Wasting to Slow Down Time - the Paradox of Informational Waste

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Abstract

This chapter examines the concept of informational waste by tracing its relationships with energy, value, and time. The concept of *data exhaust* is often used as a metaphor for datasets that have outlived their original role and are subsequently used for secondary purposes of analytics and surveillance. In this chapter, the concept is taken literally by contrasting it with physical waste and focusing on its materialities and their implications. To understand the role of infotrash in the digital economy, this article examines how it paradoxically serves as a mode of value creation. Examples discussed include the *proof-of-work* blockchain, which creates computational friction to delay transactions, and informational clutter generated to maximise the time users spend on a page. In both cases, the bulk of the information involved is not generated for its semantic content but for its material effects.

Keywords: data exhaust, data proxies, materiality

What is informational waste?

The internet can often feel like a landfill, a place swamped by a deluge of emails, spam, and unneeded data. Undoubtedly, the concept of informational waste, sometimes described as infotrash, is familiar to most people. Dealing with digital information can be unproductive and draining, as anyone who has tried downloading emails on an expensive international data plan while travelling abroad knows. "90% of what we do in digital is either useless waste to begin with or else quickly ends up in a data dump," as writer Gerry McGovern polemicises (McGovern, 2020): 90% of the web is clutter and defunct code, and 90% of data collected is never used or analysed. McGovern sees the digital world as inherently wasteful, consuming vast amounts of resources and energy, generating toxic electronic waste, and most importantly, promoting a wasteful mindset. In short, the problem of informational waste presents an urgency, just like physical trash. But this is where the analogies typically end: information and matter are considered opposing categories. Tech companies touting the dematerialisation of the economy through immaterial, frictionless, and infinitely scaleable digital information reinforce this dichotomy. This chapter challenges these claims by examining physical waste from an informational, and informational waste from a material perspective. Invoking materiality is, of course, a familiar mode of tech critique, whether it emphasises the emissions, e-waste, or exploitative labour practices of the digital economy. The two-pronged approach of this chapter goes beyond accounting for its material impacts by exploring the finer structural connections between waste and information that operate through incorporeal aspects such as value and time.

What can we learn about informational waste from our longer experience with physical trash? Waste commonly describes anything that has lost its value and is no longer useful in a particular context. This definition implies that what is currently viewed as waste was once a valuable resource in a different time or context. 'To waste' as a verb makes this notion of loss explicit—the act of wasting as the unproductive use and consumption of resources such as land, materials, labour, or time. In economic terms, waste is therefore often framed as an inefficiency. With more efficient processes, resources could have been preserved and more value extracted. More than a lost opportunity, waste is a liability that incurs costs, whether in the form of mandated waste treatment or tipping fees. From the perspective of production, it therefore makes economic sense to minimise, if not completely avoid, inefficiency and waste.

However, the lens of inefficiency does not capture the realm of consumption. In current capitalist realities, wasting is not an incidental loss but, somewhat paradoxically, a deliberate mechanism for generating value. The price of oil depends on its consumption and combustion, just as the stock market price of companies such as DOW and BASF depends on the widespread waste and disposal of single-use plastic products. “The future of plastic is in the trash can,” as the Future Modern Packaging magazine editor Lloyd Stouffer famously declared in the 1950s—in order to thrive, the plastic industry had to teach consumers how to waste (Cited in Liboiron, 2021). Wasting as the basis of value production is a pervasive notion that includes treating human labour as an expendable resource. In disaster capitalism, a crisis is a terrible thing to waste (Klein, 2007).

Given that single-use plastic waste is clearly profitable for certain industries, it is not enough to define waste solely in terms of value and utility. The concept of planned obsolescence touches on this issue, but does not go far enough. The broader goal is not just to shorten the lifespan of a product to sell more of it, but rather to produce something that is waste in the first place. It appears that only the act of wasting, discarding, or disposing ultimately determines what constitutes waste. This is reflected in international agreements such as the Basel Convention(Basel Convention, 2023) and entities such as the European Union. The latter defines waste as “any substance or object which the holder discards or intends or is required to discard” (European Commission, 2008). Discarding is, however, never a final act but rather a transition into formal and informal waste systems, expansive sociotechnical infrastructures whose size and complexity can rival every other industrial process.

