THE ENGINE OF CIVILIZATION

Let us take a few moments and reflect on why turbomachinery is used and why the reader is likely involved in this discipline. In the past several editions of Turbomachinery International, and in many coming issues, we look at various detailed issues concerning turbomachinery. So let us take a moment now to to focus on the broad subject.

What is a turbomachine?

Turbomachinery and positive displacement equipment are the two essential types of mechanical power machines. Newton's laws, extended to describe mechanical work, relate the difference. When work transfer is most easily described by multiplying force times applied distance, then one is describing a positive displacement machine (even when L is along a curved path). When work transfer is most easily described by multiplying torque times angular velocity, then one is describing a turbomachine (turbo — Latin for 'to spin or rotate'). So much for equation talk, but it cuts to the core of the issue and is the most basic description possible.

This definition actually tells us much more: Power transfer and pressure changes in turbomachinery are associated with angular motion (torque) and imply an axisymmetric flow field. This leads to machines with 'very high' energy densities, which are powerful and compact. Due to many advances in tribology over the past half century, such machines can be 'very stable,' durable, and reliable. Taken together, these attributes allow the use of cost-effective machinery for many power and fluid-handling applications.

Just how important is turbomachinery in the power field?

Most electricity is generated by an electrical generator driven by a turbine (gas, steam, or hydraulic). However, vast amounts of power are generated without electricity being involved appreciably. Internal Combustion (IC) engines drive most cars, trucks, ships, and various construction, mining, and transportation equipment. And nearly all of it is turbocharged except for some millions of cars each year, but even that is changing (about 20 million - 30 million turbochargers are manufactured each year). And all IC engines use a centrifugal pump for the cooling system!

Quite apart from the power production side of the energy equation, it has been estimated by the Electric Power Research Institute (EPRI) that about 3% of all power in the U.S. is used just to drive (turbo) pumps, and to this we must add fans, blowers, process compressors, and refrigeration compressors, all of which account for billions of electricity units worldwide. Finally, do not forget the aircraft industry with turbofan engines, and ships employing turboshaft engines that consume over 5% of all liquid fuels. Recall, too, that Goddard's earliest liquid-fueled rockets employed turbopumps from the beginning.

How great is the impact of turbomachinery on life as we know it?

Impact is not hard to see, but hard to quantify. Pumping is essential for civilization: Bringing clean water to people and taking away and processing waste must be done. Lacking this, disease will be rampant and sickness and death may follow, as frequently observed when a natural disaster strikes and wipes out infrastructure. In the 1900s, life expectancy in the U.S. increased by about 30 years: 10 years has been credited to medical advances, while the other 20 years is due to clean water and sanitation. Managing storm water is also important, but less so by comparison except for low-land areas such as Holland, New Orleans, and Bangladesh.

Transportation without turbomachinery would take us back to 1920 or so. With low-compression diesel and gasoline IC engines and steam locomotives, we would only produce a small fraction of today's electric power and would fly only at low altitudes with piston engines.

In short, turbomachinery is essential for life as we know it today: for clean water, sanitation, transportation, petrochemicals . . . the count is endless! All workers in the turbomachinery field can be proud of their efforts. Without this machinery, life would be vastly different and lacking much of the quality we now take for granted. TI

Note: *This article is based in part on the author's April 2009 lecture to the Society of Automotive Engineers at Cobo Hall, Detroit, on the occasion of receiving the annual Cliff Garrett Award given to a distinguished authority in the engineering of turbomachinery for automotive and propulsion uses.*

Author

David Japikse is Chairman of the Board, founder, and CEO of Concepts NREC. Japikse has written or co-authored six books: Introduction to Turbomachinery, Centrifugal Compressor Design and Performance, Centrifugal Pump Design and Performance, Axial and Radial Turbines, Advanced Experimental Techniques in Turbomachinery and Diffuser Performance.