

# Entities as Embodied Networks: Power, Capital, and the Structuration of Socio-Biotechnical Totality

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## Abstract

This paper develops a theoretical framework to analyse human and non-human entities as socio-biotechnical configurations shaped by historically sedimented power relations. Drawing on Actor-Network Theory, post-ANT developments, and Andrew Feenberg's critical constructivism, the argument integrates these perspectives within a Marxist approach that foregrounds the dialectic between contingency and necessity. The concepts of threads and fabrics conceptualise how networks stabilise asymmetries, consolidate exclusions, and produce fractured totalities. Capital is theorised not as a background condition but as a structuring actant that inscribes values, configures topologies, and organises the logic of valorisation. Technical codes materialise hegemonic positions within socio-biotechnical entities, while resistance and obduracy mark the persistence of the non-identical. The paper further examines how class position and subjective identification mediate technological design, showing how socio-biotechnical entities embody contested inscriptions of meaning, function, and control. Through this lens, technology is reinterpreted as a site of struggle within a historically structured socio-biotechnical totality.

**Keywords:** Socio-biotechnical entities, power dynamics, contingency, totality, capital valorisation, technical codes, capitalism, constructivism

## 1. Introduction

Thinking about technologies should involve more than merely exploring the micro-elements that constitute them or the microsocial interrelations depicted by the threads or traces of those interactions—threads that intertwine to form broader socio-biotechnical fabrics. It should be a more extensive task, one that connects these threads to broader social, political, cultural, historical, economic, and biological formations. In so doing, this paper examines how technologies function as socio-biotechnical entities embedded in historically structured networks. While these networks appear fluid, decentralised, and contingent, we argue that they are shaped by sedimented power relations and capitalist logics that structure the totality within which they operate. The core tension explored here lies not simply between contingency and necessity but in how this tension unfolds within the capitalist structuration of socio-biotechnical fabrics—a structuration that configures design, agency, and value through historically inscribed asymmetries.

This assertion, however, is not without controversy: since 1968, particularly in France and subsequently across critical theory traditions, a marked opposition to Hegelian thought<sup>1</sup> has fuelled suspicion toward the very notion of totality.<sup>2</sup> These post-68 critiques questioned the Marxist concept of totality as potentially totalitarian and homogenising. As one commentator put it, “the events of May 1968 [...] seemed to confirm the bankruptcy of the French Communist Party, to question the orthodox Marxist scenario of revolution and to feed rising suspicions that the concept of totality served both totalitarian and exclusory purposes.”<sup>3</sup> Nonetheless, within certain Marxist currents, the notion of totality was not abandoned but critically reworked. This paper specifically draws upon the contributions of Fredric Jameson, who expands Marxist frameworks by incorporating non-native concepts such as ideology, cultural analysis, and narrative form. Jameson conceptualises totality as the horizon of all interpretative acts, insisting that “always historicise” implies reading every text as part of a broader structure shaped by capitalism.<sup>4</sup> He further argues that cultural formations must be understood as expressions of an underlying socioeconomic logic, even when such logic is no longer directly accessible or consciously perceived.<sup>5</sup> Jameson’s use of totality does not posit a seamless or complete system, but a mediated structure through which capitalist logics are reproduced and contested. In this line of thought, his defence of expanding Marxist frameworks to encompass non-native concepts

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1 Vincent Descombes, *Modern French Philosophy* (Cambridge: Cambridge University Press, 1980).

2 Martin Jay, *Marxism and Totality: The Adventures of a Concept from Lukács to Habermas* (Berkeley: University of California Press, 1984).

3 John E. Grumley, *History and Totality: Radical Historicism from Hegel to Foucault* (New York & London: Routledge, 1989), 184.

4 Fredric Jameson, *The Political Unconscious: Narrative as a Socially Symbolic Act* (London & New York: Routledge, 2002).

5 Fredric Jameson, *Postmodernism, or, The Cultural Logic of Late Capitalism* (Durham: Duke University Press, 1992).

inspires us to integrate constructivist perspectives within a Marxist framework. This declaration signals our ideological intent for this paper.<sup>6</sup>

Notwithstanding, this article's understanding of totality is grounded more fundamentally in the work of Theodor Adorno, including his collaboration with Max Horkheimer.<sup>7</sup> While both thinkers developed a non-totalitarian conception of totality prior to the post-68 context, Adorno in particular emphasised the fragmentary, the non-identical, and the residual. Rather than offering a method for mapping social change, his approach constitutes a philosophical refusal of closure—an insistence on the critical potential of contradiction, negativity, and resistance. We therefore draw more heavily on Adorno's insights, especially as elaborated in *Negative Dialectics* and *Aesthetic Theory* (Adorno 2004).

A central concern in Adorno's thought is the domination of instrumental rationality and the logic of identity over experience and multiplicity.<sup>8</sup> He warns that the pursuit of coherence and systematisation—especially under the imperative of identity—produces a homogenising force that negates the richness of singularities and the non-identical.<sup>9</sup> In contrast to classical Hegelian or orthodox Marxist views, which conceive totality as a coherent and encompassing system, Adorno insists that totality is intrinsically fractured, marked by contradiction and resistance. Totality, for him, is an unavoidable abstraction—it frames our perception of reality—but it is never complete or fully coherent.<sup>10</sup> This perspective enables us to interrogate networks not as neutral assemblages of actants, but as structured fields permeated by ideological sedimentations and power asymmetries that shape but do not exhaust the configurations that emerge. A related critique of instrumental reason, developed earlier in collaboration with Max Horkheimer, also identifies the tendency of Enlightenment rationality to convert difference into sameness, reducing qualitative experience to exchangeable units.<sup>11</sup>

From this standpoint, technologies must be understood not as isolated artefacts or neutral tools, but as socio-biotechnical entities—configurations that condense social, technical, biological, and symbolic dimensions within historically structured networks. These entities emerge from and reinforce broader fabrics of power, meaning, and function. Their design and operation are shaped by sedimented asymmetries, ideological inscriptions, and institutional arrangements. In this framework, technologies are not merely used—they

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6 Slavoj Žižek, *Less Than Nothing: Hegel and the Shadow of Dialectical Materialism* (London & New York: Verso Books, 2012).

7 Max Horkheimer & Theodor W. Adorno, *Dialectic of Enlightenment*, ed. Gunzelin Schmid Noerr, trans. Edmund Jephcott (Stanford: Stanford University Press, 2002).

8 Theodor W. Adorno, *Negative Dialectics* (New York & London: Routledge, 2004), 5–19.

9 Adorno, *Negative Dialectics*, 139–65.

10 Adorno, *Negative Dialectics*, 53–54.

11 Horkheimer and Adorno, *Dialectic of Enlightenment*, 3–11.

are sites of struggle, where competing values, rationalities, and agencies are materially encoded.

To conceptualise the interplay between historical determination and contingent interaction within technological networks, this paper introduces the notions of threads and fabrics. Threads denote historically sedimented relations—patterns of alignment, exclusion, and reinforcement that shape the positions and capacities of entities within a network. Fabrics refer to the broader configurations these threads compose: dynamic yet stabilised formations that articulate the possibilities of action, meaning, and reconfiguration. These concepts allow us to theorise how what appears as fluidity is often the product of prior stabilisations—where the contingent is retroactively fixed as necessity through capitalist structuration.

In this sense, rather than functioning as a passive backdrop, capital operates as an active structuring force—an actant that configures the topology of networks. Through mechanisms of valorisation, design, and circulation, capital inscribes itself into socio-biotechnical entities, shaping not only their material composition but also the meanings, uses, and subject-positions they enable. As such, capital functions as both an ontological and political principle within socio-biotechnical totality, orienting design logics, operational standards, and the normative expectations surrounding technology.

This approach also responds to limitations identified in dominant constructivist frameworks. While Social Construction of Technology (SCOT) introduces the role of relevant social groups, it tends to overlook the structural asymmetries and ideological forces that traverse those groups.<sup>12</sup> ANT, on the other hand, emphasises relationality and symmetry but often neglects historical sedimentation, treating networks as flat and reversible configurations.<sup>13</sup> Building on critiques by Feenberg, Radder, and Winner, this paper insists that socio-biotechnical networks must be read historically and critically: not merely traced, but interpreted as sites of sedimented conflict, hegemonic reproduction, and potential rupture. Feenberg<sup>14</sup> argues that constructivist perspectives often fail to grasp the normative dimension of technological design and its entanglement with

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12 Trevor J. Pinch and Wiebe E. Bijker, "The Social Construction of Facts and Artifacts: Or How the Sociology of Science and the Sociology of Technology Might Benefit Each Other", in *The Social Construction of Technological Systems. New Directions in the Sociology and History of Technology*, ed. Wiebe E. Bijker, Thomas P. Hughes, and Trevor J. Pinch (Cambridge (MA) and London: The MIT Press, 1987), 17–50.

