the equations. The coefficients of the matrices are represented as numbers expressed in scientific notation.[1] Therefore, the computation does not precisely emulate the real phenomenon but, rather, simulates it with enough fidelity to stimulate human scientific imagination or to aid human engineering judgment. As computational power increases, the fidelity of the models can be increased, compromises in the methods can be eliminated, and the accuracy of the computed answers improves. An exact solution is never expected, but as the fidelity increases, the error decreases and results become increasingly useful.

This is not to say that exact solutions are never achieved. Many problems with precise answers are also addressed by supercomputing. Examples are found in discrete optimization, cryptography, and mathematical fields such as number theory. Recently a whole new discipline, experimental mathematics, has emerged that relies on algorithms such as integer relation detection. These are precise calculations that require hundreds or even thousands of digits.[2,3] At the hardware level, these operations are most efficiently done using integer arithmetic. Floating-point arithmetic is sometimes used, but mostly to perform whole number operations.

By studying the results of computational models, scientists are able to glean an understanding of phenomena that are not otherwise approachable. Often these phenomena are too large and complex or too far away in time and space to be studied by any other means. Scientists model turbulence inside supernovae and material properties at the center of Earth. They look forward in time and try to predict changes in Earth's climate. They also model problems that are too small and too fast to observe, such as the transient, atomic-scale dynamics of chemical reactions. Material scientists can determine the behavior of compounds not known to exist in nature.

Supercomputers not only allow people to address the biggest and most complex problems, they also allow people to solve problems faster, even those that could fit on servers or clusters of PCs. This rapid time to solution is critical in some aspects of emergency preparedness and national defense, where the solutions produced are only valuable if they can be acted on in a timely manner. For example, predicting the landfall of a

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[1] IEEE Standard 754, available at <http://cch.loria.fr/documentation/IEEE754/#SGI_man>.

[2] Jonathan M. Borwein and David H. Bailey. 2004. *Mathematics by Experiment: Plausible Reasoning in the 21st Century*. Natick, Mass.: A.K. Peters.

[3] Jonathan M. Borwein, David H. Bailey, and Roland Girgensohn. 2004. *Experimental Mathematics: Computational Paths to Discovery*. Natick, Mass.: A.K. Peters.