Design in the Age of Cascades

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Abstract

The term Anthropocene has enabled sustained attention to the scale at which human activity reshapes planetary systems, yet its species-level framing compresses the mechanisms through which action is generated, propagated, and transformed (Crutzen, 2002). This paper adopts the concept of the Callidocene (Radzikowska et al., 2025) as an analytic orientation that relocates attention from agents to distributed capability, specifying cleverness – independent of its origination – as a field operator that produces high-leverage transformations across human, institutional, and computational systems. This shift enables examination of how interventions move through interconnected regimes, extending accounts of distributed agency and mediation (Latour, 2008; Bennett, 2010).

In this context, the paper develops cascades as a central analytic unit, defining them as processes in which the space of possible trajectories contracts as transformations align, reducing optionality faster than it can be restored. Existing accounts of cascades emphasize propagation, diffusion, and amplification (Bikhchandani et al., 1992; Granovetter, 1978; Watts, 2002; Barabási, 2016). The present work extends these by foregrounding closure dynamics and differentiating cascade regimes according to how they stabilize reductions in alternatives. Cascades are shown to operate across a variety of domains, including the technical, social, and institutional, often under conditions of apparent correctness but growing instability, where constraint interactions shape outcomes over time (Meadows, 1999; Perrow, 1984).

Design is repositioned within this context as a practice for engaging cascade dynamics rather than producing isolated solutions. Reframing, constraint acquisition, and iterative adjustment are treated as mechanisms that influence cascade formation and progression (Simon, 1996; Rittel & Webber, 1973), while buffering, early-stage interception, and staged recovery are introduced as strategies for preserving recoverability. The paper further identifies the need for representational tools that maintain multiple trajectories in view, supporting evaluation of interventions in relation to their downstream effects across regimes (Star & Ruhleder, 1996).

By specifying pre-cascades in terms of opportunities to resist closure and increase recoverability, the Callidocene provides a framework for engaging systems that remain in motion, enabling more deliberate interaction with the conditions under which transformations unfold.

Keywords: Anthropocene, Callidocene, cascade dynamics, systemic design, intervention design, complex systems, distributed agency, policy design, infrastructure systems, trajectory stewardship

Introduction to Extended Cleverness

Why is it necessary to deal with the concept of extended cleverness? Because large language models (LLMs) are increasingly becoming part of the human experience of thinking. There is a moment, now common enough to pass without remark, in which a person asks an LLM for help reframing a problem, receives a response that reorganizes the task, and then proceeds to act on that reorganization as though it were an extension of their own thinking. The boundary between individual cognition and distributed assistance has thinned to the point where it no longer supports a stable analytic distinction. What operates in the situation is a capacity that moves across human and technical arrangements, taking form as transformations that can be enacted, revised, and propagated, a dynamic that Latour (2008) describes as chains of mediation in which action is continuously modified as it moves.

The naming of the Anthropocene by Paul Crutzen (2002) provided a way of marking the scale at which human activity reshapes planetary systems, coordinating inquiry across disciplines concerned with environmental change. The term locates agency at the level of the species, where aggregated human actions produce large-scale effects. That framing leaves the mechanisms of action compressed within the category of "human activity," even as the systems through which action is generated become increasingly distributed across institutions and computational processes.

A shift in analytic attention relocates the operative unit from agents to capability: the capacity to generate transformations that reorganize situations in ways that increase the likelihood of achieving some objective, whether specified in advance or discovered in the course of action. The Latin term callidus names a form of cleverness that combines resourcefulness with situational awareness, and it provides a way of

designating this capability without restricting it to human actors. The Callidocene identifies a field in which cleverness is distributed across human, institutional, and computational systems, and in which agency is enacted through configurations that extend beyond any single actor, aligning with Bennett's (2010) account of distributed agency across human and non-human assemblages.

Cleverness operates within a field that is densely connected, where interventions introduced in one location propagate through adjacent processes. A change in the interface of a widely used system alters patterns of attention, which reshapes the circulation of information, which in turn modifies the conditions under which subsequent decisions are made. The propagation occurs through the structure of the system rather than through isolated causal chains, producing sequences of transformation that extend across technical, social, and ecological domains, a pattern consistent with network-based accounts of cascading processes such as those described by Barabási (2016). The example reveals how generation processes operate under multiple pressures, producing outputs that reflect the interaction of those pressures rather than the execution of a single action.

LITERATURE REVIEW

The argument of this article brings four lines of work into closer relation: Anthropocene discourse, design theory, cascade research, and science and technology studies. Each contributes part of the conceptual apparatus required to understand how interventions propagate through contemporary systems. Read together, they support a shift from species-level agency toward a more distributed account of transformational capability.

