Love's Alterations: Complexity and Parsimony in Construction Documentation

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Love is not love / Which alters when it alteration finds

—Sonnet 116

Why is it that despite our best efforts and every innovation in technology the work of construction documentation seems to grow evermore complex and time consuming? What is the particular nature of these documents, as architectural representations, and how do they achieve (or fail to achieve) their ends? We create documents of exacting detail and comprehensiveness, only to find them insufficiently anticiptory. The bad news is this can only get worse as economies and ecologies, and their various margins, contract. The good news is that systems of ever-increasing complexity follow a predictable curve and will ultimately, necessarily, be replaced. Understanding the role that construction documents currently play in the ever-increasing complexity of architectural production, and how it might have been otherwise, is the purpose of this paper: how, that is, we might move from a prescriptive complexity to an open, yet parsimonious, representational paradigm, and why parsimony is cause for hope.

INTRODUCTION

I would like to introduce two terms, which should lend conceptual clarity to an admittedly muddy backwater of the theoretical discourse on architectural representation: that concerned with construction documentation. The first term has a life in medical practice as that thing which a doctor gives to cure the sick: a prescription. Architectural representations can act like prescriptions, and as far back as Alberti the builder began to be seen as an instrument in—or as—the architect's "hands"[1]; and the role of representation therefore to prescribe the actions of these hands such that the building be made well. This is the commponplace understanding of the structure and function of construction documents even today. The term "prescription" isolates that faculty which makes all forms of construction documentation different from other disciplinary or professional forms of architectural representation: in their prescriptive capacity, the floor plans on page A201 of a construction set are more akin to section 033000 of the accompanying specification book than they are to drawings of the very same plans lovingly shaded in full color with circles and arrows and a paragraph on the back of each one created for a client meeting. The client's rendering describes the reality of the building *as-if* it were real; the construction drawing prescribes it *such-that* it may become real. This may seem like a small grammatical distinction, but it speaks volumes.[2]

The second term I would like to introduce to parse the difference between a represnetation's *accuracy* and its *efficacy.* For while most construction documents are comprehensive and accurate, they are not all equally effective. In complexity science, that cross-disciplinary bridge between the hard and social sciences, we see the term "parsimony" used to make just this distinction. Thus the scientist observes an "Economy in the use of assumptions in reasoning or explaining; esp. in *law of parsimony* n. (also *principle of parsimony*) the principle that no more entities, causes, or forces than necessary should be invoked in explaining a set of facts or observations (cf. *Occam's razor* n.)."[3] "Occam's Razor" is that common law of deductive reasoning, that the *least complex* explanation is often the correct one. And with this razor we are able to make the cut between relatively efficacious prescriptions, and superfluous junk.

Let me define this one more term, and illustrate it with an embarrassing story. *Superfluous junk* is when something makes it into the contract documents only to be disregarded by a builder who knows better. When I was first starting out in practice, I inherited an irrigation specification and proceeded to dutifully review it and add it to the project specs. A month later I got an irate call from one of the bidders on the project. "No one does it like this here," he said. "What, I'm supposed to bury my main lines three feet down? We blow out the lines every fall, everyone does. So we don't have to trench so deep. I'm only calling you because I don't want to lose the job because I overbid because I actually read your %^& spec, where did you find this thing, Texas?" Sure enough, I later found out the specification had been written in Florida, where burying made more sense than blowing out. In an attempt to make the spec generally applicable, the writer had left a variable, "frost depth" blank in the specification. But in Montana, burying irrigation below frost depth in rocky mountain soil was so impractical as to be unheard-of. As a result, only

Figure 1: Concrete in contemporary custom residential architecture (Image: SBCH Architects)

one bidder had even thought it necessary to bring the point to my attention. The rest just assumed they would carry on with business as usual, ignoring the contract documents.

We shouldn't be surprised at this. Many things trump construction drawings. Whether it is the routing of electrical wires through the building or the geographical (and certifiable) source of structural timber, the contract documents allow for, and depend upon, external sources of review, knowledge, and ultimately, authority. Construction law devotes intense energy to distinguishing between these overlapping authorities, from the manufacturer's quality assurance, to the contractor's "means and methods," to whatever scraps of authority are left to the architect. For in the end the construction documents are created by, and, indeed, are the primary tool of, the architect. And just as I would not trust a contractor who did not know how to true her saw, the architect should be something of an expert on the way her drawings work. What is prescription, and how is it a distinct form of representation? Are there alternatives more suited to the contemporary jobsite and its sophisticated flux of availabilities and specialized knowledge, where recent innovations in communications technology foster new ways of achieving old ends? How might the scientific concept of parsimony allow us to make better drawings?

