DABEC DIGEST
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STATISTICS, PROBABILITY, ENGINEERING, AND LIFE, IN GENERAL

So, I'm sitting here in my office with a quarter in my hand. (My wife just gave me my allowance.) And I'm thinking about doing a little experiment flipping it in the air and catching it to see how many times I get "heads", and how many times I get "tails." (As you can probably tell, I'm not used to having money in my pocket.)

Since this is a relatively random event, and since almost all of us realize that the odds of getting one side or the other are about the same, you would expect me to get 50% Heads and 50% Tails, right? Well, here goes:

10 flips=6 heads and 4 tails.
20 flips=11 heads and 9 tails.
30 flips=16 heads and 14 tails.
40 flips=21 heads and 19 tails.
50 flips=25 heads and 25 tails.

I flipped my quarter 50 times in 5 sets of ten as illustrated above. There were only two sets of ten that did not result in a 5:5 tie, the first set and the last set. Ultimately, after 50 flips, we ended up right at 50% of the flips landing on each side.

The data shown above are the statistics of the experiment. Once you have a good set of statistics, you can generate the probable likelihood of a specific outcome the next time you try the experiment.

In this case, there is a 50% likelihood that each flip will result in Heads. There is also a 50% likelihood that each flip will result in Tails. That's the probability of success or failure in this experiment.

By now, you might be wondering, "What does all this have to do with engineering and my life, in general?"

Each and every day we all count on statistics and probability and don't really even think about it. We choose certain means of transportation, or certain food, or a certain neighborhood in a subconscious (most of the time) effort to keep ourselves and/or our families safe and happy.

For those of you that would like a couple of examples:

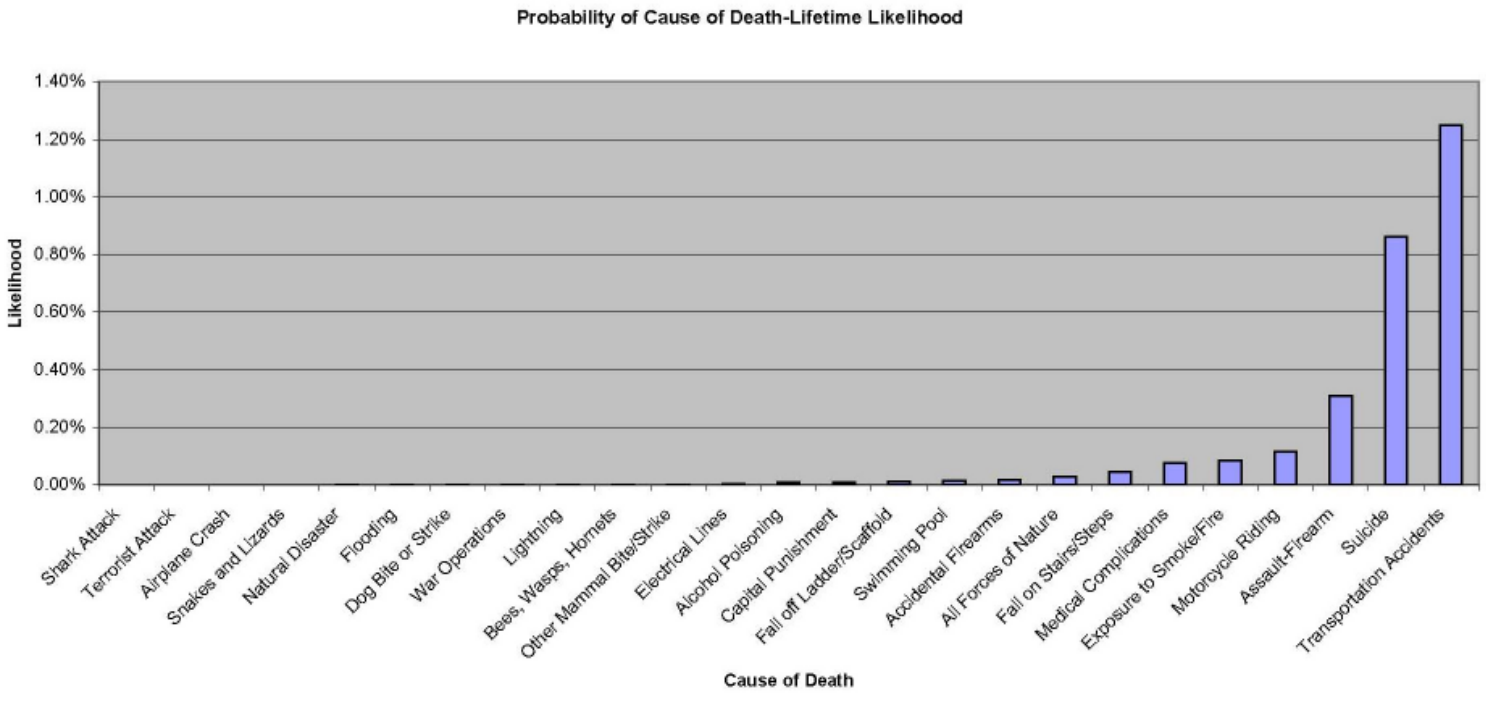
Why don't you drive 100 miles per hour through town to get to school or work in the morning? Most of us would answer in two possible ways: 1) The likelihood (probability) of getting into a wreck driving 100 mph in town is very high. 2) The probability of getting a ticket from a police officer is also very high.

