One and One Rarely Make Two: The Arithmetic of Compositional Emergence

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Abstract

Adding quantities is cumulative of quantities. Nothing else happens. But adding real objects to one another in actual space can give rise to unexpected results, including new entities. If identifiable, the new things must be countable. Where a whole is more than the sum of its parts, we can therefore count by how much. But, on another ledger, the emergent entities can have different values, sometimes negative. Exploring both forms of addition can build bridges between the mind-sets they represent.

Introduction

Architecture is a sprawling, applied field. It interweaves commerce, law, and sociology, for example, with countless branches of technology and various theories of aesthetics. Schools recruit for diverse abilities, leanings, and backgrounds, and put students through a wide range of classrooms. Some students are irritated when their rigorous and reliable ways of thinking, in an unfamiliar context, are considered “reductive” or “mechanistic.” Other students are miffed when their inventiveness and human insight are devalued as “soft” or “qualitative.” But architecture is a collaborative profession. It does its best work when practitioners appreciate the various skills that are assembled around a project table to grapple with the multifaceted and mysterious activity of design. As a starting point in acknowledging different aspects of or approaches to design, this paper posits a pair of tendencies that can sometimes feel opposed. On the one hand, there are students comfortable with explicit problems to be solved, explicit resources available, and explicit ways of evaluating results. On the other hand, there are those preoccupied with the unstated opportunities implicit in a scenario and who show a greater interest in emergent results than in stated targets. Naming these cognitive tendencies as if they were watertight categories is not productive. But simple mental challenges can be. To help students bridge mindsets – whether inter- or intra-personally – I’ve used just a couple of wooden blocks or sometimes a pair of graphic rectangles projected on a screen. Sometimes through game-play and sometimes as static lecture illustrations, thoughtful reconfiguration of the parts can illuminate differences between approaches and stimulate interplay between them. I have also used folded napkins on bar-tops and letter-paper on conference tables to much the same effect. This short paper sketches out some observations that participants have made over the years and speculates where these might lead.

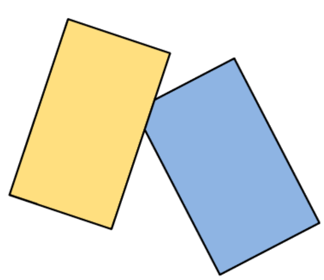


Figure 1: *Spatial juxtaposition of two rectangles in no particular orientation, configuration, or context.*

Composing Objects

Figure 1 shows two rectangles in no particular relationship, either to each other or to their context. If they're real blocks and I have a kitchen scale to hand, it's evident that the whole exactly equals the sum of the parts. But if I carefully stack one block on top of the other, then one rectangular solid and another make only one. In lay terms, the first type of addition is bean-counting. The second can be called composition: position matters. I then ask participants to accept the rectangles as the footprints of two buildings. The buildings have been optimized as financial instruments, maximizing return on the time-valued investments in project and operating costs. At this point, attendees with a feel for commercial calculation may contribute subtle questions. Accordingly, I now state that Building B was painstakingly optimized as smaller than Building Y, but the efficiencies in building identical structures outweighed the material and lifetime operating savings achievable in the smaller size. There are no functional relationships between the buildings beyond a small convenience of proximity. So there's no reason to position them one way or another beyond putting them on the same lot. In one sense the building design is complete, but in another, it has only begun.

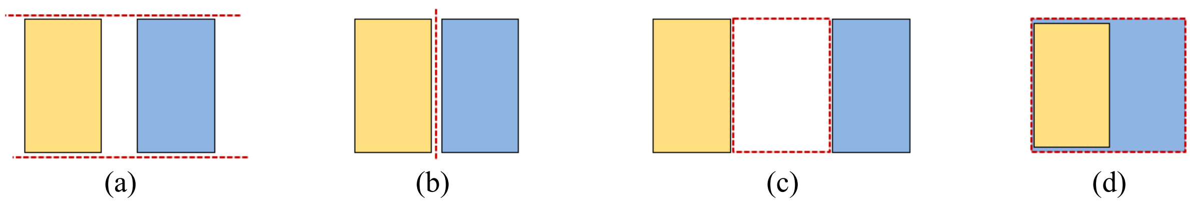
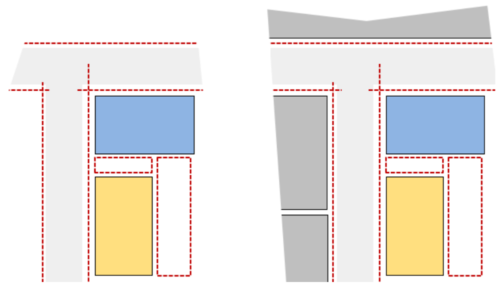


