Statistically Valid Estimation of Limit Velocity in Ballistics Testing with Small Sample Size

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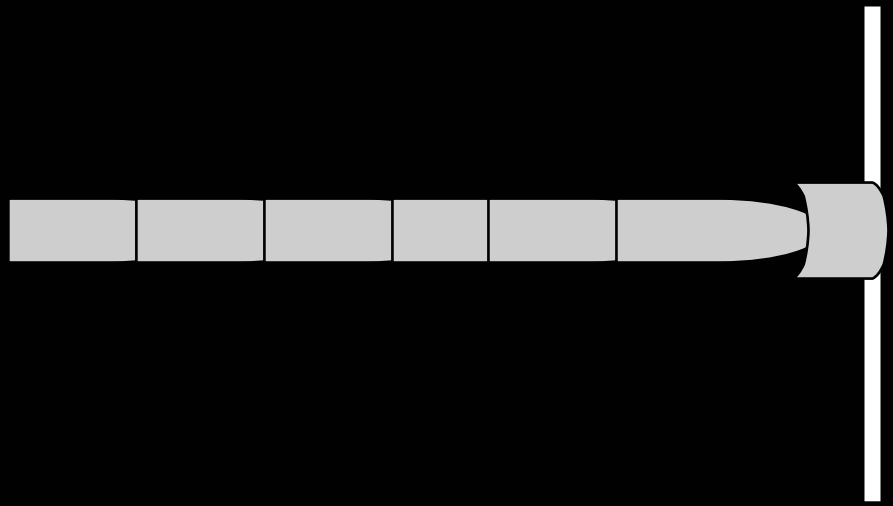
Agenda

- Background
- Current Experimental Methods
- Problem
- Solution Strategy
- Research Goals

Background

- **Limit velocity is the maximum velocity a projectile can have without penetrating armor.**



Initial velocity < Limit Velocity

Background

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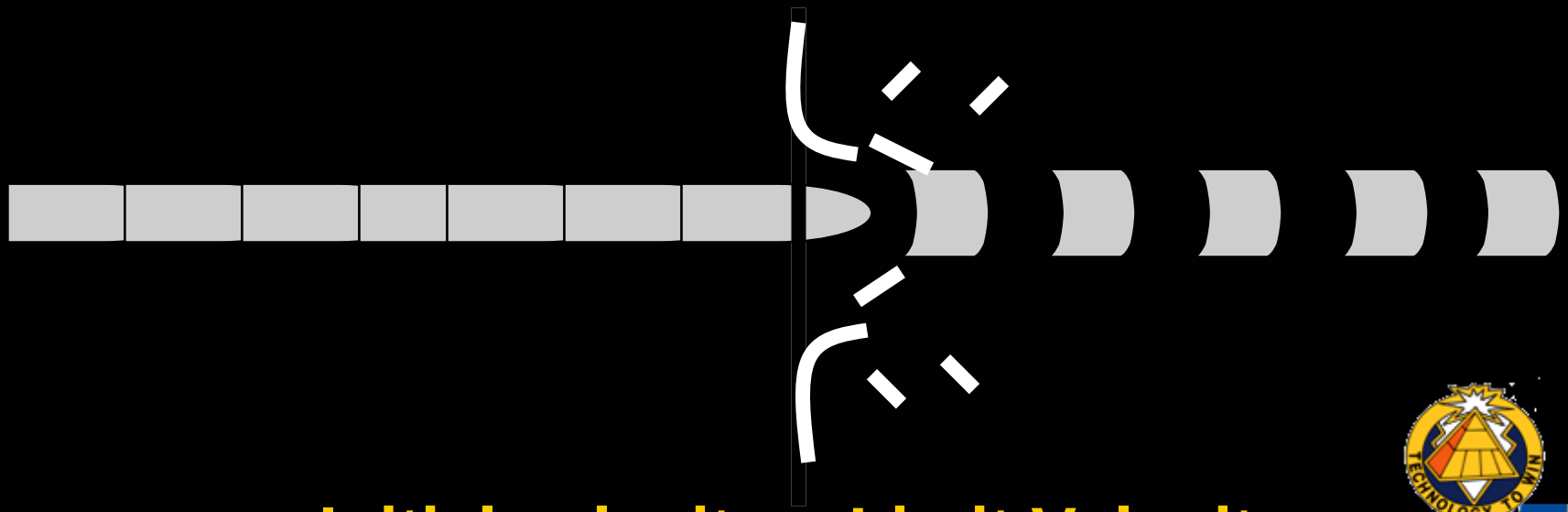