Why do you pay for insurance (health insurance, car insurance, life insurance, homeowners insurance, vision insurance, dental insurance, etc.)? Is it because you like sending multiple hundreds of dollars to someone you might never have met every month? No, my guess is that you send that money to the insurance companies every month because there is some likelihood (probability) that something bad will happen, and the insurance company is supposed to rescue your family when (or if) it does.

STATISTICS

Statistics are really just the data samples that actuaries (really good mathematicians) and other mathematicians/engineers use to determine the probability of an event occuring. Typically, the larger the data sample (millions of data points) the higher the degree of confidence in the predicted behavior (probability.) If a data sample is small (two events), it is very difficult to accurately predict future behavior or results.

Additionally, it is also important to note that probabilities are really only good for multiple future occurrences. For example, even though the probability is 50% that the coin will flip to heads next time, it will be wrong approximately 50% of the time on the next flip. If you flip the coin one million times, though, you will be really close to one



STATISTICS, PROBABILITY, LIFE....CONT.

half million heads and one half million tails events.

Why is it important to remember that these statistics are generally only good for a large data sample? While the average height of all adult males in the United States might be 5'-9", that doesn't mean that each individual is that tall. We obviously have quite a variation from that number in our population. On the whole, however, our average is 5'-9", and that number is fairly predictable.

PROBABILITIES

The probability of an event is really just the likelihood that it will happen. For example, if you live in the US and are a male adult, there is a 50% probability that you are taller than 5'-9". (There is also a 50% probability that you are less than 5'-9".)

Probabilities are very similar to their building blocks, statistics, in that the larger the pool you predicting for, the more likely your prediction will be correct.

For example, the entire city of Las Vegas, NV is completely built on statistics and probabilities. While an individual gambler might travel to Las Vegas and win money, the average of all gamblers is that they lose money in Las Vegas.

You might be surprised how small the statistical margin is between the house losing and winning on most games. I have included a chart in this newsletter to illustrate that point. If you are not mathematically oriented, you might think that a few percentage points winning margin is not enough to build a multi-million dollar casino, but with enough traffic and a large enough data sample, those small percentages add up over time. They certainly don't build those casinos and hotels by losing money every day. (By the way, if you have any questions about the odds published in the chart, you'll have to look it up on the Internet. I don't know anything about those games.....)

Probabilities also extend heavily into the sports arena. Baseball players get paid big money for having a higher probability that they will hit successfully than someone else might. They also get paid more money the more likely they are to: field a ball, make an out, strike out batters, hit with players in scoring positions, etc. Baseball might be the sport that pays the most attention to statistics and probabilities, but it certainly isn't the only one.

