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THE WASHINGTON AEROSPACE INDUSTRY

Prepared for
Aerospace Futures Alliance of Washington

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1. SUMMARY

Air transportation is a vital function of a modern economy. It entails a variety of activities: aerospace manufacturing, air passenger and freight service, airport operations, air traffic control, air transportation arrangement, and other air support services. Today, including the suppliers of these activities, air transportation employs more than 100,000 people in Washington.

This study focuses on the aerospace industry, which accounts for more than one-half of the employment in air transportation:

- The Washington aerospace industry primarily manufactures aircraft and parts.
- Led by The Boeing Company, the aerospace industry employed 65,400 people in 2005.
- With an average annual wage of $83,370, more than double the average for all industries, the aerospace industry paid $5.4 billion in wages and salaries.
- Taking into consideration the direct and indirect impact on the economy, the aerospace industry accounted for an estimated 209,300 jobs or 7.5 percent of total state employment.
- More than nine out of every ten aerospace employees worked in King County (38,800) and Snohomish County (23,700) in 2005.
- The total impact of the industry amounted to 116,400 jobs or 10.1 percent of total employment in King County and 52,100 jobs or 22.9 percent of total employment in Snohomish County.
- The aerospace industry also accounted for 40,800 jobs or 2.9 percent of total employment in the rest of the state.

2. BRIEF HISTORY

The history of the aerospace industry in Washington is almost as long as the history of the airplane. In 1916, just thirteen years after the Wright brothers took their first heavier-than-air flight at Kitty Hawk, William Boeing founded the Pacific Aero Products Company and soon renamed it the Boeing Airplane Company. Initially, Pacific Aero Products employed 16 workers earning 14 to 40 cents per hour. Selling bi-planes (Model Cs) to the navy and army during World War I, the Seattle company emerged from the conflict as a major aircraft manufacturer.

After the war, Boeing devoted much of its effort to developing aircraft for a promising commercial market. The airline industry began in 1925 when Congress turned over the job of flying mail to private contractors. Boeing formed a subsidiary called Boeing Air Transport, the forerunner to United Airlines, and successfully bid on a federal contract to fly mail between San Francisco and Chicago. In 1927, the 23-hour inaugural flight in a Model 40A carried mail as well as two paying passengers.

Table 1

WASHINGTON AEROSPACE INDUSTRY, 2005
Largest 20 Companies Ranked by August 1 Employment

	Employment	Products
1. The Boeing Co.	59,710	Airplanes, information systems
2. Goodrich Corp.	1,800	Maintenance services, landing gear assembly
3. Crane Aerospace & Electronics	1,120	Electronic products and systems
4. Esterline Technologies Corp.	1,060	Lighting, metal finishing, inspections services
5. Zodiac/Northwest Composites, Inc.	550	Interiors, composites, composite structures
6. ESP, Inc.	330	Engineering services within simulation industry
7. Tect Corp.	310	Aerostructures and mechanical assemblies
8. Hexcel Corp.	300	Composite aerospace parts
9. Electroimpact, Inc.	240	CNC machines, assembly machines, tooling
10. Skills, Inc.	240	Precision parts
11. Avtech Corp.	230	Aviation electronics
12. AIM Aviation, Inc.	180	Interior products
13. Fatigue Technology, Inc.	160	Retainers, bushings, fasteners, fittings, tooling
14. Zodiac/IDD Aerospace Corp.	140	Flight deck control panels, keyboards
15. AIM Aviation Auburn, Inc.	130	Composite products
16. Contour Aerospace Corp.	120	Machined structures and subassemblies
17. Precision Machine Works, Inc.	100	Hard metal parts
18. Saint-Gobain Aerospace Components	100	Advanced plastic and composite materials
19. Spectralux Corp.	70	Lighted displays, keyboards, avionics assemblies
20. The Insitu Group, Inc.	50	Unmanned robotic aircraft

Source: *Lists 2006*, Puget Sound Business Journal, December 22, 2005.

The Model 247, which first flew in 1933, helped revolutionize passenger air travel. A streamlined all-metal monoplane with two engines, it was capable of flying 70 miles per hour faster than its competitors. It could carry ten passengers and 400 pounds of mail. However, because it was launched during the Great Depression, it had little chance of commercial success. Altogether Boeing sold only 75 247s, including 60 to United Airlines. Later in the hard-pressed 1930s the company developed the Stratoliner (Model 307) and the Clipper (Model 314). Although only a few of these planes were built, they demonstrated the feasibility of long-range flight over land and water.