In the case of informational waste, the act of deleting a dataset from a hard drive is almost inconsequential in itself. Wasting does not take place on the side of the user but on the side of the producer, who uses energy, labour, and natural resources to produce and maintain information in vast quantities that is useless from the beginning. This chapter examines the logic of *wasting to generate value* in the digital economy, which depends, as I will argue, on constant infotrash production. To this end, I apply a critical approach that does not limit itself to an account of the harmful and neglected material impacts of digital technology but more broadly considers the production of informational waste as a material practice that plays a variety of roles in digital capitalism.

Waste as a material

Physical waste is matter that needs to be dealt with. Waste has material agency through its visceral nature, it presents itself as some kind of problem. As historians of infrastructure such as Martin Melosi have pointed out, what kind of problem depends on perspective and worldview: For a public health department, waste is a public health issue; for a homeowner association, it is an aesthetic nuisance; for engineers, it is a logistic problem; for environmental justice advocates, harm and injustice (Melosi, 2004). Each of these perspectives not only suggests different ways of dealing with waste but also conceptualises the concept in different terms and categories.

Despite its tangible presence, waste is therefore ontologically not stable. As it undergoes physical separation and chemical transformations, trash changes its labels and categories. Marjory the Trash Heap, the omniscient character in Jim Henson’s *Fraggle Rock*, receives its infinite wisdom from being *everything,* speaks in varying accents and occasionally changes its gender. Initially, discarding is an act of disqualification—throwing something away erases its individual properties; it becomes part of a fluid, undifferentiated mass (Pardo, 2006). But once materials enter the managed waste stream, new taxonomies apply;

waste is differentiated and sorted by physical properties or internal composition. The labels of waste and its associated notions of value depend on location and context, the policies and waste management systems in place.

The informational dimension of waste is inseparable from its material qualities. Reflecting different worldviews and problem definitions, frameworks and taxonomies of waste are necessarily incomplete; their metrics of quantification inevitably emphasise some aspects while leaving others out. The practice of collecting waste data offers many examples in this regard. For a long time, the bulk volume and tonnage of waste generation have been the main metric used by cities. Volume has also dominated public imagination, comparing waste production to the pyramids or considering the visibility of New York's former Fresh Kills Landfill from outer space. Only recently, the diffuse smog of microplastic pollution has entered the public consciousness. Its relevant characteristic is no longer its volume or density but its pervasive presence across the atmosphere, oceans, and living organisms. For the endocrine-disrupting effects of many plastic components, the dose and the amount of exposure are no longer relevant, only their presence (Liboiron, 2016). The many problems of plastic recycling have been discussed for some time (MacBride, 2012), but its role as a source of microplastic pollution has only recently received attention (Stapleton et al., 2023). It may take decades before a harmful impact manifests itself and decades for a regulatory response to be put into action. Assessments of waste impacts depend on the questions being asked, which evolve with scientific and political discourse.

Waste as information

I have previously called attention to various connections between waste and information (Offenhuber, 2017b). In the following discussion of infotrash, two aspects will be particularly relevant: First, the explicit labels and value attributions of waste that incompletely represent its material agencies; and second, hidden material information that is present but not recognised.

Explicit information Waste management both requires and generates a significant amount of structured data. However, due to the fragmented nature of waste systems, relevant data are rarely shared across participants in the waste system and remain confined to administrative and organisational boundaries. Municipalities and counties typically use their own systems, which have varying degrees of sophistication. As Scheinberg et al. note, the quality of waste data can be used as a proxy for the overall quality of the corresponding waste system, while the quality of waste management services tends to indicate the overall quality of local governance (Scheinberg et al., 2010: 206).[1] It has often been criticised that municipalities measure their recycling systems only through diversion rates, the proportion of recyclable materials diverted from the waste stream, but rarely track how much of that material has actually been recycled or the amount of emissions avoided (MacBride, 2012; Pollans, 2021; Zaman and Ahsan, 2019).