13 Bruno Latour, *Reassembling the Social: An Introduction to Actor-Network-Theory* (Oxford: Oxford University Press, 2005); John Law, "Material Semiotics" (Heterogeneities.net. John Law's STS Web Page, 2019), [www.heterogeneities.net/publications/Law2019MaterialSemiotics.pdf](http://www.heterogeneities.net/publications/Law2019MaterialSemiotics.pdf).

14 Andrew Feenberg, "Critical Theory of Technology: An Overview," *Tailoring Biotechnologies*, 2005, <https://doi.org/10.5040/9798400670268>; Andrew Feenberg, *Between Reason and Experience Essays in Technology and Modernity* (Cambridge, Mass.: MIT Press, 2010).

power. Radder<sup>15</sup> contends that constructivist approaches overlook the ontological and institutional conditions of scientific and technological practice. Winner<sup>16</sup> famously asserts that technologies have politics—not merely as consequences, but as intrinsic features of their design and implementation.

Within this perspective, the non-identical, in Adorno's sense, is not merely a philosophical residue—it emerges within technologies as that which resists full integration: the unintended effect, the misuse, the reappropriation, the symbolic excess. It manifests in obdurate artefacts, alternative designs, counter-hegemonic rationalities, and embodied practices that refuse standardisation. Socio-biotechnical entities thus become not only instruments of domination but also configurational sites of tension, where sedimentation and resistance co-exist.

This paper unfolds as follows: “Section Two” elaborates on the conceptual framework of threads and fabrics, showing how socio-biotechnical entities condense sedimented asymmetries through processes of stabilisation. It also develops the dialectic between contingency and necessity, offering a critique of purely fluid or eventual conceptions of networks. “Section Three” critically engages with ANT, SCOT, and the theory of large technological systems, integrating these approaches within a Marxist reading of capitalist structuration. Special attention is given to the concepts of momentum, path dependence, and accumulation. “Section Four” returns to Feenberg's theory of “instrumentalization” and introduces the concept of technical codes as a way to analyse how values are embedded in design. It also explores how class position and subjective identification shape technological configurations, drawing on empirical cases to examine the limits and potentialities of resistance.

Through this exploration, we seek to develop a critical framework for understanding technologies as socio-biotechnical entities, not only formed through heterogeneous associations but also structured by historically inscribed asymmetries and the logic of capital. In so doing, the paper aims to foreground the material and symbolic conditions under which networks are stabilised, challenged, and transformed.

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15 Hans Radder, *In and About the World: Philosophical Studies of Science and Technology* (Albany: SUNY Press, 1996).

16 Langdon Winner, “Do Artifacts Have Politics?”, in *The Whale and the Reactor: A Search for Limits in an Age of High Technology*, by Langdon Winner (Chicago: University of Chicago Press, 1988), 19–39.

## 2. Basic Elements of a Comprehensive Theory of Socio-biotechnical Entities

This section foregrounds two intertwined dynamics that orient the theoretical scaffolding of this work: the tension between contingency and necessity, and the historically conditioned tendency of networks to form a totality. To understand these dynamics, it is crucial to clarify the relationship between threads and fabrics—central analytical figures employed throughout this paper. Threads denote specific, historically sedimented relations between entities, whose durability and density reflect accumulated power asymmetries and struggles. Fabrics, in turn, designate broader socio-biotechnical structures, emerging from the interweaving and reinforcement of these relations over time. Thus, socio-technical configurations arise through contingent and unstable alignments of heterogeneous actors, interests, and materialities. Yet this openness is not infinite, as necessity asserts itself through the sedimentation of hegemonic structures, technical codification, and recursive stabilisation of power asymmetries. What appears fluid soon calcifies—not by fate, but through repetition and exclusion—producing structured formations inscribed with political rationalities often aligned with the logic of capital. The entities emerging within these configurations are not neutral, but crystallisations of antagonism, formed through historically inscribed struggles and asymmetrical alignments.

Such formations unfold within fields of relational fluidity and interwovenness that do not imply pure indeterminacy. Their dynamics are patterned through both material constraints and historically sedimented trajectories. To avoid what may be termed a Cratylean bias—wherein the emphasis on perpetual change dissolves conceptual rigour—socio-biotechnical entities must be conceived not as mere nodes within a network, but as provisional crystallisations of heterogeneous relations. These entities bear within themselves inscriptions of totality: partial, contingent, and contested, yet nonetheless operative. They emerge from networks, but also actively shape them, aligning or resisting the vectors of domination that traverse them. It is in this ambivalence that the space for non-identity endures.

Just as Marx begins *Capital* with the commodity—an apparently simple object that nonetheless crystallises the essential contradictions of the capitalist mode of production—so too must our inquiry begin with socio-biotechnical entities. For it is within these entities that the tensions, asymmetries, and historical sediments of socio-technical formations are most acutely condensed. Indeed, everything shaped by human participation emerges embedded in fabrics that are always already socio-biotechnical—manifesting power relations and structural imbalances which, despite their fluid dynamics, do not necessarily imply instability. Socio-biotechnical entities thus materialise as dynamic embodiments of such relations, amalgamating the social, biological, technical, and other implicit aspects that constitute their hybrid nature. These dimensions are so intricately interwoven that to attempt their analytical isolation from the contexts that produce and sustain them would

be not only futile but philosophically misguided. What is required, then, is a conceptual gaze attuned to the entanglements through which hybridisation becomes the condition of intelligibility.

Consider, for instance, an apparently simple object: a table. Far from constituting a neutral artefact, the table condenses a multiplicity of socio-biotechnical determinations. Its existence presupposes the extraction of wood from a specific forest, itself selected according to ecological, economic, and geopolitical considerations; it incorporates metallic fasteners—nails or screws—produced through industrial processes already inscribed within commodity circuits. The object that results is not reducible to function, for it bears the marks of cultural protocols, aesthetic conventions, legal standards, and technical affordances. The tree, its grain, its resistance, its responsiveness to tools—all participate materially in the final configuration. Such entanglement of human and non-human actors exemplifies the hybrid ontology through which socio-biotechnical entities emerge. Moreover, it gestures toward the dual process that Andrew Feenberg<sup>17</sup> conceptualises as primary and secondary instrumentalisation: the former extracting entities from their original context by isolating functional properties, the latter embedding them into new environments structured by normative, political, and cultural codes. The table, then, is not simply built—it is socially constituted, materially enacted, and politically inscribed.

This dual process—primary and secondary instrumentalisation—is not to be understood as a rigid sequence but rather as an analytical distinction within a continuum marked by constant interpenetration. Objects are not simply extracted and inserted; they are reconfigured through an evaluative logic that operates simultaneously across material, aesthetic, political, and cultural registers. As Feenberg insists, these operations are inherently structured by power, for it is through technical codes that dominant social orders are reproduced, determining which configurations become legible as “valid,” “efficient,” or “rational.”<sup>18</sup> This reveals not only the non-neutrality of technology but its function as a medium through which values are materially inscribed. In this light, the apparent separation between the natural and the social dissolves. Their entanglement is not accidental but constitutive: each is inherently part of the other, integrated through

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17 Andrew Feenberg, *Questioning Technology* (London & New York: Routledge, 1999); Feenberg, “Information Technology in Librarianship”; Feenberg, *Between Reason and Experience Essays in Technology and Modernity*.

18 Feenberg, *Questioning Technology*; Feenberg, *Between Reason and Experience Essays in Technology and Modernity*; Andrew Feenberg, *Technosystem: The Social Life of Reason* (Cambridge, MA: Harvard University Press, 2017).

continuous processes of socio-biotechnical becoming.<sup>19</sup> For each extraction, each design decision, and each material affordance participates in a process of selective constitution—operating through material inscription—whereby certain socio-biotechnical entities are rendered viable while others are excluded in advance.

Turning now to Actor-Network Theory, particularly its treatment of agency and symmetry, we observe that both humans and non-humans become actants—entities capable of producing effects within a network by enrolling, translating, and aligning others. In this configuration, they do not merely interact; they weave threads that articulate the relational fabric of the network. Thus, threads and fabrics are mutually constitutive: threads, as historically sedimented relations, create and sustain the broader fabric, which in turn provides coherence and constraint. The strength of a network is not a given but emerges from the density and persistence of these threads—the thicker the thread, the more entrenched the relation, the more durable the configuration. The concepts of resistance<sup>20</sup> and obduracy<sup>21</sup>, taken with terminological latitude, are of particular relevance here, for they mark the points at which entities—human or non-human—refuse, deviate, or counter the functions inscribed within their network positions. Technologies, as non-human socio-biotechnical entities, are not merely acted upon; they may challenge the roles assigned to them, resist their enrolment, or generate unintended effects. This capacity is mirrored, albeit differently enacted, by human actants embedded in the same configurations.<sup>22</sup> As Madeleine Akrich<sup>23</sup> argues, technological artefacts embed “scripts” that attempt to prescribe user behaviour, yet the success of such prescriptions depends upon alignment in practice—a contingency that may falter, fracture, or be reappropriated.

