Wind Turbine Details

The wind turbine consists of main shaft and a crankshaft interacting with each other via a geared connection. **Figure 1** depicts the system and highlights the locations of connections to the turbine casing, thrust block, walls, and between shaft gears.

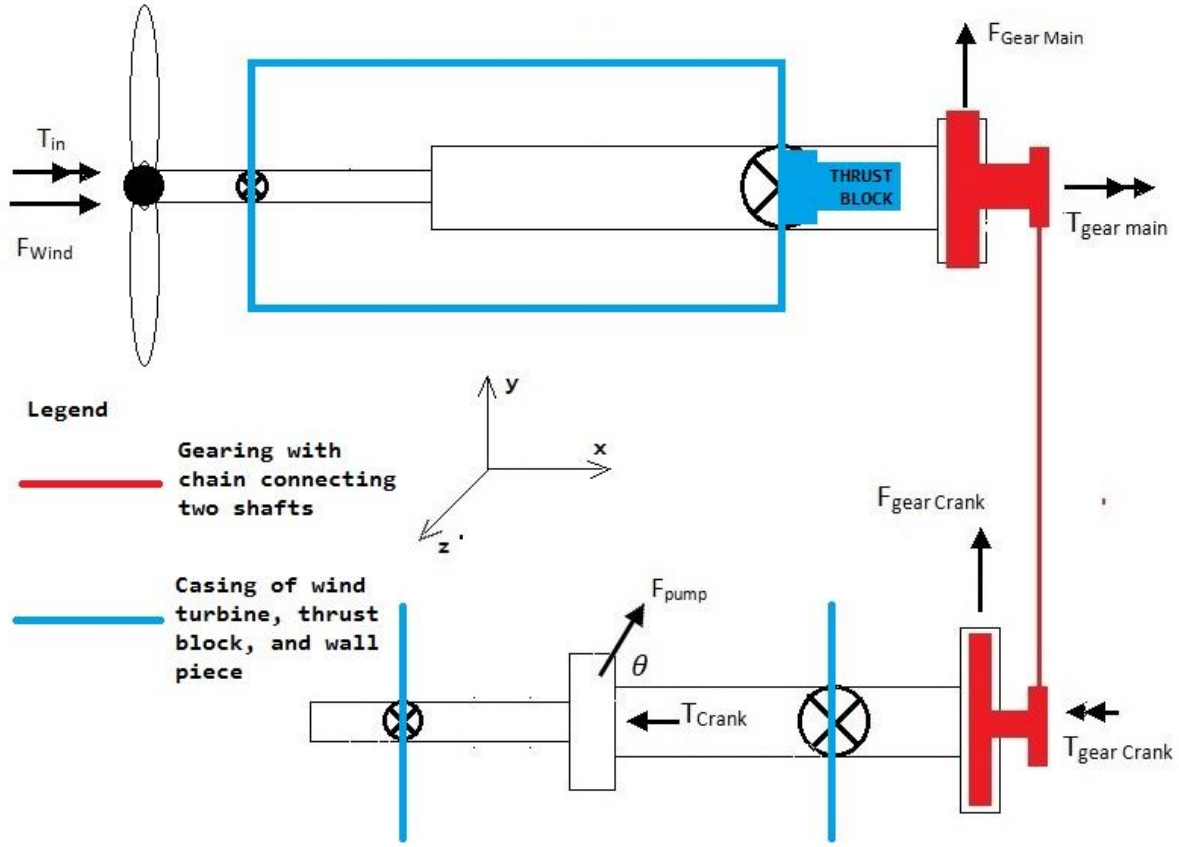

Figure 1. The wind turbine system as a whole. Wind blowing against the propeller turns the main shaft and, via a geared connection, turns the crankshaft. The rotation of the crankshaft powers an external pump or generator. The housing of the shafts, shown in blue, create reaction forces at the locations marked by an X enclosed in a circle.

Wind blowing against the turbine's propeller creates a force, F_{wind}. The resulting rotation of the propeller creates a torque, T_{in}, which is transferred across the main shaft to the gear at the right end as $T_{gear\ main}$. A gear chain links the gear of the main shaft to the crankshaft (**Figure 2**). The torque is then converted to $T_{gear\ crank}$, whose magnitude depends on the ratio of the gear radii, R_2/R_1, between the main shaft and crankshaft. Because the gear chain connection is directly to the sides (z-direction) of the shafts, a vertical (y-direction) force is created. These are depicted by $F_{gear\ main}$ and $F_{gear\ crank}$. $T_{gear\ crank}$ transfers across the crankshaft to T_{crank}, the torque applied to the gear which powers a water pump or generator.

