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Douglas S. Robertson has a Ph.D. in planetary science from MIT. He was an adjunct professor in geological sciences and is an emeritus fellow of the Cooperative Institute for Research in Environmental Sciences, both at the University of Colorado. He is an author or co-author of 96 refereed publications including 9 in *Science*, 5 in *Nature*, and one in *Scientific American*. His published articles range from geophysics to astronomy, physics, mathematics, theoretical biology, paleontology and philosophy of science. He has written two books on applications of quantitative information theory to a variety of problems in the philosophy of science, published by Oxford University Press. He is retired from the Geosciences Research Division of NOAA.

Computation and the transformation of the sciences and civilization

The computer revolution is arguably the most important event in the history of the human race. I will use quantitative information-theoretic ideas to argue that the computer revolution marks not only the beginning of civilization but also the beginning of both science and mathematics, all of which are information-limited and none of which can be done effectively without computers. It is obvious that computers are having enormous effects on all of science and much of mathematics, but with quantitative information theory we can calculate the magnitudes of these effects, and, perhaps more interesting, we can make quantitative comparisons of the effects of computer technology with the effects of revolutionary inventions in the past. These quantitative comparisons lead to the following perhaps startling conclusions:

- The computer is more important to astronomy than the telescope.
- It is more important to biology than the microscope.
- It is more important to high-energy physics than the particle accelerator.
- It is more important to geophysics than the seismograph.
- It is more important to mathematics than Newton's invention of calculus.
- And so forth.

Computer technology is going to produce the largest revolutions ever seen in virtually every field of science and mathematics. These revolutions will be simultaneous across all these fields, which has never happened before, and they will affect both the observational/experimental side of science and the theoretical side. The most important revolutions of the computer age are likely

to occur in mathematics, including such things as general techniques for solving high-order nonlinear partial differential equations. These developments in mathematics will reverberate through all of the sciences, and may change our concept of reality itself in ways that dwarf the earlier Copernican revolution that removed us from the center of the universe.

Reference:

Robertson, D.S., Phase Change: The Computer Revolution in Science and Mathematics, Oxford University Press, Oxford, UK, 2003; ISBN-10: 0-19-515748-6; ISBN-13: 978-0195157482.