The economic fortunes of Boeing turned around during World War II. When the United States entered the war in 1941, the B-17 Flying Fortress was already flying bombing missions over Germany for the British Royal Air Force. The B-29 Super Fortress, which was on the drawing boards in the 1930s, became operational in 1943. In 1944, producing up to twenty bombers per day, Boeing employment swelled to 50,000 in the company's Seattle area plants, while sales totaled $600 million. Between 1935 and 1945, Boeing built approximately 7,000 B-17s and 3,000 B-27s. Other companies, such as Douglas Aircraft, produced another 5,700 B-17s and 1,200 B-29s to meet military needs.

Boeing employment plummeted to 10,000 after the war, but it was still twice the pre-war level because of defense contracts prompted by the Cold War with the Soviet Union. Despite the development of the Stratocruiser (Model 377) in 1947, commercial aircraft production languished until the dawn of the jet age. The first commercial jet airplane was the ill-fated Comet

manufactured by British De Havilland, which went into service in 1952. Two of the airplanes crashed because of metal fatigue, slowing sales and allowing U.S. manufacturers to catch up. Boeing delivered its first jet, a 707-120, to Pan Am in 1958. Carrying up to 200 passengers at 600 miles per hour, the 707 flew comfortably above the weather and totally transformed air travel.

The key to the success of jet airplanes has been their ability to greatly reduce the cost of flying, making air travel feasible for an increasingly greater number of people. As worldwide demand for air travel soared in the 1960s, Boeing introduced the 727, 737, and the 747 in rapid succession, creating a family of airplanes to serve virtually every need. Variants of the 737, Boeing's most popular jet, and the 747, its jumbo jet, are still rolling off the production lines today. Since 1982 Boeing has augmented its fleet with the 757, 767, and 777. The company's next jet, the 787 Dreamliner, will debut in 2008. Like its predecessors, the 787 will feature a host of technological advancements in wing design, fuel efficient engines, light-weight materials, and computer-aided design and manufacturing processes intended to lower the cost of air travel.

3. INDUSTRY CHARACTERISTICS

As measured by the level of activity and types of airplanes, the Washington aerospace industry has changed significantly over the years. However, there are several characteristics of the industry that have remained more or less constant throughout its history.

1. Basic industry. The Washington aerospace industry has always been primarily an export industry, delivering aircraft and parts to customers in the rest of the United States, foreign countries, and the federal government. Such basic activity, which brings money into Washington and creates jobs not only in the exporting industry but also in other industries through the so-called multiplier (respending) process, is a key determinant of the state's economic welfare. In other words, basic industries are fundamental to the existence of the state economy.

   The importance of external markets to the aerospace industry and of aerospace exports to the state economy is evident in the latest Washington input-output study. The 1997 study showed that 96.3 percent of the industry's output was exported and that one-half of the exports were destined to foreign countries. Boeing is perennially the nation's top exporting company. The study also showed that aerospace exports accounted for 15.7 percent of Washington total exports to the rest of the United States and 40.2 percent of total exports to other countries. Earlier input-output studies, which extend back to 1963, told essentially the same story.

   A current indicator of the importance of aerospace as a basic industry is the location or concentration quotient (Figure 1). It measures the percentage of the state's total employment in an industry relative to that for the United States. If a state has the same fraction of its work force in an industry as the nation, the location quotient is one. Typically, exporting industries have location quotients greater than one, while local-serving industries, such as retail trade and personal services, have location quotients close to one.

