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Vaclav Smil, *Prime Movers of Globalization: The History and Impact of Diesel Engines and Gas Turbines*. Cambridge: MIT Press, 2010. v + 261 pp. \$30 (hardcover), ISBN: 978-0-262-01443-4.

Reviewed for EH.Net by William Sjostrom, Centre for Policy Studies, National University of Ireland, Cork.

A book that begins with scornful dismissals of both Thomas "Flat Earth" Friedman and of the concept of "sustainable development" is a book that I admit I very much want to like. And in many ways I did. The core chapters tell the story of the development of the diesel engine and the gas turbine, discussing both the personalities and technology. Smil's big goal is to persuade his readers that engines, in particular diesels and gas turbines, are ignored relative to the vastly more fashionable microchip, but are at least, if not more, important to the development of the modern world.

This is an enormously fun book to read. Smil clearly knows and loves engines, and his book conveys that enthusiasm. Although there are a number of entertaining diversions, Smil has two primary interests. The first is the turbojet (and later the much smoother turbofan) engine and its role in expanding passenger travel by air. The second is the huge marine diesel engines that power large cargo ships. (And I mean huge: Smil has a picture of an engine that is bigger and taller than my three-story house.)

The best part, and the core, of Smil's book is chapters 2 through 5. Chapter 2 sets the stage by telling the history of the gasoline powered Otto-cycle engine (the standard four-stroke gasoline engine). The history is the context for his argument that although the Otto-cycle engine is important for the automobile, it is inadequate for long distance air travel and for large scale movements of freight (by truck and by sea) and passengers (by train). Smil emphasizes the much higher ratio of weight to energy in the Otto-cycle engine compared to the diesel and the jet engine as well as the higher energy content of diesel and jet fuel compared to regular gasoline, both problems imposing severe limits on travel distance.

Chapters 3 and 4 review the history and development of, respectively, the diesel engine and the gas turbine engine, and are replete with useful information. Smil shows the challenges of developing new technology. Rudolf Diesel committed suicide, beleaguered by critics of his engine. Frank Whittle, who developed the gas turbine, retired from the Royal Air Force at age 41 in frustration and exhaustion. Smil does a good job of explaining many of the problems that had to be overcome in engine development. For example, marine diesels operate at a low rpm so that the engine can be connected directly to the screw, bypassing any need for a transmission. This is of substantial benefit at sea, because transmissions are delicate things, and you do not want to have a broken transmission and be consequently powerless in the middle of the ocean. The early diesel engines, however, were not reversible so a ship could not back up without tugboats. (It is routine with modern marine diesels to simply stop the engines and start them up in reverse direction to back up a ship.)

Chapter 5 brings the reader up to date on more recent developments in diesel and jet engines, including the shifts in the location of engine manufacturing. There are fascinating diversions into train diesels and into stationary jet turbines used for power generation.

Chapter 6 is Smil's foray into economic analysis, wholly devoted to an economic analysis purporting to show the importance of the diesel and jet engines. The results are not pretty. The short version of the problem is that Smil thinks big means important. Lot of stuff gets transported on diesel powered ships, and lots of people travel on jets, so they must be important. The reader is subjected to summaries of the sorts of economic impact studies regularly released by trade groups.

But ignore the failed economics. This is a good business history, and the book is valuable as a source of research questions. The biggest is the question Smil fails to answer: how much of a difference have the diesel engine and the gas turbine made to incomes or to the growth in trade. Smil does not answer the question, but he lays a good groundwork in the technological issues

Here is a second research topic. Jet engines were originally developed in Britain and America, and those countries remain dominant. Jet engine design and manufacture is still dominated by General Electric, Rolls-Royce, and Pratt & Whitney, the companies that pioneered these engines. Diesels were developed in Europe, and the original European firms continue to dominate the design of marine diesels. Rudolf Diesel's first contracts were with Maschinenfabrik Augsburg, and, now known as MAN Diesel, it is the world's largest designer of marine diesels. Diesel sold the Swiss patent rights to Sulzer Bros. of Winterthur. Now a subsidiary of Wärtsilä of Finland, it is the second largest. Unlike the jet engine, however, marine diesel manufacture has left its original home, and is now dominated by South Korea and Japan. Why does one industry move and not the other?

There are irritations, notably Smil's habit of changing how much background technological knowledge the reader has. He will occasionally jump from tediously overdone explanations in one paragraph, to barely explaining a complex diagram in the next. But these are few, and Smil is mostly a clear writer. And did you know that both Rudolf Diesel and Gottlieb Daimler hated to drive, and they were both unusually bad drivers? I bet Bill Gates isn't this interesting.

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