THE POWER OF PEZONOMICS

Joel Orr
Orr Associates International
Chesapeake, Virginia

There are not many virtual worlds in working environments today, but the few that there are suffer from a flaw similar to the biggest fault of less-engaging computer systems: they are designed with little consideration for the way people really are, and the way they behave. They are, in a word, ergonomically unsound.

Inconsistency is one of the biggest problems. We have grown to expect different programs to have different ways of doing things. Type ALT-F, X to exit from one program, CONTROL-Q to leave another. If cars were as inconsistent, renting one in a strange city could be a problem: "This new ergonomic model has the brake pedal on the right, and the accelerator is operated with your left elbow. Just initial in these eleven places, and sign here—sir? Where'd he go?" Out to the taxi stand.

Disregard for the human shape is another. Take the standard computer keyboard. The arrangement of its keys was designed in the nineteenth century to slow down typists, to keep them from typing another letter before the previous letter key had a chance to fall away from the platen of the typewriter. Moreover, the keyboard's size has been reduced, while hand sizes have grown. And the keys are not positioned to meet naturally-placed human fingers. That successful design is still working, sending the children of hundreds of orthopedists through college by creating a whole branch of the repetitive stress injury market.

Indifference to health and safety is not unusual among designers of hardware and software. Manufacturers reduce harmful radiation from CRT's only under duress, and they do not want to know what electromagnetic fields might be doing to people.

To add insult to injury, most computer systems are just not *fun* to learn or to use; they are arcane drudgery.

We need to think about human interfaces to computer systems in general, and virtual worlds in particular, in a new way; a good place to start the revolution is with terminology. *Pezonomics* is my replacement for ergonomics. Ergonomics comes from two Greek words that mean "work" and "law"—"the law of work," in other words. Too austere! The most popular, easy-to-learn computer systems in the world are video games, prime examples of successful application of pezonomics—"the law of play." We need to capture the essence of play and calibrate our computer systems to its cadences.

Why do we love to play? Perhaps it is that in play, we have permission to win or lose; we find closure; and we can exercise skills in a protected environment.

The places in which we try out new things—new designs, new concepts—ought to somehow be environments in which consequences are attenuated. That is the power of simulation: the consequences of crashing a Boeing 747 simulator are noticeably milder than those of crashing a real 747. So we can make mistakes, and live to learn from them.

This is one of the great promises of VR. A virtual world has *controlled* consequences, but at the same time, it engages and involves the participant in active ways; she or he is not merely an observer.

When introducing people to new things, I measure their responses on a scale of *astonishment*. The unit of this scale is the *gasp*, when positive, and the *yawn*, when negative. Extremes are not desirable; a five-gasp novelty could lead to heart failure, while a five-yawn novelty may result in snoring.

A friend once told me he designs systems according to the "principle of minimal astonishment." He said his goal was to minimize surprises to his customers, both in the creation of the system and in its use. "The customer or user should always know what is going to happen next, and should have some control over that next event," said this wise man.

But as in marriage, complete predictability can lead to boredom. To maintain interest, we need *controlled surprise*; flowers and romantic greeting cards without a birthday or anniversary, unplanned acts of warmth and kindness. Good programs and virtual worlds should have an unending stream of pleasant surprises, nice things that happen to the user when they are not expected.

Perhaps the simplest approach to pezonomics involves engaging the "right brain" through the use of graphics. Normal people find computer systems unapproachable. Graphical user interfaces help—by providing spatial access to sequential pieces, much like what writing does for speechwriting, and by offering the user a consistent approach to multiple applications, thereby reducing the cost of trying out a new application. Mac users, Apple reported a few years ago, use six to eight applications on average, while DOS users employed only two. A more recent study shows that Windows users have caught up with Mac users. GUIs have pezonomic qualities.

