from *The Craft of Controlling Sound* by Stephen Solum

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Excerpt from Chapter 11...

The Digital Game

How is the Digital World fundamentally different from all we've studied so far? Here's one way: the Digital Game—the process—never attempts to capture something *like* sound (similar to sound), whether an analogous wave or an analogous magnetic pattern. Good, durable digital fidelity thus is not the fervent attempt to stay *like* the original (as in the Analog World), because it never is *like* to begin with. Digital "sound" appears to resemble the other two sound Worlds only because equipment designers figured out that we humans can keep track of what we're doing more easily that way. In like manner, although digital information often travels from one component to another along a wire, its conceptual architecture is not *like* a signal path at all.

> Making digital sound and equipment appear like the Analog World on screens and readouts actually takes a tremendous amount of computer power, all of which has nothing whatsoever to do with the quality of the digital representation or the precision of its control. Early Digital World sound work was done without this window-dressing, and was therefore limited to the relatively few folks willing to spend the time and energy to work with it on its own terms: primarily those in universities or other research entities.

Big Concept: *The Digital Game is not about something like sound waves or even signal paths at all; it's about rules and numbers.*

Numbers are exact and durable. 3 is 3. There's nothing fuzzy about it. By itself, 3 can't sink into some noise floor and become vaguely 3, nor become so intense it grows sharp edges and becomes buzzy 3. Even when it looks different (the tangible representation of it changes), 3 is 3 is **3** is three is *tres* is III is *3.* 3 will still be 3 next week. It won't drift and become 3-and-a-little-more. Close this book, drive to the next state, find a river or lake, rent a boat, sit out there in the middle of the water, and just think of that number… and it will still be exactly 3. Email 3 to all your friends and each one will get 3, not a watered down version of it, or some fraction of it.

> This is not to say there can be no digital noise or distortion or degradation, but these irritations will arrive a bit later.

Numbers are the only information, the only substance in the Digital Game. And *by themselves* they're perfectly exact and durable.

Rules are the instructions for playing the specific game (a word processor "game" on a Macintosh, for example), and the operations that process the numbers. At their deepest and most abstract, operations generally are either mathematical (multiply 3 by 5; find the square root of 81), or logical (all the numbers below 17 go over there, 17 and above come over here; if the next number is anything but 9, then go to the next instruction, but if it *is* 9, then stop; etc.). Billions of those operations together do powerful work, and yet more billions put numbers into forms we can understand (like Analog World forms). Because it consists only of durable numbers and abstract rules, the architecture of the Digital Game is fundamentally different and can skirt many of the limitations of the other ways to control sound.

The Components

The Digital World is comprised of the numbers, the rules, and the shell in which they reside. Let's discuss them using the more conventional terms:

- **Hardware** (the shell)
- **Software** (the rules)
- **Data** (the numbers)

Hardware

Hardware includes, of course, the computer console, the screws, the screen, and the printer. More specifically, inside the console there may be a **CPU** (central processing unit), a hard drive, RAM chips and CD-R for storage of numbers, a modem or some other device for connecting to the Internet or network, and other nuts, bolts, and things labeled with computer lingo. Hardware also refers to devices that might not appear to be computers: digital keyboards, sound modules, effects processors. My fancy new toaster and your DVD player—everything that contains a **microprocessor**—are really just computers dedicated to one or two specific tasks rather than many. My toaster also has its (very limited) software and data built into it, along with the simple circuits and other hardware it needs. Hardware also includes wires and buttons and resistors and transistors and all the other things that seem to be very "Analog." Further, I (and probably no one else) might argue that even the electricity going down the wires is part of the hardware, although it isn't very hard and we can't see it.

At first glance, the Digital World may seem very analog-ish. There are electric currents being directed down wires inside boxes with buttons and sometimes rotary pots, and many devices even have (digital) outputs and inputs. What's going on?

Well, all this electronic stuff is merely the shell, the house. The Digital *Game* and its logic and organization happen to reside there, but they use electricity in a different manner than the Analog Game.

> Let's return yet again to baseball. Baseball parks have home plates and outfields and pitchers' mounds and sometimes restrooms, but that's not baseball. That's just the place where the game is played. The game is the three strikes and nine innings and drama and the rules that make a winner and a loser.

The Digital Game lives in an electric shell, and the circuits and wires and electricity and the boxes make up the hardware. In the next chapter, we'll kill two birds with one stone and explore a practical, easy-to-grasp example of playing the Digital Game in an electric shell. That example is MIDI, an important part of the Digital World that uses electricity and cables without AC analog audio signals.

Software

Software is all the programs, rules, and instructions—very general to very specific—that govern the process of digital work.

Some rules tell the hardware what it is, so to speak. When you first turn on the computer (or **"boot"** in the lingo), the software tells it, "You're a computer, you're a Macintosh computer, you're a Macintosh computer using OS X" (or "You're a computer, using Windows XP"), or even "You're just a toaster—calm down…". The **operating system** (OS X, Windows XP, etc.) sets up the ground rules for the manner in which the computer communicates with you, and does other general tasks.

Other software, as you know, makes the computer function as a word processor, or a digital recording device, or a photo editor. Within that software are yet more specific instructions, allowing me, for instance, to underline this phrase.

Data

Data is information of any sort, represented by numbers. In modern digital work the line between software and data can become blurred, but for our purpose right now, we'll keep them separate. Sometimes data is a quantity: the number of black flies on my left arm at one moment yesterday (31) is already in number form. (The North Woods is a blessing that's mixed at times.) A bit trickier, but just as important to know, is that data can be a *label*, in the form of a number. My office door at school is labeled with the number "261;" a studio down the hall is "254." These are labels, not quantities, and while I can add 254 and 261 and get 515, that total isn't very logical or useful information.

> I believe it's important—in many areas of life—to understand and practice this distinction between labels and quantities. In this age when most arithmetic is done for us by machines, it's easy to regard all numbers as merely labels, and not actively imagine the quantities behind some of them. Truly understanding what the three $20 dollar bills in your pocket represent in terms of CDs and hamburgers and rent is the key to handling money well. In the sound world, it's easy for "5 kHz" to be merely a label for a pitch, but we know that the quantity of 5000 cycles of vibration per second has ramifications for how it behaves and how we can make use of it in all three Worlds.