4	High Tech Establishments
9	**Taxes & Incentives Rank**
16	Total Taxes/GDP
17	Workers' Compensation
9	Corporate Income Tax
15	Individual Income Tax
22	Manufacturing Tax
23	Property Tax
6	Sales Tax

6. Georgia

Georgia finishes as the sixth most competitive state for aerospace manufacturing.

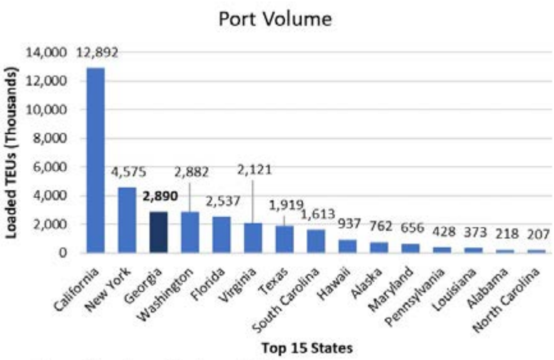


Source: Federation of Tax Administrators, 2017.

It ranks near the top in two categories, Labor & Education and Taxes & Incentives, coming in at #9 and #10 respectively.

Georgia also has three other categories that fall in the top twenty, Industry (#15), Costs (#19) and Risk to Operations (#19).

Contributing to Georgia's strength in Labor & Education was its #6 ranking for the Aerospace Production Worker metric and it's #14 ranking for the Aerospace Engineers metric.



Source: Army Corps of Engineers, 2016.

Taxes & Incentives is bolstered by its twin #7 rankings in Total Taxes/GDP and Sales Tax. Other individual metrics that make Georgia attractive are Port Volume (#3), GDP Per Capita Growth (#5), Aerospace Exports (#6), Aerospace Sales (#7) and Aerospace Value Added (#7).

- **Lockheed Martin's Marietta facility is home to the C-130 line, the longest-lived military aircraft program in world history.**

- **In April 2018, Gulfstream Aerospace Corp. announced an investment of $55 million that will create an estimated 200 new aerospace jobs in Savannah. The operations will focus on support, maintenance and refurbishment of the Gulfstream fleet.**

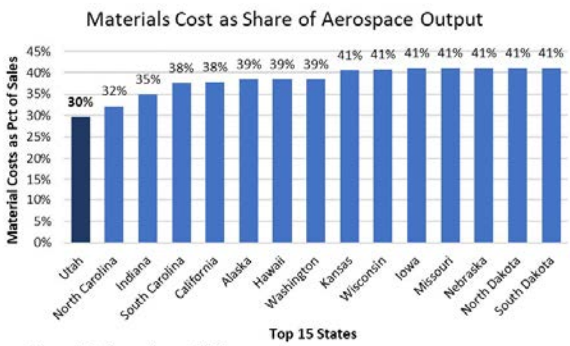
- **Georgia Tech hosts the second-ranked Aerospace Engineering program in the nation behind MIT. In June 2017, it opened the Boeing Manufacturing Development Center within its 19,000-square foot Delta Advanced Manufacturing Pilot Facility. Students at the center will partner with Boeing researchers to explore ways to increase automation in Boeing's production process.**

- **Pratt & Whitney will invest nearly half a billion dollars in its Columbus, Georgia facility. This is estimated to create more than 500 new jobs related to the growing needs of its Geared Turbofan engine and F-135 production lines.**

Rank	Metric
6	**Overall Rank**
19	**Costs Rank**
14	Unit Labor Cost
38	Unit Material Cost
11	Energy Cost
12	Construction Cost
9	**Labor & Education Rank**
14	Aerospace Engineers
6	Aerospace Production Workers
24	Engineering BAs
19	Graduate Degrees
40	High School Degree or More
38	Education Spending
15	**Industry Rank**
7	Aerospace Sales
7	Aerospace Value Added
5	Aerospace Exports
32	Workforce Growth
23	Supplier Density
46	Crowding Out
23	**Infrastructure Rank**
20	Airports
11	Freight Railroad
3	Port Volume
25	Road Condition
47	Transportation Funding
19	**Risk to Operations Rank**
16	Insurance Losses
32	Insurance Premiums
16	Earthquake Premiums
24	Extreme Weather
23	**Economy Rank**
30	GDP Per Capita
5	GDP Per Capita Growth
31	Manufacturing
21	Global Manufacturing Connectivity
30	Unemployment Rate
29	**Research & Innovation Rank**
28	Patents per Capita
40	Public R&D
30	Private R&D
12	High Tech Establishments
10	**Taxes & Incentives Rank**
7	Total Taxes/GDP
25	Workers' Compensation
15	Corporate Income Tax
29	Individual Income Tax
19	Manufacturing Tax
20	Property Tax
7	Sales Tax

7. Utah

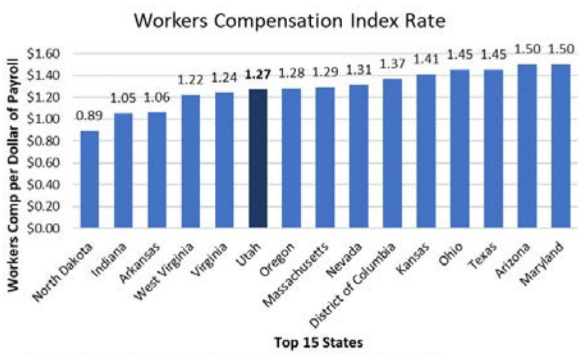
A number of categories play an important role in Utah's seventh highest ranking as an aerospace competitive state.



Source: U.S. Census Bureau, 2016.

It scores particularly high in Research and Innovation, coming in at #4 in this category. Utah's ranking for all four of the metrics that make up this category are within or near the top ten. For High Tech Establishments it is #6.

Utah also is #4 in the Risk to Operations category. Insurance Premiums are relatively low, giving it the #2 ranking for this metric.



Source: Oregon Department of Consumer and Business Services, 2016.

While Utah's ranking for the Costs category is just outside the top ten at #13, it performs extremely high for two of the metrics in this group: Unit Material Cost (#1) and Energy Cost (#8).

Utah is also a solid performer in Taxes & Incentives. The state is #4 overall in the category, ranking high in Workers Compensation (#6) and Total Taxes/GDP (#8).