Figure 1

WASHINGTON LOCATION QUOTIENTS, 2005

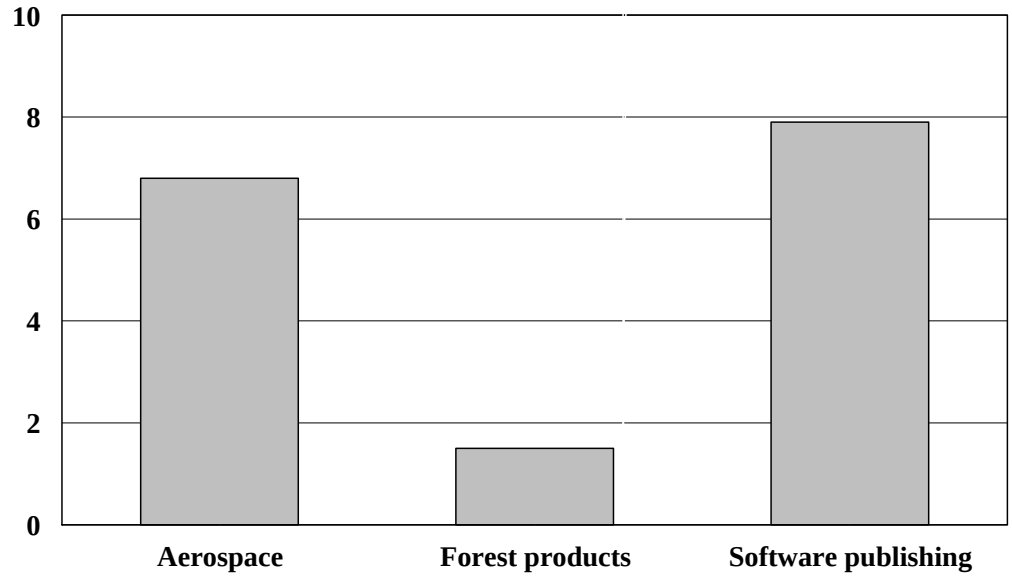
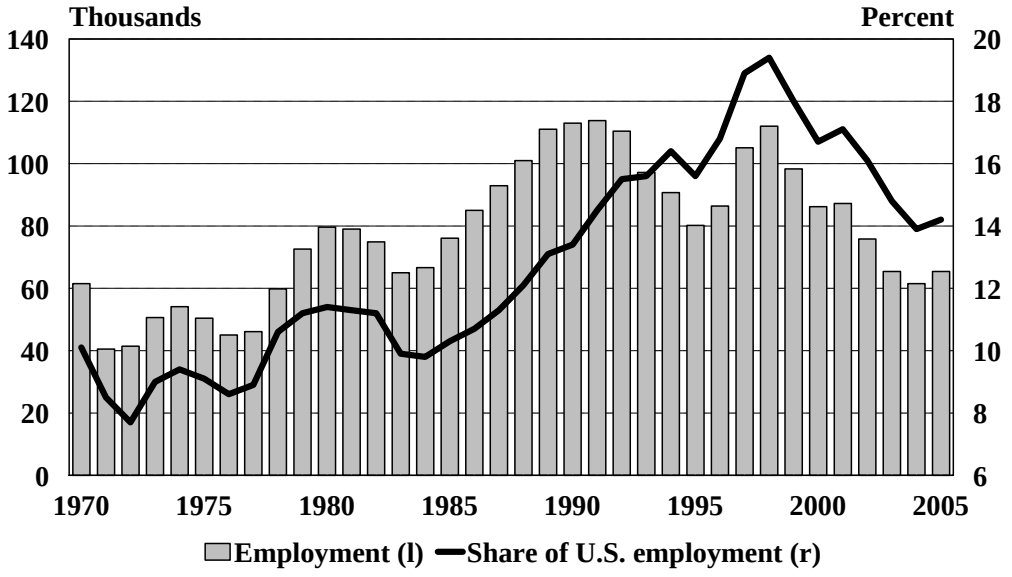


Figure 2

WASHINGTON AEROSPACE EMPLOYMENT



In 2005, the aerospace industry exhibited a location quotient of 6.8, indicating a very high concentration of the industry in the state. The software publishing industry, led by Microsoft, had a similar location quotient (7.9). Reflecting its declining importance as a basic industry, the forest products industry had a location quotient of only 1.5.

2. Major employer. Ninety years after its founding, the aerospace industry is still a major employer. Aerospace is Washington's largest manufacturing industry, while Boeing is its largest private employer. In 2005, the aerospace industry employed 65,400 workers, including approximately 58,000 at Boeing. Despite little change in the level of employment between 1970 and 2005, the aerospace industry's share of total state employment dropped from 5.7 percent to 2.4 percent.

