COMPARING RED LIGHT RUNNING TO CRASHES

Ignoring the Multilevel Reliability Model

Brian Ceccarelli
M.IEEE, M.ASCE, M.ITE
4605 Woodmill Run
Apex, NC 27539
ceccareb@talussoftware.com
919-815-0126
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Abstract

American Traffic Solutions (ATS) and the Insurance Institute of Highway Safety (IIHS) release videos and studies which equate red light running (RLR) to crashes while implicitly blaming RLRs and crashing on drivers. Such videos and studies are not limited to ATS and IIHS. The videos and studies conceal engineering defects, misrepresent engineering goals, and deceive government and public into believing that drivers are to blame.

Such equating and blaming is engineering malpractice. ATS and IIHS violate a well-established engineering practice spanning engineering disciplines. The practice is called multilevel reliability modeling. This paper describes multilevel reliability modeling by example and how ATS and IIHS mispresent it.

The Multilevel Model of Reliability

All disciplines of engineering use the *multilevel model of reliability*. I will describe the model with two examples. The first example is of the Toyota sticky-accelerator defect. The second example is of the yellow light defect. Both defects are from real-life.

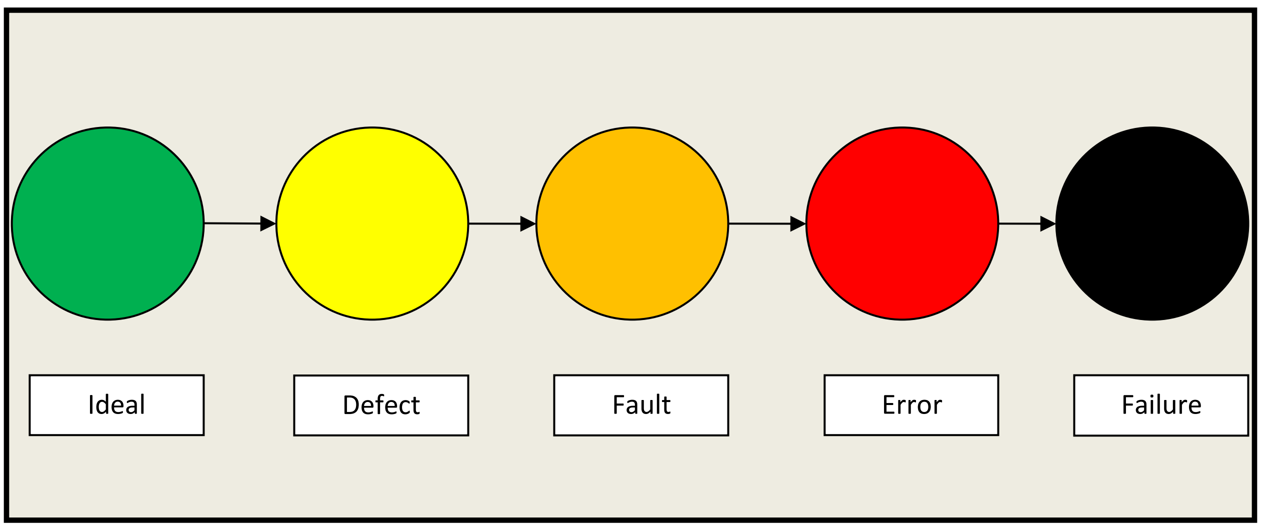

Figure 1 – System States and State Transitions in the Multilevel Model of Reliability

Example 1 – Toyota Sticky-Accelerator Defect

Refer to Figure 1. Toyota and the sticky accelerator problem. The problem causes unwanted acceleration. For this example, we define a *failure* as a crash.

Defect

Toyota introduced a mechanical *defect* into several of its car lines. The defect is in the accelerator pedal's electronic linkage to the engine. Under certain circumstances, the defect causes the pedal to keep sending the message "accelerate" to the engine, even when the driver takes his foot off the pedal. The result is unwanted acceleration.

Fault

A Toyota driver steps on the accelerator pedal. Circumstances are such that the electronic linkage behaves correctly. The driver experiences no problems.

Engineers say that a *fault* occurred simply by virtue that the driver is using the pedal. If the driver never stepped on the pedal, then a fault would never occur.

Error

A Toyota driver steps on the accelerator pedal. Circumstances are such that the electronic linkage breaks. The pedal is in the *error* state. The driver removes this foot from the pedal. The pedal keeps telling the engine to accelerate. The driver is cool and clever. The driver puts his car in neutral. Even though the engine is still getting gas, the gears are not engaged. The driver presses the brake. The car comes to a stop. The car is still revving but the car has stopped. Driver turns off car.