- **Utah supports research and innovation through its Utah Science, Technology and Research (USTAR) Initiative, providing grants, training and research. In November 2017, USTAR opened a new USTAR Innovation Center facility near Hill Air Force Base aiming to seed new aerospace and innovation companies in the state.**

- **Albany Engineered Composites continues to grow along with the F-35, 787, and GE/Safran's Leap-1 engine, on which Albany produces a variety of advanced structures.**

- **Parker Hannifin announced in January 2018 that it would move 77 repair operations jobs to Ogden, UT and make a $2.8 million capital investment after receiving a tax rebate from the Governor's Office of Economic Development (GOED).**

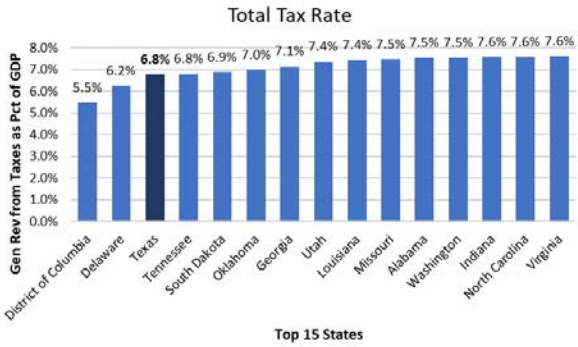
- **Ram Company, a designer and manufacturer of solenoids, valves and manifolds for the aerospace industry received a 10-year freeze on tax increases from the City of St. George, UT in April 2018.**

Rank	Metric
7	**Overall Rank**
13	**Costs Rank**
42	Unit Labor Cost
1	Unit Material Cost
8	Energy Cost
18	Construction Cost
14	**Labor & Education Rank**
15	Aerospace Engineers
19	Aerospace Production Workers
21	Engineering BAs
23	Graduate Degrees
11	High School Degree or More
51	Education Spending
18	**Industry Rank**
26	Aerospace Sales
19	Aerospace Value Added
32	Aerospace Exports
17	Workforce Growth
12	Supplier Density
27	Crowding Out
50	**Infrastructure Rank**
48	Airports
46	Freight Railroad
22	Port Volume
16	Road Condition
41	Transportation Funding
4	**Risk to Operations Rank**
8	Insurance Losses
2	Insurance Premiums
46	Earthquake Premiums
6	Extreme Weather
6	**Economy Rank**
31	GDP Per Capita
4	GDP Per Capita Growth
19	Manufacturing
12	Global Manufacturing Connectivity
10	Unemployment Rate
4	**Research & Innovation Rank**
12	Patents per Capita
12	Public R&D
11	Private R&D
6	High Tech Establishments
6	**Taxes & Incentives Rank**
8	Total Taxes/GDP
6	Workers' Compensation
11	Corporate Income Tax
18	Individual Income Tax
24	Manufacturing Tax
14	Property Tax
26	Sales Tax

8. Texas

Texas is one of seven states that do not have a state income tax, thereby helping to lift the state to the #2 ranking in Taxes & Incentives and contributing to Texas' #8 overall competitiveness ranking.

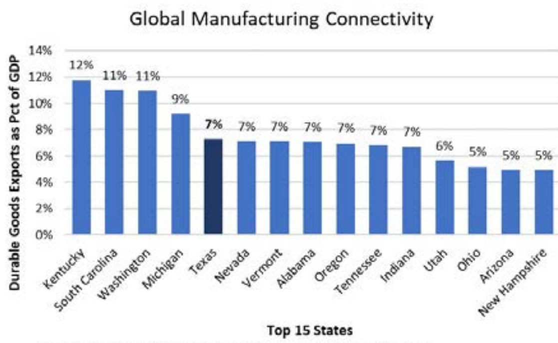
Key metrics supporting the state's excellent tax position are: Individual Income Tax (#1), Total Taxes/GDP (#3), Corporate Income Tax (#4) and Manufacturing Tax (#8).



Source: U.S. Census Bureau, 2014.

Economy is Texas' second highest ranked category at #9, where it scored high for Global Manufacturing Connectivity (#5) and GDP Per Capita Growth (#9).

Texas has a strong aerospace presence and ranks #11 in the Industry category, including top five rankings for Aerospace Sales, Aerospace Value Added and Aerospace Exports.



Source: U.S. Census Bureau; Bureau of Economic Analysis, 2016-2017.

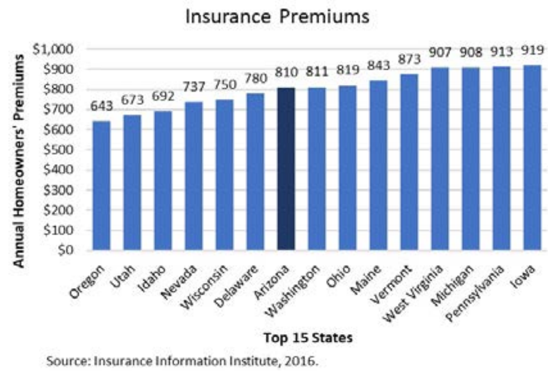
- **Lockheed Martin which already employs about 14,500 people at its Fort Worth plant manufacturing the F-35 is working to add another 1,800 employees by 2020. The F-35 is the largest defense program in the world. Bell Helicopter Textron is the state's second largest aerospace prime.**
- **In April 2017 Boeing announced that it would invest $3 billion to set up a new division in Plano, Texas that focuses on training, supply chain management, aircraft modernization and data optimization for its customers.**
- **Boeing's venture investment division, Horizon X, invested in Texas-based SparkCognition, an artificial intelligence and machine-learning company.**
- **Firefly Aerospace was approved by the U.S. Air Force to take over Space Launch Complex 2 at Vandenberg Air Force Base.**

Rank	Metric
8	**Overall Rank**
22	**Costs Rank**
22	Unit Labor Cost
29	Unit Material Cost
6	Energy Cost
35	Construction Cost
20	**Labor & Education Rank**
12	Aerospace Engineers
21	Aerospace Production Workers
11	Engineering BAs
35	Graduate Degrees
50	High School Degree or More
43	Education Spending
11	**Industry Rank**
3	Aerospace Sales
3	Aerospace Value Added
4	Aerospace Exports
33	Workforce Growth
19	Supplier Density
47	Crowding Out
35	**Infrastructure Rank**
21	Airports
35	Freight Railroad
7	Port Volume
37	Road Condition
34	Transportation Funding
22	**Risk to Operations Rank**
15	Insurance Losses
50	Insurance Premiums
10	Earthquake Premiums
16	Extreme Weather
9	**Economy Rank**
16	GDP Per Capita
9	GDP Per Capita Growth
26	Manufacturing
5	Global Manufacturing Connectivity
23	Unemployment Rate
21	**Research & Innovation Rank**
18	Patents per Capita
26	Public R&D
27	Private R&D
11	High Tech Establishments
2	**Taxes & Incentives Rank**
3	Total Taxes/GDP
12	Workers' Compensation
4	Corporate Income Tax
1	Individual Income Tax
8	Manufacturing Tax
33	Property Tax
37	Sales Tax

9. Arizona

Arizona ranks in the top ten in four categories, the top twenty for two more, making the state a highly competitive environment for aerospace manufacturing companies.

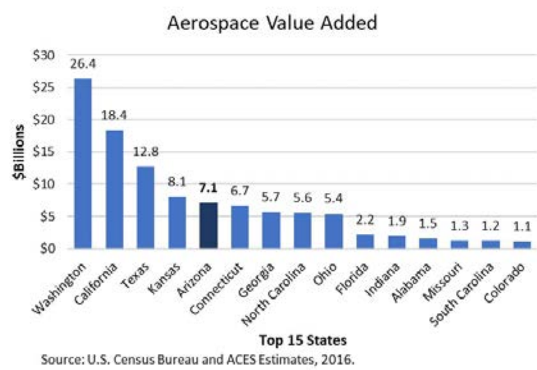
Arizona is #1 in the Risk to Operations category, relying on strong scores in all four metrics, especially Extreme Weather (#5) and Insurance Premiums (#7).



Source: Insurance Information Institute, 2016.

Arizona ranks seventh highest in the Industry category, based on competitive rankings in Supplier Density (#4), Aerospace Value Added (#5) and Aerospace Sales (#6).

In addition, Arizona is the eight strongest state in the Labor & Education category, boasting a #5 ranking for Aerospace Production Workers.



