**SE3250 Project 1 (Winter AY2012)**

**Modeling technological superiority and implications for today (2012)**

**Objectives:**

**Create a simple model to represent combat**

**Explore the model implications**

**Communicate the results**

**Part A. Incans vs. Spaniards**

This project compares two battles of interest in the ‘civilization’ of the Americas. The first is the battle of Cajamarca[[1]](#footnote-1), fought 16 November 1532 in present-day Peru between the Inca Emperor Atahuallpa (with 80,000 Indian infantry) against Francisco Pizarro (with 168 Spaniards: 62 cavalry and 106 infantry). In eight hours, it is estimated that the Spanish killed 7000 Inca and captured the Emperor, without losing a single man.

Armaments for the forces were quite different. The Incas were armed with clubs and stone hatchets. They wore quilted ‘armor’. The Spaniards had steel helmets and body armor, and steel swords and lances. The Indian quilted armor was effective against blunt instruments such as clubs, but offered little protection against piercing by steel swords and lances. The Spaniard armor was quite effective against the Indians’ primitive weapons.

Consider the Spanish forces to be *S* and the Inca forces to be *I*. In this situation, we can model the battle with the following differential equations:



The attrition rate for the Incans is given as zero (*a = 0)* – why? because they did not kill a single Spaniard.

**Requirement 1:** Set time in minutes. Use the historical data (above) and estimate the value of *b* in Equation 1.1. Give a plain language explanation of *b* – that is, how would you explain the value of *b* to a non-analyst?Why are we using the linear law, not the square law?

**Requirement 2:** Using a fixed step model in Extend, construct a model that faithfully replicates the historical results. Produce a plot of *S(t)* and *I(t)* for the eight hours of the battle. Ensure the plot is properly annotated.

**Requirement 3:** In your opinion, would any tactics employed by the Incas have mattered? Support your answer. Suppose, for instance, their attrition coefficient (*a)* no longer 0, but rather one hundredth of the value you found for *b*? One thousandth?

**Part B. Sioux vs. 7th Cavalry**

Setting: Read the descriptions of the battle of Little Bighorn in the course notes.

Assumptions: Consider the 7th Cavalry (B) and the Sioux forces (R) to be homogenous cavalry forces. The initial strengths are as given in the article: Custer had 600 men, and there were 5,000 Sioux warriors. Assume initially that the battle follows the Lanchester square laws without reinforcement, given by:



**Requirement 4:** Assume that the ratio of *b/a* is 3.0, *a = .01*, and both *a* and *b* are constant with respect to time. What are the units of *a* and *b?* Model the battle in Extend using Equations (1.2), and **for the scenario where all of the 7th Cavalry attacks all of the Sioux at once**, determine the battle outcome. How long until one side is annihilated, and what are the ending strengths?

**Requirement 5:** Now assume that Custer divides his forces, and 115 men under MAJ Reno attack 1000 Sioux. 225 men under LTC Custer attack 500 Sioux, and are then counterattacked by 1,000 more Indians. What is the outcome of those battles? How well does this match the historical outcomes? Hint: one method of modeling simply takes the end strengths of the first phase of the battle to provide the starting strengths for the second phase.

**Requirement 6:** Now assume that the attrition coefficient is not a constant. Include a surprise coefficient (here a factor of 20) that lasts only for the first ten minutes of the battle, producing



For consistency of units, set *a* = 0.01. How does this change your answers to requirements 4 and 5?

**Part C. Exploration**

**Requirement 7:** Using Equations (1.3) and fixing *a = 0.01,* experiment with values of *b* and tactics (e.g. attacking the Sioux sequentially 500 at a time) in order to find a combination of surprise, technological superiority (here represented by *b/a)* and tactics that produces an outcome where the 7th Cavalry is not annihilated. Summarize that scenario in words and comment on its plausibility. In particular, comparing with the battle of Cajamarca, what was the long term effect when the Native Americans were armed with rifles and mounted on horses? [[2]](#footnote-2) Why does the square law apply here, not the linear law?

**Requirement 8:** Make one improvement to model (1.3). Update your Extend model to reflect the new model, and report the outcomes.

**Requirement 9:** Comment on the effects of technical superiority and force ratios on modern campaign planning.

**Part D. Communicate your results  
  
Requirement 10:**

**a)** Summarize your findings from Requirements 1 - 9 in a concise, well-written, and well-illustrated written report. This report is **due for our fourth class meeting.**

***This report, and those that follow for Project 2 and Project 3, should be no more than 12-15 pages in length – the key is to provide sufficient detail to support your analysis, and no more.***

Write this as a technical narrative – what’s the background (why you’re doing this, what’s the context for the data), what did you do (describe the analysis), what were the results (what did you discover or confirm), what does it mean (interpret the results), what are your conclusions and recommendations (put the analysis and results into context for an executive/decision maker). Basically, figure out what you learned from the analysis and tell that story. Imagine that your audience is educated but disassociated – that is, they will understand the technical complexity of what you are doing, but they did not materially participate in the analysis. So, for instance, if you use an ANOVA in your analysis, you don’t need to describe ANOVA as an analytic technique, but you would need to give your rationale for using it, and then explicitly interpret the results.

**b)** Include a four (4) slide summary brief as an appendix (a title slide is allowed – that is a fifth slide). Craft the brief as if the intended audience is a **senior** decision maker, i.e. **focus on the insights** you gained from the study with sufficient detail to establish the credibility of your assertions and recommendations, but do not get “into the weeds” (e.g. a screen shot of your completed Extend model would probably not be a good idea and provides little value added). Insure that all file names and documents include your team members’ names.

1. Jared Diamond, *Guns, Germs, and Steel.* New York: Norton, 1999. This Pulitzer prize-winning book is worthy of study by every military professional. [↑](#footnote-ref-1)
2. See Diamond, page 75. [↑](#footnote-ref-2)