



Prime Movers of Globalization: The History and Impact of Diesel Engines and Gas Turbines. Vaclav Smil. The MIT Press, Cambridge, Massachusetts 02142. 2010. 269 pp. Price: US\$ 29.95.

The phenomenon of globalization has been examined from many perspectives by several authors, but one approach that has been conspicuously missing from these examinations, is the focus on technologies that have made globalization possible.

The book under review provides an excellent account of the role played by technology in the creation of global economy. Vaclav Smil offers a history of two technological developments that have driven globalization, namely the high compression non-sparking internal combustion engine invented by Rudolf Diesel in 1890s and the gas turbine engine developed by Frank Whittle and Hans-Joachim Pabst von Ohain in 1930s.

Compared to the previous generation of prime movers such as steam engine, efficiencies and sizes of diesel engines have increased through an evolutionary technology development. Smil brings out in fair detail, the role of this evolutionary technology in enhancing the international shipping. The role of gas turbine engine in enhancing air transportation is also explained in good detail. He demonstrates that these prime movers played far more important role in global economy than any corporate structure or international trade agreement.

Europe's first attempt at globalization started with voyage of Captain Ferdinand Magellan which was not a success. Formation of East India Company in Surat in 1615 and United East India Company at Batavia in 1619, led to global trade which was growing by 1% during this period. Sails were the primers of this pioneering wave of globalization. As brought out in the book, wind and sails

continued to propel many merchant ships in spite of the serious limitations of these prime movers until the World War I. With the advent of steam engine, the sails were replaced by the steam engine which was bulky, heavy and pretty inefficient. Transporting people made a greater difference during this era of globalization than transportation of goods. As pointed out in the book, the world trade expanded at about 4% but the steam-powered trade was slow with speeds no more than 15 km per hour.

The third wave of globalization, in the post-1945 era, has been enabled by two different prime movers – the high compression non-sparking internal-combustion engine and the gas turbine engine.

This book provides an excellent understanding of the history of these machines and the reasons for their success. It also analyses why gasoline-fuelled engines with ignition by sparking and with relatively low compression ratio did not succeed. It also tries to analyse why piston engines failed and were replaced by gas turbine engines in aviation.

Rudolf Diesel's engine belongs to that rare category of pioneering 19th century inventors whose idea arose from theoretical analysis rather than from experimentation with actual design. However the advances were based overwhelmingly on incremental improvements that were derived from practical experience and experimentation with existing designs. The book brings out in detail the struggles of Rudolf Diesel in converting an invention to a marketable machine. As stated in the book, four-fifths of the world's cargo vessels are powered by diesel engines.

Unlike the diesel engines which are heavily deployed for transportation of goods, the gas turbine engine – the other quintessential prime mover of modern globalization – has a steeper ascent to commercial dominance and became the backbone of passenger air transportation.

As stated by Frank Whittle, the inventor of gas turbine engine in 1935, the prospects for developing his patented gas turbine engine were poor, but it did not take long for the gas turbine to become a reality. After the first practical prototypes were tested, the commercialization was very rapid. This feat was made more remarkable given the engine's complexity, its demand for materials of high quality and durability and the fact that the development took place at two loca-

tions, entirely independently in Britain (Frank Whittle's concept) and in Hitler's Germany (based on invention of Hans-Joachim Pabst von Ohain). Gas turbines are particularly attractive for powering large aircraft because they have a much higher specific power output than reciprocating engines. The engine of Orville and Wilbur, the inventors of Aeroplane, had a mass to power ratio of about 8 g/W whereas Whittle's pioneering turbojet of 1940 needed just 0.38 g/W, whereas the present generation turbofans weigh less than 0.1 g/W. As stated in the book, Whittle's work belongs to the same class as Diesel's innovative designs, which proceeded from scientific understanding to practical machines. Whittle was able to lay down the engine's performance with the 'Precision of Newton'. The book brings out in fair detail the rapidity with which gas turbines were commercialized and how they have contributed to extraordinary growth of air transportation.

Continuing improvements of diesel engines and gas turbines have shared a number of common characteristics – quest for higher efficiency, lower operating costs, greater reliability and lowered environmental impact. Although the gas turbine engine fuel remained the same, viz. kerosene, the development of marine diesel engine fuels were broadened from standard diesel to heavy fuel and natural gas. The book brings out the history of the changes and their impact on globalization very well.

The low cost of fuel and enhanced efficiencies of prime movers helped growth of global trade. The book describes in detail the expansion of global trade in bulk commodities and the role of container vessels. The improved reliability and fuel efficiency of turbo fans heralded long distance air travel.

The book brings out all the technical reasons for the remarkable achievements of the two prime movers and also the multifaceted enormity of their consequences and influences in terms of varied benefits. This book fills an important gap in the literature on globalization as regards the role of technology. It is a must read for all those interested in globalization and technology.

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