PRESCRIPTIVE DRAWINGS

Long before I knew anything about architecture, I was hired by a construction company to help triage the massive flow of RFI's and submittals generated by a project they were working on, a glossily modern concrete house in the hills above Washington's Puget Sound. (Figure 1.)

One of the first things I ever did on a job site (if you don't count my own family's everevolving home) was to painstakingly pore over a Hopes Windows shop drawings package over 40 pages—24"x36"—long, comparing it to the construction documents and specifications. This was where I learned what is still one of my favorite terms in architecture, V.I.F. (verify in field). There is some-thing antirepresentational, something arcane, about "V.I.F.". It is also an excellent introduction to prescription, for it is often by studying the exception that we learn the rule.

V.I.F. says, "I'm going to specify the dimension here, but you should check and make sure, based on what happens when you do the work prior to this." And while scheduling the sequence of tasks on the jobsite falls squarely within the contractor's means and methods, the architect reaches into this realm and hands over, like-it-or-not, one small piece of the authority which is normally reserved for the designer, for example, the size and shape of a window, because the architect knows that to jack-hammer out a concrete wall to fit in a window sized perfectly to the drawings would be a failure of—here's the word in it's more ordinary context—parsimony. Should the contractor go ahead and order the windows to the dimensions listed in the architect's drawings, before measuring the concrete walls into which those windows fit, then it is, says that pesky little V.I.F., the contractor's responsibility to decide whether he prefers the jackhammer, or the ordering of a new custom window at his own expense.

This shows I think quite clearly the unique representational faculty, and force, of the construction drawing. The typical dimensional statement on the drawing (without the V.I.F.) says, "Build *this* thing *this* size." We are left with two possibilities:

1. The drawing relates to built reality as a representation that *successfully prescribes* that reality.

2. The drawing fails to relate as a prescription, in which case the failure of representation is either:

a., *insignificant*, and while it may generate further drawings and texts (R.F.I.'s, etc.) it will ultimately remain as built, divergent from its representation. Or,

b., the problem is significant, in that it has down-stream effects on other representations and/or facts, such as a concrete window opening within its own apposite craft tolerances but 1/4" too narrow to fit the window as dimensioned on the window schedule. In this case it will be considered to have been a failure of execution rather than representation, and will be corrected and brought into congruence with that representation. This will necessarily result in improvisation, and perhaps the jackhammer.

In this context the utility of a caveat such as V.I.F. becomes clear: order that Hopes window 6'-6" long, but measure the rough opening as-built first, and make the adjustment. Tolerances are a fascinating topic in their own right, and an argument could be made either for or against their unsung significance; for our purposes we will simply note that they are ubiquitous throughout the formal language of contract documents—and understanding this formal language may help to give us control over our tools.

THE FORMAL LANGUAGE OF CONTRACT DOCUMENTS

In his 2001 study of organizational systems, Arthur Stinchcombe takes as one of his primary examples the representation of external (plumbing, electrical, etc.) systems in architectural drawings. He distinguishes, as most sociologists after Max Weber do, between formal and informal systems, though his is a particularly nuanced treatment, as the 'formality' of formal systems is the primary concern of his work. In sociology a formal system, like law, or the game of chess, is a structure for social interaction which prescribes certain behaviors and proscribes others. The construction drawing is a formality, per Stinchcombe, that governs the action of