   The drop in the aerospace industry's employment share requires qualification. First, it does not mean that the Washington aerospace industry is on the decline. In fact, between 1970 and 2005, Washington aerospace employment as a share of U.S. aerospace employment rose from 10.1 percent to 14.2 percent. Further evidence of the fundamental strength of the Washington aerospace industry is the fact that over the same period it continued to account for about one-quarter of the state's manufacturing jobs (Figure 3).

   Second, the decline in aerospace employment as a share of total state employment is attributable to relatively large productivity gains in the industry. The high productivity growth rate has in turn allowed aerospace companies to pay increasingly higher wages. In 2005, aerospace workers earned on average more than $80,000 in wages and salaries, about twice the average for all industries in the state. Thus, with 2.4 percent of the employment, the aerospace industry accounted for 4.9 percent of total Washington wages and salary disbursements.

3. Volatile demand. The demand for aircraft, whether stemming from the military or the world airline industry, is highly volatile. Given that Boeing is a major employer, the fluctuations in aircraft demand have often sent ripples throughout the state economy. The ramp-up in Boeing production during World War II, which led to 40,000 new jobs, helped pull the Seattle area out of the Great Depression. The subsequent lay-offs at the conclusion of the war precipitated a recession.

   Despite a declining employment share, the aerospace industry can still impart significant fluctuations to the Washington economy (Figure 4). Surging aerospace employment coupled with a strong national economy triggered state economic booms in the late 1970s, 1980s, and 1990s. Spurred by 48,000 new hires in the aerospace industry, the 1983-90 expansion created fully one-fifth of the jobs in the state economy today. Back-to-back aerospace slumps contributed substantially to the last recession.

Figure 3

WASHINGTON MANUFACTURING EMPLOYMENT
Thousands

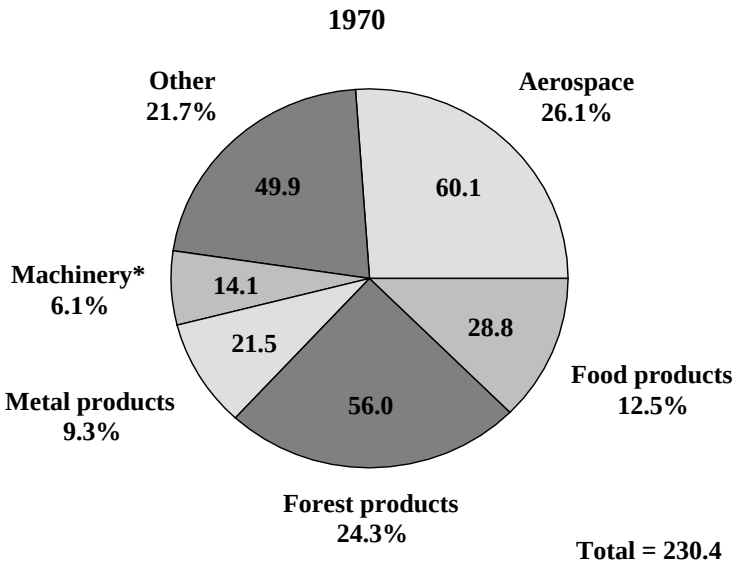
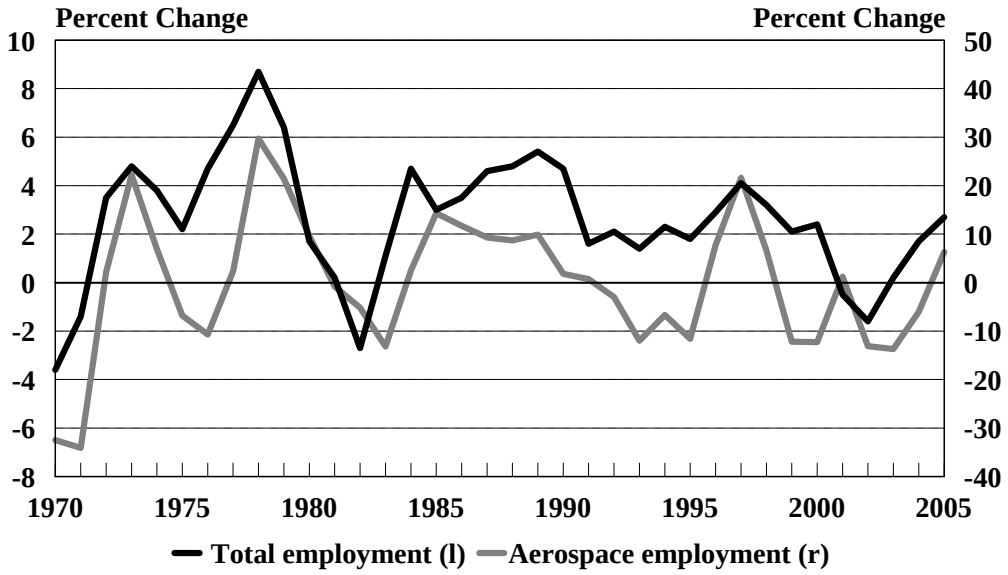