19 See Horacio Correa Lucero, “Tecnología, Artificialidad y Hábitat: Teoría Crítica de la Tecnología y su Aplicabilidad al Estudio del Hábitat en tanto Objeto Tecnológico”, *Revista Horizontes Sociológicos* 4, no. 8 (2016): 123–46; Donna Haraway, “A Cyborg Manifesto: Science, Technology, and Socialist-Feminism in the Late Twentieth Century”, in *Simians, Cyborgs, and Women: The Reinvention of Nature*, ed. Donna Jeanna Haraway (New York: Routledge, 1991), 149–82; Latour, *Reassembling the Social*; Gíslí Pálsson, “Ensembles of Biosocial Relations”, in *Biosocial Becomings: Integrating Social and Biological Anthropology*, ed. Tim Ingold and Gíslí Pálsson (New York: Cambridge University Press, 2013), 22–41; Anna Lowenhaupt Tsing, *The Mushroom at the End of the World: On the Possibility of Life in Capitalist Ruins* (Princeton & Oxford: Princeton University Press, 2015).

20 Feenberg, *Technosystem: The Social Life of Reason*. The concept of resistance is used here in a broader sense than in Feenberg’s original formulation, although it remains inspired by his critical theory of technology.

21 Anique Hommels, *Unbuilding Cities. Obduracy in Urban Sociotechnical Change* (Cambridge (MA): MIT Press, 2005); Anique Hommels, “Changing Obdurate Urban Object: The Attempts to Reconstruct the Highway through Maastricht,” in *Urban Assemblages. How Actor-Network Theory Changes Urban Studies*, ed. Ignacio Farías and Thomas Bender (New York & Abingdon: Routledge, 2010), 139–59.

22 Differences between human and non-human entities, while significant, are understood here as shaped by network configurations rather than pre-given essences. See Section 3 for further elaboration.

23 Madeleine Akrich, “The De-Description of Technical Objects,” in *Shaping Technology/Building Society. Studies in Sociotechnical Change*, ed. Wiebe E. Bijker and John Law (Cambridge (MA) & London: MIT Press, 1992), 205–24.

Similarly, Feenberg's notion of technical codes<sup>24</sup> reveals how design becomes a terrain of struggle: hegemonic groups seek to objectify their values in material form, but these inscriptions remain contestable and prone to subversion.

Such agency, human and non-human alike, should not be understood as neutral responsiveness but as embedded potentiality within historically situated configurations. Socio-biotechnical entities do not merely participate in networks—they co-constitute them through tensions, displacements, and asymmetrical inscriptions. Insofar as they acquire meaning only through their position within a network of relations, these entities may be read, following a poststructuralist sensibility, as signifiers<sup>25</sup> whose identity is constituted through a process of differential articulation that unfolds within historical determinations. Contingency—from a standpoint not fully aligned with poststructuralist thought—is never absolute; it is structured, bounded, and haunted by what preceded it.

Resistance, in this light, is not external to the network but emerges from within the very bodies of the entities involved: a friction between their preconfigured trajectories and the values or functions imposed upon them. These entities act not in isolation but through the threads that tie them to other entities and to the broader socio-biotechnical fabric—threads that carry sedimented histories, inscribed interests, and latent contradictions. In the case of human entities, this resistance may find articulation in language, symbolic action, or political contestation. In the case of non-human entities, resistance may take the form of functional divergence, obduracy, or misalignment, marking points where the totalising impulse of the network fails to fully capture its elements.

The emergence of alternative technological configurations depends upon the efforts of distinct groups whose values, intentions, and positionalities shape the trajectories of socio-biotechnical entities. These values—axiological, political, epistemic—do not simply widen the horizon of the possible; rather, they operate through selective articulations that delimit, stabilise, and ultimately close certain pathways. As these closures sediment

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24 Feenberg, *Questioning Technology*.

25 The notion of signifier employed here draws primarily from the poststructuralist theory of discourse elaborated by Ernesto Laclau and Chantal Mouffe. In this framework, signifiers do not refer to fixed referents but acquire meaning through differential articulation within a discursive field. While this perspective offers useful insights, the present analysis departs from its emphasis on pure contingency by foregrounding the structuring role of historical determinations. Socio-biotechnical entities, insofar as they participate in networked configurations, may thus be understood as contingent signifiers whose identity is constituted through hegemonic articulation—but always within historically sedimented constraints. For foundational formulations, see Ernesto Laclau and Chantal Mouffe, *Hegemony and Socialist Strategy. Towards a Radical Democratic Politics*, 1st. edition (London & New York: Verso, 1985); and Ernesto Laclau, *New Reflections on the Revolution of Our Time*, 2st. edition, Phronesis (London & New York: Verso, 1990). For a psychoanalytic inflection of the signifier within ideology critique, see also Slavoj Žižek, *The Sublime Object of Ideology*, 2nd. Edition, The Essential Žižek (London & New York: Verso, 2008).

over time, necessity appears—not as an ontological given, but as the historical result of contingent possibilities being rendered obsolete, excluded, or naturalised. It is in this process that power manifests most forcefully: not by eliminating contingency outright, but by rendering its traces illegible. The movement toward totality thus unfolds not as a completion, but as a structuring logic that absorbs, transforms, and suppresses—what Adorno identifies as a fractured totality, marked by fissures, residues, and the stubborn persistence of the non-identical.<sup>26</sup> These dynamics require closer examination if we are to understand how technologies become the site of both hegemonic inscription and potential rupture.

To proceed, it is necessary to clarify what is meant by “technology,” a term that transcends its common association with tools and gadgets and aligns with the conception herein presented: a socio-biotechnical construct shaped by power dynamics. While everyday objects such as chairs, computers, plastic packaging, or headphone accessories are typically classified as technologies, their technological status within this analysis depends strictly on how networks position and embed these entities within specific socio-historical contexts. What appears as mundane functionality conceals a sedimented field of exclusions and normativities. Technology, then, is defined not by the mere presence or instrumental function of an object, but by its contextual embedding in socio-biotechnical networks—networks wherein distinct power relations, values, interests, and ideologies are inscribed. For this reason, the preferred term throughout this paper is “socio-biotechnical entity,” as it precisely captures this contextual specificity and avoids the conceptual imprecisions inherent in the broader signifier “technology.”<sup>27</sup> These socio-biotechnical entities—including what we conventionally name as technologies—do not exist in isolation. They are mutually constituted through shifting configurations of power, meaning, and material interaction. Their significance and function are not intrinsic but emerge from their relational embeddedness within historically contingent and asymmetrically structured networks.

The values and intentions inscribed in socio-biotechnical entities are not external additions but internal to their very construction. This process is aptly conceptualised by Andrew Feenberg through the notion of technical codes. These codes constitute not

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26 On the entanglement of technological design, conflict, and competing interests, see Feenberg, *Between Reason and Experience Essays in Technology and Modernity*; and Akrich, “The De-Description of Technical Objects”. While these works foreground contestation in design, the present analysis seeks to show how the accumulation of such contestations, once sedimented, produces necessity as a historical effect of power—thereby constraining contingency not from without but from within.

27 A similar methodological sensitivity underlies Heidegger’s reluctance to use the term subject, preferring Dasein to avoid the conceptual baggage associated with modern anthropocentrism. While this paper does not directly engage Heidegger’s ontology, it shares his attentiveness to the implications of terminological choices—particularly in avoiding categories that within the context of this paper might sound reductive, such as “technology”.

merely the formal logic of problem-solving, but the material embodiment of particular interests, worldviews, and hegemonic aspirations. Technologies, in this sense, are never neutral instruments; they are battlegrounds—sites where conflicting values confront one another and where, ultimately, certain meanings become sedimented as design choices, interface conventions, or infrastructural norms. In our terms, this process manifests the dialectical logic of technological constitution: group struggles, contradictions, and asymmetries materialise within the socio-biotechnical entity itself, giving form to what is otherwise abstract. The technical code thus becomes the trace of conflict, the stabilised residue of hegemonic imposition.<sup>28</sup>

Once inscribed, these values are not only stabilised but also propagated. Dominant groups aim to embed their vision into the technologies—or more broadly, into socio-biotechnical entities—under construction, ensuring easy adoption and seamless embodiment by users and interacting elements. This process contributes to the reproduction of a way of life by objectifying specific interests within the very networks where entities operate. It strengthens particular threads, forming a topology of potential actions and exclusions, and showcases the capacity of technological configurations to propagate dominant ideologies under the guise of neutrality. As Langdon Winner has argued, technologies may not only reflect but also enforce political arrangements, materialising power relations through design.<sup>29</sup>

Socio-biotechnical entities, once stabilised, may become woven into everyday practices in ways that obscure their origins in conflict and contestation. Their functions and forms appear naturalised<sup>30</sup>—what Gramsci would describe as hegemonic<sup>31</sup>—precisely because their axiological content has been normalised through repetition and habituation. It is thus essential to identify the groups that intervene in technological design, and to scrutinise the values and interests they embed in these configurations. Whether reinforcing existing hegemonies or attempting to subvert them, these groups act upon both human and non-human actants, seeking to configure the network in ways that favour their own position. Design becomes an arena of strategic intervention: a means of subjecting entities—material and symbolic alike—to a socio-biotechnical logic oriented by power.