Initial velocity > Limit Velocity

Background

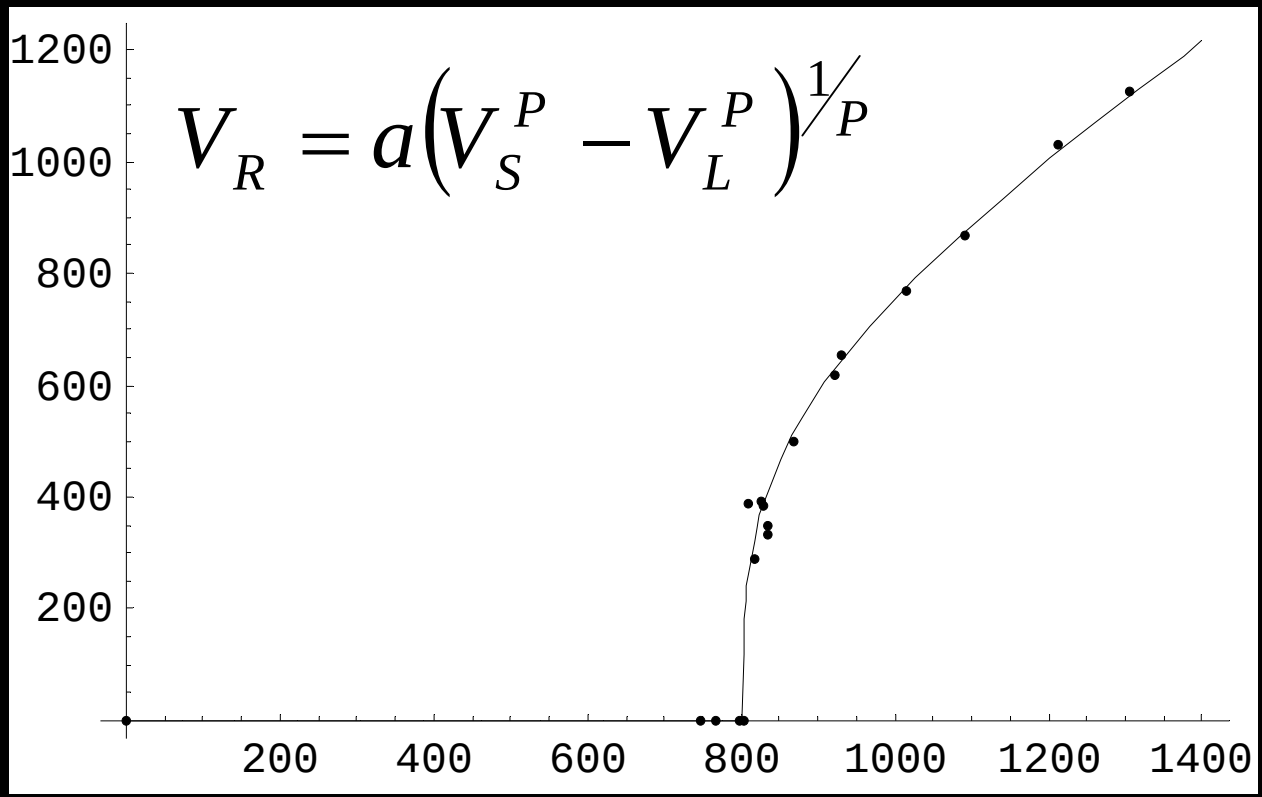
- Government agencies conduct ballistics testing to determine the limit velocity of different armor.
- There is no first principles approach to determining limit velocity.
- Ballistics testing is expensive, therefore sample size is small.

