Monte Carlo simulations have come a long way since they were initially applied in the 1940s when scientists working on the atomic bomb calculated the probabilities of one fissioning uranium atom causing a fission reaction in another.

Since those days when uranium was in short supply and there was little room for experimental trial and error, Monte Carlo simulations have always specialized in computing reliable probabilities from simulated data. Today, simulated data is routinely used in many scenarios, from materials engineering to medical device package sealing to steelmaking. It can be used in many situations where resources are limited or gathering real data would be too expensive or impractical. With Engage or Workspace's Monte Carlo simulation tool, you have the ability to:

- Simulate the range of possible outcomes to aid in decision-making.
- Forecast financial results or estimate project timelines.
- Understand the variability in a process or system.
- Find problems within a process or system.
- Manage risk by understanding cost/benefit relationships.

THE 4 STEPS TO GET STARTED FOR ANY MONTE CARLO SIMULATION

Depending on the number of factors involved, simulations can be very complex. But at a basic level, all Monte Carlo simulations have four simple steps:

1. IDENTIFY THE TRANSFER EQUATION

To create a Monte Carlo simulation, you need a quantitative model of the business activity, plan, or process you wish to explore. The mathematical expression of your process is called the "transfer equation." This may be a known engineering or business formula, or it may be based on a model created from a designed experiment (DOE) or regression analysis.

2. DEFINE THE INPUT PARAMETERS

For each factor in your transfer equation, determine how its data are distributed. Some inputs may follow the normal distribution, while others follow a triangular or uniform distribution. You then need to determine distribution parameters for each input. For instance, you would need to specify the mean and standard deviation for inputs that follow a normal distribution. If you are unsure of what distribution your data follow, Engage and Workspace have a tool to help you decide.

3. SET UP SIMULATION

For a valid simulation, you must create a very large, random data set for each input — something on the order of 100,000 instances. These random data points simulate the values that would be seen over a long period for each input. While it sounds like a lot of

work, this is where Engage and Workspace shine. Once we submit the inputs and the model, everything here is taken care of.

4. ANALYZE PROCESS OUTPUT

With the simulated data in place, you can use your transfer equation to calculate simulated outcomes. Running a large enough quantity of simulated input data through your model will give you a reliable indication of what the process will output over time, given the anticipated variation in the inputs.

Algorithm

1. Identify the independent and dependent variables and define their domain of possible inputs.
2. Determine a probability distribution to randomly generate inputs over the domain
3. Compute the output for the problem based on the randomly generated inputs
4. Repeat the experiment N number of times and aggregate the results

It's common practice to calculate the variance and standard deviation when conducting this experiment. Generally, the smaller the variance, the better

Advantages & Disadvantages

I will outline few of the most notable advantages and disadvantages of using this method.

Advantages

- Strong way of estimating uncertainty
- Given the correct boundaries, this model can survey the parameter space of problem
- Simple & intuitive, this approach is quite easy to understand

Disadvantages

- Computationally inefficient — when you have a large amount of variables bounded to different constraints, it requires a lot of time and a lot of computations to approximate a solution using this method
- If poor parameters and constraints are input into the model then poor results will be given as outputs