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28 Feenberg, *Questioning Technology*; Andrew Feenberg, “Teoría crítica de la tecnología”, *Revista iberoamericana de ciencia, tecnología y sociedad* 2, no. 5 (2005): 109–23; Feenberg, *Between Reason and Experience Essays in Technology and Modernity*.

29 Winner, “Do Artifacts Have Politics?” Winner argues that technologies are not neutral artefacts but may embody specific political relationships through their design, organisation, and use. His central claim is not that artefacts are ‘political’ in a simplistic sense, but that their material form can stabilise and reinforce patterns of power and authority. This view resonates with the present analysis, where technological configurations are understood as structured fields of hegemonic inscription and selective closure.

30 Michel Foucault, *Discipline and Punish. The Birth of the Prison*, trans. Alan Sheridan (New York: Vintage Books, 1995).

31 Antonio Gramsci, *Prison Notebooks* (Columbia University Press, 2011).

Alternatively, hegemonic groups may reproduce values within the socio-biotechnical entities they routinely engage with, positioning themselves as translated actors through both non-human and human intermediaries. Socio-biotechnical relations affect all entities, but asymmetrically: the difference lies in their topological position and in the range of actions that each configuration enables or forecloses. In this context, contingency persists, but it does so while navigating the gravitational pull of necessity—a necessity forged through sedimented power relations and stabilised design choices. The apparent fluidity of networks often obscures how specific trajectories become entrenched, inscribed, and reiterated over time. These threads, or traces, mark not openness, but constraint: they indicate the stabilisation of configurations that, while historically contingent, have come to function as if they were necessary.

This reading diverges from key tenets of ANT, which tends to dissolve the question of structural asymmetry into the methodological imperative of symmetry. In ANT, any entity may be positioned at the centre of the network depending on the observer's analytical perspective.<sup>32</sup> While this principle reveals the multiplicity of associations, it risks flattening historically constituted inequalities by privileging epistemic vantage points over ontological constraints. Here, it is not merely a matter of who is followed, but of which entities are more likely to become central due to the sedimented threads that shape the network itself. Possibility, in this sense, is not equally distributed. What appears as openness is often the residue of structured exclusions. Older networks, formed through extended socio-biotechnical interaction, tend to favour particular entities over others, reinforcing hegemonic positions while limiting the space for reconfiguration.

All that we have discussed resonates with the concept of totality, echoing the insights of Theodor Adorno and Max Horkheimer.<sup>33</sup> For us, the network unfolds as a structure in which socio-biotechnical entities attempt to impose meanings on other participants—whether human or non-human. The outcomes of these interactions shape and perpetuate those meanings, contributing to the formation of a totality that operates not as a seamless system, but as a structured field marked by internal contradictions and uneven inscriptions. Such a totality is not monolithic; its apparent coherence is continually disrupted by the emergence of that which resists full integration.

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32 Michel Callon, "Some Elements of a Sociology of Translation Domestication of the Scallops and the Fishermen of St Brieux Bay", in *Power, Action and Belief A New Sociology of Knowledge?*, ed. John Law (London: Routledge, 1986), 196–229; John Law, "On the Methods of Long-Distance Control: Vessels, Navigation and the Portuguese Route to India", *Power, Action and Belief: A New Sociology of Knowledge*, 1986, 234–63. See also Latour, *Reassembling the Social*. For a critique of this methodological symmetry and its aversion to structural asymmetries, see Feenberg, *Between Reason and Experience Essays in Technology and Modernity*, chap. 4.

33 Horkheimer and Adorno, *Dialectic of Enlightenment*; Adorno, *Negative Dialectics*.

In Adorno and Horkheimer's terms, within this totality, the dominant cultural industry produces a standardised reality composed of commodified and mass-produced meanings. Whether consciously or not, participants in the network become both consumers and defenders of this manufactured reality. However, the fissures within totality serve as openings through which the non-identical asserts itself, challenging the predetermined horizon of possibilities dictated by the network. This acknowledges that while the totality constrains the horizon of the possible, its fissures leave open the space for discontinuity, refusal, and reconfiguration.

Against this backdrop, the potential to transcend the confines of the network and reshape its configuration—or to construct a new one—lies in recognising and amplifying these contradictions. Adorno's negative dialectics prompt an interrogation of the fissures within totality as signs of resistance and transformation—fissures that represent the emergence of the non-identical countering the hegemony exerted by leading entities and the threads through which that hegemony is stabilised.

Having outlined the fundamental dynamics through which socio-biotechnical entities embody contested configurations of power and contingency, "Section 3" explicitly engages with the historical dimension of these threads, illuminating how capital and its logic of valorisation shape and constrain the very topology of socio-biotechnical fabrics.

### **3. Theoretical Foundations**

#### ***3. 1 Constructivism assessment: ANT, post-ANT, and the gateways to Marxism***

This section engages with Andrew Feenberg's critical constructivism, the Frankfurt School, and broader constructivist notions as points of departure. Having already analysed the main tenets of the Frankfurt School we are adopting and the aspects we draw upon from Feenberg, we now delve deeper into an analysis of the constructivist perspectives. In doing so, this framework enriches constructivist insights by explicitly incorporating historical sedimentation, structural asymmetry, and the totalising influence of capital, overcoming key limitations identified in traditional ANT and SCOT analyses.

Unlike ANT's perspectivist notion of multiple centres—where any entity may appear central depending on the analyst's observational path—we approach centrality as a historically conditioned topological position, shaped by sedimented power relations. In the realm of STS and the sociology of technology, the contributions of constructivists were notable. This includes scholars examining large technological systems, proponents of SCOT, and ANT/post-ANT. Large technological systems, which amalgamate social and technical dimensions, gain momentum during use, reinforcing the power of the groups

that guide their creation. These groups may invest additional capital, political influence, and cultural sway to fortify their hegemonic stance.<sup>34</sup> While we use alternative terms, our alignment with the underlying ideas is apparent. Meanwhile, the SCOT perspective helps identify relevant social groups that incorporate values into the technology under scrutiny.<sup>35</sup> The concepts drawn from this perspective align with those embraced by Feenberg, who, to some extent, transformed and was inspired by them through his critical constructivism.<sup>36</sup> Simultaneously, ANT complexifies the identification of actors or actants, endowing the technology under development with meaning—entities that may be human or non-human. In this view, an actant denotes any entity capable of influencing others by conveying or transforming meanings within the network it occupies.

In line with ANT/post-ANT, we argue that all entities share the equal potential to occupy the centre in socio-biotechnical networks, webs, or weaves. Yet our stance on contingency, necessity, power, totality, and the internal configurations of entities diverges significantly from these perspectives. While these scholars acknowledge the diminishing significance of contingency as power emerges, they place greater emphasis on it at the onset of a network than we do. We posit, instead, that networks cannot fully begin anew; emerging configurations remain tethered to broader historical fabrics that delimit their topology before they even begin to unfold. This continuity, always partial and uneven, links directly to the concept of totality—though one fractured by fissures.

Without contradicting our earlier premise, we maintain that actors hold an equal potential to become central within a network. However, the actualisation of that potential—particularly in terms of translating the actions of others—is contextually constrained. This tension lies not in the ex-ante distribution of possibilities, but in the historically sedimented configuration of each network. A central distinction here lies in our conception of capitalism—not simply as a mode of production, but as a totality embedded in a socio-biotechnical fabric whose enduring structure will be examined further in this section and the next.

On the other hand, we argue that individual entities acquire their configuration

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34 Thomas P. Hughes, "The Evolution of Large Technological Systems," in *The Social Construction of Technological Systems: New Directions in the Sociology and History of Technology*, ed. Wiebe E. Bijker, Thomas P. Hughes, and Trevor J. Pinch (Cambridge (MA): The MIT Press, 1987), 51–82.

35 Pinch and Bijker, "The Social Construction of Facts and Artifacts: Or How the Sociology of Science and the Sociology of Technology Might Benefit Each Other"; Wiebe E. Bijker, *Of Bicycles, Bakelites, and Bulbs: Toward a Theory of Sociotechnical Change* (Cambridge (MA): MIT Press, 1995); Trevor J. Pinch, "The Social Construction of Technology: A Review", in *Technological Change: Methods and Themes in the History of Technology*, ed. Robert Fox (Amsterdam: Harwood Academic Publishers, 1996), 17–35.