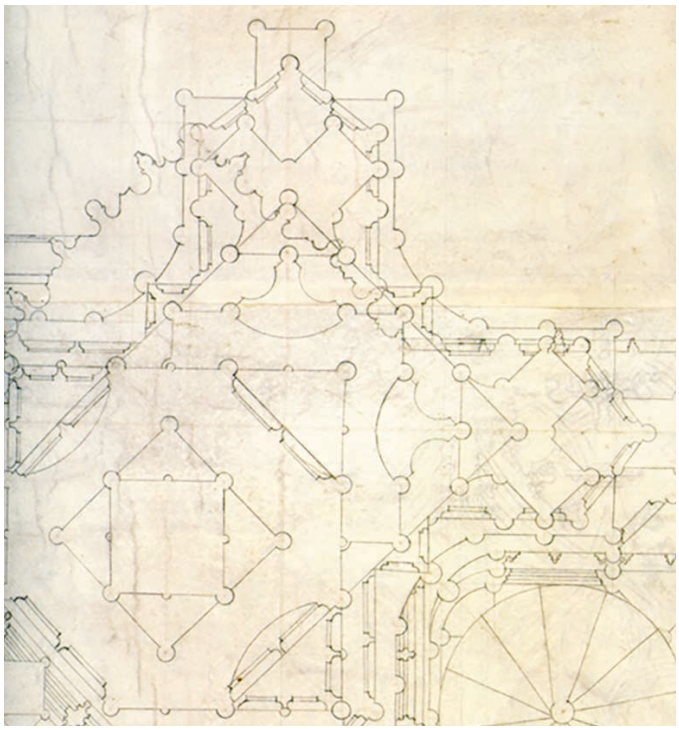

Figure 2: St. Stephan Wien north tower c. 1465, Gregor Hauser Master Mason (Detail) (Image: Vienna Akademie/City of Vienna Archives). In this Medival plan of a cathedral steeple, there are as many as 40 different levels of plan view collaged into a single image. It is left to the historian's imagination to consider the diagolues which were engendered—and necessitated—by this minimal represention.

building with remarkable accuracy, cognitive economy, and robustness.[4] I am not sure I share his optimism regarding the facility with which a drawing becomes a building. But his point is well taken: the representational system of construction documentation works, when it works, by transferring the fiscal authority of the client through the structuring representation of the architect, to the material fabrication of the building.

This translation requires a shared language. To make use of a set of drawings, "One has to know how a notation of "Finished Floor Elevation 1919.00'," is turned into practical measurements on the ground for building forms to pour concrete into."[5] But Stinchcombe wants to differentiate his analysis from the more orthodox view of formal systems, in which the translations from law to everyday life are described as negotiations between formal and informal systems of action.

> Just as a cookbook recipe for bread relies on one knowing what "smooth and elastic" bread dough feels like (though if designed for beginners, the cookbook may include an extended essay on the craft of bread making at the beginning of the series of recipes), the blueprint relies on a plumber knowing how to fit a 1 percent grade of a waste pipe into a wall as that wall has been actually built (up to 0.2 percent out of plumb). The semantics of the abstractions in the first instance are given by craft knowledge, quite often craft knowledge that the architects or engineers themselves do not have."[6]

That is, "the informal competence of craftspeople is part of the semantic system that tells us what the blueprints mean."[7] Stinchcombe's liberal understanding of formal systems is especially pertinent to architectural representation, because so much of what is described by a set of contract documents depends upon a tacit assumption of competence in craft knowledge. This was true even before Alberti, as a Medieval architect might create a single prescriptive drawing to describe the entire complexity of the tower of a cathedral. (Figure 2.)

Thus a good construction set is not necessarily the most complete description of the building to be built; rather, it is the clearest prescription of that building, the one most readily followed to a successful outcome. And often, as we endeavor to describe with perfect fidelity the complex reality of building, we end up mirroring that complexity. *We task ourselves with the creation of a perfect mirror,* and when we find it has lapsed, either during the drawing or during the building process, we patch it.

COMPLEX DRAWINGS

Often the value of complexity well exceeds its cost to the organizing party. But this does not mean that its value necessarily exceeds its cost. And this does not guarantee that the relative value of com-plexity will remain constant. Complexity, and particularly complexity theory, belongs to a preexisting set of disciplines, and carries those categories forward, which we should be aware of in our mispris-onings and metaphorical uses of the term. Can architects make productive use of complexity theory? Certainly—just as soon as we stop using it as a metaphor for architectural activities which would never meet the criteria for a complex system.[8]

I've written elsewhere about the relevance of complexity theory to architectural production; here I would like to speak specifically to the way complex adaptive systems work, or could work, as architectural representations. With complex adaptive systems we often proceed without knowing the full details of that system. Salk, for example, formulated his legendary vaccine without any of the insights provided by DNA sequencing. But this was not merely taking a shot in the dark and getting lucky: there is a systematic way to proceed in cases where the complexity or indeterminacy of the system exceeds our ability to predict. (Thus it would seem there is always something new to learn from Salk.)

