Not Simulating Systems: Why I'm So Bad at Pool

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I've always been a terrible pool player. Until recently, I attributed this complete lack of talent to my abysmal hand-eye coordination skills. As it turns out, I may have been too hard on myself in that my inability is almost entirely due to the fact that I generally fail to properly take account of all the physical phenomena that influence the pool table when making a shot. More specifically, it's because I usually neglect to to take account the gravitational attraction of the big dude sitting at the opposite corner of the bar. In the past few blog posts we've talked about the importance of 'simulating the system', the process by which we try to account for all the factors that are likely to significantly influence the performance of a design in operation, and how failing to account for some of those physics can reduce the accuracy of your prediction. Exactly the same principles apply when lining up a pool shot!

Let me explain?

On paper at least, calculating the elastic collision of two pool balls is a relatively trivial task, one that should be easily within the grasp of any high school physics student. Using Newton's laws of motion, given an initial velocity and and angle of collision you should be able to predict - to a fairly high degree of accuracy - the subsequent trajectory of the two balls. By taking account of the frictional rolling resistance between the balls and the baize, you would also be able to predict where the balls would eventually come to rest.

Having mastered a two ball collision, it would be tempting to think that you could simply extend the calculation to take account of subsequent collisions (with other balls or with the rails of the table). However, even though each individual collision obeys Newton's laws, it turns out that as the number of collisions increases, the amount of physics you need to account for in order to maintain the accuracy of your prediction increases at a staggering rate.

In his book "The Black Swan [1]", Nassim Nicholas Taleb describes a set of calculations by English physicist Professor Michael Berry [2] that address exactly this problem:

> If you know a set of basic parameters concerning the ball at rest, can computer the resistance of the table (quite elementary), and can gauge the strength of the impact, then it is rather easy to predict what would happen at the first hit. The second impact becomes more complicated, but possible; and more precision is called for. The problem is that to correctly computer the ninth impact, you need to take account the gravitational pull of someone standing next to the table (modestly, Berry's computations use a weight of less than 150 pounds). And to compute the fifty-sixth impact, every single elementary particle in the universe needs to be present in your assumptions! An electron at the edge of the universe, separated from us by 10 billion light-years, must figure in the calculations, since it exerts a meaningful effect on the outcome.

Obviously this is an extreme example. Thankfully, as engineers, we are rarely called upon to make exact predictions such as the one described above. More often than not, we are rescued by 'The Law of Large Numbers', which allows us to make deterministic predictions about phenomena that are basically stochastic in nature. While we may not be able to accurately predict the outcome of a ten collision pool shot, we can easily calculate the bulk effect of billions of air particles randomly colliding against a wall.

Extreme or not, this example does illustrate how even apparently simple engineering systems are influenced by physical phenomena that might easily be neglected at first glance. It also demonstrates that the accuracy of prediction depends, at least in part, on the amount of physics you capture in your model, and that capturing 'all of the physics' is rarely an option. Finally, it also explains why I am so bad at playing pool. At least, that's my excuse and I'm sticking to it!

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[1] http://www.amazon.com/The-Black-Swan-Improbable-Robustness/dp/081297381X
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