36 Andrew Feenberg, "Critical Constructivism, Postphenomenology, and the Politics of Technology," *Techné: Research in Philosophy and Technology* 24, no. 1 & 2 (2020): 27–40.

through dynamic interactions with their environment—that is, through their relational entanglement with other entities within historically conditioned networks. As noted earlier, not everything is possible. Certain capacities—such as language in humans or lactation in mammals—emerge not from essential properties, but from topological positions shaped by prior configurations. Networks, too, exhibit such patterned constraints: their structure is not neutral, but the outcome of accumulated relations sedimented over time. In this sense, our conceptual framework is not restricted to particular domains; it applies to all entities insofar as their existence and potentiality are shaped by the socio-biotechnical fabrics they inhabit. This opens the space to address a central category in our analysis: capital. For us, capital is not simply a social relation—as it is traditionally conceived in Marxian thought—but a socio-biotechnical one. It configures networks by inscribing values, objectives, and differential capacities into both human and non-human entities, structuring the possibilities available to them and shaping their role within the broader topology of power.

The notion of flat ontology can be linked to the previous ideas. While we acknowledge that material semiotics encompasses various dimensions beyond our specific concerns, we emphasise that its focus on the role of materiality and non-human actants in shaping social and cultural formations remains a crucial point of convergence. According to this view, both human and non-human entities may act within networks, influencing their formation, transformation, and resilience. Moreover, this perspective challenges the traditional distinctions between the social and the material, arguing that they are inextricably intertwined. As John Law notes, “a flat ontology is one that assumes there are no essential distinctions between different kinds of things. Things are different, yes, but this arises in practice in the weave of relations.”<sup>37</sup>

Yet, our understanding of practice diverges from the more immediate, situational reading offered by ANT. For us, practice includes past actions—that is, the sedimented, historically configured threads that contour and constrain networks. In this light, there are no essential distinctions between entities beyond those presupposed by the network’s historical configuration. Returning to the previous examples, one can observe that entities endowed with biological life are themselves the outcome of particular network arrangements: certain configurations can give rise to a cow rather than another entity. This is why some interactions lead to mammals, others to birds, insects, or amphibians.

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37 Law, “Material Semiotics,” 4.

In this sense, the past is of utmost importance, for it shapes the duration<sup>38</sup> through which networks and the entities that inhabit them are moulded. Duration, as we understand it, is not neutral passage, but structured temporality: it accounts not only for constraint, but also for variation. For instance, a cow may manifest as many variations as there are potential interactions among entities within the relevant configuration. What emerges is contingent upon these potentialities—but that very potentiality is already a necessity of the configuration itself.

The emphasis placed here on temporality and historical configuration seeks to address a well-documented tension within constructivist traditions. Both SCOT and ANT have been repeatedly criticised for their reluctance—or methodological inability—to account for the historical conditions that shape the very networks they analyse. Langdon Winner, for instance, has argued that the social constructivist focus on the interpretative flexibility of technologies neglects not only their long-term consequences but also the sociotechnical possibilities that were foreclosed in the process of stabilisation.<sup>39</sup> Hans Radder has similarly pointed out that constructivist approaches often omit the structural conditions under which scientific and technological practices unfold.<sup>40</sup> And David Bloor, representing the Strong Programme, has long contested the methodological symmetry of ANT, arguing that it abandons historical and sociological explanation in favour of descriptive tracing.<sup>41</sup> This critique is sharpened in his essay “Anti-Latour”<sup>42</sup> where he accuses ANT of dissolving causality and power into an undifferentiated field of associations. While ANT introduced an important expansion of the analytic field by including non-human actants, its commitment to tracing associations in the present often results in a kind of empirical presentism. Against this background, the framework developed here seeks to retain the analytical openness of actor-network analysis while embedding it within a robust account of historical duration and structural sedimentation.

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38 The use of the term duration here bears an intentional yet critical resonance with Henri Bergson’s conception of *la durée*; see Henri Bergson, *Time and Free Will: An Essay on the Immediate Data of Consciousness*, trans. F.L. Pogson, Dover Books on Western Philosophy (Mineola, N.Y: Dover Publications, 2001); originally published as *Essai sur les données immédiates de la conscience* (1889). While Bergson understood duration as the qualitative, indivisible flow of conscious experience, the usage here refers to the historically configured temporality through which socio-biotechnical networks sediment possibilities and constrain emergence. This formulation retains Bergson’s insight that time is not reducible to homogeneous instants but diverges in that it aligns more closely with a topological logic of material inscription than with a philosophy of lived experience. I acknowledge this genealogy as part of the conceptual atmosphere in which this text was first developed—even if my sympathies tend to diverge, particularly in light of Bergson’s polemic with Einstein, whose understanding of temporality I find in some respects more persuasive.

39 Winner, “Do Artifacts Have Politics?”.

40 Radder, *In and About the World*, esp. chapter 2.

41 David Bloor, *Knowledge and Social Imagery* (Chicago: University of Chicago Press, 1991).

42 David Bloor, “Anti-Latour,” *Studies in History and Philosophy of Science Part A* 30, no. 1 (1999): 81–112.

As John Law suggests, understanding the relationships between humans and non-humans requires attention to the structures in which they are embedded—structures that may be conceptualised as weaves, webs, or networks. As we interpret them, these forms correspond to varying levels of complexity. Weaves represent simple patterns of interconnection—threads entangled within a local fabric. Webs imply a more intricate structure, akin to a spider’s web, with multi-directional connections that integrate several weaves. Networks, in turn, denote expansive configurations composed of multiple webs and weaves interacting dynamically. These networks do not remain isolated; they combine with others of similar extension to generate broader architectures. Together, such configurations contribute to what we term the capitalist network—a more persistent and stabilised formation often referred to as the capitalist system. It operates, in this sense, as a network of networks, or a system of systems, organising the conditions under which all other networks unfold.

Material semiotics suggests that networks can be traced indefinitely in their associations and effects, implying a potential for infinite unfolding. We do not dispute this possibility, but insist that such unfolding is never neutral: it always refers back to and is delimited by the broader and enduring socio-biotechnical formation of capitalism. Every thread traced ultimately reveals its connection to that structuring network, whose historical stability renders the very idea of openness contingent upon prior configurations of power and value.

This notion aligns with the Adornian concept of totality. The interconnectedness of networks—a system of systems—does not generate coherence but rather introduces structural tensions and contradictions. The overlap between subsystems becomes a generative site for these contradictions, as competing logics and asymmetrical configurations confront one another. Simultaneously, this very interconnectedness gestures toward the existence of a totality: not a seamless unity, but a structured field in which fissures and residues persist. It is, in other words, a fragmented and incomplete network—a fractured totality in which the non-identical resists full absorption.

The concepts of path dependence and “QWERTY-nomics”—closely related to the dynamics explored by Hughes in his theory of large technological systems<sup>43</sup>—resonate with our understanding of how socio-biotechnical networks sediment configurations over time, progressively narrowing the field of viable alternatives. As Paul David has shown, once a particular technological path becomes dominant—such as the QWERTY keyboard layout—subsequent developments are increasingly constrained by compatibility requirements, institutional inertia, and cumulative investment in infrastructure and user

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43 Hughes, “The Evolution of Large Technological Systems.”

habituation.<sup>44</sup> Brian Arthur expands on this insight, noting that increasing returns often reinforce suboptimal paths, not because they are inherently superior, but because their adoption triggers a positive feedback loop across economic and technical domains.<sup>45</sup> In socio-biotechnical terms, this is not merely a matter of economic lock-in: it reflects the thickening of specific threads within the network—threads that materialise prior alignments of values, decisions, and interests. Over time, such configurations displace alternative paths and become naturalised. What was once contingent comes to function as necessity—not ontologically, but through historical sedimentation and network reinforcement. This logic illustrates how even within frameworks attentive to contingency and actor multiplicity, the past continues to impose topological constraints on what may emerge.

Having clarified how socio-biotechnical configurations sediment over time—transforming contingent pathways into stabilised structures—we are now in a position to revisit the interwoven concepts of hegemony, necessity, and totality. These categories, initially introduced as theoretical orientations, may now be reformulated as emergent features of historically reinforced networks—whose most persistent and structurally dense expression, in the current historical moment, is capital.

In hegemonic configurations, threads symbolise not merely past interactions but the normalisation of specific values and interests within socio-biotechnical entities. These values do not appear externally imposed, but are so smoothly embodied that they seem intrinsic to the entities themselves. When this embodiment becomes dominant, the network no longer enables all possibilities to unfold—necessity emerges, not as an ontological given but as a historical narrowing of what counts as viable. The configuration thus ceases to operate as a site of pure contingency; it becomes a topology structured by exclusions, alignments, and constraints. The interconnection of networks, or systems of systems, gives rise to a totality: a broader, persistent, though incomplete structure. In the present era, this formation bears the name of capitalism—a socio-biotechnical fabric whose encompassing reach is fractured by residues that resist full absorption, thereby allowing the emergence of the non-identical.