In these cases, we look for points of leverage, moments at which a small input cascades through the system and has a disproportionate outcome—just as for Salk, when dead poliovirus strains injected into a patient triggered an immune response. This is called an 'amplifier effect.'[9] Unlike a drug, which as a chemical substance will often have a relatively straight-forward & linear effect the vaccine is a biological substance, and works by engaging with a preexisting and unpredictable complexity, the body's immune system, stimulating the production of antibodies which far exceeded any available drug in terms of their efficacy.

PARSIMONIOUS DRAWINGS

A lean prescription should be accurate, concise, and adaptable. A good plan is not, for example, lacking accuracy or completeness in its dimensions; it is not overdimensioned (this occurs when mul-tiple dimension strings locate the same objects in space, resulting in redundancy or even contradicting measurements); and it makes use of tolerances and caveats like V.I.F. to avoid counterproductive overspecification (a.k.a., superfluous junk).

Let us return to Stinchcombe, and his claim that 'craft activities are the semantics of abstractions' (61). Semantics, according to the O.E.D., is "the meaning of signs," (definition 1), or the "system of meanings" in a communication (definition 3).[10] To parse this, note the plural: the system itself, the structure of that system, would more rightly be called syntax; but Stinchcombe does not say 'syn-tax,' he says 'semantics,' and this makes his statement, if a bit counterintuitive, profound. According to Sinchcombe it is the tacit, informal (or differently-formal, depending on your position) acts and practices, rather moreso than the explicit, prescribed operations, that constitute the meaning of the formal system of architectural drawing.

Might this help to explain the need for a whole category of representation the budding young architect is never taught in school, that of jobsite ephemera? "Wait," says the R.F.I., "is this what you meant?" "No," the architect responds, "what I really meant was..." "Here," says the submittal, "I think you're asking me to make it like this." "Wait," responds the architect, "You missed the bit by the fire-place." I hope this raises a telling question: why do we do it the way we do? Couldn't we find better, more fluid and efficient form of dialogue, even (or especially) if it means sacrificing some of our formality?

Architectural modernism is filled with stories of significant communication by informal means. From Louis Kahn on the job site with trowel in hand, to Lawrence Halprin's architectural choreography, architects find ways to connect with the intangible attributes of their materials and sites --we should begin to notice how often these moments are accompanied by significant, *and* ephemeral, architectural representations. They run as a consistent undercurrent in the highwatermarks of moden architecture. Scarpa is said to have actually rehersed, the night before an important meeting, the impromptu sketches he would employ in that meeting[11]; and Gaudi is famous for having moved into the Sagrada Familia in the last years of his life, where he would wake up every morning and walk through the site, determining what needed to be said to the builders when they arrived.

Can we then make room for that sort of ad-hoc, often oral, decision-making in contract documents? (Remembering that the room is already there, in the R.F.I.'s that have yet to be written.) There is of course provision in contract law for oral agreements; but established conventions of construction documentation preculde their use.

In any case, it seems to me we need to make a distinction here, between reactive improvisations, which are already well accommodated by conventional construction documentation, and anticipatory ones. Let's take an example. When my wife and I were building our own house, I knew I wanted rainscreen cladding, rather than something applied directly to the building sheathing. On the permit drawings, we called out "rainscreen cladding", and did nothing else. We could certainly have made the decision early on in the design process, and chosen something inexpensive and unobjectionable, like fiber cement board. Or something modern & adventurous, like Corten steel. (We would get around to that on the tower.) Instead we left it at rainscreen, working out the details of flashing and drainage planes but leaving a nominal inch and a half for the siding. (So much? It was a good thing we did.)

One day I was driving down the Bitterroot valley to visit my folks and I noticed a truly monstrous tangle of wood by the roadside, downhill from a cluster of sheds. One of the sheds had a sign board sticking up from its metal roof: Findlay's Lumber. So I stopped and asked the fellow what was up with the giant pile of sticks. "Slash pile," he said. "Good kindling. Help yerself."