Why are some basketball players closely guarded beyond the three-point line and others are fouled on purpose to put them at the free-throw line? Do you think that is just coincidence? Players and coaches play the odds that one player will hit more shots, while another won't hit as many.

How about football, where one receiver might have two corner backs guarding him while another receiver on the same play only has a line backer in the vicinity? Again, the players and coaches are working the probability that one player will hurt them while another player won't.

On a down by down (or play by play, or pitch by pitch) basis this may not pay off, but over the course of an entire game, or an entire season, it probably will. Each player can exceed their expectations on a given day (or a given play), but over the long haul, each player will ultimately end up at their average.

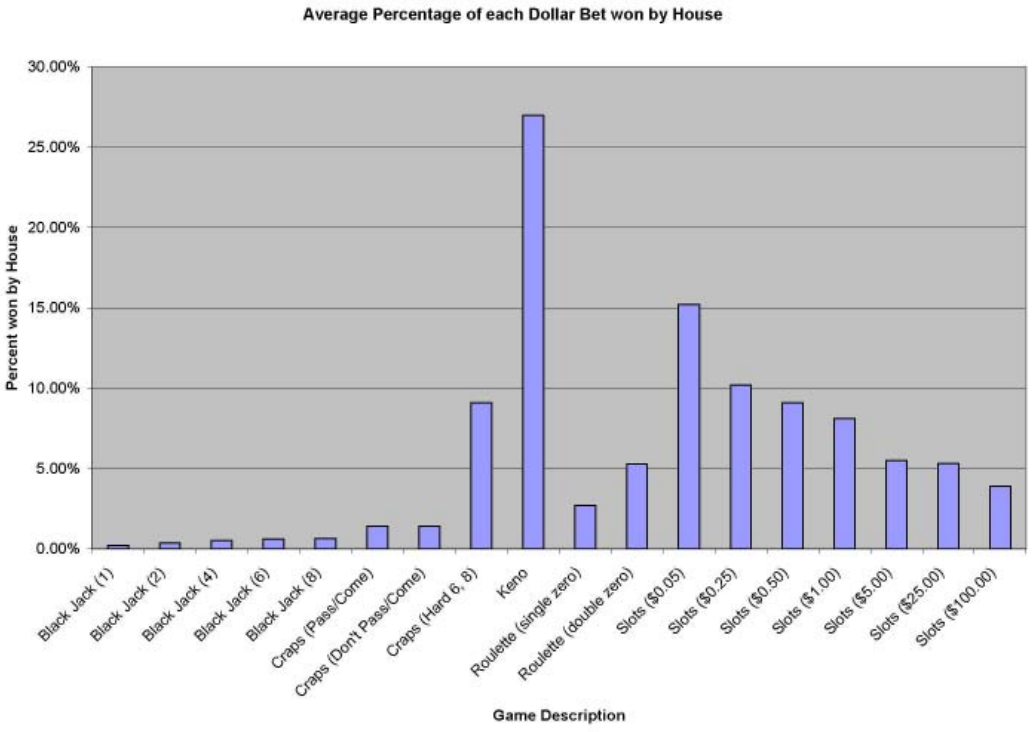
Now, I'm sure you're asking, "What does this have to do with engineering?"

Well, everything that an engineer designs is based upon statistics and probability. Even the raw construction materials we use have their basis in statistics and probability.

Have you ever noticed that not all two by fours look identical, or that every car on the highway is in a different state of repair, or has a different amount of weight in it? How about the fact that each home generates a different amount of waste and uses a different amount of water each day?

As engineers, we have to design against the most likely, worst case, scenario, and then make sure no one will get hurt. Deviations from the average have to be accounted for in all designs, and then we have to make sure that freak occurences don't cause catastrophic failures.

If thinking about that makes your head hurt, I would recommend watching a baseball game, or even going to a basketball game. See you next month!



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