This analysis invites a final question: what is the ontological status of the primary actant that sustains and reproduces the coherence of this socio-biotechnical totality? While the answer will be developed further in the next subsection, we can anticipate it here: capital, in its historically sedimented form, has come to operate not only as a dominant force but as a structuring agent of networks themselves. Through its transformations into commodities,

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44 Paul A. David, "Clio and the Economics of QWERTY," *The American Economic Review* 75, no. 2 (1985): 332–37.

45 W. Brian Arthur, *Increasing Returns and Path Dependence in the Economy* (Ann Arbor, Michigan: University of Michigan Press, 1994).

money, and abstract labour, capital does not merely shape human action—it configures the positionalities of entities within the network, inscribing relational asymmetries that must be continually reproduced. These configurations constitute a dynamic, historically contingent topology in which the threads of domination and resistance are constantly reknotted, frayed, or severed. It is this terrain—marked by both structural reproduction and potential rupture—that demands further exploration.

### *3.1.1 Threads, Historicity, and Critique in Networks*

The critique of ANT for its rejection of history, ideology, and structure not only allows for the reintroduction of a politicisation previously expelled by its excessive empiricism but also enables a more rigorous conceptual reformulation of the very notion of the network. Indeed, if socio-biotechnical configurations do not emerge *ex nihilo* but are constituted through historically sedimented processes—selective, conflictual, and unequal—then the connections that structure them cannot be conceived as flat or interchangeable links. It is here that our concept of the thread becomes meaningful: not as a mere visual metaphor, but as an analytical figure that captures the temporal, topological, and political density of the relations that compose a network.

Unlike the symmetrical links of ANT—where anything can be associated with anything else by virtue of its performative inscription—threads operate as socio-biotechnical vectors of sedimentation, whereby each condenses technical decisions, institutional prescriptions, normed bodies, stabilised signs, and memories of exclusion. Far from referring to any pre-existing substantiality, their thickness emerges from a dynamic of repetition with difference, where returning elements are transformed by the historical tensions that traverse them. This is not a difference that proliferates without memory, but a differentiation historically inscribed in relations of power, in which unresolved conflicts are reactivated without being overcome, configuring trajectories that sediment antagonisms in contingent yet non-arbitrary forms—forms whose very configuration bears witness to the unresolved conflict that constitutes them. Contiguity, within this framework, is not neutral: not all proximities are equivalent, nor do all associations have the same effects. Positions within the network stabilise or destabilise depending on their relation to logics of valorisation, which modulate which connections prosper, which are rendered invisible, and which become structurally operative.

These threads do not merely connect; they anchor. They do not simply allow movement; they distribute friction. In this sense, the network may be read as a tense formation, in which certain persistent centralities are not merely effects of tracing, but rather manifestations of a politics of stabilisation that operates on and through the tracing itself, in a simultaneous and constitutive relation. This tension ultimately refers to the logic of hegemony: threads stabilise configurations without fully closing them, modulating the

field of the possible without eliminating its contingency. The resulting totality is not closed but unstable—always in tension, yet no less effective for it.

If, in ANT, the network is topologically open, multiple, and reversible, the notion of the thread allows us to identify how certain trajectories fix meaning, foreclose bifurcations, and reinforce necessity within the heart of contingency. Contingency persists, but it is oriented, compressed, and stratified by forces that are not symmetrically distributed. Where ANT sees assemblages, we read asymmetrical codifications of duration and power. In that asymmetry lies the politicisation of networks—not as the outcome of external impositions, but as the immanent result of their own formative processes.

This perspective thus distances itself from the relational neutrality of ANT, recovering the core of the critique formulated by Söderberg and Netzén, who warn that a theory which dissolves all structuration into ephemeral networks risks becoming “hot air,” incapable of either intervention or articulation with the material conditions of social reproduction.<sup>46</sup> Against this, the concept of thread allows us to expose how capital is not merely one position among others within the network, but a logic of differential threading, a practice of codification that transforms flexibility into a vector of valorisation and contingency into a resource for capture.

### ***3.2 The Importance of the Capital Valorisation Cycle***

#### *3.2.1 Entities Produced as Commodities.*

Having established that networks are socio-biotechnical configurations structured by differential threads of power and capital, we now turn to the entities that inhabit and animate these formations. These entities are not merely embedded within the network—they are articulations of its logic. As crystallisations of sedimented threads, they condense design, control, and function, circulating not as neutral intermediaries but as active sites of valorisation. In this sense, they are not simply technological artefacts, but commodity-entities—forms whose operationality depends on their insertion into broader circuits of reproduction and accumulation.

Capital—understood, following Marx, as a process of dialectical transformation—advances through the valorisation cycle by converting commodities into surplus value. For any socio-biotechnical entity, including technologies, to participate in this cycle, it must be produced and sold at a profit. This condition is not optional: failure to achieve

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<sup>46</sup> Johan Söderberg and Adam Netzén, “When All That Is Theory Melts into (Hot) Air: Contrasts and Parallels between Actor Network Theory, Autonomist Marxism, and Open Marxism,” *Ephemera: Theory & Politics in Organization* 10, no. 2 (2010): 95–118.

profitability jeopardises the reproduction of values within the socio-biotechnical fabric and undermines the hegemonic position of those who encoded their interests into the entity's design. The threads sustaining a given configuration begin to fray if valorisation is interrupted. Indeed, without already occupying a favourable topological position, no group can contest the network's structure unless this requirement is met—for the topology of capital only amplifies those entities that reinforce its reproduction.

However, it is not only necessary to close the cycle but also to realise the expanded reproduction of capital.<sup>47</sup> Failure to achieve this may lead other companies to displace specific production with alternatives meeting this new requirement. Thus, it is mandatory to generate a monetary output funding the renewal of capital, tied to the amount of use values produced per hour per worker, compared to another producer of a similar socio-biotechnical entity or technology. The technological landscape in capitalism tends to showcase technologies that succeed in valorising the cycle set in motion by capitalists who created or reproduced them. These dynamics reinforce the thickening of certain threads within the network, privileging configurations that align with capital's reproductive imperatives.

Success implies competition and the intrinsic need to regularly reduce costs to increase market share against alternatives. The valorisation cycle suggests that the additional money obtained in the formula M-C-M' (Money–Commodities–More Money) tends to be realised more quickly in a competitive environment. This accelerates the demand for shorter production times, prompting further reductions in costs during the production process. In this context, advertising plays a significant role in enabling new technologies to reach larger audiences, thereby helping to secure the way of life for hegemonic groups when campaigns succeed. Every advertisement functions not merely as a tool of persuasion, but as a socio-biotechnical entity in itself—one that organises perception, encodes values, and limits contingency by aligning consumer decisions with preconfigured market trajectories. These advertising threads, too, become woven into the broader fabric of capital, reinforcing the circuits through which valorisation is achieved and replicated.

In this framework, parts composing commodities—as dialectical transformations of capital—emerge as key actants in the valorisation process. Their obduracy to be assembled with less labour time shapes the actions of capitalists seeking to control or redesign production methods. Yet capital remains the primary actor, continually pursuing self-valorisation within the capitalist accumulation cycle. It does so by organising and aligning commodities with its own objectives, fully embodying the logic of the M-C-M' cycle. Hence, capital operates as the driving force within the entire socio-biotechnical

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<sup>47</sup> Karl Marx, *Capital. A Critique of Political Economy*, trans. David Fernbach, vol. II (Harmondsworth, Middlesex, London: Penguin & New Left Review, 1992).

network, translating humans into capitalists or workers, and technologies into means of production and commodities.<sup>48</sup> These translations are not neutral: they crystallise and reinforce the threads through which capital sustains its topology of domination.

This dynamic resonates with Hughes' notion of technological momentum and the related concept of path dependence.<sup>49</sup> The notion of path dependence clearly illustrates how initial contingencies become historically sedimented necessities, reinforcing hegemonic configurations in socio-biotechnical networks. A well-known case is the QWERTY keyboard—as mentioned above—whose historical adoption limited subsequent alternatives. Groups capable of fuelling expanded capital reproduction acquire momentum in their configurations, making it increasingly difficult to integrate competing technologies into the existing fabric. These inherited structures exemplify thicker and reinforced threads—relations that sediment prior investments, exclusions, and hegemonic values within the network. Importantly, this valorisation dynamic not only constrains entities produced as commodities. Its influence extends—albeit more indirectly—even to those configurations that emerge outside strictly commodified contexts, as we will discuss in the following section.

### 3.2.2 Entities not Produced as Commodities.

If commodification is not achieved, the capital valorisation cycle may not fully unfold. Yet this does not imply an absence of influence: the effects of previous sedimentations persist. Consider that even if the produced entity is not a commodity, the effects of past threads (or paths and stock of technologies) will still exist, and the logic of capital may have an impact depending on the positions within the network topology of human actors or actants who design and construct any given technology.

We already know the threads constituting the enduring capitalist network are embodied in socio-biotechnical entities to varying degrees. The topology created is continually reproduced, and it is guaranteed by the threads' thickness and quantity, which, in turn, relates to the values reproduced by those networks. These threads link entities of any form and type, but the unfoldings of capital embodied in those entities, represented by the threads capital creates, are the condition of possibility for the network's broader expansion and temporal durability. For instance, capital creates capitalists or workers. When a human assumes the pre-existent topological role of a capitalist, it is simply because they follow the rules.