Source: U.S. Census Bureau and ACES Estimates, 2016.

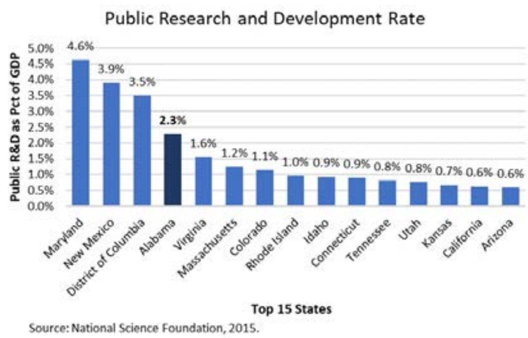
Arizona's fourth top ten category is Research & Innovation (#10). The state places in the top twenty in each of the four metrics in this category, demonstrating a strong, consistent performance.

- **In April 2018, Orbital ATK, producer of rocket launch vehicles and propulsion systems, broke ground on two new buildings in Chandler, AZ which will total 617,000 sq ft when they open in September 2019.**
- **In August 2017, the City of Mesa, AZ also broke ground on a 150,000 sq ft industrial facility designed to attract aerospace and defense businesses to the Falcon Field District.**
- **Mesa is home to Boeing's Apache attack helicopter program, and MD Helicopters.**

Rank	Metric
9	**Overall Rank**
12	**Costs Rank**
23	Unit Labor Cost
20	Unit Material Cost
14	Energy Cost
12	Construction Cost
8	**Labor & Education Rank**
10	Aerospace Engineers
5	Aerospace Production Workers
17	Engineering BAs
25	Graduate Degrees
38	High School Degree or More
49	Education Spending
7	**Industry Rank**
6	Aerospace Sales
5	Aerospace Value Added
11	Aerospace Exports
35	Workforce Growth
4	Supplier Density
37	Crowding Out
51	**Infrastructure Rank**
45	Airports
48	Freight Railroad
22	Port Volume
14	Road Condition
46	Transportation Funding
1	**Risk to Operations Rank**
14	Insurance Losses
7	Insurance Premiums
9	Earthquake Premiums
5	Extreme Weather
38	**Economy Rank**
44	GDP Per Capita
41	GDP Per Capita Growth
20	Manufacturing
14	Global Manufacturing Connectivity
37	Unemployment Rate
10	**Research & Innovation Rank**
16	Patents per Capita
15	Public R&D
15	Private R&D
18	High Tech Establishments
14	**Taxes & Incentives Rank**
18	Total Taxes/GDP
14	Workers' Compensation
10	Corporate Income Tax
13	Individual Income Tax
36	Manufacturing Tax
22	Property Tax
23	Sales Tax

10. Alabama

Finishing out the top ten is Alabama. Taxes and Incentives competitiveness plays an important role in making Alabama an attractive state for aerospace companies. It scores #4 in this category with highly competitive rankings in Manufacturing Tax (#3), Property Tax (#3) and Sales Tax (#7). For Total Taxes/GDP, the state is ranked just outside the top ten (#11).



Alabama ranks as the seventh most competitive state in the Industry category with solid performance across several metrics, including Supplier Density (#8), Aerospace Value Added (#12) and Aerospace Exports (#15). Aerospace Employment Growth (#16) is another contributing factor to the state's strength in the category.

Alabama was able to leverage its very strong showing in Aerospace Engineers (#2) and Aerospace Production Workers (#13) metrics to achieve a #12 ranking for the Labor & Education category.

Other measures where the state performs well include Public R&D (#4 among all states), Manufacturing (#5) and Global Manufacturing Connectivity (#8).

- **In April 2018, Boeing completed a new 28,000 sq ft facility to support its Patriot Advanced Capability-3 (PAC-3) missile seeker program.**
- **In October 2017, Aerojet Rocketdyne broke ground on a 136,000 sq ft manufacturing facility in Huntsville, AL that could bring 800 private space industry jobs to the region.**
- **In 2017, the Huntsville City Council agreed to pay millions in tax credits and exemptions to Blue Origin to incentivize the company to build a manufacturing facility in Huntsville that could eventually employ up to 400 new workers. Taxpayers will also fund grading of the site, road improvements and utilities.**
- **In order to keep up with other states in automotive and aerospace research and development, the University of Alabama launched its Automotive-Aerospace Accelerator.**
- **In July 2017, Boeing reaffirmed its commitment to growing its Alabama-based aerospace operations. Boeing, already with an Alabama workforce of roughly 2,700 employees indicated that it was looking to add 400 more by 2020, while making a capital investment of $70 million.**
- **Safran, the French aerospace giant, announced in August 2017 that it would launch a manufacturing operation at the Mobile Aeroplex in Mobile, AL. The operation will produce and install aircraft engine nacelles.**

Rank	Metric
10	**Overall Rank**
30	**Costs Rank**
25	Unit Labor Cost
43	Unit Material Cost
17	Energy Cost
12	Construction Cost
12	**Labor & Education Rank**
2	Aerospace Engineers
13	Aerospace Production Workers
32	Engineering BAs
39	Graduate Degrees
47	High School Degree or More
40	Education Spending
7	**Industry Rank**
15	Aerospace Sales
12	Aerospace Value Added
14	Aerospace Exports
16	Workforce Growth
8	Supplier Density
34	Crowding Out
36	**Infrastructure Rank**
37	Airports
23	Freight Railroad
14	Port Volume
11	Road Condition
43	Transportation Funding
23	**Risk to Operations Rank**
18	Insurance Losses
40	Insurance Premiums
18	Earthquake Premiums
22	Extreme Weather
16	**Economy Rank**
46	GDP Per Capita
28	GDP Per Capita Growth
5	Manufacturing
8	Global Manufacturing Connectivity
21	Unemployment Rate
34	**Research & Innovation Rank**
45	Patents per Capita
4	Public R&D
31	Private R&D
36	High Tech Establishments
4	**Taxes & Incentives Rank**
11	Total Taxes/GDP
27	Workers' Compensation
24	Corporate Income Tax
18	Individual Income Tax
3	Manufacturing Tax
3	Property Tax
7	Sales Tax

