Towards building a civilian Lethality Index

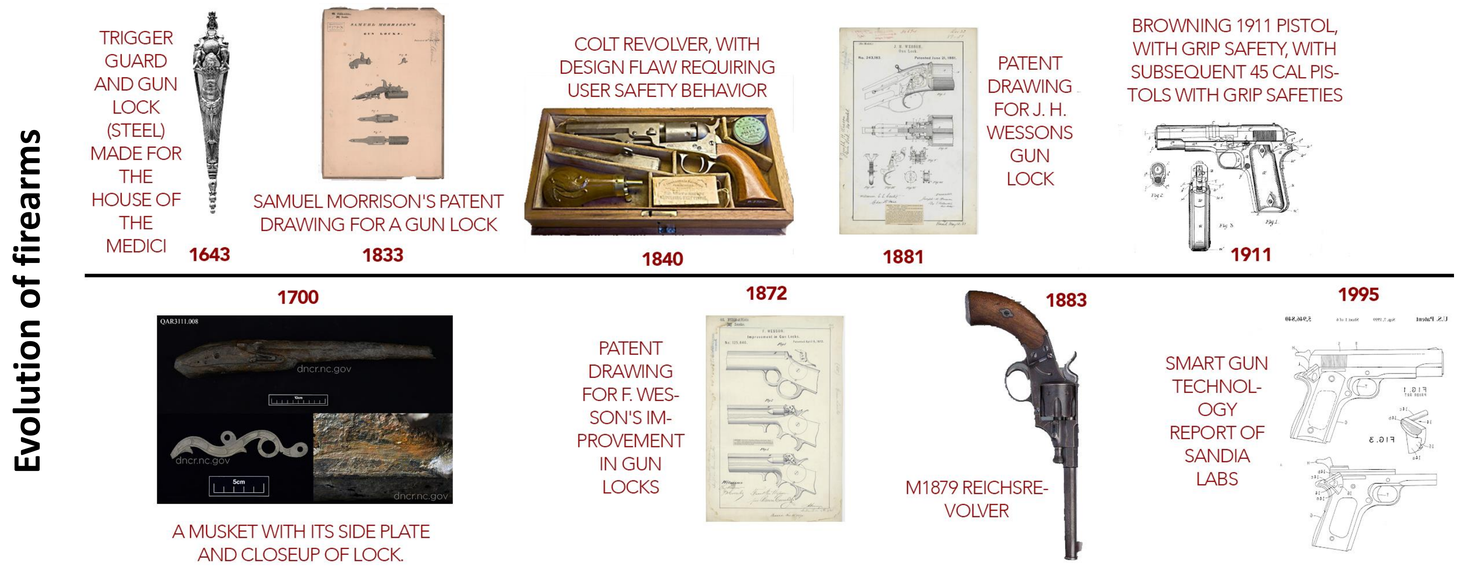
Cheyenne McLaskey , Applied Data Analysis, Wesleyan University

Introduction

- As the American judicial system has placed increasing importance on history, understanding how modern weapons differ from historical firearms and when these changes occurred could be valuable for gun safety advocacy.
- The Theoretical Lethality Index(TLI) was developed by the Dupuy Institute to compare the lethality of weapons relative to each other. (see **Fig1** for military TLI).

Research goal

- **Quantify and examine changes in guns over time, build a collection of resources related to specific models of firearms to facilitate further research, and modernize the TLI. It will also help in the creation of the Practical Lethality Index(PLI), which will be based on actual case-uses of firearms.**



TLI

1. TLI Sample

- Small arms (n = 111) manufactured between 1720 and 2020 **(Fig2)**. Assistance from the Dupuy Institute, Christopher Lawerence to select specific weapons to use in this research. Observations were researched individually.

Variables

- Caliber in millimeters, muzzle velocity in meters per second and sustained rate of fire for one hour. Reliability and accuracy as scores out of 1. Relative incapacitating effect, out of 1, and potential targets per strike (PTS) based on caliber. Range factor based on muzzle velocity and caliber.
- TLI based on rate of fire, PTS, range factor, accuracy, and reliability.
- Model name, country of origin, and year first produced.
- General type; Sidearms, Muzzle loaded muskets and rifles, Breech loaded rifles, Manual action rifles, Semi-automatic rifles, and Automatic rifles and submachine guns.