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48 Within “flat ontology,” practice determines the topological structure of hierarchies. Roles, such as capitalists and workers, are dictated by the current network, but future entities may assume these topological positions, maintaining symmetry between humans and non-humans.

49 See: David, “Clio and the Economics of QWERTY,” and Arthur, *Increasing Returns and Path Dependence in the Economy*.

Within the socio-biotechnical fabric, specific positions emerge from the relationships between diverse entities. Humans and means of production, for example, set constraints and possibilities for action. Ownership and control of means of production, indicative of the potential to embody capital, lead to distinct possibilities and constraints in technology development compared to actors without that potential. Söderberg (2010)<sup>50</sup> offers illustrative examples, some of which we will briefly explore in the following section.

#### **4. Capital, Technical Codes, and the Structuration of Socio-biotechnical Positions**

Technological analysis cannot be reduced to the mere tracing of heterogeneous associations. It requires attending to the ways in which values are encoded, stabilised, and reproduced within socio-biotechnical entities. This is the premise of critical approaches such as Feenberg's instrumentalisation theory and his concept of technical codes, which identify how dominant social groups inscribe particular norms, objectives, and constraints into the material structure of socio-biotechnical configurations—structures usually referred to as technologies. These inscriptions are not incidental, but politically structured: they reflect the position of actors—human or non-human—within broader configurations of power. While perspectives like SCOT name these groups “relevant social groups” and stress the interpretative flexibility of artefacts, and ANT highlights the symmetrical contribution of human and non-human actors, our approach insists that not all actors participate from equivalent positions. What matters is not only that a network is formed, but who is structurally positioned to shape its codes—and how subjective identifications mediate the values inscribed in these processes.

This question brings us to the structural role of capital within networks. For us, capital is not simply a background condition or a social relation external to technological development—it is an actant, for it actively structures the topology of the socio-biotechnical fabric. Through the process of valorisation, capital inscribes itself into entities, transforming them into commodities or means of production, and positioning them according to the imperatives of accumulation. This logic does not merely influence actors from the outside; it configures the very conditions under which actors can emerge, operate, and stabilise their influence. Flat ontology, when reused critically, does not negate these structural asymmetries—it demands that we account for them within the network itself. If everything is relational, then the persistence of capital as a structuring force is a relational achievement—one that shapes the codes, positions, and constraints within which other entities unfold.

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50 Johan Söderberg, “Reconstructivism versus Critical Theory of Technology: Alternative Perspectives on Activism and Institutional Entrepreneurship in the Czech Wireless Community,” *Social Epistemology* 24, no. 4 (October 2010): 239–62, <https://doi.org/10.1080/02691728.2010.506962>.

In this context, direct control names a topological position within the network that an entity—typically a human actor—subsumes others to the logic of capital by actively orchestrating the valorisation process. This is not mere participation, but agency on behalf of capital. The one who exerts direct control commands the fixed capital involved, steers design and production choices and directs the integration of other entities (human or non-human) into the accumulation cycle. In this sense, we conceptualise the capitalist not only as someone who owns the means of production, but as a socio-biotechnical configuration capable of aligning heterogeneous elements under the imperative of surplus extraction. Control, here, is not a property of subjects but a positional achievement conditioned by the broader network's sedimentation. What we call “direct” is not immediate voluntarism, but structured efficacy: the capacity to act in the name of capital and to configure other positions accordingly.

These dynamics can be observed in Söderberg's analysis of wireless community networks, where class positions and access to production resources directly shape technological design. In projects like Ronja, actors lacking capital ownership experimented with alternative models—such as donation-based frameworks—that resisted dominant market logics. However, these efforts faced limitations imposed by the broader capitalist network: dependencies on global supply chains, monetised notions of time, and infrastructural constraints revealed the difficulty of maintaining autonomy in a system that rewards capital-friendly designs. By contrast, projects like Crusader, which aligned more closely with entrepreneurial values, adopted design choices conducive to mass production, proprietary protection, and market integration.<sup>51</sup>

This contrast illustrates how the socio-biotechnical fabric conditions technological possibility. Design is not a free-floating practice; it is situated within networked positions that carry historically sedimented values, constraints, and incentives. Capital, in this light, is not just one actor among others—it is the structuring principle of the broader topology, reinforcing configurations that secure its reproduction. Technologies may deviate from its logic momentarily, but the gravitational pull of valorisation and market rationality tends to reassert itself, reconfiguring even the most experimental efforts toward forms legible within the hegemonic fabric.

In this framework, the means of production—conceptualised as non-human actors and as the manifestation of capital within the productive process—exert manifold influences on human actors keen to initiate the capital valorisation cycle (regardless of how they name or frame this process). For example, the Ronja project, as highlighted by Söderberg, deviated from the conventional entrepreneurial route by experimenting with a donation model. Clock, the initiator of the Ronja project, believed that user-controlled technology

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51 Söderberg, “Reconstructivism versus Critical Theory of Technology.”

was incompatible with market dynamics. However, this attempt faced contradictions, such as dependence on the global market in consumer electronics and the inadvertent reintroduction of a monetarised way of thinking about time. On the one hand, the model relied on the existing market for consumer electronics to realise the Ronja project: components were sourced globally, exposing an inherent dependence on market relations. On the other hand, the donation model reintroduced monetarised logics by calculating contributions based on the hours Clock spent problem-solving—linking financial support directly to time invested. These entanglements reveal the difficulty of escaping capitalist dynamics, even when alternative imaginaries are pursued.<sup>52</sup>

The second aspect relates to subjective self-perceptions of human actors or actants. The values they attempt to inscribe in technologies under development vary depending on how they conceive of themselves. For instance, a self-identification as a hacker, rooted in a set of values and interests inscribed in the psyche and body of a particular person, can lead to the incorporation of corresponding values into technological designs that align with the ideals of those particular groups. Consequently, it is not surprising to find conceptions of freedom of circulation of digital goods in such subjects and, thereby, in the technological designs they conceive. They might then attempt to organise other participants in the networks they engage with, seeking validation for a value system consistent with the one they advocate for the object under construction. If successful, the technology integrates those values into its structure. This highlights the importance of identifying technical codes in socio-biotechnical analysis, as they allow us to uncover the ways of life being projected, normalised, and potentially hegemonised through technology. These codes are not purely rational inscriptions; they condense the affective, symbolic, and practical dimensions that actors carry with them into the design process.

These observations point to a more general principle: decision-making does not emerge from reason alone but from a multiplicity of dispositions—emotions, intuitions, sensibilities—shaped within the socio-biotechnical fabric in which each actor is embedded. Even when rationality would suggest consistency, identification and context may bend a decision in unforeseen directions. Thus, when analysing socio-biotechnical entities, one must trace not only the local network that gives them form but also the broader architectures that sustain their emergence and constrain their configuration. In the present historical conjuncture, this broader, more persistent fabric is capitalism—a socio-biotechnical totality whose dominant modes of accumulation (be they post-Fordist, cognitive, informational, or financial) inscribe new threads into the very entities we seek to understand. This demands a critical orientation, one that does not simply describe networks but interrogates the structuring presence of capital within them.

In this way, capital not only mobilises entities but also reinforces specific threads whose

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52 Söderberg, “Reconstructivism versus Critical Theory of Technology.”

density and alignment weave the broader socio-biotechnical fabrics in which design, agency, and value are inscribed.

## 5. Conclusions

This paper has developed a critical approach to socio-biotechnical networks by integrating constructivist insights, actor-network perspectives, and Marxist analysis within a broader reflection on totality. Against the empiricist flattening of difference found in traditional ANT and the limited theorisation of structural power in SCOT, we have foregrounded the tension between contingency and necessity as a defining feature of technological configuration. Our approach insists that while networks may emerge from contingent alignments, these are quickly constrained by historically sedimented structures—what we conceptualise as threads—whose accumulation gives rise to the broader fabrics that condition the field of possibility.

Within this framework, socio-biotechnical entities are not neutral intermediaries but sites of valorisation shaped by asymmetrical power relations. The concept of technical codes allows us to trace how values are embedded in material forms, aligning design with the hegemonic interests of dominant groups. But this embedding is not merely imposed; it is negotiated through positionalities within the network. Capital, in this light, is not simply one actor among others—it is the structuring principle of the broader topology, shaping which entities may stabilise their positions and how.

We have introduced the concept of direct control to name the capacity of certain actors—particularly human ones—to act on behalf of capital by orchestrating the valorisation cycle and aligning other entities with its logic. This positional capacity is not a personal attribute but the effect of networked sedimentations that render certain roles structurally central. Technological design, therefore, is not merely a technical or cultural act—it is a politically situated intervention into the topology of the socio-biotechnical fabric.