The Anthropocene has been valuable because it concentrates attention on the scale at which human activity reshapes planetary conditions (Crutzen, 2002). Its strength is scalar. It makes visible that the consequences of human action are geological, ecological, and civilizational. At the same time, the category of "human activity" compresses the mechanisms through which action is generated, coordinated, and propagated. The question is no longer only what humans do at scale, but how capabilities move through socio-technical arrangements in which institutions, infrastructures, and computational systems participate in the shaping of outcomes.

Design theory provides one route into those mechanisms. Simon's account of design as the transformation of existing situations into preferred ones places intervention within structured conditions rather than outside them (Simon, 1996). Rittel and Webber's (1973) wicked problems sharpen this point by showing that in many social contexts the formulation of the problem is inseparable from the formation of possible responses. Irwin's (2015) transition design extends this orientation across longer temporal and systemic horizons, emphasizing that design increasingly operates in fields where interventions continue to reverberate beyond the immediate project frame. What emerges across this literature is a view of design as organized engagement with constraint, trajectory, and consequence.

The Callidocene builds on this design-oriented understanding of intervention by relocating attention from agents to distributed capability. Radzikowska et al. (2025) propose cleverness not as an individual trait but as a field condition in which resourceful transformations can be generated across human, institutional, and computational systems. This shift allows action to be tracked through configurations rather than attributed in advance to bounded actors. Bennett's (2010) account of vibrant matter supports this move by loosening the assumption that agency is exclusively human and by emphasizing the distributed character of efficacy in assemblages.

Research on cascades provides a second necessary component. Informational cascades describe alignment processes in which early signals shape subsequent decisions (Bikhchandani et al., 1992). Threshold models show how local adoption can trigger broader systemic shifts once critical conditions are met (Granovetter, 1978; Watts, 2002). Network and complex systems research generalize these dynamics, examining how localized disturbances propagate through connected structures and produce large-scale transformation (Barabási, 2016; Sornette, 2003). Ecological work such as Paine (1966) demonstrates that such propagation is not limited to human systems; interventions at one point can reorganize relationships throughout an entire field. Across these traditions, cascades are primarily understood through three features: propagation, amplification, and diffusion.

The present article builds on that work by drawing stronger attention to closure. Cascades move effects across a system, and they also alter the range of what can follow. As transformations align, some trajectories become more available while others are reduced or lost. This emphasis on changing optionality brings cascade research into closer relation with design, where the arrangement of constraints has always mattered, and with systems thinking, where leverage depends on structural positioning (Meadows, 1999).

Science and technology studies helps specify how propagation and closure occur in heterogeneous settings. Suchman's (2007) work on human-machine reconfiguration shows that action is situated and distributed rather than simply executed by isolated agents. Latour's account of mediation likewise treats action as something modified as it moves, with each step in a chain altering what is carried forward (Latour, 2008). Bowker and Star (1999) add a further layer by demonstrating how classification systems and infrastructures stabilize certain forms of action while making others less available. Stengers's (2010) cosmopolitical

orientation is especially important here because it insists on preserving plurality within evolving situations rather than allowing them to collapse too quickly into singular accounts.

Taken together, these traditions support a rearticulation of design for conditions of distributed cleverness and cascading consequence. Anthropocene discourse identifies the scale of transformation. Design theory clarifies intervention under constraint. Cascade research explains propagation across connected systems. STS shows how those propagations are mediated, stabilized, and rendered unevenly available. The Callidocene gathers these strands into a framework in which the central question becomes how interventions move through a field, how they reduce or preserve optionality, and how design might engage those dynamics without mistaking temporary coherence for durable adequacy.

CASCADES IN THE CALLIDOCENE

The Callidocene names a field in which transformations are continuously generated and propagated across interconnected human, institutional, and computational systems. Within this field, cascades provide a unit for describing how those transformations move and how they reshape the conditions under which further action occurs. In short, cascades alter optionality. As transformations align with one another and with existing constraints, some trajectories become increasingly available while others diminish or disappear. The defining feature of a cascade is therefore not only that effects travel, but that the range of viable futures is reorganized as they do so.

This reorganization can proceed in different ways. In some cases, cascades amplify trajectories that are already present, selecting among available options and reinforcing those that satisfy dominant constraints. For example, consider navigation systems that optimize for travel time. As users converge on recommended routes, those routes become increasingly dominant, while alternatives fall out of use. The system appears to operate efficiently within its frame, yet the contraction of options reduces its capacity to adapt when conditions change.