Full Results

Category Rankings

State	Overall	Costs	Labor & Education	Industry	Infrastructure	Risk to Operations	Economy	Research & Innovation	Taxes & Incentives
Washington	**1**	2	2	1	14	5	1	5	5
Ohio	**2**	14	10	3	16	12	14	24	16
North Carolina	**3**	1	45	6	28	16	28	19	12
Kansas	**4**	9	3	2	20	50	26	23	30
Colorado	**5**	32	4	14	44	28	17	3	9
Georgia	**6**	19	9	15	23	19	23	29	10
Utah	**7**	13	14	18	50	4	6	4	6
Texas	**8**	22	20	11	35	22	9	21	2
Arizona	**9**	12	8	7	51	1	38	10	14
Alabama	**10**	30	12	7	36	23	16	34	4
Missouri	**11**	5	21	13	37	47	36	30	17
Virginia	**12**	33	16	26	11	17	40	11	23
Michigan	**13**	35	22	16	47	3	10	12	18
California	**14**	37	7	4	25	21	11	2	45
Oklahoma	**15**	20	17	21	42	51	31	38	3
Indiana	**16**	16	47	23	30	29	2	33	8
South Dakota	**17**	4	34	40	31	30	39	51	1
Florida	**18**	36	36	5	13	31	34	28	22
Wisconsin	**19**	17	32	23	17	9	5	31	38
North Dakota	**20**	23	26	39	10	32	25	50	7
Kentucky	**21**	15	48	17	15	39	17	44	19
South Carolina	**22**	23	15	10	43	43	15	41	29
Massachusetts	**23**	47	13	22	1	36	12	1	39
Connecticut	**24**	48	1	9	12	40	22	6	48
Pennsylvania	**25**	41	24	25	6	18	29	19	31
Wyoming	**26**	11	27	46	22	15	45	39	15
Oregon	**27**	43	30	19	38	2	13	16	21
Iowa	**28**	3	39	30	21	35	3	36	40
Arkansas	**29**	8	33	12	48	45	33	49	24
Minnesota	**30**	23	31	19	18	26	4	13	44
New Hampshire	**31**	46	11	27	19	10	6	7	37
West Virginia	**32**	7	35	34	24	13	48	46	26
Maryland	**33**	45	5	44	7	20	35	8	41
Idaho	**34**	9	36	31	49	10	19	18	35
Nevada	**35**	5	51	47	45	8	44	32	11
Delaware	**36**	29	46	48	9	24	32	16	27
Illinois	**37**	38	38	35	2	38	24	15	43
Hawaii	**38**	26	25	37	29	25	27	42	36
New Mexico	**39**	34	28	38	46	7	47	25	25
New York	**40**	31	40	29	5	44	30	27	46
Vermont	**41**	44	6	43	3	33	19	26	49
Nebraska	**42**	18	43	41	27	42	21	43	34
Tennessee	**43**	40	49	31	33	37	8	35	13
Alaska	**44**	26	42	36	39	14	51	37	33
Louisiana	**45**	21	50	45	40	41	50	48	20
Maine	**46**	42	18	28	25	6	41	44	50
Mississippi	**47**	28	41	49	41	48	43	47	32
District of Columbia	**48**	50	23	51	4	27	49	14	28
Montana	**49**	39	44	33	32	34	46	39	42
New Jersey	**50**	49	19	42	8	46	42	9	51
Rhode Island	**51**	51	29	50	34	49	37	22	47

Individual Rankings

Category 1: Costs

State	Rank	Unit Labor Cost	Unit Material Cost	Energy Cost	Construction Cost
North Carolina	**1**	1	2	15	12
Washington	**2**	4	6	1	31
Iowa	**3**	15	11	9	18
South Dakota	**4**	15	11	37	5
Missouri	**5**	15	11	25	18
Nevada	**5**	7	21	5	35
West Virginia	**7**	12	25	24	7
Arkansas	**8**	5	42	13	4
Kansas	**9**	19	9	28	18
Idaho	**9**	29	21	12	1
Wyoming	**11**	2	21	28	27
Arizona	**12**	23	20	14	12
Utah	**13**	42	1	8	18
Ohio	**14**	6	17	26	31
Kentucky	**15**	10	40	7	12
Indiana	**16**	21	3	34	24
Wisconsin	**17**	11	10	35	31
Nebraska	**18**	33	11	31	2
Georgia	**19**	14	38	11	12
Oklahoma	**20**	27	36	4	7
Louisiana	**21**	20	32	3	31
Texas	**22**	22	29	6	35
North Dakota	**23**	15	11	40	41
South Carolina	**23**	46	4	21	24
Minnesota	**23**	3	37	33	27
Hawaii	**26**	8	6	51	50
Alaska	**26**	8	6	50	51
Mississippi	**28**	24	43	19	5
Delaware	**29**	12	25	36	39
Alabama	**30**	25	43	17	12
New York	**31**	34	16	16	44
Colorado	**32**	26	21	30	35
Virginia	**33**	39	31	23	12
New Mexico	**34**	41	45	10	2
Michigan	**35**	32	18	32	35
Florida	**36**	38	30	38	7
California	**37**	35	5	45	45
Illinois	**38**	36	28	22	41
Montana	**39**	45	49	2	18
Tennessee	**40**	31	48	20	24
Pennsylvania	**41**	28	47	27	27
Maine	**42**	47	33	42	7
Oregon	**43**	43	46	18	18
Vermont	**44**	47	33	44	7
Maryland	**45**	40	25	41	39
New Hampshire	**46**	44	33	46	27
Massachusetts	**47**	47	19	48	48
Connecticut	**48**	30	39	47	46
New Jersey	**49**	37	41	43	47
District of Columbia	**50**	48	50	39	48
Rhode Island	**51**	48	50	49	43

Metrics Included:

- Unit Labor Cost - The amount of labor, measured by payroll, necessary to produce $1 in aerospace revenue
- Unit Material Cost - The amount of materials necessary to produce $1 in aerospace revenue
- Energy Cost - The cost (cents/kilowatt hour) for the Industrial End-Use Sector
- Construction Cost - The National Association of Builders modifiers for construction costs for buildings by state

Category 2: Labor & Education

State	Labor & Education Rank	Aerospace Engineers	Aerospace Production Workers	Engineering BAs	Graduate Degrees	High School Degree or More	Education Spending
Connecticut	**1**	5	3	9	4	18	4
Washington	**2**	1	2	2	12	15	28
Kansas	**3**	3	1	27	17	17	32
Colorado	**4**	6	8	5	8	13	39
Maryland	**5**	4	29	7	3	24	12
Vermont	**6**	16	23	20	7	8	6
California	**7**	11	12	4	16	51	29
Arizona	**8**	10	5	17	25	38	49
Georgia	**9**	14	6	24	19	40	38
Ohio	**10**	7	20	29	32	26	20
New Hampshire	**11**	38	18	8	10	4	11
Alabama	**12**	2	13	32	39	47	40
Massachusetts	**13**	27	31	1	2	19	8
Utah	**14**	15	19	21	23	11	51
South Carolina	**15**	17	9	35	36	39	33
Virginia	**16**	13	41	6	5	28	24
Oklahoma	**17**	9	11	44	45	34	48
Maine	**18**	43	7	41	22	7	16
New Jersey	**19**	20	44	3	8	28	5
Texas	**20**	12	21	11	35	50	43
Missouri	**21**	25	14	39	25	27	31
Michigan	**22**	26	30	10	24	19	21
District of Columbia	**23**	21	50	13	1	19	3
Pennsylvania	**24**	33	25	25	18	24	10
Hawaii	**25**	24	42	23	28	9	17
North Dakota	**26**	22	32	43	51	6	15
Wyoming	**27**	19	47	37	37	1	7
New Mexico	**28**	8	48	18	19	46	34
Rhode Island	**29**	23	50	15	11	32	9
Oregon	**30**	46	22	16	14	23	30
Minnesota	**31**	35	43	19	19	3	18
Wisconsin	**32**	48	17	34	33	10	22
Arkansas	**33**	31	10	50	46	43	35
South Dakota	**34**	28	24	46	43	14	41
West Virginia	**35**	32	15	49	46	43	23
Florida	**36**	29	33	22	30	35	42
Idaho	**36**	18	39	31	44	19	50
Illinois	**38**	45	36	14	13	31	14
Iowa	**39**	50	16	40	41	11	27
New York	**40**	47	35	30	6	40	1
Mississippi	**41**	40	4	51	46	49	47
Alaska	**42**	41	49	26	28	1	2
Nebraska	**43**	36	38	45	30	15	19
Montana	**44**	39	40	33	34	4	25
North Carolina	**45**	34	34	28	25	36	45
Delaware	**46**	50	45	12	15	28	13
Indiana	**47**	44	27	36	41	33	36
Kentucky	**48**	42	28	48	38	45	37
Tennessee	**49**	37	37	38	39	37	44
Louisiana	**50**	49	26	47	46	48	26
Nevada	**51**	30	46	42	50	42	46