Results

Due to the interdependence of the variables, a linear regression could only be performed on the relationship between year and the TIL, which was shown to be significant ($p < 0.05$) and accounts for a noticeable portion of the variation ($R^2 = 0.205$). In the future, using a polynomial regression would likely better express this relationship **(Fig 4).**

As manufacturing improved the ability to retain pressure and increase muzzle velocity and rate of fire, guns could be chambered for smaller caliber rounds while maintaining or increasing the weapon's lethality. The visualization of this data also makes very clear the difference between the capabilities of automatic weapons compared to even semi-automatic firearms **(Fig3).**

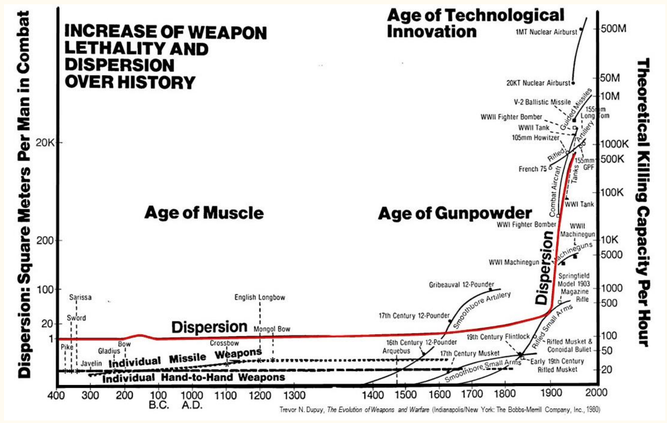


Fig1. TLI[1]