In other cases, cascades reshape the terrain through which they move. Interventions introduced into systems that mediate attention alter what is visible and how it is engaged. A modification to an interface may reorganize patterns of interaction, producing new forms of alignment that were not previously available. Here, the cascade does not simply select among existing trajectories. It reconfigures the conditions under which trajectories can form, producing closure that reflects a transformed field rather than a pre-existing structure.

A further configuration occurs when cascades stabilize around existing patterns through processes of selection embedded in institutional or computational systems. As an example, take predictive allocation models. When resources are distributed based on historical data, activities that are already well-represented in the dataset are reinforced, while those that fall outside the established frame become less visible and less viable. The cascade operates through alignment with prior patterns, producing a contraction of possibilities that is typically experienced as consistency--which it is--rather than loss--which is equally the case.

Although these different configurations can be identified, in practice they often overlap. A single intervention may amplify certain trajectories, reshape the terrain, and reinforce existing patterns simultaneously. The distinctions are analytic, allowing the mechanisms of closure to be made visible without reducing them to a single form.

The emphasis on closure introduces the concept of recoverability. A system is recoverable to the extent that it can sustain multiple trajectories and shift among them as conditions change. Cascades reduce recoverability when alignment proceeds more quickly than the system's capacity to generate or maintain alternatives. The critical parameter is therefore not propagation alone, but the rate at which closure occurs relative to the system's ability to restore optionality.

This perspective clarifies why cascades often operate under conditions of apparent correctness. Outputs align with specified objectives, and local coherence is maintained. The narrowing of alternatives is not registered as failure because it occurs through the interaction of constraints that are themselves taken as given. Over time, however, the reduction in optionality limits the system's capacity to respond to new conditions. The cascade becomes visible not as an error but as diminished adaptability.

Within the Callidocene, cascades are pervasive because the field is densely connected and continuously active. Transformations introduced in one location propagate across adjacent processes, interacting with other transformations that are themselves in motion. The result is a landscape in which multiple cascades intersect, overlap, and influence one another. The effects of any single intervention cannot be understood in isolation. They must be situated within a field of ongoing propagation.

Design enters this field as a practice that engages with these dynamics directly. Reframing alters the initial conditions under which cascades form, changing which trajectories are available and how they are interpreted. Constraint acquisition shapes the pathways along which propagation can occur, privileging certain forms of alignment while limiting others. Iterative adjustment introduces sequences of displacement that influence how cascades unfold, creating opportunities to observe and redirect their progression before closure stabilizes.

The role of design, in this context, is not to produce isolated solutions that resolve bounded problems. It is to participate in the configuration of cascade dynamics, attending to how interventions influence propagation, closure, and recoverability over time. This participation does not require complete control over the system. It requires the capacity to recognize how transformations move, how they interact with constraints, and how their effects accumulate across interconnected regimes.

The next section develops this orientation by examining how design can operate within a cascading field. It specifies a set of practices through which interventions can be introduced, observed, and adjusted in ways that preserve optionality while engaging with the ongoing dynamics of the system.

DESIGN FOR A CASCADING WORLD

The conditions described above reposition design within a field characterized by ongoing propagation, partial observability, and uneven closure. Interventions introduced into such a field do not terminate at the point of implementation. They continue to move, interacting with other transformations and with the constraints that structure the system. Design practice, under these conditions, becomes an engagement with how cascades form, develop, and intersect, rather than a sequence of discrete problem-solving episodes.

At early stages of cascade formation, trajectories remain dispersed and alignment pressures are weak. Multiple configurations coexist, and the system retains a degree of flexibility that allows for intervention. Work on threshold models of collective behavior demonstrates how small shifts in local conditions can influence whether alignment occurs or remains distributed (Granovetter, 1978; Watts, 2002). In design terms, reframing operates at this stage by redistributing attention across the field, altering which elements are considered relevant and which trajectories become viable. The intervention does not resolve the situation. It changes the conditions under which resolution might later occur.

As cascades begin to consolidate, certain trajectories gain momentum while others recede. Alignment pressures increase, and the system becomes more sensitive to disturbances at points of fragility. Research on tightly coupled systems shows how small disruptions in such contexts can propagate rapidly, producing disproportionate effects (Perrow, 1984). Design practice engages this phase through iterative adjustment, introducing controlled displacements that allow emerging patterns to be observed and, where necessary, redirected. The emphasis is on influencing the progression of alignment rather than on selecting among stabilized outcomes.

