

# **Why computer modeling should become a popular hobby**

**Ken Forbus**  
**Professor of Computer Science and Education**  
**The Institute for the Learning Sciences**  
**Northwestern University, USA**  
**<http://www.qrg.ils.nwu.edu>**

Building and playing with models has always been a popular hobby. Model trains, cars, boats, airplanes, helicopters and rockets enable us to experience vicariously some of the thrills and excitement of vehicles that we might never have the opportunity to operate in real life. Models of famous buildings, people, and events help deepen our understanding by providing concrete representations that engage our senses. Model-building is one way of coming to grips (sometimes literally) with aspects of our world that would otherwise be beyond our grasp. For this reason museums are filled with models, and models are widely used in education. But models and model-building are so enjoyable that many people do it on their own, for fun, as a quick tour of any good hobby shop or toy store will indicate. Different people enjoy different kinds of models, ranging from everyday objects like cars and houses to things that never were like starships and werewolves.

I believe that one consequence of the performance/price revolution still underway in computing will be the rise of computer-based modeling as a popular hobby. Like modeling today, computer modeling activities will range from the creation of static models which depict the structure and appearance of things (i.e., VRML models of famous buildings) to dynamic simulations that let the player experience the consequences of things that are uneconomical or impossible to do in real life (i.e., twiddle the parameters of a planet's ecology). Physical models can provide cutaway views that let you see aspects of something that would be invisible in the real artifact, but computer models can also provide visualization tools and explanation facilities that support multiple perspectives, ranging from the microscopic to the cosmic, and integrated access to enough background materials to slake anyone's thirst for knowledge. Physical models that reproduce behavior are limited by the physics of the world, while computer models have much looser bounds. It takes large fields to fly model airplanes and model rockets, but only a large CPU and memory to fly computer models of them. Physical models require space and materials to build and operate, computer models require disk space. For most people with computers, it is already easier to find disk space for a VRML model of the Süleyman Mosque than it is to find shelf space for an equivalently detailed physical model. As the price of computing continues to plummet, and the price of housing doesn't, this difference will be felt even more strongly. The VRML model is also a lot easier to dust, and when one is tired of it, much easier to recycle. Physical models of living things can reproduce very few behaviors, compared to simulation models, and physical models simply cannot capture the sorts of species-level and conceptual-level phenomena that artificial life and artificial intelligence models do. Computer models enable you to run

companies and civilizations, fight battles, and evolve new species, activities which simply aren't possible with physical models, with the major cost being loss of sleep.

No doubt you may be reminded of existing commercial products, such as the "Sim" games from Maxis and the various QuickTime VR models that are now available. Indeed, these ideas grew from contemplating such products. However, I believe that there are several advances, some technological and some social, needed before computer modeling will become as popular as it might be. The rest of this essay examines why promoting computer modeling as a hobby could be a wise thing for society to do, and how it might be done.

Outside of those who might do it, why should anyone care about computer modeling as a hobby? The failure of our educational system to prepare people for today's technological world is well-known. Democratic ideals are threatened when citizens do not understand science and mathematics well enough to understand their impact on public policy. Crash courses in "computer literacy" or generating lists of facts that every well educated person might want to know are not solutions. Having memorized a list of key facts won't, for example, help someone understand how to evaluate statistical evidence or the possible long-term effects of a small but steady change in a system with complex dynamics. Instead, I believe that a significant part of the answer lies in viewing simulations and computer models as a new expressive medium.

Imagine the impact on human culture if the skills of running, interpreting, and creating computer models were as widespread as the skills of reading, interpreting, and writing text are today. The person on the street would have new intellectual tools for making sense of the world around them. Decision-making might improve as the public understanding of issues moves beyond sound-bites. The fog surrounding economic projections, and the other uses and abuses of statistical evidence in politics, might lift at least a little. Unlike many hermeneutic activities spawned by the Information Age, modeling urges one to look outward at that which is being modeled, which could lead to more involvement and less passivity. The widespread establishment of computer modeling as a hobby seems to me one clearly necessary aspect of broadening cultural participation, just as reading for pleasure and writing for personal purposes were necessary driving factors for widespread use of text.