Current Experimental Methods

- **V50: Bracket the limit velocity with an upper and lower bound.**

- **Limit Velocity: Use X-ray measurements of residual velocity to parameterize a Lambert-Jonas curve.**

Lambert – Jonas Curve



Problems

- **V50:**
  - **Limited by the quality of the initial estimate of the limit velocity**
  - **Does not estimate well in a zone of mixed results**

Problems

- **Limit Velocity:**
  - **Challenge of estimating 3 parameters and error with a limited number of tests**
    - **Parameter a**
    - **Parameter p**
    - **Limit Velocity**
    - **Error**

$$V_R = a\left(V_S^P - V_L^P\right)^{1/P}$$

Arena - [ARL Ballistics 2.doe]

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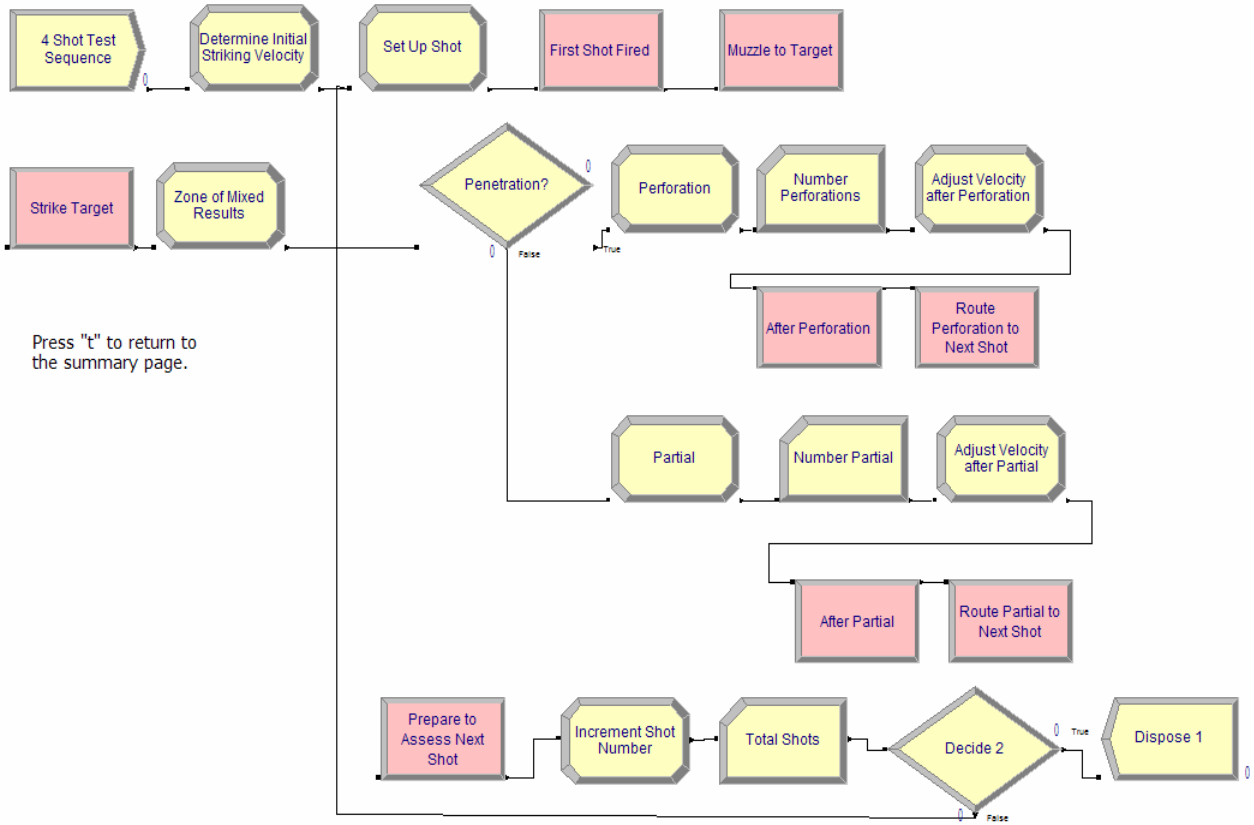
First Shot Logic

This logic models the first shot. The engineer determines the initial velocity according to a normal distribution. The lab sets up the shot with some normal error. The shot is then routed to the target for animation purposes. The Zone of Mixed Resutls block determines if the shot penetrated the target. Based on whether or not the target was penetrated, the next shot is set-up.



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Research Goals

- Determine marginal benefit of adding additional test shots for each testing method.
- Compare methods for accuracy and cost.
- Potentially develop an improved hybrid method of ballistics testing.