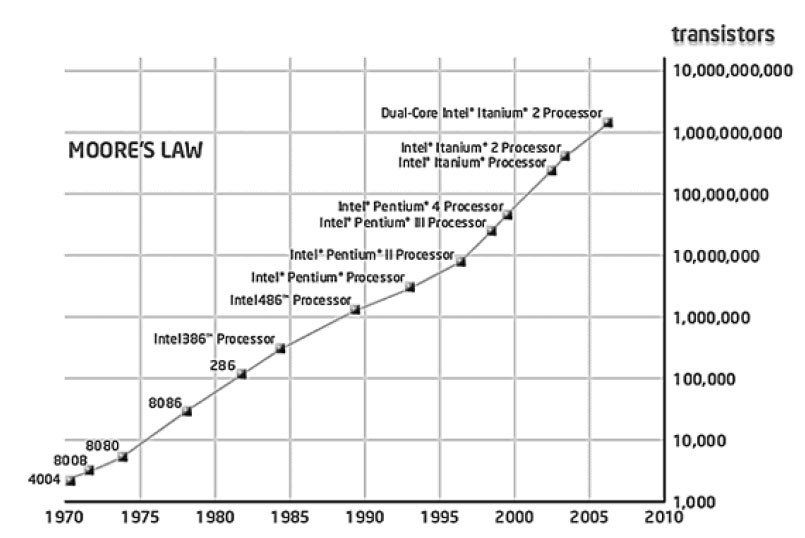
Statement: Advances in computing power mean that numerical modelling will replace practical experimentation

Answer:

In the mid 1960s Gordon Moore made and the observation that the power of computer, which can actually be measure by the number of transistor contained in a microprocessor, would double every 18 months (figure 1). For the past 20 years this observation has come to be true, and as a consequence mankind has been wondering when computing power would be sufficient to equal the human brain or to simulate the real word. Also, will the computer power will a day be enough to replace experiments? This is what is going to be discussed here.

  
Figure 1: Moore’s law for microprocessors.[[1]](#footnote-2)

First of all, the accuracy of a numerical model, which is given by the spatial discretization, is going to be considered in this first part of the answer. As a definition, the smaller the spacing between the grid points of a numerical model is, the more accurate is the simulation.

Based on a simple interpretation of the law, Moore’s observation can be summed up in the following equation: P = A x 2 ½ x Y where A is the power of the computer at Year(Y) = 0[[2]](#footnote-3)

Using the most powerful computer of 2008 for a direct simulation, it would not be possible to calculate more than a 108 grid point spatial discretization. Furthermore, the scale needed to fully describe the behaviour of a material with a complete 3D simulation is the lattice scale. Therefore, a quick calculation shows that for a direct simulation of physical phenomena at a lattice scale (10-9m), the number of grid points needed for a 1 meter model would be:   
 (10 x 109)3 = 10 27

This is obviously a very large number but if Moore’s law is true, computer would be able to do it in 2100. Considering this, statement is right. It is indeed true that advances in computing power mean that direct simulation of material behaviour at any scale would soon be possible and would replace experiments, even the most accurate ones.

However, the scale is not the only thing that matters in a numerical modelling. Indeed, models have to be built on proven laws and validated physical theories. The problem here is that scientists do not have formulas or equations to describe everything that is going on in the real world, even when considering just materials. As a consequence, if a mechanism is not very well know it cannot be used in a numerical model otherwise results would not be accurate at all, and no matter how small is the scale size.

That is also why real life experiments, and only them, can be used to build hypotheses and new theories or to verify them. It is absolutely not reasonable to do so with a numerical model because it works the other way: theory has to be established and verified first. As a consequence, considering this, no matter the power of the computer is, numerical modelling will never replace real experiments.

Furthermore, it sometimes happens that even if a model is supposed to be reliable, it gives completely wrong results compared to what happens in reality. For instant, an unknown mechanism for a particular condition during the experiment could indeed suddenly appear. This would never be taken into account in a numerical model and that is why even with the constant increase of the computing power models are only just closer to reality but never really match it.

As a conclusion, everything that has been said proves that the statement is wrong. Experiments will always be needed for science improvement, and to build new theories. Numerical models are only programmed by humans. As a consequence, their reliability is directly linked to our current understanding of the world and we are far from having discovered everything. Reliability has nothing to do with computing power and that is why numerical modelling will never replace practical experimentation.

The only hope is may be to find one day a universal formula which would unify science (physics, mechanics, chemistry etc...) by regrouping everything in a single equation. Scientists have been hoping for this for ages, but this is way beyond modern science and only pure speculation.

1. http://nano-taiwan.sinica.edu.tw/2008\_WinterSchool/index.htm, viewed 13 Nov 2008. [↑](#footnote-ref-2)
2. http://efd.safl.umn.edu/publications/pub/jcp\_179(2)\_voller\_porte-agel.pdf [↑](#footnote-ref-3)