Figure 4

WASHINGTON EMPLOYMENT



4. Outsourcing. Considering the debates of late, one might get the impression that outsourcing production and jobs is a relatively new phenomenon. In fact, it is a long-standing practice in the Washington aerospace industry. For example, during World War II, Boeing manufactured only a support assembly in the wing of the B-29. As historian Carlos Schwantes noted, "Wing tips were manufactured in Cleveland, landing gear in Milwaukee, engine housings in Detroit, and engines in a Dodge factory in Chicago. Puget Sound businesses handled no more than 5 percent of Boeing's subcontracted work."

   The growth of local suppliers to the aerospace industry since World War II has reduced the need to outsource production, but not by much. In 1997, Boeing and the other aerospace companies purchased $21.9 billion in goods and services to support operations, according to the input-output study. Of that amount, $2.3 billion or 10.6 percent was procured from in-state businesses. The two largest local purchases were aerospace products ($0.6 billion) and professional and business services ($0.3 billion). In 1963, the aerospace industry purchased 10.9 percent of its goods and services from local firms.

   In light of the variety and complexity of aircraft components, which range from composite structures to avionics, it is not surprising that Boeing and the other aerospace companies acquire them from all over the world. At the same time, the aerospace industry's high volume of imported goods and services does represent a significant business opportunity for local suppliers.

4. ECONOMIC IMPACT

The Washington aerospace industry primarily manufactures aircraft and parts (Table 1). The Boeing Company, traditionally the world's leading manufacturer of commercial jet aircraft, is the largest member of the industry with almost 90 percent of the employment. The other aerospace companies, many of which are subcontractors to Boeing, produce a wide range of goods and services: composite materials, interiors, ducting, lighting, control panels, keyboards, assembly machines, engineering services, and aircraft maintenance. Companies with more than 1,000 employees also include Goodrich Corporation, Crane Aerospace & Electronics, and Esterline Technologies Corporation, according to *Lists 2006* published by the Puget Sound Business Journal.

Table 2

WASHINGTON AEROSPACE INDUSTRY, 2005

	Establishments	Employment	Wages (mils. $)	Average Annual Wage ($)
Aircraft manufacturing	20	57,000	5,015.3	87,990
Aircraft engines and parts	7	200	12.9	64,500
Other aircraft parts	127	7,500	378.3	50,440
Space vehicles	7	700	46.0	65,710
Aerospace	161	65,400	5,452.5	83,370

Data from the Washington Employment Security Department indicate that there were 161 establishments in the aerospace industry in 2005 (Table 2). These included 20 in aircraft manufacturing, 7 in aircraft engines and parts, 127 in other aircraft parts, and 7 in space vehicles. Note that some companies, such as Boeing, have more than one establishment.

In 2005, there were 65,400 employees in the aerospace industry, including an estimated 58,000 working at Boeing. The Boeing strike reduced both of these figures by 1,400. Virtually all of the jobs were in aircraft manufacturing (57,000) and other aircraft parts (7,500). Aircraft engines and parts and space vehicles had 200 and 700 jobs, respectively. As noted previously, the aerospace industry accounted for 2.4 percent of total wage and salary employment in Washington.

