

## Conservation Laws

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A conservation law says that the total amount of some quantity, like mass, momentum or energy contained in any domain, changes at the rate at which this quantity flows across or is created at the boundary of the domain. I find this idea beautiful because it is so basic. But once you specify details of the rate of creation you get a huge variety of phenomena. The laws governing the flow of fluids are conservation laws.

Conservation laws are a key to understanding shock waves. I got involved with shock waves in 1945 while in the army, when I was shipped to Los Alamos to work on the atomic bomb project, instead of the Pacific to participate in the invasion of Japan, which the atomic bomb made unnecessary. Since atomic bombs cannot be built by trial and error, it was of paramount importance to be able to calculate the flow that takes place when a bomb is detonated. Von Neumann recognized that such a calculation cannot be done without computers and this gave him the original impetus to champion computers. Of course he realized the paramount importance of computers for tasks other than designing atomic weapons.

Von Neumann had the beautiful and original idea to treat shocks in numerical calculations not as boundaries but as part of the flow. It is a powerful simplifying way of looking at flows with shocks. Many people are unaware that von Neumann was not only one of the leading theoretical mathematicians of the 20<sup>th</sup> century, but also one of the leading applied mathematicians.