Findlay had a rustic setup: one big saw for slicing logs into planks, and a second, edging saw for trimming off the bark and making the plank square. He sold the roughsawn planks in a yard beside the sheds, and they were so green they wept trails of sap down the sides of the stacks. The offcuts, though—if the sawyer had been efficient with his cuts, in places the bark was attached to little more than a triangle of solid wood. But in many others—given the natural variation in logs, taper over the length of the trunk, etc.—there was as much as two inches of wood, with the bark still firmly attached. The lengths were plus or minus twenty feet, and the widths a true one or two inches wide, mostly one. The first day (of several) I just filled the truck with the best ones I could find: clean, dry, and relatively straight. In the weeks that followed I would become a connoisseur of off-cuts. I took them back to the job site and we made a jig and began laminating the sticks together into planks, mix-ing and matching the depths and bark pattern of individual pieces. Then we laid up the planks over furring. (Figures 3 and 4.)

Was this "free" siding actually free? If you count the labor, it cost more than fiber cement (but less than Corten). And I was pleased to read, just the other day, that the first siding ever to receive William McDonough's cradle to cradle certification was—indeed—bark shingles. Sadly (for my prospects of early retirement) I had nothing to do with that. But I am happy to report that my own improvised bark rainscreen is still, ten years later, holding its bark; and that this was achieved with the most sustainable adhesive ever invented: none at all. Presumably, eventually, the bark will delaminate and slough off. I hope I'm around to see it. I wondered, for years, why it wasn't occurring. Standing dead trees in the forest often keep their bark for a few seasons, but it eventually, over time, loosens from the trunk. As I write this however it occurs to me that the tree dries, and shrinks, as a unit, and perhaps the bark shrinks more than the trunk. The off-cuts don't have nearly as much differential shrinkage to accommodate, and so their prognosis is, I hope, good.

At one point in his book about the formality of informality, Stinchcombe tells us his father was a painting contractor, and I find this incredibly apt, because I've never met a painting contractor who needed to look at the plans, provided you could tell him the square footage; who needed to anticipate or alter his bid for any of the dings or patches or reconfigurations that are so exhaustively documented in a modern construction set. A painting contractor who tried to track every change in a building until finally—finally!—it was his turn to complete his work is a painting contractor who would never get any painting done. Let me be clear that the painting contractor's engagement with the architectural representations that govern his work are not, despite their minimal nature, inconsequential; rather, the painting contractor merely engages with the drawings to the exact degree—no more and no less—that he needs to, to take from those drawings the specific semantic content (nearly all of it tacit) particular to his own activities. "The system of abstraction," Stinchcombe

Figure 3: Reclaimed bark rainscreen siding. (Image: Author)

Figure 4: Reclaimed bark rainscreen siding. (Detail) (Image: Author)

writes, "and the corresponding semantic system for translating it into a building is nicely adapted to what needs to be communicated. Nothing about the path of conduit through the walls needs to be said, so the electrical symbols and drafting conventions have no way to say it."[12]

Now a lean drawing set would find a way to say only those things that need saying, to only those people who need to hear it. Forget the rest. And the principal of parsimony says the best instruction set will be the leanest. That is to say, our representations should invoke the maximum tacit knowledge available with the minimum representational content possible. But wouldn't a drawing like this require an incalculably vast and intimate knowledge of the "semantics" of all craft practice? (I await this eventuality in Revit version one-million-and-two-point-oh.)

CONCLUSION: FLIPPING THE JOBSITE

There has been a great hubbub of late in collegiate pedagogy about "flipping the classroom." I think this is a wonderful meme (though its originality depends on our willingness to believe that it has not always been thus, the teacher learning from the student as much as he is willing to listen) but I don't think it is unique to the classroom. We should endeavor whenever possible to flip the jobsite. The point of my story about the bark siding was not to say that we should wait for Fortuna to smile upon us. It was a story I was able to tell because in that instance I was both architect, trying to draw minimally, and contractor, trying to find the best thing the drawings meant, and so made possible. (How often are our drawings creatively interpreted to the betterment of the project? I am willing to bet it happens more often than we like to admit.)

Accidents are bound to happen to even the most rigorous plans. Sometimes these alterations, like the serpentine crack in the ceiling of Corbusier's gymnasium at the Unité Marseilles, become something to celebrate (or even to adorn with red paint). But we should ask ourselves if these celebrations of spontaneous beauty need necessarily be after-the-fact. Can we make space for happy accident? (Whether we play sheet music, or jazz, we still call it a concert.)