Conservatives might view the idea of computer modeling as a hobby similar to other forms of modeling as heresy. Indeed, I believe it would be a tragedy if computer modeling completely replaced more traditional modeling activities. No one should miss the experience of crafting a tangible object representing something that they find really intriguing. However, in today's world, many people already do miss that experience. The joys of computer modeling overlap the joys of physical modeling: Less tangible, but wider variety. The skills computer modeling requires overlap those required for physical modeling: Less manual dexterity, more numerical and logical dexterity. Ideally, computer modeling will complement physical modeling where they overlap. Indeed, there are already programs for designing model aircraft, and flight simulators that mimic the experience of flying a remote control aircraft, so that first fifty mistakes one makes while

learning to fly don't each cost dozens of hours of repair work. On the other hand, the plasticity of the medium vastly increases the range of phenomena that can be modeled by computer as opposed to by physical models. This increased range makes it more likely that someone will find some activity that interests them: If one doesn't find race cars exciting, maybe one will find creating animals that can thrive in a desert environment, policies that prevent the extinction of tigers, or agents that can hold their own in an on-line discussion of presidential politics, more to taste.

What will it take for computer modeling to become more popular as a hobby? We can take the widespread availability of powerful computers for granted, thanks to the strong market desire for multimedia computing. The limiting factors right now are software. Much can be done with the imaginative use of existing tools, as the computer gaming industry has shown. However, I believe it is important to create new tools and technologies that expand people's abilities, and make simulation even more accessible. Here are some examples:

- *Customizable simulations.* Most simulations allow you to only change a handful of parameters over a narrow range. Simulations that make it easy to explore the consequences of major model changes, such as plugging in a different traffic model in SimCity 2000, enable more people to get "under the hood" and experiment in ways they find meaningful. (Soloway's [Model-It](#) is a good example.)
- *Easy to use visualization tools.* The ability to graphically depict the results of a simulation and simplify the process of comparing these results to real-world data is essential for removing much of the remaining drudgery in interpreting a simulation. (The [CoVis project](#)'s visualization tools are a good example.)
- *Simulation construction kits.* Like Erector Sets and Lego, we need a variety of software tool kits that provide high-level tools for creating models in particular areas of interest. (Repenning's [AgentSheets](#) is a good example.)
- *Consumer CAD tools.* Software simple enough for the person on the street to use for creating and customizing object models. (Eisenberg's [HyperGami](#) system is a good example.)
- *Shared federated simulation environments.* Several on-line services already offer shared virtual environments where players can race cars or fight battles together. What if, in addition to driving standard cars, they could "soup up" their simulated cars by dropping in a new motor? Designing your own components for such simulations could be possible with [articulate virtual laboratories](#).
- *Articulate simulations.* Incorporating a deep conceptual understanding of a domain in a simulator that is tied directly to its numerical component enables the simulator to explain its results in human-like terms. Using qualitative physics techniques to embed this understanding in software also enables such simulators to be generated automatically, from high-level descriptions. ([Self-explanatory simulators](#) are a good example.)

A variety of opportunities will appear as computer modeling becomes more popular as a hobby. Schools will use the creation and interpretation of simulations with a frequency

approaching that of reading and writing. Companies will sell models, simulation construction kits, and data sets. Organizations will sponsor modeling contests, with prizes in categories such as highest accuracy, most elegant, and most computationally efficient simulations. Part of the fun of a hobby is communication with like-minded folks. The Web is the obvious medium for publishing papers, code, and data. Digital libraries can play a valuable role, as a clearinghouse for data and models. Ultimately, the most important opportunity is for all of us to be able to explore our world better than we ever could before.

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