Figure 2: *Emergent space: (a) nominal, (b) minimized, (c) sized, (d) eliminated.*

Figure 2(a) shows the buildings aligned to each other, to simplify drafting and on-site layout. This produces a partially enclosed exterior space. Does one and one makes three, then? Heated discussion may ensue. If the additional entity has no money-making (or losing) implications, accountants insist one and one remains two. Or someone may argue that compactness is a virtue, anticipating that this would facilitate the sale or development of the remaining land. If so, the interstitial space has a negative value and is sharply reduced, as in case (b). But now we have one of those slots that accumulates garbage yet can't be cleaned, creating an unexpected negative. One and one makes three entities, but they're worth less than two. In Figure 2(c) the space has been enlarged to a point where it can accommodate a parking lot, a morale-building volleyball court, or a garden supplying the cafeteria. Now, even the strictest bean counter may see unexpected financial value. Unexpected to them, though not to the compositional thinker.

Case (d) shows an idea that has occurred to more than one participant, prompted by the ugly alleyway in case (b). They propose putting the structural and interior layers of the buildings in direct contact so that the envelope layers can be reduced in extent and thus in construction cost. A proponent from a cold climate pointed out the energy savings. But what if the building were located in a warmer region? The cross-ventilation possible in narrow buildings could pre-empt climate control costs, whereas lowering the surface area might require installation and operation of a mechanical cooling system. Generative thinking leads to emergent ideas, but inevitably, the beans need counting. And context matters. Habitual awareness that a system only operates in context, habitually scanning the context for latent advantages and drawbacks is not itself quantitative work, but it can have massive quantitative implications.

On the next page, in Figure 3(a), the colored rectangles or wooden blocks have been arranged in an L. Students quickly identify the small space emergent between them. Some suggest the "L-ness" of the composition and the larger space should also be recognized as entities, as in Figure 3(b). This may lead others to roll their eyes. That is, unless or until the context of streets is shown, as in case (c) or an urban fabric of buildings (d) is made explicit. Now, sceptics see the larger space as a protected yard, and possibly that the aligned buildings contribute to the cohesion of the streets. It's been offered that the passage to the yard could also act as a common entrance space for the two buildings, encouraging all the inhabitants to

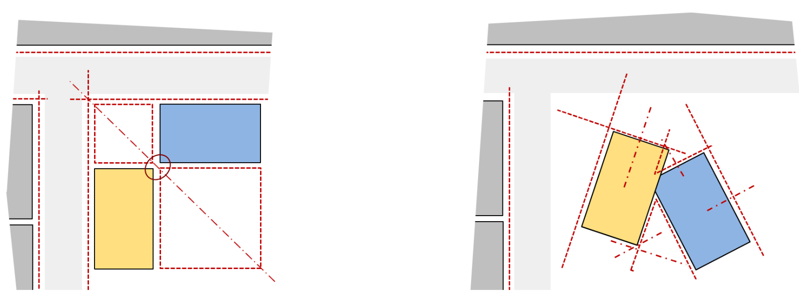


(a) (b) (c) (d)

Figure 3: *Concept and context: (a) The idea of corner and court, (b) street context, (c) building context.*

socialize. For participants who complain "why didn't you just tell us that these things count?" emergent results are irritating. For those who made the suggestions, the results aren't surprising or contentious. Emergences are inherent in any situation, awaiting discovery. How much any of the implied entities count to the building owner, to inhabitants, or to neighbors becomes a matter of bean-counting.

As enthusiasm has built, both for the generation of countable entities and their evaluation, several participants in these exercises have proposed the configuration shown in Figure 4(a). Here the inner corners of the two buildings almost meet. But even observers who recognize the entrance plaza and the inner court as entities may resist seeing the corner-to-corner relationship as an item. Others argue that any entity, even something "solid" is fundamentally a set of perceived relationships. Such relationships may be delicate. The situation in Figure 4(a) recalls the electrodes of a spark plug, which must be close enough to generate a spark but far enough apart to do so without fusing. The gap is a critical thing. The two building corners can generate a visual tension between contact and separation when they're spaced far enough apart to allow passage, but not so far to leave a mere void without perceptual charge.



