The Future of Simulation

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INTRODUCTION

Marshal McLuhan is best known for his statement that "the Medium is the Message." [*Life in the Global Village*] This statement has been interpreted several ways, but I want to consider only two of them. The first of these is that the medium comes to define the message. The second is that the structure of the message is determined, even defined, by the nature of the medium.

CONTENT AND COMPOSITION

At first glance, these two seem to be almost the same. In fact, they are similar, but there are enormous differences that we shall briefly explore. In the first interpretation, the message is defined by the medium. Thus, only messages that are locally optimal to the medium are transmitted. We see this behavior today in messages such as music video and MTV®.

This behavior even effects simulation. We see this in continual efforts to increase the dynamic content of INTERNET web pages (however much many of us decry this because of the realities of bandwidth limitation and our desire for "real" information rather than entertainment - both at least partly subjective quantities!) This manifests several aspects: the tendency of code writers to push the envelope of completeness; the tendency to extend completeness by elaboration of software and hardware capability in an increasingly tight cooperation; and, most importantly (?), the increasing importance of push information logistics.

I'll return to this last later, but the first two of these are most evident in today's simulation environment in the computer and video game industries. Contemporary games are characterized by a continual extension of software capabilities and hardware standards that treads a fragile economic tightrope between legacy architecture and consumer disinterest. The supply – demand relationship here is dominated by the economic and esthetic proclivities of the consumer.

The second interpretation, that the form of the message is determined by the medium, differs from the first in the degree that the message is shaped. Whereas under the first, only messages that make optimal use of the medium are transmitted, under the second the message is limited and filtered by the medium. Simulation has always been shaped in this manner. Regardless of what is to be simulated, the form of that simulation is shaped by the architecture that links the simulationist to the instrumentality of executing the simulation.

ENFORCED OBSOLESENCE

This limitation is, of course, obvious to the simulationist and has been a driving force in the extension of software capability, abetted by a natural craving for completeness. The days when we had to be content with the numeric capabilities of FORTRAN and printer plots are now long past with modern languages that allow manifold manipulation of quantities and qualities.

This also illustrates one of the inherent difficulties between the "serious" simulation community and the entertainment simulation community. While both are driven to extend the capabilities of their simulations, entertainment simulationists deal with a fast paced dynamic situation. The situation of "serious" simulationists is slower paced and characterized much more by relative permanence of the simulation than a dynamic of inherent transience.

During the start up period of microcomputers, the "serious" simulation community was repeatedly stung by bad judgment in selecting architectures for developing new simulations. These included languages, such as FORTH, but most frequently memory extensions and graphics hardware. With marketplace abandonment of the architecture, the inevitable result was at worst the abandonment of the simulation and at best the need to massively recode its architecture interfaces.

THE COMPUTER NERVOUS SYSTEM

Happily, two things occurred. First, industry recognized these limitations and shook itself out – essentially reducing us to a handful of memory architectures. This corrected the problems with proprietary extensions in the interest of providing a stable environment for commercial software. Second, the simulation community learned the OPTEMPO of the marketplace and began to develop stable architecture standards. On the surface, this looks like continued division between the entertainment and serious communities but deeper down, there are other forces in action.

Two other critical developments appear to be the INTERNET and Object Languages. The impact of the two is not easily divisible. Maturation of both has placed a greater premium on push information logistics. The crucial effect of this has been a fundamental change in the way we build simulations. With the internalized understanding of how to operate across individual computers made possible by the INTERNET and local networking, the old paradigm of developing better simulations as bigger sets of code with more algorithms and more data (the Wirth code model) on bigger computers has been superceded.

The new paradigm rather asks what information from one simulation is needed by another simulation, the two not necessarily running on the same computer. The first now pushes this information to the second. This preserves the integrity of both simulations to a greater degree and thereby increases the reliability of the combination. It also largely defuses the individual and organizational, to say nothing of legal, social questions of ownership. This paradigm is now espoused and practiced at AMCOM and increasingly throughout the Army.

Carried to a logical, but not necessarily realistic, conclusion, this offers a new paradigm of coding where all information in a simulation is "push"-able and clearly

documented. This logical conclusion presents such considerable challenges that logic must likely play fetch for reality.

INFORMATION LOGISTICS

Let us take a step back, however, and view simulations as encodements of models. We may then view this advance in terms of recent moves initiated within government and extended by industry to adopt standards for models and simulations. Standards provide a path for the documentation of this "push"-able information that exists in the models and can be/is implemented in simulations.

Initially, I was not taken with standards, viewing them as over-centralized control of what I saw as professional responsibility. Closer examination revealed considerable value behind the façade of bureaucratic formality.

First, the idea behind standards recognizes that simulation is too widespread to have a professional cultural ethos defined and dominated by a couple of professional societies, as the hardware side is. This is at least partly the product of the INTERNET, which fosters small, focused professional organizations. Standards provide an overarching forum of professional societies, like SCS and INFORMS, can support and strengthen in the most fundamental way – through their members.

Second, standards are participative. They are nominated at the individual and local organization levels, but are formulated, developed, and affirmed by a consensual team process. Thus they inherently incorporate a peer review process that embraces the inherently poly-disciplinary nature of modern simulation while fully building on the strong traditional societal peer review of conferences like this one and journals like *SIMULATION* and *MILITARY OPERATIONS RESEARCH*.

Third, they move to balance an increasingly difficult condition of modern life. With more widespread use of business practices of customer funding over institutional, documentation of simulation has sagged. While this embraces short-term productivity, it also compromises long-term continuity. By enabling documentation of baseline, both long and short-term needs are balanced.

This then is a vehicle for implementing the widespread usability of push information logistics in simulation. Perhaps a natural re-labeling would be Verification, Validation, Standardization, and Accreditation, bringing what has traditionally been called configuration control into greater visibility of its central role. In this picture, the future of simulation may be seen as akin to Tinker Toys or an Erector Set.

