Comparing Current Railroad Crossing Hazard Ranking Formulae

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10/27/2015
Outline

• Existing Formulae
• Data Comparison
• Challenges
• Conclusions
Existing Formulae

- USDOT Accident Prediction Formula
- New Hampshire Hazard Index
- Peabody-Dimmick
- Custom Equations
  - Florida
  - California
  - Illinois
  - Kansas
  - Missouri
  - Arkansas
  - Connecticut
  - …
Existing Formulae

• USDOT Accident Prediction Model

\[ a = K \times EI \times MT \times DT \times HP \times MS \times HT \times HL \]

- K is a constant
- EI is the exposure index
- MT is the main tracks factor
- DT is the through trains factor
- HP is the highway paved factor
- MS is the maximum timetable train speed factor
- HT is the highway type factor
- HL is the highway lane count factor
Existing Formulae

• Exposure index

\[
\left( \frac{c \times t + 0.2}{0.2} \right)^f
\]

– c is the vehicular traffic
– t is the average train movements per day
– f is a factor based on crossing type
  • 0.3334 for passive crossings
  • 0.2963 for flashing lights
  • 0.3116 for gated crossings
Existing Formulae

- New Hampshire Hazard Index
  \[ HI = V \times T \times P_f \]
  - \( V \) is the AADT
  - \( T \) is the average daily train traffic
  - \( P_f \) is the protection factor
    - 0.1 – 0.13 for gates
    - 0.2 – 0.6 for flashing lights
    - 1.0 for passive
Existing Formulae

• Peabody-Dimmick Accident Prediction Formula

\[ A_5 = 1.28 \times \frac{V^{0.170} \times T^{0.151}}{P^{0.171}} + K \]

– \( A_5 \) is the five year accident rate
– \( V \) is the AADT
– \( T \) is the average daily train traffic
– \( P \) is the protection coefficient
– \( K \) is a balancing constant from a chart
Existing Formulae

• Florida DOT Accident Prediction Model (gates)

\[ t_a = -8.075 + 0.318 \ln(S_t) + 0.166 \ln(T) + 0.293 \ln(A) + 0.387 \ln(V_v) + \left( 0.28 - 0.28 \times \frac{MASD}{RSSD} \right) + 0.225 \times (L - 2) - 0.233 \]

• \( t_a \) is then plugged into the following formula to get the accidents per year

\[ y = e^{0.938 \times t_a + 1.109} \]

\[ y = \frac{4}{4} \]
Existing Formulae

- Illinois Modified Expected Accident Frequency Formula

\[ HI = 10^{-6} \times A^{3.14816} \times B^{0.26019} \times C^{-0.02405} \times D^{0.45467} \times (18.76 \times N + PF) \]

- A is the log of daily traffic times daily trains
- B is the maximum timetable speed
- C is the total number of main and other tracks
- D is the number of highway lanes
- N is the number of crashes per year
- PF is the protection factor
Existing Formulae

- Other state formulae are generally modifications of the NH formula

- California’s version

\[ HI = \frac{V \times T \times PF}{1000} + AH \]

- V is the vehicle volume
- T is the train volume
- PF is the protection factor
- AH is the accident count for the last 10 years
Existing Formulae

• Connecticut’s version

\[ HI = \frac{AADT \times (T + 1) \times (A + 1) \times PF}{100} \]

– T is the train volume per day
– A is the number of veh.-train collisions in 5 yrs
– PF is the protection factor
Data Comparison

• Input Data commonalities
  – AADT
  – Daily Trains
  – Protection Factor
  – Accident History
  – Train Tracks
  – Lane Count
Data Comparison

• Data outputs are in two forms
  – Estimated accident rate
    • USDOT
    • Florida
    • Peabody-Dimmick
  – Hazard Index
    • New Hampshire
    • California
    • Connecticut
Data Comparison
Passive Crossings in Ohio
Data Comparison
Flashing Light Crossings in Ohio
Data Comparison
Gated Crossings in Ohio
Challenges

• None of the formulae examined identified anything extraordinarily hazardous about the most dangerous crossing

• A quick look at the site indicates some factors we should look at including
  – Roadway offsets/curves
  – Sight lines
  – Does gate position insufficiently discourage drivers from circumventing the gate?
Challenges
Challenges
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• When many of these formulae were created there were
  – Hundreds of incidents per year
  – 50+ fatalities per year
• Currently Ohio has <100 incidents per year with <10 fatalities
• Peak accidents occurred in 1978 with 945 collisions and 83 fatalities
Challenges

Rail-Highway Incidents

- Highway Deaths
- Highway Incidents
Challenges

• The problem breaks down to one of signal to noise
• Our signal has been getting weaker as the most dangerous crossings have been upgraded
• The noise has been increasing with traffic
Challenges
Challenges
Challenges

Signal to Noise (1:100)
Challenges

Signal to Noise (1:10)
Challenges

Signal to Noise (1:1)
Challenges
Conclusions

• Currently our analyses are very sensitive to accident history
• The vast majority of crossings have zero accidents in a year
• A random accident at a RR crossing represents a major skew in priority
Conclusions

• We have addressed the majority of the problems we can identify with current tools
• We need to improve our formulae and data collection practices
  – More refined data on traffic by time of day
  – Train data by time of day
  – Examine accident history by RR contribution
  – Other geometric factors (sight lines, etc.)