(a) (b)

Figure 4: *Two more discoveries: (a) implicit diagonals, (b) explicit diagonals.*

Once implicit diagonals enter the picture, they can be used explicitly, as in Figure 4(b). Here the combined form doesn't seem to generate any useful spaces. It resembles Louis Kahn's Norman Fisher House, which discourages the visitor from drawing space-defining relationships between two components. The blocks are connected only by literal contact, making a single object isolated on a plot of ground. One and one makes one? The inner corners are hard to maintain, but the complex is a kind of sculpture. Participants able to visualize the form in three dimensions enjoy the perspective changing dynamically from one vantage point to the next. So, does the value of the combined entity come to more or less than one? Note that the configuration is identical to that in Figure 1, underscoring the importance of context.

A participant has noted that computer graphic objects explicitly encode features like projected sides and axes that are only implied in a block of wood, and that enable compositions to be "snapped" together. Presumably, one could encode the explicit recognition of interstitial spaces and other emergent entities, even with variable parameters.

Some Thoughts on Arithmetic

One bean *plus* one bean necessarily *equals* two beans. But one thing *and* one thing can *make* more than two things, worth more or less than two. In the material or even graphic world onto which arithmetic is sometimes mapped, one item juxtaposed with another can bring further items into being. These emergent entities fall outside the domain of arithmetic, at least as understood today. In the Pythagorean understanding of number, the member units of integers had spatial consequence. Whether numbers formed squares or triangles mattered. The number line was a fret-board of harmonic ratios. Odd numbers exhibiting a central member were seen as male, and even numbers, manifesting a central space, as female. Implicit properties and emergent results were fundamental to this Platonic conception of integral unit quantity. That integers and remnants of integers could also be used to tally earthly amounts was of lesser interest.

But in architecture, even today, both senses of number come into play. From heating degree-days to coefficients of thermal expansion to occupant loads there are uncountable things to be totted up in the bookkeeper's way and compared, optimized, whatever. But whether your portico has an even or odd number of columns matters, too. Not in the conventional understanding of quantity where thirteen happens to be one more than twelve, but in the Pythagorean sense where a square of twelve columns offers three entrances per side, and where one more column destroys the heavenly symmetry. This is not just as Vincent Foster Hopper has it, a matter of "number symbolism" [1]. It's a matter of physical fact, with an impact on function. Many questions in spatial and formal design can be analysed as topology or graph theory. Measure and other aspects of geometry play a role, too. But the rigorous understanding of implicitness and emergence, of the composition of wholes, is something else. It's a contentious area that touches on perception and cognition as well as mechanical fact. Is it math? Psychology? Philosophy? The ambiguity can be unsettling to a rigorous mind. But the immediate experience of composition and emergence in form and space has a way of dissolving professional boundaries. It can turn those anxieties into fun.

Summary and Conclusions

As a short paper, this essay recounts some experiences, asks some questions, and suggests directions for investigation. It explores conventional, lay, oppositions such as "hard" vs. "soft" thinking, implicit vs. explicit properties, emergent vs. predicted results. Few exemplars actually inhabit the poles of such binary constructs, but the poles can help us locate individual cases. A third pole can sometimes be found to broaden the space under consideration. In that regard, could it be that *configurational* thinking not only shares in but is distinct from both the *qualitative* and *quantitative*? The paper explores such ideas with respect only to a single phenomenon, the generation of space by form. And it only scratches the surface of that phenomenon. Analogous games and demonstrations could be devised for other areas of interest, further design fields, greater complexities. Regardless, even these simple games and demonstrations have occasioned fierce argument as well as pleasure, a sign that they've helped to build bridges.

Acknowledgements

I would like to honor the late Essy Baniassad, FRAIC (1936-2023) erstwhile Dean of Architecture at the Technical University of Nova Scotia. I'm forever inspired by his effort to push the limits of explication – and by his deep delight in what must remain implicate.

References

[1] F.H. Hopper. *Medieval Number Symbolism.* Cooper Square Publishers, 1938