



October 26, 2011 | Reviewed by Bill Gates

## **Prime Movers of Globalization: The History and Impact of Diesel Engines and Gas Turbines (Book Review)**

*Few innovations in the last 100 years have had as much impact on the way we live as the diesel engine and the gas turbine. In "Prime Movers of Globalization" Vaclav Smil tells the story of their incremental innovation and sweeping influence on society.*

I've flown hundreds of times on airplanes and watched huge container ships enter Seattle's busy seaport without ever giving much thought to the powerful jet and diesel engines that make the movement of people and cargo by air and sea an everyday occurrence.

Vaclav Smil, on the other hand, has written an entire book about the development and impact of gas turbines and diesel engines. *Prime Movers of Globalization* is another remarkable book by Smil, a professor at the University of Manitoba and a prolific author who takes an interdisciplinary approach to writing about important topics in the fields of energy, the environment, population, food production, and technical innovation.

As a history buff, I appreciate books that give you a sense of the people behind important inventions and the sweeping impact they have had on society. Often – as in the case of the diesel engine and the gas turbine – incremental advances obscure the profound impact of technology. In *Prime Movers*, Smil focuses in on a slice of 20<sup>th</sup> century technological innovation and shows the phenomenal impact it has had on international trade and travel.

To put the significance of the diesel engine and the gas turbine in perspective, Smil points out that until coal-powered steam engines came along a few hundred years ago, animals and human muscle were the "prime movers" of manufacturing, and wind and sails the prime movers of international travel and trade. The steam engine was an important underpinning of the industrial revolution. But its impact pales in comparison to the diesel engine and the gas turbine.

Today, the diesel engine powers virtually all of the ships that ply the oceans with bulk commodities such as grain and oil, and finished products like cars and consumer electronics. It also is the power source for most freight trains and large trucks. The gas turbine powers more than 18,000 jets that carry millions of people and billions of tons of cargo around the world daily.

Although there were a lot of people tinkering with engines at the turn of the 19<sup>th</sup> century, Rudolph Diesel is generally credited with inventing the diesel engine. Diesel didn't live to see the widespread adoption of his invention. Heavily criticized for his ideas and despairing that they would ever be fully realized, Diesel apparently committed suicide in 1913 by jumping over the side of a steamer ship. Ironically, it soon became obvious that the diesel engine was by far the most efficient, reliable, powerful, and low-maintenance power source for ocean-going vessels, locomotives, large trucks, and heavy-construction equipment.

Building on advances in turbines in the first half of the 20<sup>th</sup> century, the U.S. and Germany both began testing gas-powered turbine engines in military aircraft during World War II. That led to the introduction of commercial jet service in the 1950s, with gas turbines quickly replacing propeller-driven engines because of their greater power, efficiency, and performance.

But it was the launch of the first wide-bodied jet – the Boeing 747 – in 1970 that really made gas turbines a prime mover. I've ridden on 747s many times and have always been impressed – especially during takeoff – by their size. But I didn't realize what an important role they've played in fostering international trade and travel by reducing the cost of flying and making it possible to ship goods around the world overnight.

In fact, Smil says, today's prime movers have reduced the cost of shipping so much that "distance to the market has been largely eliminated" as a factor in siting manufacturing facilities, sourcing imported materials, or pursuing new export markets. Another important development was the containerization of cargo so it can be quickly loaded on and off ships, trains, and trucks. This one advance cut the delivery time of many shipments by more than 95 percent.

Smil includes some fun anecdotes about the people who had a role in these innovations. For instance, the idea of containerized shipping originated with a North Carolina trucker who got tired of waiting all day to have his bales of cotton unloaded at the docks in New Jersey. Why couldn't they just pick up the trailer attached to his truck and put it on the ship, he wondered?

He also points out several instances of parallel innovation, which is when two or more inventors come up with the same idea at virtually the same time. This is not as uncommon as you might think. Alexander Graham Bell and Elisha Gray each filed patents for the telephone on the same day. In the case of the jet engine, a British inventor and Royal Air Force pilot, Frank Whittle, filed for a patent in 1930. Six years later, a German engineer, Hans Joachim Pabst von Ohain, filed for a patent without knowing of Whittle's previous work. Ohain's design was the first to be put to the test in a 1939 flight. But Whittle's turbojet endured, becoming the foundation on which modern jet engines were built by General Electric, Pratt & Whitney, and Rolls-Royce.

Given my deep concern about climate change and our overuse of fossil fuels, I was happy to see Smil address the issue of energy consumption. Lowering the speed of fast container vessels by 20 percent would reduce fuel consumption by 40 percent – an amount equal to the annual oil consumption in India or Russia. Better hull designs could lower fuel demand by another 10 percent. And although efficiencies in engine design

have reduced the fuel consumption of jet engines by 50 percent, Smil believes airlines could further reduce their carbon footprint by improving operational processes. He cites two examples: towing airplanes to the runway rather than having them taxi using their jet engines, and slowing down the speed of aircraft as they approach an airport in order to avoid wasting fuel while they circle their destination.

There are a lot of fascinating historical points and statistics in Smil's book that make it an interesting read, but what most fascinated me was learning about the incredible impact these two innovations have had on so many aspects of our lives.