SIMULATION TINKER TOYS

At this point, we have to diverge a bit to look at the model that is in one form the bookstore and in another is the library. At the heart of the distinction between these two are the economics of distribution and the legalities of copyright. Some of the aspects of this are already being explored in the environment of entertainment simulations. Admittedly, this has the form of unique extensions for specific games, but it does point to the potentiality of joining standard simulation components together to form special purpose simulation constructs. This offers to be the mass production paradigm of 21st Century simulation.

This is not the mass production of Ford and the Model T, but the mass production that gave rise to electronic components, be they stereo or computer, that could easily (well, relatively speaking!) interfaced. At the same time, this may be similar to the mid-Twentieth Century activity of automobile modification.

SIMULATION AS BUILDING TRADE

Given this environment of standard and special simulation components, we may expect to see the rise of a calling of simulation carpenter or plumber that is intermediary between the network computer engineer and the code writing simulationist of tradition. The tools of these new simulators are pieces of software that largely do not exist today – utilities that determine whether simulation components can be interfaced, perform the interface, and may even be smart enough to determine range limitations of the interface due to resolution and granularity differences among the simulation components.

This should not be the death knell of the simulationist, but rather a proliferation of the need for such skills. Even with standard simulation components, there will still be the need for new special components. Given this catalog of standard components and the availability of tools to interface them with special components to craft special purpose simulations, it requires no great imagination to foresee the expansion of simulation beyond its traditional scope of application.

PRODUCT, NOT PROCESS

Lately, I have heard numerous discussions of something called “Effects Based Simulation”. At first glance, this seems somewhat foolish, since modeling and simulation draw from the scientific method and are formulated in terms of cause and effect. What is meant by this term is bridging the gap between measurables and ponderables. This is clearly a call for simulations that go beyond metrics and measures.

This is an area that the entertainment simulationists have explored for some time, but it is repugnant to the serious simulationist. Traditional serious simulation has largely been technical in nature, whether the simulation be a six degree of freedom trajectory simulation or a futures market predictor simulation. To meet the needs of Effects Based Simulation, the scope of modeling will have to expand beyond its traditional practice and the instrumentality of simulation will have to continue to grow.

THE SIMUFAMILY

In particular, one may envision two areas of growth in simulation under the conditions of this environment. The first is people simulation. While several simulations of human characteristics have been developed such as ergonomic simulations (JACK ®) and academic simulations for the Turing Test, the future we paint here has a need for not just artificial intelligences but artificial personalities and artificial experts to serve as companions and advisors for normal, average people on matters ranging from economic, mental, and physical health through serving as the minds of robots. We stand at the edge of Asimov’s Robots.

Because these simulations will have large impact on human well being, we may anticipate some form of legal control as well as social and cultural changes. Obviously, the form of the license will evolve, and unless the current rend in responsibility avoidance

reverses, simulation manufacturers may expect a time in the future when they are sued because a bug in their simulation allowed/caused people to get sick or go broke. This may be presaged by legal arguments that some defendant is not liable or responsible for some action because their simulation told them to do it.

The mirror to these simulation advisors is the simulation clone. This simulation is not an advisor but a stand-in. While it seems easier to build a knowledge base simulation of a lawyer, physician, or investment councilor, it is only a matter of extension and the right models to build a simulation of a person's knowledge, personality, and temperament.

Kurzweil [*The Age of Mystic Machines*] tells us that the human processing capacity CPU is only a few years away. While this level of capacity will not be sufficient for cloning, mostly because we can't write code and compilers as efficient as Mother Nature, we must recognize this as a milestone on the way to CPU capable of supporting simulation clones of ourselves.

Do we have models of all the pieces we need for this? No, but we haven't worked on it very hard yet either.

What will we do with these simulation clones? Giving them legal status to act for us will probably take seriously longer than to make them commonplace. Still, they'll have considerable usefulness in non-binding situations. They can attend information meetings for us and provide what they learned back to our simulation advisors. One may even envision cyber relationships with other simuclones that allow us to avoid sterile, unproductive, even destructive relationships before we spend human time on them. But we probably won't be able to use them to visit with our Mother-in-Law or take Annual Ethics or Security Awareness Training for us.

The second is what is variously called Course of Action or Decision Support simulation. Currently, these are largely outgrowths of existing simulations made available by the advances in microcomputers. What we may expect to see is the proliferation of these simulations beyond the current scope of High Tension customers like the military and Fortune 500. Every organization that currently builds a business plan may be expected to have a business simulation. Indeed, every organization, even most individuals, who do any form of planning or management, any sort of decision making, seems likely to want, even have, a simulation for that purpose. One may easily envision the simulation becoming a component of everyday life.

For the individual, these won't be too distinct from some of the people simulations, except that we'll want to turn off the human to human interaction for the comfort of a one-sided man to machine interface. For the organization, these simulations may be expected to fill many of the same roles as the human simulations do for individuals. It is a fairly short step, as our coworkers who build autopilots will tell us, from a software simulation to hardware in the loop simulation to a controller program.

CONCLUSION

The software/hardware capabilities of today will not be adequate for this challenge, but we can expect them to grow in the same manner that they have. We expect modeling to continue to have a crucial role in simulation and that it will be an area of particular stress. This area looks so stressful that I expect even greater blurring of the

distinction between modeling and simulation as the conceptual environment pf hardware/software is added to mathematics and logic and the new cognitive creativity of the young replace us old, FORTRAN-ridden Turks.

The road to this future is not easy. It will require not just change and growth, but great effort and more difficultly, great cerebration. This is a great challenge for the simulation community and one can ask for little better than great challenges.