Metrics Included:

- Aerospace Engineers - The Aerospace Engineers per 1000 jobs
- Aerospace Production Workers - The Aerospace Production Workers Hours/(Total Employees x Average Hours)
- Engineering BAs - The percentage of population 25+ with an engineering B.A.
- Graduate Degrees - The percentage of population 25+ with an advanced degree
- High School + - The percentage of population 25+ with at least a high school education
- Education Spending - Primary and Secondary Education Spending Per Pupil

Category 3: Aerospace Industry

State	Industry Rank	Aerospace Sales	Aerospace Value Added	Aerospace Exports	Workforce Growth	Supplier Density	Crowding Out
Washington	**1**	1	1	1	19	3	33
Kansas	**2**	5	4	12	22	1	19
Ohio	**3**	8	9	9	20	9	28
California	**4**	2	2	3	37	6	38
Florida	**5**	11	10	6	12	11	48
North Carolina	**6**	9	8	10	8	35	9
Arizona	**7**	6	5	11	35	4	37
Alabama	**7**	15	12	14	16	8	34
Connecticut	**9**	4	6	8	40	2	44
South Carolina	**10**	18	14	7	11	24	22
Texas	**11**	3	3	4	33	19	47
Arkansas	**12**	14	16	15	36	7	10
Missouri	**13**	10	13	19	9	21	49
Colorado	**14**	16	15	37	2	29	7
Georgia	**15**	7	7	5	32	23	46
Michigan	**16**	21	20	20	15	17	24
Kentucky	**17**	29	27	2	13	30	8
Utah	**18**	26	19	32	17	12	27
Oregon	**19**	31	31	31	14	10	25
Minnesota	**19**	33	32	28	7	22	14
Oklahoma	**21**	19	21	27	39	5	40
Massachusetts	**22**	22	22	25	5	32	50
Indiana	**23**	13	11	16	42	25	39
Wisconsin	**23**	34	33	26	1	33	15
Pennsylvania	**25**	12	24	22	21	34	42
Virginia	**26**	24	25	24	3	45	36
New Hampshire	**27**	39	37	29	4	27	23
Maine	**28**	25	23	35	24	31	17
New York	**29**	17	17	13	38	38	41
Iowa	**30**	23	28	34	24	41	31
Idaho	**31**	43	40	41	31	13	5
Tennessee	**31**	32	36	17	45	28	11
Montana	**33**	46	46	47	6	20	26
West Virginia	**34**	27	30	36	34	39	13
Illinois	**35**	20	18	21	41	49	35
Alaska	**36**	49	49	43	10	14	32
Hawaii	**37**	36	35	33	24	48	3
New Mexico	**38**	45	45	42	18	18	30
North Dakota	**39**	42	43	48	24	26	6
South Dakota	**40**	38	39	50	24	36	1
Nebraska	**41**	41	42	46	23	37	3
New Jersey	**42**	37	34	18	43	44	29
Vermont	**43**	40	38	45	24	42	21
Maryland	**44**	28	26	23	46	47	45
Louisiana	**45**	30	29	38	49	46	12
Wyoming	**46**	48	47	51	44	15	2
Nevada	**47**	44	44	39	47	16	43
Delaware	**48**	47	48	44	24	43	18
Mississippi	**49**	35	41	40	48	40	20
Rhode Island	**50**	50	50	49	50	51	16
District of Columbia	**51**	50	50	30	50	50	51

Metrics Included:

- Aerospace Sales - Aerospace Parts and Manufacturing Total value of shipments and receipts for services
- Aerospace Value Added - Aerospace Parts and Manufacturing Value Added
- Aerospace Exports - Aircraft, Spacecraft and Parts Exports
- Employee Growth - Percent Increase in Aerospace Employees
- Supplier Density - Aerospace Parts and Manufacturing establishments/Total establishments
- Crowding Out - Federal Aerospace Manufacturing Contracts/Total value of shipments and receipts for services

Category 4: Infrastructure

State	Infrastructure Rank	Airports	Freight Railroad	Port Volume	Road Condition	Transportation Funding
Massachusetts	**1**	9	6	16	17	15
Illinois	**2**	12	5	22	20	9
Vermont	**3**	17	21	22	3	7
District of Columbia	**4**	1	1	22	51	1
New York	**5**	13	15	2	44	4
Pennsylvania	**6**	8	7	12	36	17
Maryland	**7**	3	12	11	33	21
New Jersey	**8**	4	2	19	43	18
Delaware	**9**	2	4	17	49	16
North Dakota	**10**	35	31	22	10	3
Virginia	**11**	15	10	6	32	25
Connecticut	**12**	7	14	22	23	24
Florida	**13**	10	28	5	12	31
Washington	**14**	22	32	4	39	11
Kentucky	**15**	33	19	22	5	26
Ohio	**16**	6	3	22	30	42
Wisconsin	**17**	14	22	22	41	20
Minnesota	**18**	30	27	22	34	12
New Hampshire	**19**	19	36	22	1	33
Kansas	**20**	31	25	22	7	30
Iowa	**21**	36	16	22	31	19
Wyoming	**22**	49	44	22	15	5
Georgia	**23**	20	11	3	25	47
West Virginia	**24**	40	9	22	27	28
California	**25**	38	38	1	47	13
Maine	**25**	34	37	21	8	27
Nebraska	**27**	42	34	22	9	23
North Carolina	**28**	16	18	15	21	45
Hawaii	**29**	27	51	9	50	6
Indiana	**30**	5	8	22	28	50
South Dakota	**31**	44	41	22	29	8
Montana	**32**	46	42	22	26	10
Tennessee	**33**	26	20	22	4	48
Rhode Island	**34**	11	45	22	18	35
Texas	**35**	21	35	7	37	34
Alabama	**36**	37	23	14	11	43
Missouri	**37**	23	26	22	13	44
Oregon	**38**	39	40	20	24	22
Alaska	**39**	50	50	10	48	2
Louisiana	**40**	24	17	13	46	36
Mississippi	**41**	32	29	18	19	40
Oklahoma	**42**	28	33	22	35	29
South Carolina	**43**	25	13	8	38	51
Colorado	**44**	43	39	22	45	14
Nevada	**45**	51	49	22	2	32
New Mexico	**46**	47	47	22	6	37
Michigan	**47**	18	24	22	40	49
Arkansas	**48**	29	30	22	42	38
Idaho	**49**	41	43	22	22	39
Utah	**50**	48	46	22	16	41
Arizona	**51**	45	48	22	14	46

Metrics Included:

- Airports - Airports per Square Mile
- Freight Railroad - Total Freight Railroad miles per Square Mile
- Port Volume - Total Container Traffic at U.S. Ports
- Road Condition - Index of Road Quality
- Transportation Funding - Total Airport, Highway, Seaport and Transit spending/Population