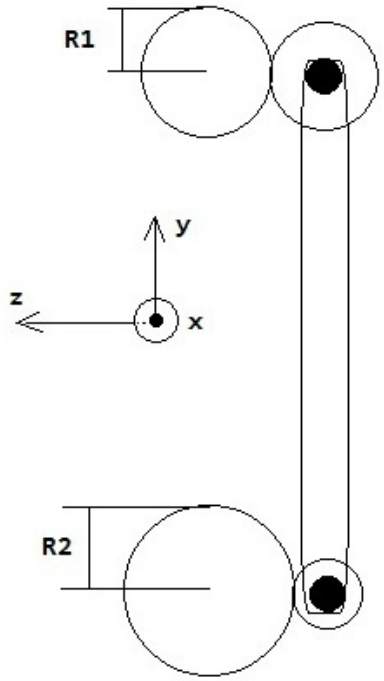

Figure 2. The back view of the wind turbine showing the geared connection between the main shaft at the top and the crankshaft at the bottom.

The housings of the main shaft and crankshaft are connected to the shafts at locations marked by an enclosed X. These connections create reaction forces on the shafts, R_{1y}, R_{1z}, R_{2y}, etc. These reaction forces are shown in **Figures 3 & 4**. Also shown are sections and their lengths and diameters.

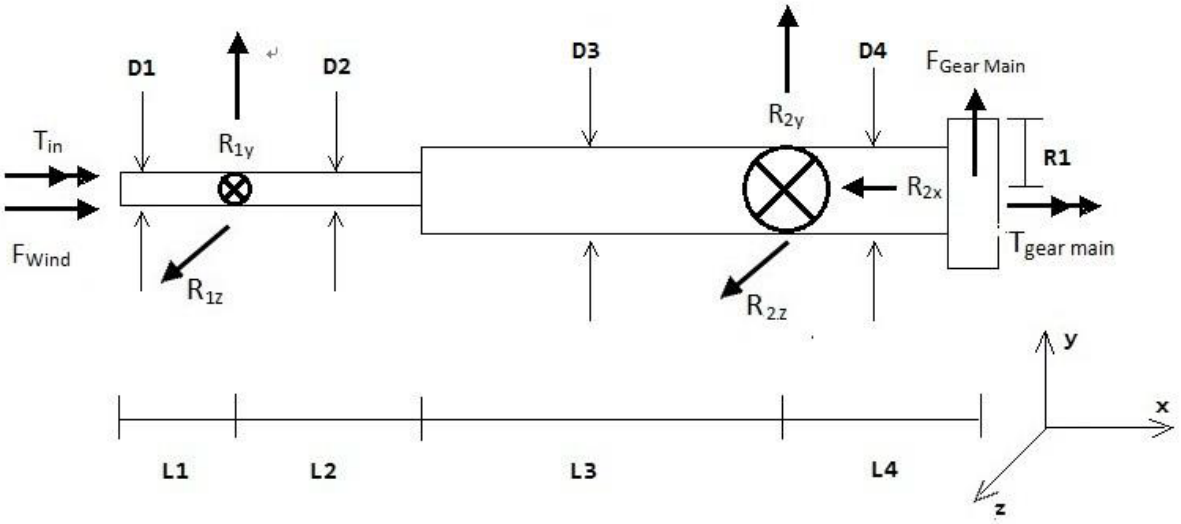

Figure 3. The main shaft and the forces acting on it. The four sections shown each have their own diameter and length.