Rhythm is important in pezonomics. Human beings are complex systems—too complex to have simple natural frequencies. But there are certain frequencies that "resonate"—or at least, interact—with some human phenomena. Low-frequency sound pulses at or near a person's heart rate seem to cause the human system to "lock in" to the frequency of the sound generator; once this occurs, changes in the frequency cause corresponding changes in the person's heart rate, as well as in other physical functions. The most popular video games are not the ones with the best graphics; they are the ones that have an audible heartbeat-rate low-frequency pulse, that accelerates as the game progresses. This auditory entrainment causes the player's heart rate to speed up, with an accompanying production of adrenaline and endorphins. By the end of the game, the player is "hyped"—and wants more. (My term for the rhythmic aspects of the person-computer interface is *anthropocybersynchronicity*.)

This entrainment also creates a deep sense of *rapport* —special connection. Good sales people have long known what practitioners of neurolinguistic programming have recently written about: you can establish rapport with someone by intentionally mirroring different aspects of their behavior—their rate of breathing, their blinking rate, the rate at which their leg is swinging, for example. After a few minutes of matching, you can verify that you have rapport by leading—changing the rhythm, and watching to see if they follow. If they do, you are communicating with the person on a very primal level, and they are much more open to your suggestions and other forms of leading than when such rapport is absent.

Studies of people in singles bars back this up. Observers noted that people who began to mirror each other's behavior soon left together; people who were "out of synch" with each other after a few minutes separated and made other contacts.

Proper pezonomics will also result in increased person-computer *coupling*. The computer is a general-purpose tool, something we use to do a job. We must measure its effectiveness by how easily and how well it helps us accomplish our goal—which is usually *not* operating the computer; it is writing, accounting, designing, drafting, or something to which the computer—except for the specifics of its assistance—is irrelevant.

We can increase our control of the tool by increasing our coupling to it—the extent to which our actions and the actions of the computer system affect each other. Coupling is a kind of rapport; rhythm, through resonance, enables us to increase that coupling.

Of course, increasing coupling might give the tool more control over the user, which could be undesirable; like the binding of a ski, it has to be both loose and tight. You do not want the ski to fall off while you are going down a slope, but you want it to come off easily if you fall.

Our goal is to get at our work, our art, our play; the computer is only a means to an end. It is like reading, or learning to understand pictorial imagery. Ultimately, it is not literacy, or pictoracy, we desire; it is not even "mediacy," a facility with multimedia. Rather, we yearn for *immediacy*—enhanced access to our problems so that we are empowered to solve them without apparent mediation, without the intrusion of the irrelevancies of the computer or our disabilities. Pezonomics can bring us closer to this goal.

Suppose the headband of your head-mounted display had a sensor that could detect your pulse. When you first put it on, the system would ask you about your mood and alertness, from time to time. It would build a table with the corresponding heart rates. After a period of calibration, it could then sense your level of alertness, and use rhythmic auditory and visual pulsation to alter it. It could, for example, flash a feature in your field of view, subtly, at the rate of your pulse, while making an unobtrusive but audible clicking sound. When it detected synchronization between your pulse rate and its beat, it could speed up the flashing and clicking, checking to see that your pulse was entrained.

By increasing your heart rate, the system would cause your body to generate the substances that are the concomitants of the "fight or flight" response—including endorphins and enkephalins, pain-blunting, pleasure-enhancing, morphine-like chemicals that could make you more effective.

They could also make you less effective, if your work required a more contemplative mood. And there is now evidence that activation of the "fight or flight" response causes stress and disease. For this reason, you had better be able to control what the system does to you.

"What do you call people who practice the rhythm method of birth control?" goes the riddle. "Parents," is the answer. Like any other tool or approach, rhythm does not ensure success.

Rhythm can be a powerful ally or a formidable foe, a liberator or an enslaver. I do not believe it is intrinsically evil, but it can be used for evil purposes, such as controlling people against their will. We should approach it cautiously and intelligently, respecting its destructive power while we harness it for our benefit.