Category 5: Risk to Operations

State	Risk to Operations Rank	Insurance Losses	Insurance Premiums	Earthquake Premiums	Extreme Weather
Arizona	**1**	14	7	9	5
Oregon	**2**	7	1	47	3
Michigan	**3**	17	13	2	17
Utah	**4**	8	2	46	6
Washington	**5**	2	8	48	7
Maine	**6**	21	10	17	13
New Mexico	**7**	24	18	6	10
Nevada	**8**	22	4	39	2
Wisconsin	**9**	33	5	3	23
New Hampshire	**10**	10	16	20	25
Idaho	**10**	35	3	23	4
Ohio	**12**	3	9	29	39
West Virginia	**13**	19	12	1	40
Alaska	**14**	12	18	49	1
Wyoming	**15**	5	28	35	11
North Carolina	**16**	9	26	14	32
Virginia	**17**	4	17	25	43
Pennsylvania	**18**	28	14	12	36
Georgia	**19**	16	32	16	24
Maryland	**20**	13	18	22	46
California	**21**	20	22	50	8
Texas	**22**	15	50	10	16
Alabama	**23**	18	40	18	22
Delaware	**24**	43	6	7	48
Hawaii	**25**	6	23	40	49
Minnesota	**26**	31	39	8	20
District of Columbia	**27**	1	33	32	51
Colorado	**28**	27	43	21	14
Indiana	**29**	26	21	37	37
South Dakota	**30**	51	29	5	21
Florida	**31**	32	51	4	19
North Dakota	**32**	50	34	11	12
Vermont	**33**	36	11	51	29
Montana	**34**	47	27	33	9
Iowa	**35**	48	15	19	41
Massachusetts	**36**	11	42	31	45
Tennessee	**37**	25	30	44	33
Illinois	**38**	37	24	36	34
Kentucky	**39**	29	25	42	44
Connecticut	**40**	23	44	27	42
Louisiana	**41**	46	49	13	15
Nebraska	**42**	49	41	15	26
South Carolina	**43**	30	36	41	38
New York	**44**	40	37	30	35
Arkansas	**45**	38	38	43	27
New Jersey	**46**	44	30	24	50
Missouri	**47**	39	35	45	30
Mississippi	**48**	41	46	38	18
Rhode Island	**49**	34	45	26	47
Kansas	**50**	45	47	28	31
Oklahoma	**51**	42	48	34	28

Metrics Included:

- Insurance Premiums –Average Homeowners Insurance Premiums
- Insurance Losses - Incurred Insurance Losses, Commercial Insurance, by State/State GDP
- Earthquake Premiums - Total Earthquake Premiums/Population
- Extreme Weather - Total number of storm events per Square Mile

Category 6: Economy

State	Economy Rank	GDP Per Capita	GDP Per Capita Growth	Manufacturing	Global Manufacturing Connectivity	Unemployment Rate
Washington	**1**	10	3	11	3	37
Indiana	**2**	28	13	2	11	14
Iowa	**3**	20	6	10	29	4
Minnesota	**4**	13	12	12	23	12
Wisconsin	**5**	24	15	6	19	10
Utah	**6**	31	4	19	12	10
New Hampshire	**6**	21	25	13	15	2
Tennessee	**8**	37	11	8	10	12
Texas	**9**	16	9	26	5	23
Michigan	**10**	34	2	3	4	37
California	**11**	9	1	21	20	30
Massachusetts	**12**	2	17	23	25	16
Oregon	**13**	22	38	1	9	24
Ohio	**14**	25	14	9	13	45
South Carolina	**15**	47	21	7	2	29
Alabama	**16**	46	28	5	8	21
Colorado	**17**	17	10	35	43	7
Kentucky	**17**	43	34	4	1	30
Idaho	**19**	50	18	17	22	7
Vermont	**19**	36	40	27	7	4
Nebraska	**21**	15	23	33	40	4
Connecticut	**22**	6	47	16	17	30
Georgia	**23**	30	5	31	21	30
Illinois	**24**	14	22	28	16	45
North Dakota	**25**	5	48	37	39	2
Kansas	**26**	29	43	18	26	16
Hawaii	**27**	18	16	49	49	1
North Carolina	**28**	32	26	15	31	30
Pennsylvania	**29**	23	7	29	32	43
New York	**30**	3	24	44	27	37
Oklahoma	**31**	35	8	34	38	24
Delaware	**32**	4	32	47	30	30
Arkansas	**33**	49	19	24	34	19
Florida	**34**	42	20	40	24	22
Maryland	**35**	11	27	43	44	24
Missouri	**36**	39	36	22	35	19
Rhode Island	**37**	26	30	30	37	30
Arizona	**38**	44	41	20	14	37
South Dakota	**39**	27	46	25	46	14
Virginia	**40**	19	42	38	42	18
Maine	**41**	45	33	32	41	9
New Jersey	**42**	12	37	42	36	37
Mississippi	**43**	51	39	14	18	43
Nevada	**44**	38	45	39	6	45
Wyoming	**45**	8	44	48	50	24
Montana	**46**	41	35	45	47	24
New Mexico	**47**	40	29	46	28	50
West Virginia	**48**	48	31	36	33	48
District of Columbia	**49**	1	49	51	48	49
Louisiana	**50**	33	50	41	45	37
Alaska	**51**	7	51	50	51	51

Metrics Included:

- GDP Per Capita - GDP Per Capita
- Growth in GDP Per Capita - GDP Per Capita 5-Year Growth
- Manufacturing Industry - Durable Goods Output/State GDP
- Global Manufacturing Connectivity - Durable Goods Exports/State GDP
- Unemployment Rate

Category 7: Research & Innovation

State	Research & Innovation Rank	Patents per Capita	Public R&D	Private R&D	High Tech Establishments
Massachusetts	**1**	2	6	2	9
California	**2**	1	14	1	7
Colorado	**3**	10	7	19	4
Utah	**4**	12	12	11	6
Washington	**5**	3	16	5	18
Connecticut	**6**	7	10	6	23
New Hampshire	**7**	6	19	7	16
Maryland	**8**	26	1	23	5
New Jersey	**9**	11	33	9	10
Arizona	**10**	16	15	15	18
Virginia	**11**	31	5	28	2
Michigan	**12**	9	23	4	33
Minnesota	**13**	5	37	12	16
District of Columbia	**14**	30	3	39	1
Illinois	**15**	14	28	16	15
Oregon	**16**	4	36	8	28
Delaware	**16**	25	45	3	3
Idaho	**18**	17	9	14	39
North Carolina	**19**	20	25	17	20
Pennsylvania	**19**	23	17	18	24
Texas	**21**	18	26	27	11
Rhode Island	**22**	19	8	26	30
Kansas	**23**	27	13	24	22
Ohio	**24**	21	21	21	28
New Mexico	**25**	32	2	36	26
Vermont	**26**	8	35	22	35
New York	**27**	13	31	29	30
Florida	**28**	33	30	32	14
Georgia	**29**	28	40	30	12
Missouri	**30**	35	20	10	46
Wisconsin	**31**	15	41	20	36
Nevada	**32**	29	34	42	8
Indiana	**33**	22	43	13	36
Alabama	**34**	45	4	31	36
Tennessee	**35**	37	11	38	42
Iowa	**36**	24	32	25	50
Alaska	**37**	49	22	50	24
Oklahoma	**38**	43	39	45	20
Wyoming	**39**	38	49	51	13
Montana	**39**	42	29	47	33
South Carolina	**41**	34	42	37	39
Hawaii	**42**	46	24	44	39
Nebraska	**43**	36	44	35	44
Kentucky	**44**	39	46	33	42
Maine	**44**	44	38	34	44
West Virginia	**46**	50	27	40	47
Mississippi	**47**	51	18	48	48
Louisiana	**48**	47	50	49	26
Arkansas	**49**	48	51	46	30
North Dakota	**50**	41	48	40	49
South Dakota	**51**	40	47	43	51