The greatest problem with prescriptive specifications is not that they are often out of date, or ignorant of local conditions, or beholden to certain manufacturers of selected products, though all of these things erode the parsimony of the specification. Rather, it is that prescriptive drawings build their solutions cumulatively, adding complexity to complexity, pushing further and further down the com-plexity curve[13] to where, finally, the energy requirements of the system of organization outweigh the productive capacity of that system. Soon, the system draws down its reserves; and no organization can long outlive the depletion of its reserves. The pursuit of exhaustive specification is also, I think, a misguided project. Even if it were possible to find the encyclopaedist and jack-of-all-trades so expert as to know the sum of tacit craft knowledge, we would still need to find the poet who could put it into parsimonious words.

We can't possibly foresee Findlay's cornucopia of off-cuts, nor should we try. Rather, we should find a way to encourage and encompass, whenever possible, the creative intelligence of every participant in the construction process. This may mean we have to outgrow two of the greatest heroic conceits of the profession: that of the architect-artiste, and the autocratic master-builder.

And it will mean a willingness to love the alterations.

ENDNOTES

1. As Alberti writes in the prologue to *De re Aedificatoria*: "Before I go any farther, however, I should explain exactly whom I mean by an architect; for it is no carpenter that I would have you compare to the greatest exponents of other disciplines: the car- penter is but an instrument in the hands of the architect." Alberti Leon B. On the Art of Building in Ten Books (trans: Rykwert J, Leach N, Tavenor R). MIT Press, Cambridge, 1988.
2. Indeed, volumes have been written about the significance of the "as-if" construction. See Vaihinger, Hans and C. K. Ogden. The Philosophy of 'as if' : A System of the Theoretical, Practical and Religious Fictions of Mankind. International Library of Psychology, Philosophy, and Scientific Method. London: K. Paul, Trench, Trubner, New York, 1924.
3. "parsimony, n.". OED Online. December 2016. Oxford University Press. http://www.oed.com/view/Entry/138169?redirectedFrom=parsimony (accessed February 01, 2017).
4. Stinchcombe, Arthur L. When Formality Works: Authority and Abstraction in Law and Organizations. Chicago: University of Chicago Press, 2001. See particularly Chapter Three.
5. Ibid., 57.
6. Ibid, 59-60.
7. Ibid., 61.
8. Because architecture partakes of so many bodies of knowledge, it is often infected with their memes, and we should, first of all, distinguish what context—what "category", as the philosopher of language Gilbert Ryle would say —we are dealing with when we seek to understand why our drawings—our systems of representation—grow evermore complex. See Ryle, Gilbert. The Concept of Mind. Chicago: University of Chicago Press, 1949. Thus when Robert Venturi proposes to revitalize architectural thinking by encouraging complexity he is thinking in terms of the historical trajectories of style and of aesthetic effect. And when Charles Jencks takes up the same question he is careful to distinguish his thought from Venturi's, looking to complexity as a sort of underlying ruleset for cosmic order-within-disorder. (It's a shame Jencks had read his T.S. Eliot but not, it would seem, his Frost.) We have a very bad habit in architecture of borrowing the heroes of other sagas and attempting to make them fight our battles for us (as is the case presently with "algorithm," "big data," and the admittedly exciting mechanics of 3D printing and rapid prototyping). Thus for Jencks complexity was a way of introducing disruptions and divigations in a time of uniformity (not to say conformity) and plenty. A laudable goal. But not, I think, an exercise we will have particular need of in the future. See Jencks, Charles. The Architecture of the Jumping Universe. London: Academy Editions, 1995.
9. Holland, John H. Hidden Order : How Adaptation Builds Complexity. Helix Books. Reading, Mass.: Addison-Wesley, 1995. 5.
10. "semantics, n.". OED Online. December 2016. Oxford University Press. http://www.oed.com/view/Entry/345083?redirectedFrom=semantics (accessed February 01, 2017).
11. Dayer, Carolina, "Material Intuitions: Tracing Carlo Scarpa's Nose," in Matthew Mindrup. The Material Imagination: Reveries on Architecture and Matter. Farnham, Surrey, England ; Burlington: Ashgate, 2015.
12. Stinchcombe, 69.
13. The anthropologist Joseph Tainter has studied the diminishing returns on increasing complexity in formal systems, proposing that "return on investment in complexity varies, and that this variation follows a characteristic curve. [...] After a certain point, increased investments in complexity fail to yield proportionately increasing returns. Marginal returns decline and marginal costs rise. Complexity as a strategy becomes increasingly costly". See Tainter, Joseph A. The Collapse of Complex Societies (Cambridge: Cambridge University Press, 1988): 92-93.