We trustingly submit our entire sensoria to immersive virtual reality. Yet participants in virtual worlds can become disoriented, even to the point of nausea or more enduring ill effects. Perhaps these can be mitigated through pezonomic rhythm management.

System designers seek better person/machine coupling. To date, we have looked at human interface issues with the mathematics of Euclid and Newton, whose underlying assumptions derive from Plato's: everything in the world is an approximation of an ideal. Recent discoveries in "the mathematics of chaos" reveal that things are both simpler and more complex than we ever imagined. Sealed mysteries of natural phenomena, and biological phenomena in particular, are yielding in embarrassing profusion to this new "Open Sesame." I wonder if there will be found, in a biological setting, a chaotic or fractal analog to the Newtonian notion of resonance, one that will help us design virtual worlds that will liberate people without endangering them.

Conclusion: Pezonomics—the law of play—must be developed and applied to computer systems in general, and VR in particular, if these artificial environments are to become hospitable for humans. Without playful interfaces, virtual worlds will be as arcane and inaccessible as UNIX. The coming information superhighway promises a high-bandwidth information infrastructure that will make possible a shared multisensory space. We must pad its walls pezonomically or endanger the innocent.

The Power Pezonomics

Safe and Engaging Immersion through Rhythm and Play

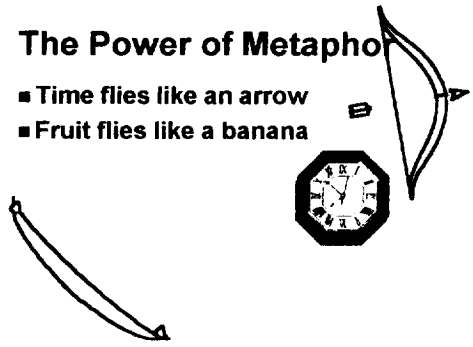
- Joel N. Orr
  President
  Virtual Worlds Society

VR: A Dangerous Place?

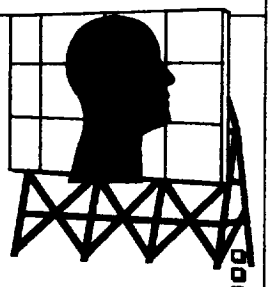
- Sensory "amputation"
- Disorientation
- False signals
- Electrical & mechanical effects
- Physiological problems
- Psychic challenges

The Power of Metaphor

- Time flies like an arrow
- Fruit flies like a banana



Between the idea
And the reality
Between the notion
And the act
Falls the shadow



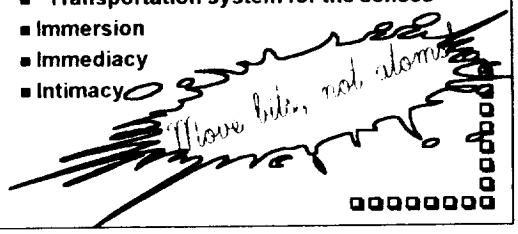
--from T. S. Eliot, "The Hollow Men"

The Fertile Verge

- Increased sense of community
- Greater self-awareness
- More tolerance for innovation

What is it?

- *Artificial* reality
- God-like power in a forgiving world
- "Transportation system for the senses"
- Immersion
- Immediacy
- Intimacy



"Every man, wherever he goes,
is surrounded by
a cloud of comforting convictions,
which follow him
like flies on a summer day."

Bertrand Russell

Any medium has the power to restructure our minds in a unique way by imposing its own mode of thought.

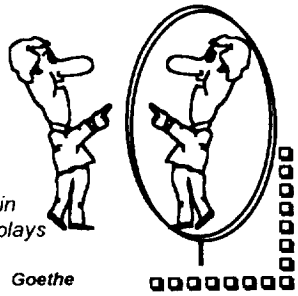
Marshall McLuhan

Functions of VR

- Immersion
- Simulation
- Buffering

Functions of VR

- Mirroring

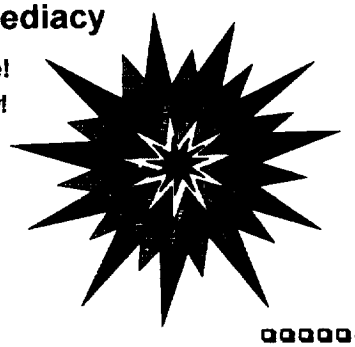


Behavior is a mirror in which every one displays his image.