Metrics Included:

- Patents per Capita - Patents Issued to Residents/Total Population
- Public Research and Development - Federal R&D Spending for Selected Agencies/State GDP
- Private Research and Development - Private R&D from All Sources/State GDP
- High Tech Establishments – Percent of Businesses in Industries with High Science, Engineering, and Technology (SET) Employment

Category 8: Taxes and Incentives

State	Taxes & Incentives Rank	Total Taxes/GDP	Workers' Compensation	Corporate Income Tax	Individual Income Tax	Manufacturing Tax	Property Tax	Sales Tax
South Dakota	**1**	5	20	1	1	18	25	13
Texas	**2**	3	12	4	1	8	33	37
Oklahoma	**3**	6	44	15	18	2	2	13
Alabama	**4**	11	27	24	18	3	3	7
Washington	**5**	12	37	6	1	4	18	41
Utah	**6**	8	6	11	18	24	14	26
North Dakota	**7**	51	1	8	8	1	4	16
Indiana	**8**	13	2	21	10	7	12	47
Colorado	**9**	16	17	9	15	22	23	6
Georgia	**10**	7	25	15	29	19	20	7
Nevada	**11**	27	9	3	1	23	15	44
North Carolina	**12**	14	30	7	25	20	13	15
Tennessee	**13**	4	22	24	18	21	11	47
Arizona	**14**	18	14	10	13	36	22	23
Wyoming	**15**	32	29	1	1	34	38	7
Ohio	**16**	24	12	5	17	37	21	24
Missouri	**17**	10	32	21	29	25	16	12
Michigan	**18**	26	18	15	12	14	39	27
Kentucky	**19**	29	16	15	29	15	8	27
Louisiana	**20**	9	42	37	29	13	5	16
Oregon	**21**	17	7	33	49	6	30	1
Florida	**22**	21	19	14	1	41	36	27
Virginia	**23**	15	5	15	26	42	31	20
Arkansas	**24**	38	3	24	36	5	7	41
New Mexico	**25**	33	32	20	16	30	6	19
West Virginia	**26**	42	4	24	33	9	17	27
Delaware	**27**	2	46	48	34	44	1	1
District of Columbia	**28**	1	10	44	44	45	9	24
South Carolina	**29**	23	34	11	39	29	32	27
Kansas	**30**	28	11	30	14	31	35	41
Pennsylvania	**31**	34	26	50	9	12	29	27
Mississippi	**32**	43	23	11	18	26	28	47
Alaska	**33**	30	47	47	1	27	43	1
Nebraska	**34**	22	20	35	35	28	37	21
Idaho	**35**	25	24	32	40	33	24	27
Hawaii	**36**	45	35	23	42	34	10	7
New Hampshire	**37**	20	35	39	18	51	51	1
Wisconsin	**38**	37	40	36	41	10	41	16
Massachusetts	**39**	35	8	37	18	38	40	37
Iowa	**40**	19	28	51	47	17	34	27
Maryland	**41**	39	14	40	26	39	27	27
Montana	**42**	31	41	29	36	46	42	1
Illinois	**43**	41	44	34	11	32	44	37
Minnesota	**44**	40	30	49	48	11	26	45
California	**45**	36	51	42	51	16	19	51
New York	**46**	50	49	24	43	43	45	7
Rhode Island	**47**	44	43	30	28	47	47	47
Connecticut	**48**	47	47	44	38	40	46	40
Vermont	**49**	49	38	41	44	48	49	27
Maine	**50**	48	38	43	50	49	48	21
New Jersey	**51**	46	50	44	46	50	50	45

Metrics Included:

- Total Taxes/GDP - Total Taxes as a percent of State GDP
- Workers' compensation premium rate
- Corporate Income Tax - Top Corporate Income Tax Rate, or Implied Corporate Income Tax Rate using B&O and Aerospace Margin
- Personal Income Tax - Top Individual Income Tax Rate
- Manufacturing Tax - Taxes on Production and Imports Minus Subsidies for Durable Goods Manufacturing/GDP for Durable Goods Manufacturing
- Property Tax - State & Local Property Tax Collection Per Capita / GDP Per Capita
- Sales Tax - General Sales Tax Rate

Methodology, Weighting & Metrics

Numerous quantitative measures were evaluated for inclusion in the ranking methodology. Some were included, and others rejected. For inclusion, a variable must meet all or most of the following criteria:

1. Important to manufacturing costs and profitability
2. Readily available for all 50 states and the District of Columbia
3. Uniformity of calculation and reporting, so that the variable can be fairly compared across all states
4. Publicly available data
5. Available for a recent year
6. Aerospace industry specific

In the final analysis, 41 quantitative measures were included in the ACES model. Each was included in one of the following categories:

1. Manufacturing Costs
2. Labor & Education
3. Aerospace Industry
4. Infrastructure
5. Risk to Operations
6. Economy
7. Research & Innovation
8. Taxes & Incentives

Each metric is ranked by state based on the absolute variable value. The result is a matrix of rankings by metric by state: 41 metrics by 51 states. The rankings for all metrics and all states are presented in the tables below.

Weighting of Metrics

Once the metrics where chosen, based on the criteria outlined above, weights were established for each of the categories and for each of the metrics within a category. The final decision for establishing weights was based on a review of potential impact to a typical aerospace company's income statement and profitability. The more directly impactful a category (or individual metric) was believed to be, the higher the weight assigned. For example, Costs are more directly linked and impactful to an individual corporation's overall cost structure and ability to generate profit than are indirect impacts from the state's Economy. Therefore, Costs receive a weight of 20%, while Economy receives a weight of only 5%.

Likewise, the specific metrics within a category received a higher weight depending on their perceived income statement impact within the overall category. Where individual metrics were perceived to be somewhat equal in importance, or their impact was understood to be less direct to the income statement, then similar weights were assigned, or the weighting was clustered in a narrow range.

The rankings for each category of metrics (i.e. Infrastructure) is calculated by multiplying each of the category's metric weights by its corresponding metric rank. Then each state's resulting ranking for a category is multiplied by the corresponding category rank, resulting in the overall rank.

It should be noted that anyone can construct their own model framework and weighting scheme from the information provided in this report. The weights can be changed and then multiplied by each of the metric ranks to determine alternative category ranks, which can then be multiplied by alternative category weights to arrive at alternative overall state rankings.

Estimation of Metrics

The ACES Rankings include data that are as aerospace-specific as possible while also remaining publicly available for all 50 states and the District of Columbia, and for the large majority of metrics, data were available for every state. However, for a handful of metrics, data were missing for one or more states. In these cases, analytical techniques were used to come to an accurate estimation of the state's missing data for that metric. These techniques used data from the previous year, data from the state's census sub-region and data from a broader NAICS category to develop an accurate estimate.

