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Despite the joke that nuclear fusion “will always be 10 years away,” devices capable of initiating nuclear fusion in a controlled environment have actually been around since at least the 1960’s. These devices take in more energy than they put out – hence not solving the world’s energy problems – but they have important uses, especially as a mechanism for generating a large number of neutrons in a very short time duration. In this work, we will present some recent research on fusion devices that is specifically focused on controlling the neutron production, along with some scientific applications in industry and government. Controlling production requires that one understand the phenomena leading to the fusion reaction, which is partially done using computational models and partially determined experimentally, with new mathematical models and computational algorithms required to extract the information of interest from measurements. In addition to results from a US Department of Energy (DOE) pulsed neutron source, we will discuss additional projects and lines of inquiry that are ripe for mathematicians interested in joining the DOE research enterprise. (Received September 15, 2020)