

Duality and Design

Duality is a fascinating concept that appears in a wide range of domains from philosophy to religion to physics and mathematics, including mathematical optimization. In each of these domains, duality has a particular definition, and oftentimes even several definitions within each domain. In my layman's mind, duality is a basic human concept, where we acknowledge that our world, real or imaginary, has at least two different ways to look at it or two different ways that it behaves, sometimes conflicting and sometimes complementary. Duality is there when we think and talk about design in JMD: computational or physical models, analysis or synthesis, simulation or experimental, industrial or academic, research or innovation, theoretical or practical, and so on. Much of our arguing often comes from the position that something is or must be either the one or the other, while it can be both.

I was recently driven to these philosophizing thoughts while reading *Thinking, Fast and Slow* by Daniel Kahneman, a psychologist that got the 2002 Nobel Prize in Economics for his work on decision analysis with Amos Tversky (Farrar, Straus, and Giroux, New York, 2011). The basic premise is that our mind (brain?) has its own duality of two functioning systems: "system 1 operates automatically and quickly, with little or no effort and no sense of voluntary control," while "system 2 allocates attention to the effortful mental activities that demand it, including complex computations. The operations of system 2 are often associated with the subjective experience of agency, choice, and concentration." One major point in the book is that both systems are active when we are awake and they continuously interact, usually with system 2 kicking in when system 1 "runs into difficulty."

These ideas have been around for a long time in various forms. One common viewpoint is that system 1 developed in early human brains as a weapon against imminent danger where fast

action would be necessary for survival, while system 2 is what sets humans apart and gives us our human identity. Some marketing experts like Clotaire Rapaille even contend that our reptilian brain (system 1?) controls all our purchasing decisions. Kahneman argues that system 1 is very active, even dominant, in daily activities requiring choices.

Accepting, even partially, the paradigm of design as a decision-making process, the above construct gives us pause: It is hard to imagine a paper published in JMD that was written by system 1 thinking; it is equally hard to find a JMD paper that addresses system 1 design activity. But if system 1 is pervasive and dominant in everything we do, it must be also so when we design. Are we missing research in a big chunk of what is design? And if we do, would that matter? After all, we can only trust system 2 because system 1 may be fast but it can be also wrong—you know, fast talking for fast thinking. So how do we deal with the system 1–system 2 duality?

My take at this point is that we do have some choices (ok, they are system 2 ones): We can look at using the ideas from research in psychology in formulating and solving design problems; for example, how the Kahneman and Tversky prospect theory affects what we derive as optimal design results. We can explore how to purposefully merge the two systems modes in a design process. We can also choose to stay with system 2 only and slowly but correctly derive repeatable results. My feeling is, however, that the saber-tooth tigers and their friends have guaranteed already that our forebearers did not design only with system 2 thinking.

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