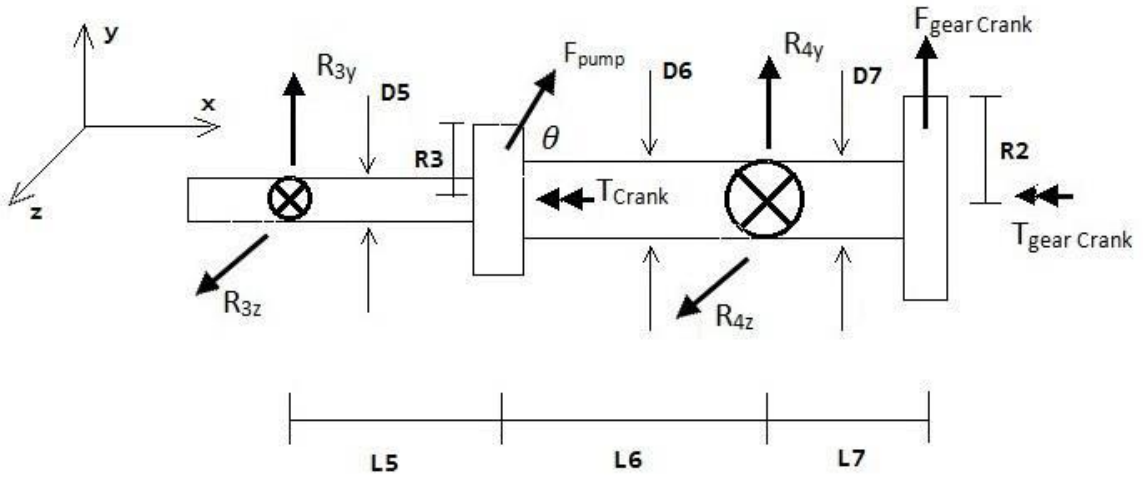

Figure 4. The crankshaft and the forces acting on it. Unlike the main shaft, which has 4 sections, the crankshaft is separated into 3 sections.

The crankshaft provides power to a pump/generator. The crank—the arm connecting the crankshaft to the pump—is shown in **Figure 5**. The force F_{pump} acts on the crankshaft at angle θ relative to a horizontal axis passing through the center of the crankshaft. The crankshaft itself rotates at an angular velocity, ω. The radius of the gear connecting the crank to the crankshaft has a radius, R_3, that determines the magnitude of F_{pump}.

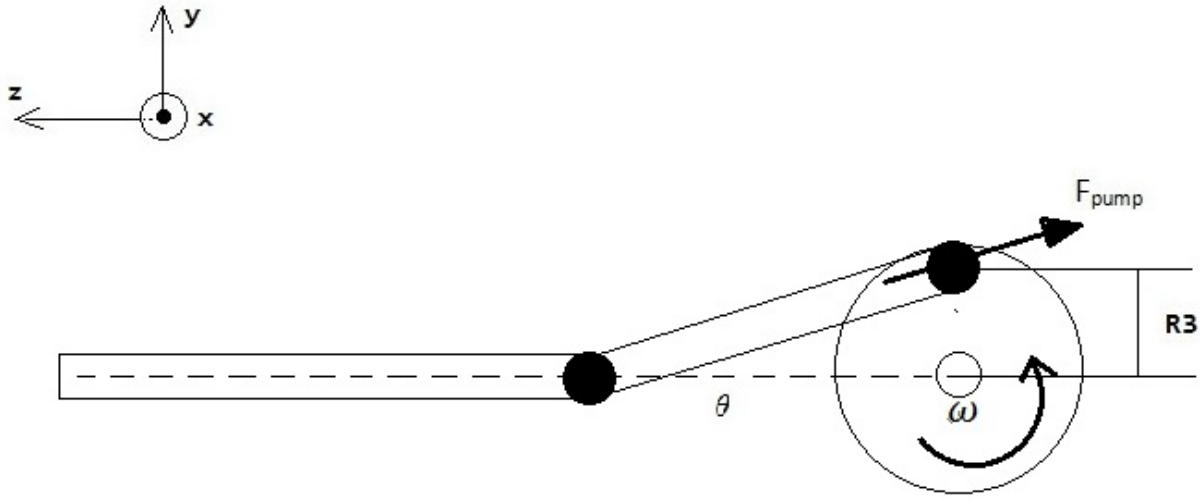

Figure 5. The crank arm as seen looking down the axis of the crankshaft. The crank itself is connected to a gear, with radius R_3, on the crankshaft. The rotation of the crankshaft is converted to a linear back-and-forth motion which can power a pump or generator.

*Images are from Cornell's Professor Hernandez's Spring 2013 MAE 2120 class projects.