Categories & Metrics Included in ACES

Category	Metric	Notes	Source
Costs	Unit Labor Cost	The amount of labor, measured by payroll, necessary to produce $1 in revenue (2016)	U.S. Census Bureau
	Unit Material Cost	The amount of materials necessary to produce $1 in revenue (2016)	U.S. Census Bureau
	Energy Cost	The cost (cents/kilowatt hour) for the Industrial End-Use Sector (December 2017)	U.S. Energy Information Administration
	Construction Cost	The National Association of Builders modifiers for construction costs for buildings by state (2017)	National Building Cost Manual
Labor & Education	Aerospace Engineers	The Aerospace Engineers per 1000 jobs (2016)	U.S. Bureau of Labor Statistics
	Aerospace Production Workers	The Aerospace Production Workers Hours/(Total Employees x Average Hours) (2016)	U.S. Census Bureau U.S. Bureau of Labor Statistics
	Engineering BAs	The percentage of population 25+ with an engineering B.A. (2016)	U.S. Census Bureau
	Graduate Degrees	The percentage of population 25+ with an advanced degree (2016)	U.S. Census Bureau
	High School +	The percentage of population 25+ with at least a high school education (2016)	U.S. Census Bureau
	Education Spending	Primary and Secondary Education Spending Per Pupil (2015)	U.S. Census Bureau
Industry	Aerospace Sales	Aerospace Parts and Manufacturing Total value of shipments and receipts for services (2016)	U.S. Census Bureau
	Aerospace Value Added	Aerospace Parts and Manufacturing Value Added (2016)	U.S. Census Bureau U.S. Bureau of Economic Analysis
	Aerospace Exports	Aircraft, Spacecraft and Parts Exports (2017)	U.S. Census Bureau
	Employee Growth	Pct Increase in Aerospace Employees (2012 - 2016)	U.S. Census Bureau
	Supplier Density	Aerospace Parts and Manufacturing establishments/Total establishments (2015)	U.S. Census Bureau
	Crowding Out	Federal Aerospace Manufacturing Contracts/Total value of shipments and receipts for services (FY 2016)	USASpending.gov U.S. Census Bureau
Infrastructure	Airports	Airports per Sq Mile (2013)	U.S. Department of Transportation
	Freight Railroad	Total Freight Railroad miles per Sq Mile (2012)	U.S. Department of Transportation Association of American Railroads
	Port Volume	Total Container Traffic at U.S. Ports (2016)	U.S. Army Corps of Engineers
	Road Condition	Index of Road Quality (2013)	U.S. Department of Transportation
	Transportation Funding	Total Airport, Highway, Seaport and Transit spending/Population (2014)	U.S. Census Bureau
Risk to Operations	Insurance Premiums	Average Homeowners Insurance Premiums (2015)	Insurance Information Institute
	Insurance Losses	Current 2012 - 2016 Incurred Insurance Losses, Commercial Insurance, by State/Current State GDP (2012 - 2016)	U.S. Bureau of Economic Analysis
	Earthquake Premiums	Total Earthquake Premiums/Population (2015)	U.S. Bureau of Economic Analysis
	Extreme Weather	Total number of storm events per Sq Mile (2012 - 2016)	U.S. National Oceanic and Atmospheric Administration
Economy	GDP Per Capita	Real GDP Per Capita (4Q 2016 - 3Q 2017)	Bureau of Economic Analysis
	Growth in GDP Per Capita	Real GDP Per Capita 5-Year Growth (4Q 2011 - 3Q 2012, 4Q 2016 - 3Q 2017)	U.S. Bureau of Economic Analysis
	Manufacturing Industry	Real Durable Goods Output/Real State GDP (4Q 2016 - 3Q 2017)	U.S. Bureau of Economic Analysis
	Global Manufacturing Connectivity	Current Durable Goods Exports/Current State GDP (4Q 2016 - 3Q 2017)	U.S. Census Bureau U.S. Bureau of Economic Analysis
	Unemployment Rate	Unemployment Rate (December 2017)	U.S. Bureau of Labor Statistics
Research & Innovation	Patents per Capita	Patents Issued to Residents/Total Population (2017)	U.S. Patent and Trademark Office
	Public Research and Development	Current Federal R&D Spending for Selected Agencies/Current State GDP (2015)	National Science Foundation
	Private Research and Development	Current Private R&D from All Sources/Current State GDP (2013)	National Science Foundation
	High Tech Establishments	Pct of Businesses in Industries with High Science, Engineering, and Technology (SET) Employment (2014)	National Science Foundation
Taxes & Incentives	Total Taxes/GDP	Current Total Taxes as a pct of Current State GDP (2014)	U.S. Census Bureau U.S. Bureau of Economic Analysis
	Workers' Compensation	Workers' compensation premium rate (2016)	Oregon Department of Consumer and Business Services
	Corporate Income Tax	Actual or Estimated Corporate Income Tax Rate (Estimated using B&O and Aerospace Margin) (2017)	Tax Policy Institute, Delaware Division of Revenue, Nevada Department of Taxation, Ohio Department of Taxation, Texas Office of the Comptroller, Washington State Department of Revenue, Dr. Aswarth Damodaran, NYU STEM School of Business
	Personal Income Tax	Top Individual Income Tax Rate (2017)	Tax Policy Institute
	Manufacturing Tax	Current Taxes on Production and Imports Minus Subsidies for Durable Goods Manufacturing/Current GDP for Durable Goods Manufacturing (2015)	U.S. Bureau of Economic Analysis
	Property Tax	Current State & Local Property Tax Collection Per Capita (2014) / Current GDP Per Capita (2014)	Tax Policy Institute U.S. Bureau of Economic Analysis
	Sales Tax	General Sales Tax Rate (2017)	Federation of Tax Administrators

Weights for Categories & Individual Metrics

Category	Weight	Metric	Metric Weight
Costs	20.0%	Unit Labor Cost	30.0%
		Unit Material Cost	30.0%
		Energy Cost	20.0%
		Construction Cost	20.0%
Labor & Education	17.5%	Aerospace Engineers	30.0%
		Aerospace Production Workers	30.0%
		Engineering BAs	10.0%
		Graduate Degrees	10.0%
		High School Degree or More	10.0%
		Education Spending	10.0%
Industry	15.0%	Aerospace Sales	20.0%
		Aerospace Value Added	15.0%
		Aerospace Exports	15.0%
		Workforce Growth	20.0%
		Supplier Density	20.0%
		Crowding Out	10.0%
Infrastructure	15.0%	Airports	17.5%
		Freight Railroad	17.5%
		Port Volume	17.5%
		Road Condition	17.5%
		Transportation Funding	30.0%
Risk to Operations	5.0%	Insurance Losses	30.0%
		Insurance Premiums	30.0%
		Earthquake Premiums	20.0%
		Extreme Weather	20.0%
Economy	5.0%	GDP Per Capita	20.0%
		GDP Per Capita Growth	20.0%
		Manufacturing	20.0%
		Global Manufacturing Connectivity	20.0%
		Unemployment Rate	20.0%
Research & Innovation	5.0%	Patents per Capita	25.0%
		Public R&D	25.0%
		Private R&D	25.0%
		High Tech Establishments	25.0%
Taxes & Incentives	17.5%	Total Taxes/GDP	20.0%
		Workers' Compensation	10.0%
		Corporate Income Tax	17.5%
		Individual Income Tax	15.0%
		Manufacturing Tax	17.5%
		Property Tax	10.0%

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