In 2005, excluding benefits, the industry paid $5.4 billion in wages and salaries, representing 4.9 percent of the Washington total. Aircraft manufacturing employees received $5.0 billion. Annual pay ranged from $50,440 per employee in other aircraft parts to $87,990 in aircraft manufacturing. The average for the entire industry was $83,370. This meant that aerospace workers earned more than twice the average of all Washington workers ($40,660). It also meant the average pay in the aerospace industry had been growing at a relatively fast rate. Aerospace workers earned 105 percent more than the state average in 2005, up from 78 percent in 1990.

As a basic industry, aerospace's impact extends well beyond its 65,400 jobs. Revenue from export sales triggers rounds of spending in the local economy (the multiplier process), creating thousands jobs in other industries, such as retail trade, personal services, and local government.

Multipliers are used to estimate an industry's total impact on an economy. They are derived from simulations with complex though imperfect models of the economy. Multipliers should therefore be considered as "intelligent guesses," rather than precise estimates.

Based on previous studies, the Washington aerospace wage and salary employment multiplier is 3.2, implying that each aerospace job indirectly supports 2.2 other jobs in the state. Thus, the total impact of the aerospace industry amounts to 209,300 wage and salary jobs. This represents 7.5 percent of total state employment or approximately one out of every 13 jobs. Although the state economy has substantially grown and diversified over time, this finding shows that aerospace is still Washington's most important industry. [Other industries, such as retail trade, have more employment than aerospace, but they are not basic industries.]

Table 3

AEROSPACE EMPLOYMENT IMPACT, 2005

	Impact
Washington impact	
Direct employment	65,400
Indirect employment	143,900
Total employment	209,300
Percent of total state employment	7.5
King County impact	
Direct employment	38,800
Indirect employment	77,600
Total employment	116,400
Percent of total county employment	10.1
Snohomish County impact	
Direct employment	23,700
Indirect employment	28,400
Total employment	52,100
Percent of total county employment	22.9

The aerospace industry is highly concentrated in King and Snohomish counties, the home of Boeing's large manufacturing plants. Together, the two counties account for 62,500 jobs or 95.6 percent of total aerospace employment in the state. Their implied location quotients are 9.8 and 29.2, respectively.

King County is the primary beneficiary of the aerospace industry's impact. With 38,800 aerospace jobs, the total impact amounted to 116,400 jobs or 10.1 percent of total county employment in 2005. The estimated employment multiplier in this case is 3.0. Although Snohomish County's impact is smaller in absolute terms, it is substantially greater in relative terms. With 23,700 aerospace jobs, the total impact amounted to 52,100 jobs or 22.9 percent of

total county employment. In other words, the aerospace industry was directly and indirectly responsible for more than one out of every five employment opportunities in Snohomish County. It is little wonder that the recent aerospace turnaround is currently causing county employment to grow at a 7 percent annual rate.

Despite the concentration of aerospace companies in King and Snohomish counties, the industry's indirect impact spreads throughout the state: aluminum manufacturing jobs in Spokane, food processing jobs in Yakima, and government jobs in Olympia. In 2005, the aerospace industry supported an estimated 40,800 jobs in the rest of the state. This represented 2.9 percent of the total employment in the other counties.

5. PROSPECTS

It would be an overstatement to say that as the aerospace industry goes, so goes the Washington economy. But recent experience suggests that this is not a bad rule of thumb. Combined with the dot-com bust, the loss of 25,000 aerospace jobs during the post-9/11 downturn pulled the economy into recession. Currently, the state economy is expanding at nearly twice the national rate, boosted in large part by the addition of 7,000 aerospace jobs over the past year.

Table 4

WASHINGTON AND U.S. EMPLOYMENT
Fourth Quarter 2004-Fourth Quarter 2005

	Change	Percent Change
Aerospace	7,000	11.2
Construction	13,700	8.1
Professional and business services	14,400	4.7
Other	41,000	1.9
Washington	76,100	2.8
United States	2,066,000	1.6

The prospects for the aerospace industry look good. Boeing production and employment are clearly on the rebound, especially in light of last year's record 1,002 aircraft orders. The favorable response to the 787, the longevity of the 737, and the improvement in the airline market, particularly overseas, have turned Boeing's fortunes around.

Without being specific, we will venture the following forecast: Boeing will regain its title as the number one producer of commercial jet aircraft in the world and the aerospace industry will add thousands of jobs over the next few years. If this prediction comes to pass, the Washington economy will grow faster than the U.S. economy for the rest of the decade.

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