The acceleration of closure introduces a different set of conditions. As trajectories narrow, the capacity to intervene from within the system diminishes, since available pathways are increasingly aligned with the dominant configuration. Meadows' analysis of leverage points suggests that interventions at deeper structural levels can have significant effects, but also that such interventions become more difficult as systems stabilize (Meadows, 1999). Within this framework, buffering becomes a critical design activity. By maintaining partially external structures—alternative representations, parallel processes, or latent capacities—design preserves the possibility of introducing new trajectories even when internal flexibility is reduced.

Recovery introduces yet another phase. When cascades have already produced significant closure, interventions must operate through sequences of reconfiguration rather than immediate reversal. Dewey's account of inquiry as iterative reconstruction provides a useful analogue here, emphasizing that change often proceeds through successive adjustments rather than abrupt transformation (Dewey, 1938). Design, in this context, engages recovery by introducing intermediate configurations that gradually reopen the space of possible trajectories, allowing the system to regain flexibility without destabilizing existing structures entirely.

Across these phases, the central activity of design can be understood as the management of constraint in relation to propagation. Simon's characterization of design as action under constraint remains operative, but the nature of those constraints is now explicitly dynamic, shaped by prior interventions and by the ongoing movement of cascades (Simon, 1996). Constraint acquisition is not a preliminary step that precedes solution development. It is a continuous process through which the designer participates in shaping the pathways along which future transformations can occur.

The representational dimension of design also takes on increased significance under these conditions. Cascades are difficult to engage when their trajectories remain implicit or only partially visible. Work in science and technology studies has shown how representations—whether diagrams, models, or classifications—do not merely describe systems but participate in their organization (Latour, 2008; Bowker & Star, 1999). Within a cascading field, representations that make multiple trajectories visible support more informed intervention by allowing designers to see where alignment is occurring, where alternatives remain available, and where closure is accelerating.

This requirement extends to the temporal dimension. Static representations capture configurations at particular moments, but cascades unfold over time. The capacity to represent change, to track how interventions propagate and how constraints evolve, becomes central to design practice. Such representations function not as final accounts but as working instruments that support ongoing adjustment,

aligning with Stengers' emphasis on maintaining plurality within evolving situations (Stengers, 2010).

The Callidocene provides a frame within which these activities can be situated. By treating cleverness as a distributed capability, it allows design to be understood as one among many processes through which transformations are generated and propagated. The role of design is not to stand apart from these processes but to engage them deliberately, shaping how cascades unfold while recognizing that outcomes emerge through the interaction of multiple actors and systems.

In this sense, design becomes a practice of trajectory stewardship. The aim is not to eliminate cascades or to impose stable end states, but to influence the conditions under which transformations occur, preserving the system's capacity to sustain multiple trajectories while guiding their development in desirable directions. This orientation does not reduce complexity. It engages complexity by attending to how it moves, how it aligns, and how it can be redirected without foreclosing the possibilities that make adaptation possible.

CONCLUSION

The field characterized by distributed cleverness and institutional propagation calls for approaches that integrate design, analysis, and ongoing observation. Interventions do not conclude at the point of deployment. They enter into processes that continue to shape the conditions under which subsequent actions become possible, aligning with Dewey's (1938) account of inquiry as a continuous reconstruction of situations.

Within this context, cascades provide a means of understanding how transformations move and how they reorganize the space of possible trajectories. By attending to both propagation and closure, the framework developed in this article makes visible the conditions under which optionality is preserved or reduced. The emphasis on recoverability introduces a further dimension, directing attention to the system's capacity to sustain and restore alternative pathways as conditions change.

The Callidocene situates these dynamics within a field in which capability is distributed across human, institutional, and computational arrangements. This shift allows interventions to be examined in terms of how they participate in ongoing processes rather than as isolated acts attributed to discrete agents. Design, within this frame, operates as a practice that engages directly with these processes, shaping how cascades form, develop, and interact.

The implications are methodological as well as conceptual. Reframing, constraint acquisition, and iterative adjustment function as mechanisms through which cascade dynamics can be influenced. Buffering and staged recovery provide means of maintaining or restoring optionality under conditions of accelerated closure. Representational tools that make multiple trajectories visible support the evaluation of interventions in relation to their downstream effects across regimes.

The contribution of this work lies in articulating cascades as processes of accelerated closure within a field of distributed cleverness, and in positioning design as a practice oriented toward engaging these dynamics. The preservation of navigability within such a field depends on the capacity to recognize how transformations propagate, how they align, and how their effects accumulate over time. By developing concepts and tools that support this recognition, the framework provides a basis for more deliberate interaction with systems that remain in motion.

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