Goethe

Immediacy

- Here!
- Now!

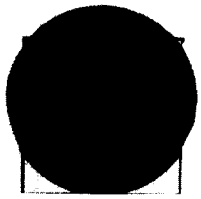


Intimacy

- Negroponte's prophecy
- Richard Avedon's "unearned..."
- The cognitive definition

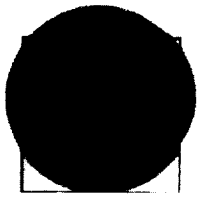
The Human/Computer Interface

Ergonomics?



The Human/Computer Interface

Pezonomics!



The Human/Computer Interface

Anthropocybersynchronicity!

The Dark Side

- Electromagnetic dangers
- Ergonomic issues
- Loss of reality
- Loss of control
- Loss of humanity

Effects

People using telephone, TV, or radio, or any other electric service do not have bodies; they are discarnate beings.

Marshall McLuhan

More Warnings from the Prophet

"We recognized that communication satellites had ushered in a new Global Electric Theatre of the Absurd, where only the unexpected happens, precisely because old logical Thinking can no longer keep pace with new eco-logical Being."

"Electric speedup had created global crises of identity, regardless of any intent to improve human communication."

What Should We Do?

- Add rhythm to the research agenda
- Focus on play
- Avoid deconstructionism

In Short...

- VR may well be "the promised land," but
- with its milk and honey, there are "giants" in the land;
- overcoming them is possible, but
- requires planning.
- Think "whole"!

Questions?

Write or call me:

75300.1614@compuserve.com

804/467-2677; fax 804/495-8548

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY *(Leave blank)*	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	November 1995	Conference Publication

4. TITLE AND SUBTITLE

Human-Computer Interaction and Virtual Environments

5. FUNDING NUMBERS

WU 505-63-50-17

6. AUTHOR(S)

Ahmed K. Noor, Compiler

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

NASA Langley Research Center
Hampton, VA 23681-0001 and
University of Virginia Center for Computational Structures Technology
Hampton, VA 23681-0001

8. PERFORMING ORGANIZATION REPORT NUMBER

L-17547

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

National Aeronautics and Space Administration
Washington, DC 20546-0001

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

NASA CP-3320

11. SUPPLEMENTARY NOTES

Ahmed K. Noor
University of Virginia Center for Computational Structures Technology
Hampton, VA 23681-0001

12a. DISTRIBUTION/AVAILABILITY STATEMENT

Unclassified–Unlimited

Subject Category 62

12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*

This document contains presentations and discussions from the joint UVA/NASA Workshop on Human-Computer Interaction and Virtual Environments held at the location of the Virginia Consortium of Engineering and Science Universities in Hampton, VA on April 26-27, 1995. The presentations addressed activities in the areas of human factors, virtual environment, sonification, haptic interfaces, distributed and collaborative environments, and engineering applications of some prototype synthetic environments. Workshop attendees represented NASA, NIST, WPAFB, Sandia National Labs, automotive and commercial software industries, and academia. The workshop objectives were to assess the state-of-technology and level of maturity of several human-computer interaction facilities; their potential applications to future engineering systems; and to provide directions for future research.

14. SUBJECT TERMS	15. NUMBER OF PAGES
Synthetic environment; Virtual environment; Human factors; Telerobotic systems; Sonification; Auditory display; Haptic interfaces; Distributed and collaborative environments	315
	16. PRICE CODE A14

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
Unclassified	Unclassified		