NOTE: I don’t know how to add the social and economic impacts of globalization and the 787 into this.

* Globalization not possible without transportation
  + Planes led to increase in globalization
  + Technological advancements leading to more complex planes
  + Most Recent: Boeing 787
  + Multiple different countries and companies involved:
    - Look at infographic
    - Lifetime miles travelled: 52 million miles
    - Raw materials: aluminum, steel, carbon fiber
      * Waste is most common in this stage
    - Sent to factories to assemble them

Raw Materials 🡪 Section Assembly 🡪 Transportation to Final Assembly 🡪 In Use 🡪 End of Service after 52 Million Miles

At just over a century old, the aerospace industry has made significant strides in travel through technological advancement. One of the most innovative advancements is the Boeing 787 Dreamliner, a lightweight and green solution that is the result of globalization. The new Boeing 787 Dreamliner is comprised of 50% Carbon Fiber, 20% Aluminum, 15% Titanium, 10% steel, and 5% plastic (https://www.altenergymag.com/article/2007/12/the-worlds-first-eco-friendly-airliner/404/) which posed several obstacles because Boeing had previously never used Carbon Fiber as the majority of its raw resources.

The first step in the commodity chain for the Boeing 787 Dreamliner is the collection and refinery of raw materials. Carbon Fiber is mined and assembled in Japan by Toray Industries (<https://www.reuters.com/article/us-toray-industries-boeing/toray-in-expanded-8-6-billion-carbon-fiber-deal-with-boeing-idUSKCN0J103R20141117)>. While the Toray’s assembly is secret, we do know how they make their polyacrylonitrile (PAN) Carbon Fiber which comprises of at least 90% of the commercially available carbon fiber. Figure 1 shows the general steps needed to convert PAN Fiber into a usable Carbon Fiber after intense heating, oxidization, carbonization, and graphitization to increase its bonding properties.

Boeing uses two types of aluminum during construction: Bauxite ore and recycled material. Both versions of the raw material come from Alcoa, the world’s largest Aluminum manufacturer. Alcoa retrieves the Aluminum from a mine in Juruti, Brazil (https://www.sec.gov/Archives/edgar/data/1675149/000119312517012427/d309876ds1.htm). Then, it is sent to a mill in Iowa for refining, and finally sent to the Kansas for the nose and cockpit construction by Spirit Aerosystems using the Aluminum sheets (<http://www.aerospacemanufacturinganddesign.com/article/alcoa-spirit-aerosystems-aluminum-sheet-agreement-051214/)>.

Lastly, Titanium is mined by the world’s largest titanium producer, VSMPO-Avisma. They mine the Titanium ore in the region of Sverdlovsk and the Ural Mountains. VSMPO-Avisma and Boeing are launching a second venture in the Ural Mountains to increase capacity and joint work in research and development (https://rostec.ru/en/about/companies/145/). After the Titanium is mined, it is refined to pure ignots in an argon environment. Titanium is the most energy intensive to produce because of the sheer electricity and heat needed to melt the ore. After refining, the Titanium is then shipped off to Everrrett, Washington for the final assembly to develop the cockpit window frame, vertical and horizontal stabilizers, and special coatings to prevent the aluminum from corroding (<https://www.reuters.com/article/us-boeing-787-titanium-insight/boeing-looks-at-pricey-titanium-in-bid-to-stem-787-losses-idUSKCN0PY1PL20150724)>.

The changes in metals for the Boeing 787 Dreamliner come with five environmental benefits. First is the reduction of fuel use. Reuter’s cites in 2015 that the Dreamliner uses 20% less fuel than previous plane models. Second is the cut in emissions. Since carbon dioxide and nitrogen oxide are produced as a direct result of fuel use, reduced fuel use leads to a reduction in emissions. Third is quieter takeoffs and landings. Boeing wrote in 2009 that the noise footprint in the 787 Dreamliner is 60% quieter than other airplanes today. Fourth is point-to-point travel by allowing shorter travel times, less fuel, fewer takeoffs and landings. Last but not least is the reduction in waste. According to Materials Innovation Technologies, the Boeing 787 is made up of carbon fiber, which like other composites can be recycled at almost 70% the price to develop new fiber.

After the final pieces are put together at the world’s largest assembly line in Everett, Washington. The Boeing 787 will last at least as long as the 777 which travels an average of 52,500,000 miles before retirement. That is equivalent to travelling 2080 around the Earth. ( <https://www.usatoday.com/story/travel/columnist/cox/2012/11/19/ask-the-captain-how-far-does-a-jet-fly-during-its-lifetime/1712269/)>. After reaching its final years, it will be taken apart and recycled for its parts. However, the first 787, which was never supposed to enter commercial status was retired in 2011. Now, it is sitting in storage until it might end up at Museum of Flight at Boeing Field in Seattle.