Failure

A Toyota driver steps on the accelerator pedal. Circumstances are such that the electronic linkage breaks. The driver does not have the time to react. He crashes into a pedestrian. A *failure* has occurred. The pedestrian is an old man and he dies.

Example 2 – Yellow Change Interval Defect

Refer to Figure 1. A car approaches a signalized intersection. The light turns yellow. We define a *failure* as a crash.

Defect

The math equation traffic engineers use to set the duration of yellow lights is defective. The calculated duration is only long enough for unimpeded straight-thru motion cars. For all other types of motion, for example turning cars, the calculated duration can be several seconds too short and can cause the car to run a red light.

Fault

A car is going to turn. The equation does not work for this case. The car is too close to stop. The conditions are present which invoke the defect. The state of the system transitions from *defect* to *fault*. The car is close enough to the intersection that the yellow light is long enough for the car to enter the intersection on a yellow light. Car enters intersection legally. The *fault* does not progress to *error*.

Error

A car is going to turn. The car is too close to stop. The car is too far from the intersection such that the yellow light is not long enough for the car to enter the intersection. The car unavoidably runs a red light. This is an *error*. The defect caused the car to enter the intersection illegally.

Conflicting traffic has not yet entered the intersection and hence there is no crash. There is no *failure*.

Failure

A car is going to turn. The car is too close to stop. The car is too far from the intersection such that the yellow light is not long enough for the car to enter the intersection. The car runs a red light. The yellow is so short that conflicting traffic has entered the intersection. The car hits conflicting traffic. This is a *failure*.

Fault-Tolerant Systems

Engineers strive to create *fault-tolerant* systems. A fault-tolerant system is one that gracefully handles defects and prevents them from transitioning into failures. Along with creating a fault-tolerant system is the engineer's admission that the system has defects. All man-made systems have defects.

Most engineers are comfortable with allowing defects to turn into errors.

Most engineers are not comfortable allowing defects to turn into failures.

For example, the Institute of Transportation Engineers (ITE) recommends that engineers make drivers run red lights (errors) so long as the vehicles do not crash (failures). ITE tells traffic engineers to adjust the yellow time so that about 3% of all vehicles will run the red light.[2] ITE tells engineers to cap the yellow light to 5 seconds in spite that the yellow change interval equation says to make the yellow longer. To compensate for more drivers running red lights (errors), ITE tells the engineer to increase the all-red clearance interval to prevent crashes (failures). [3]

Engineers accept that failures are inevitable. Engineers use a metric called MTBF—the mean time between failure. Traffic engineers set a MTBF requirement for crashes. They set the Crash MTBF to a value greater than zero. So even a percentage of failures, caused by the engineer's own defects, is acceptable to the engineer.

American Traffic Solutions Point-of-View

American Traffic Solutions profits from errors but markets failures. Such videos do not represent the typical error; they represent the rare failure--and that rare failure further confined to one type of failure—the catastrophic T-bone crash.

But for every T-bone crash, there are about 500,000 errors. The typical error is a car entering the intersection a fraction of a second after the light turned red. It is an RLR event so puny that it is imperceptible to the human eye.

Traffic Engineer's Point-of-View

Engineers design systems to minimize failures and are comfortable with ignoring errors. Traffic engineers do not care if drivers run red lights; they do care if drivers crash.

To help prevent errors from turning into failures, traffic engineers use *mitigation* techniques. Engineers employ dilemma zone detectors, advance detectors, longer all-red clearance intervals, traffic signal back-plates, masts instead of hanging wires, slower speed limits, etc. These techniques mitigate the defect of the yellow light. They do not remove the defect. The techniques are Band-Aids. The Band-Aids cannot stop the bleeding because the defect is much bigger than the Band-Aids.

The vast majority of traffic engineers are unaware of the defect.

Driver Point-of-View

To the driver, to the police and to engineering practice law, illegally entering the intersection is a *failure*. The traffic engineer does not see it that way.

Summary

Government agencies and red light camera companies blame engineering defects on drivers. The organizations produce videos and studies equating red light running to crashes. In doing so they deceive the public who is unware of engineering practices--in this case the multilevel reliability model. The public comes away believing that drivers are bad and that engineering defects do not exist.

The engineering defect with the yellow light can easily be remedied. Remove the 2 from the denominator of the ITE yellow change interval equation.

References

1. Brian Ceccarelli, The Yellow Change Interval – Four Major Engineering Errors and Omissions
2. Institute of Transportation Engineers, Determining Vehicle Signal Change Intervals, 1989, p. 30
3. Institute of Transportation Engineers, Traffic Engineering Handbook, 2010, p. 412