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them; rather, design architectures should be decided on how the architecture assists analytical thinking about evidence." We render our abstraction in models, and we use those models to reason about our abstractions.

The best models have two important characteristics: they codify each design decision in a manner that is predictive, and they serve as the basis against which we can ask questions. For example, back to my services scenario, a good model would be predictive in that, if I invoke a service, I should be able to understand what other services are triggered and thus collaborate as that service plays out. Similarly, a good model should allow me to ask questions, such as how long might I expect a service to take to respond, or where might the bottlenecks arise were I to trigger a set of services at such and such a frequency.

The Threads of an Architecture

You've heard me say in this column that the code is the truth, but it's not the whole truth. In the common vision that an architecture-as-an-artifact provides, there are five interwoven threads:

- architecture as a collection of significant design decisions,
- patterns as the themes,
- cross-cutting concerns as the traces,
- rationale as the back story, and
- tribal memory as the human story.

Thus, a description of a system's living architecture is formed from technical as well as social elements.

The first three threads are primarily technical. The significant design decisions we assert give rise to our system's essential shape, much like the load-bearing walls of a building or the essential mechanisms that operate within a cell. The patterns we find name the societies of collaborating abstractions; a given abstraction may participate in my many patterns, and the presence of those patterns gives rise to elegance and simplicity in the face of essential complexity. Cross cutting concerns—elements such as security or performance—represent things that are architecturally significant but so deeply embedded in the very fabric of a system that we can't reason about them unless we pop up a level of abstraction. These are things that, more so than patterns, give rise to emergent behavior.

The remaining two threads are primarily social. Rationale is the metaknowledge as to why we chose one decision over another; tribal memory is the institutional knowledge of who did what, when, and why. A body of code, even if well commented, represents the winner of all the hundreds of thousands of small design decisions. Be it for overwhelming technical reasons or historical or even emotional reasons, what wasn't chosen will be lost in time unless something is done to preserve that metaknowledge. In the moment, it's easy to make a choice and then move on, but for decisions that are linchpins—which in mechanical engineering are important elements of support and stability—the reason they were chosen as such mainstays will be lost in the dust of the decisions that fall down over them. Later on, people will either be afraid to touch that bit of code ("it works but no one understands it, so let's leave it alone") or they will touch it accidentally, and the whole system will collapse upon itself.

Architectural Governance

A system's architecture not only provides a common vision, it also provides a vision around which stakeholders can rally. This is where architectural governance fits in—the architecture-as-an-artifact serves as the backbone against which all other decisions are made. In this way, a system's architecture becomes the place where shared trust is made manifest; this is the shared hallucination. But it's more than just a place where in code we trust, it's also the place where new stakeholders can be brought to get oriented. Consider your experience when you're parachuted in to a new code base: you'll spend time pouring over the code, but more often than not, you'll seek out and hold hands with people who have that code under their nails, and ask them to give you the lay of the land. That lay of the land is the system's architecture, and the more visible it is, the more transparent the decisions that formed it, the easier it will be to trust the architecture and to efficiently grok that lay of the land.

As an artifact to which stakeholders are led, a well-syndicated architecture serves as sort of a strange attractor, a stable intermediate form that shapes the mob of stakeholders who work on that system. As Steve McConnell mentioned in Andrew Stellman and Jennifer Greene's book *Beautiful Teams*, it's important in any venture to have an elevating goal. As he notes, "A classic example is if you're out digging ditches, that's not very elevating or inspiring. But if you're digging ditches to protect your town that's about to be attacked by an enemy, well, that's more inspiring, even though it's the same activity." The statement of a system's architecture can be the place where such a goal is named.

Finally, architecture is the place where we grow the system in controlled, steady fashion, where we make our vision manifest. Some transformations from models to executables are tedious, some are noisy, some are lossy, and some are somewhat reversible. The tedious ones lend themselves to model-driven development. The reversible ones lend themselves to automated mining; those that are noisy or lossy require human intervention.

As Carl Sagan noted in *Cosmos*, "The brain does more than just recollect. It intercompares, it synthesizes, it analyzes, it generates abstractions."

As the architect Ludwig Mies van der Rohe once said, "Architecture starts when you carefully put two bricks together." For software-intensive systems, architecture starts when you lay down your first line of code, thus beginning the shared hallucination.

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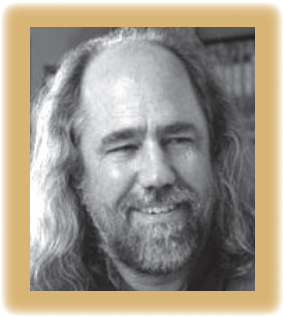
Architecture as a Shared Hallucination

Grady Booch

In Jane Wagner's play *The Search for Signs of Intelligent Life in the Universe*, Lily Tomlin's character Trudy remarks, "What is reality, anyway? A collective hunch." She goes on to suggest, "Reality was once a primitive method of crowd control."

So it is with the architecture of a software-intensive system.



An architecture is just a collective hunch, a shared hallucination, an assertion by a set of stakeholders about the nature of their observable world, be it a world that is or a world as they wish it to be. An architecture therefore serves as a means of anchoring an extended set of stakeholders to a common vision of that world, a vision around which they may rally, to which they are led, and for which they work collectively to make manifest.

When I say that an architecture is a shared hallucination, I mean that an architecture-as-artifact is a naming of the mutually agreed-upon set of design decisions that shape a software-intensive system. While an architecture is just an abstraction of reality, an architecture-as-artifact is a declaration of that shared reality. In this way, that shared hallucination represents a common vision among a set of stakeholders as observed simultaneously through several different points of view and represented by a set of interlocking models.

Modeling

Now, to be clear, a model is just an abstraction of reality; a model is not reality. Although he was talking about statistical models, George Box quite properly observed that "all models are wrong, but some are useful." In other words, as Scott McCloud wrote in *Understanding Comics*, we use models to achieve "amplification through simplification." A useful model focuses on a particular concept to raise it above the cacophony of the complexity that surrounds it.

Building useful abstractions is hard: they must have degrees of freedom and at the same time be unambiguous. For example, if I'm trying to reason about the mix of services I want to expose in a given enterprise, in one view I might wish to consider the physical components that deliver up those services and where they're deployed in a given network; in another view, I might wish to consider the granularity of those services from a functional perspective. In both cases, I'll want to have a fairly unambiguous statement of the semantics of these services. In the former case, I may abstract away the implementation of those services (to focus on their deployment), whereas in the latter, I may abstract away the location (to focus on their functionality). This is why one view is never enough: if you try to pile all of a thing's meaning into one view, you end up with the code itself, and that complexity will obscure the more delicate yet important threads that shape the system.

As Carl Sagan noted in *Cosmos*, "The brain does more than just recollect. It intercompares, it synthesizes, it analyzes, it generates abstractions." He goes on to say that "the brain has its own language for testing the structure and consistency of the world." This is why I'm a rabid fan of graphical models: they allow us to present an abstraction with some degrees of freedom yet without ambiguity, and then let the brain do the reasoning. As Edward Tufte noted in an interview (*Technical Communication Quarterly*, Autumn 2004), "The point is that analytical designs are not to be decided on their convenience to the user or necessarily their readability or what psychologists or decorators think about

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