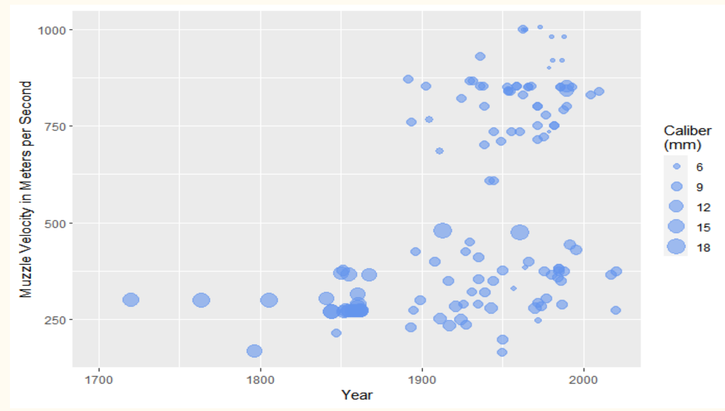


Fig3. Muzzle Velocity and Caliber over Time

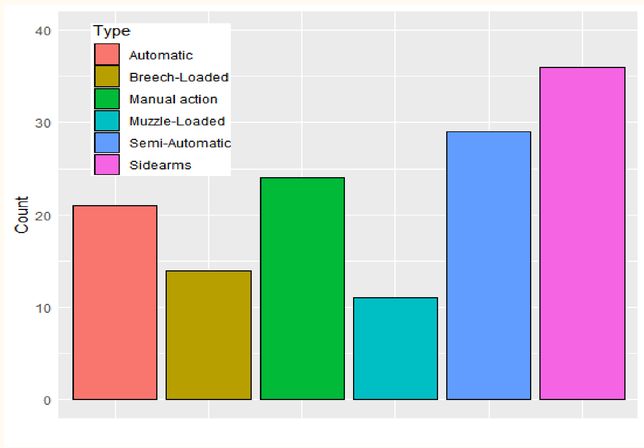


Fig2. Count of Weapons Included in dataset by Type

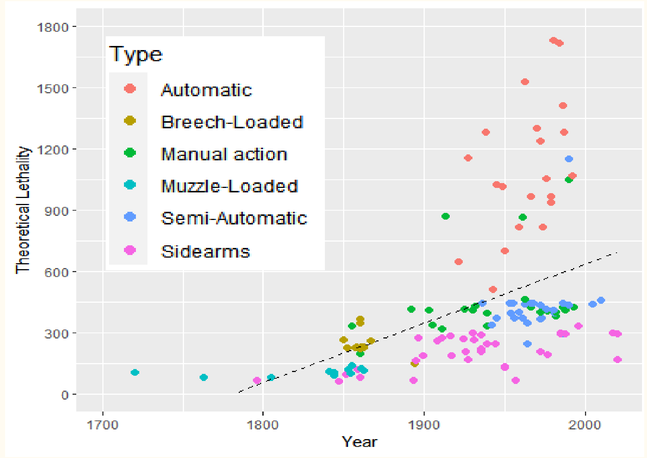


Fig4. TLI over Time by Type

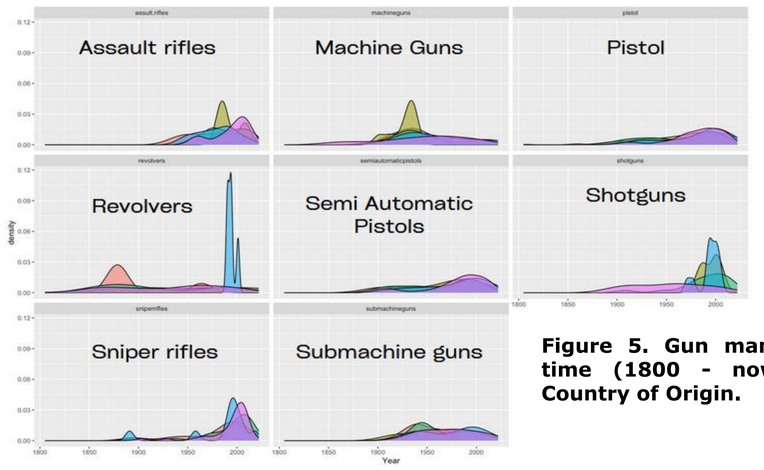


Figure 5. Gun manufacturing across time (1800 - now) by Type and Country of Origin.

2. Gun manufacturer Sample

- Gun manufacturer dataset (n = 1740) is a sample of of guns manufactured since 1805. Shows manufacturing trends with a focus on the largest firearm producing nations. Eventually connecting the production information of firearms could reveal if the weapon's lethality has any effect in the length of its production or the number manufactured **(Fig5)**

3. Ballistic kinetic energy

The ballistics dataset (n=154) contains physical measure of such as bullet weight, gun type, Muzzle velocity and other velocity measure, trajectory at different ranges. Kinetic energy was calculated using $k = mv^2$.

The properties of ammunition has an important effect on a firearm's capabilities, eventually connecting specific rounds to weapons in the TLI and PLI could show which ballistics are the most dangerous. ((**Fig6.)**

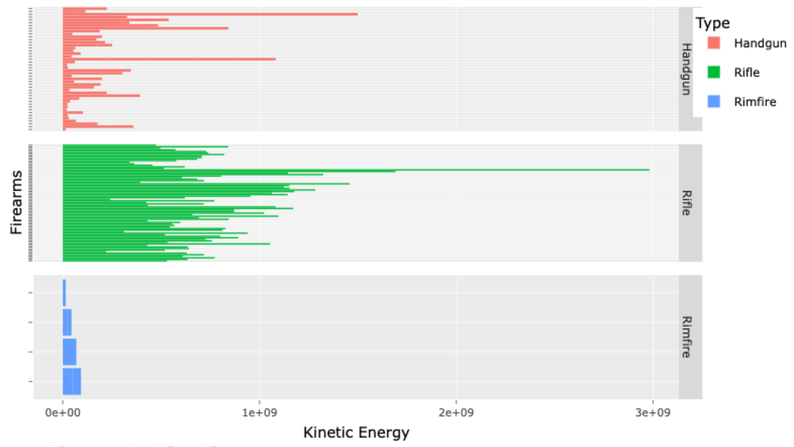


Figure 6. Kinetic energy across gun types

Discussion

This project was part of the preliminary research and data collection on the wider gun safety and manufacturing project at the QAC. This gave a basic overview of the last 300 years of improvements in small arms and shows that lethality has increased in a statistically significant way.

Future work

In the future, it would be helpful to more narrowly define the types of weapons and ammunition to reflect more specific features and capabilities. The TLI dataset will eventually be connect with the Database of Gunfights to produce the PLI. It could also be beneficial to connect lethality with inflation-adjusted cost and the number manufactured to start to understand the accessibility of weapons through history. There has already been data collection and organization efforts for both price and production amounts.

It may also be beneficial to expand the features contained in the TLI and reflected by the lethality score. The addition of features and manufacturers will help connect this project to the wider research being done on gun design and innovation through the patent dataset scraped by other students involved with the project.

[1] Trevor N. Dupuy, *The Evolution of Weapons and warfare* (Indianapolis/New York: The Bobbs-Merrill Company, Inc., 1980)
Advised by Maryam Gooyabadi, with data visualization assistance from Braeden Falzarano and subject matter advice from Christopher Lawerence and William Sayers.