Electromagnetic launchers, or mass accelerators have been studied and used in various engineering applications since the early 1900’s. However, despite this there has not been much attempt to develop, collect, or present a full theory of these systems in a linear fashion. Thus, much of the information is scattered throughout the literature repositories. In 2005 Dr. William Slade published a landmark paper in the IEEE Transactions on Magnetics presenting what would become the Slade model of reluctance acceleration. Here we present a discussion of theories of reluctance launchers. We examine the ideal theory and the simple Slade theory. A brief history as well as ideas critical to these theories are presented and discussed. Simulations show how changing various parameters of the system affect performance and critical values such as: coil current waveform, acceleration, and muzzle velocity.

Experimental design of electromagnetic launchers in the past has always been plagued by low amounts of electromechanical energy transfer between the energy source and armature. New technological advances in society have finally made the construction of high efficiency electromagnetic launchers possible. A small linear reluctance accelerator was constructed for the purpose of achieving high energy efficiency and verifying the theoretical model from Dr. Bill Slade’s 2005 IEEE paper. Efficiency was improved by using a large capacitor bank, high saturation magnetic materials, armatures designed to minimize eddy currents, and a fast switch that can handle high voltage and high current with minimal resistive loss. Instrumentation was designed to accurately measure the solenoid current as well as to measure the armature exit velocity. Results were analyzed and compared the Slade model.