Yet despite this structuration, contingency persists. It persists not as infinite openness, but as the residue of what could have been otherwise—traces of unrealised alternatives that resist full integration. Following Adorno, we have argued that the totality formed by these networks is fractured: it cannot wholly absorb the non-identical, which manifests in obdurate artefacts, counter-hegemonic values, and marginal positions. These fractures matter, for they mark the limits of domination and the points at which new values, configurations, and collectivities may emerge.

To analyse socio-biotechnical entities critically, then, is to trace not only the networked associations they mobilise but also the sedimented threads they carry, the values they

encode, and the fractures they reveal. It is through such a gaze that critique can intervene—not from outside the fabric, but from its very seams.

**Author note:** This work utilised AI tools to translate sections from Spanish to English and to assist in reviewing the English writing, as English is not my first language. The author also gratefully acknowledges editorial guidance that contributed to improving the quality and clarity of the English expression.

## References

Adorno, Theodor W. *Negative Dialectics*. New York & London: Routledge, 2004.

Akrich, Madeleine. "The De-Scription of Technical Objects". In *Shaping Technology/Building Society. Studies in Sociotechnical Change*, edited by Wiebe E. Bijker and John Law, 205–24. Cambridge (MA) & London: MIT Press, 1992.

Arthur, W. Brian. *Increasing Returns and Path Dependence in the Economy*. Ann Arbor, Michigan: University of Michigan Press, 1994.

Bergson, Henri. *Time and Free Will: An Essay on the Immediate Data of Consciousness*. Translated by F.L. Pogson. Dover Books on Western Philosophy. Mineola, N.Y: Dover Publications, 2001.

Bijker, Wiebe E. *Of Bicycles, Bakelites, and Bulbs: Toward a Theory of Sociotechnical Change*. Cambridge (MA): MIT Press, 1995.

Bloor, David. "Anti-Latour". *Studies in History and Philosophy of Science Part A* 30, no. 1 (1999): 81–112.

———. *Knowledge and Social Imagery*. Chicago: University of Chicago Press, 1991.

Callon, Michel. "Some Elements of a Sociology of Translation Domestication of the Scallops and the Fishermen of St Brieux Bay". In *Power, Action and Belief A New Sociology of Knowledge?*, edited by John Law, 196–229. London: Routledge, 1986.

Correa Lucero, Horacio. "Tecnología, Artificialidad y Hábitat: Teoría Crítica de La Tecnología y Su Aplicabilidad al Estudio Del Hábitat En Tanto Objeto Tecnológico". *Revista Horizontes Sociológicos* 4, no. 8 (2016): 123–46.

David, Paul A. "Clio and the Economics of QWERTY". *The American Economic Review* 75, no. 2 (1985): 332–37.

Descombes, Vincent. *Modern French Philosophy*. Cambridge: Cambridge University Press, 1980.

Feenberg, Andrew. *Between Reason and Experience Essays in Technology and Modernity*. Cambridge, Mass.: MIT Press, 2010.

———. "Critical Constructivism, Postphenomenology, and the Politics of Technology". *Techné: Research in Philosophy and Technology* 24, no. 1 & 2 (2020): 27–40.

———. "Critical Theory of Technology: An Overview". *Tailoring Biotechnologies*, 2005. <https://doi.org/10.5040/9798400670268>.

———. *Questioning Technology*. London & New York: Routledge, 1999.

———. *Technosystem: The Social Life of Reason*. Cambridge, MA: Harvard University Press, 2017.

———. "Teoría crítica de la tecnología". *Revista iberoamericana de ciencia, tecnología y sociedad* 2, no. 5 (2005): 109–23.

Foucault, Michel. *Discipline and Punish. The Birth of the Prison*. Translated by Alan Sheridan. New York: Vintage Books, 1995.

Gramsci, Antonio. *Prison Notebooks*. Columbia University Press, 2011.

Grumley, John E. *History and Totality: Radical Historicism from Hegel to Foucault*. New York & London: Routledge, 1989.

Haraway, Donna. "A Cyborg Manifesto: Science, Technology, and Socialist-Feminism in the Late Twentieth Century". In *Simians, Cyborgs, and Women: The Reinvention of Nature*, edited by Donna Jeanna Haraway, 149–82. New York: Routledge, 1991.

Hommels, Anique. "Changing Obdurate Urban Object: The Attempts to Reconstruct the Highway through Maastricht". In *Urban Assemblages. How Actor-Network Theory Changes Urban Studies*, edited by Ignacio Farías and Thomas Bender, 139–59. New York & Abingdon: Routledge, 2010.

———. *Unbuilding Cities. Obduracy in Urban Sociotechnical Change*. Cambridge (MA): MIT Press, 2005.

Horkheimer, Max, and Theodor W. Adorno. *Dialectic of Enlightenment*. Edited by Gunzelin Schmid Noerr. Translated by Edmund Jephcott. Stanford: Stanford University Press, 2002.

Hughes, Thomas P. "The Evolution of Large Technological Systems". In *The Social Construction of Technological Systems. New Directions in the Sociology and History of Technology*, edited by Wiebe E. Bijker, Thomas P. Hughes, and Trevor J. Pinch, 51–82. Cambridge (MA): The MIT Press, 1987.

Jameson, Fredric. *Postmodernism, or, The Cultural Logic of Late Capitalism*. Durham: Duke University Press, 1992.

———. *The Political Unconscious: Narrative as a Socially Symbolic Act*. London & New York: Routledge, 2002.

Jay, Martin. *Marxism and Totality: The Adventures of a Concept from Lukács to Habermas*. Berkeley: University of California Press, 1984.

Laclau, Ernesto. *New Reflections on the Revolution of Our Time*. 2nd edition. Phronesis. London & New York: Verso, 1990.

Laclau, Ernesto, and Chantal Mouffe. *Hegemony and Socialist Strategy. Towards a Radical Democratic Politics*. 1st. edition. London & New York: Verso, 1985.

Latour, Bruno. *Reassembling the Social: An Introduction to Actor-Network-Theory*. Oxford: Oxford University Press, 2005.

Law, John. "Material Semiotics". Heterogeneities.net. John Law's STS Web Page, 2019. [www.heterogeneities.net/publications/Law2019MaterialSemiotics.pdf](http://www.heterogeneities.net/publications/Law2019MaterialSemiotics.pdf).

———. "On the Methods of Long-Distance Control: Vessels, Navigation and the Portuguese Route to India". *Power, Action and Belief: A New Sociology of Knowledge*, 1986, 234–63.

Marx, Karl. *Capital. A Critique of Political Economy*. Translated by David Fernbach. Vol. II. Harmondsworth, Middlesex - London: Penguin & New Left Review, 1992.

Pálsson, Gísli. "Ensembles of Biosocial Relations". In *Biosocial Becomings: Integrating Social and Biological Anthropology*, edited by Tim Ingold and Gísli Pálsson, 22–41. New York: Cambridge University Press, 2013.

Pinch, Trevor J. "The Social Construction of Technology: A Review". In *Technological Change: Methods and Themes in the History of Technology*, edited by Robert Fox, 17–35. Amsterdam: Harwood Academic Publishers, 1996.

Pinch, Trevor J., and Wiebe E. Bijker. "The Social Construction of Facts and Artifacts: Or How the Sociology of Science and the Sociology of Technology Might Benefit Each Other". In *The Social Construction of Technological Systems. New Directions in the Sociology and History of Technology*, edited by Wiebe E. Bijker, Thomas P. Hughes, and Trevor J. Pinch, 17–50. Cambridge (MA) and London: The MIT Press, 1987.

Radner, Hans. *In and About the World: Philosophical Studies of Science and Technology*. Albany: SUNY Press, 1996.

Söderberg, Johan. "Reconstructivism versus Critical Theory of Technology: Alternative Perspectives on Activism and Institutional Entrepreneurship in the Czech Wireless Community". *Social Epistemology* 24, no. 4 (October 2010): 239–62. <https://doi.org/10.1080/02691728.2010.506962>.

Söderberg, Johan, and Adam Netzén. "When All That Is Theory Melts into (Hot) Air: Contrasts and Parallels between Actor Network Theory, Autonomist Marxism, and Open Marxism". *Ephemera - Theory & Politics in Organization* 10, no. 2 (2010): 95–118.

Tsing, Anna Lowenhaupt. *The Mushroom at the End of the World: On the Possibility of Life in Capitalist Ruins*. Princeton & Oxford: Princeton University Press, 2015.

Winner, Langdon. "Do Artifacts Have Politics?". In *The Whale and the Reactor: A Search for Limits in an Age of High Technology*, by Langdon Winner, 19–39. Chicago: University of Chicago Press, 1988.

Žižek, Slavoj. *Less Than Nothing: Hegel and the Shadow of Dialectical Materialism*. London & New York: Verso Books, 2012.

———. *The Sublime Object of Ideology*. 2nd. Edition. The Essential Žižek. London & New York: Verso, 2008.