The effort spent on gathering waste data tends to mirror the perceived worth of the waste itself, regardless of whether that value is positive or negative. Recycling companies are particularly interested in the amount of metals found in curbside recycling; aluminium, steel, and copper are not only high-value secondary raw materials but are also not difficult to recycle. Likewise, materials with a negative value need to be closely observed: materials designated as toxic or hazardous that require costly treatment and, therefore, require monitoring and tracking. Neoclassical economics explicitly ties the concept of value to information, treating market price as an informational signal and a key indicator of value. The extreme reductiveness of this concept makes it flexible and widely applicable, but it comes at the cost of ignoring environmental and social consequences.

[1] Waste management is typically a municipal responsibility.

Latent information While the act of wasting reduces individual objects into an undifferentiated mass, waste still bears the traces of its history; a material witness that testifies to past events and processes (Schuppli, 2020). It is not a coincidence that waste plays an important role in forensic investigations. Gonzo Journalist and self-described *garbologist* AJ Weberman understood this when he kept stealing trash bags from Bob Dylan's townhouse in Greenwich Village, seeking evidence that would support his various conspiracy theories about the musician (Weberman, 1980). Another garbologist, Bill Rathje, excavated landfills in Arizona to study the behaviours of consumer society. As an archaeologist, he knew that the refuse people leave behind often reveals more about their behaviour than surveys and interviews (Rathje and Murphy, 2001). Rathje found, for example, that people generally overestimate their recycling behaviour and understate their alcohol consumption. As a physical trace of human activity, waste is material information. For Rathje, it is a reliable source because it is incidental. But while explicit labels are intended to capture a single aspect, material traces capture a wide range of events—they have *autographic* or self-inscriptive qualities (Offenhuber, 2023).

The latent and explicit informational aspects of waste are closely interconnected. The act of disposal involves erasing explicit information but, at the same time, generates a physical trace that includes not only the discarded object but also the imprints of its place, use, and context. Furthermore, both forms of information stand for two distinct methods of examining waste. Creating labels and categories are modes of generalisation, while the forensic perspective is concerned with individualisation, "the idea that no two things in the physical world are ever exactly alike" (Kirschenbaum, 2008: 10). Both methods are used to renegotiate the informational aspects of waste—for example, in waste composition studies, in the international trade of waste, or in the investigations of a future garbologist.

Informational waste

In the realm of infotrash, we can also find data that have fulfilled their original purpose and require management and disposal. Similarly, we can distinguish between explicit and latent information. Before turning to the materiality of informational waste, I will examine these two aspects in the symbolic domain: information explicitly obtained for a particular purpose and incidental information associated with the process of data collection.

Data waste Data have a lifecycle just like consumer products; at some point, a datum has outlived its original purpose and is no longer useful. Just like its physical counterparts, data waste can present an urgency. For once, its volume can be substantial; version control systems preserve every single datum in countless instances. Cloud storage for long-time archiving can be expensive, and obsolete data presents a risk and a liability when it falls into the wrong hands. Considering the capabilities of forensic data recovery methods, the only reliable way to destroy a dataset that has become a toxic liability is the shredder, which turns data literally into scraps of e-waste. Similar to hazardous substances, obsolete data are subject to regulations that prescribe specific treatments. To prevent organisations from unnecessarily keeping data about individuals, the European Union's General Data Protection Regulation's (GDPR) framework requires media companies and data controllers to remove data that is "inadequate, irrelevant, or no longer relevant."(European Commission, 2018)

Even before regulations such as the GDPR were in effect, most data were destroyed at the end of their life cycle; the current practice of pervasive and obsessive data retention is a relatively recent phenomenon. According to the tech journalist Kevin Kelly, the online auctioning platform eBay did not archive expired transaction data as late as 2006, as it saw no use for this information.[2] The city of Los Angeles has counted traffic on major

[2] In a personal conversation

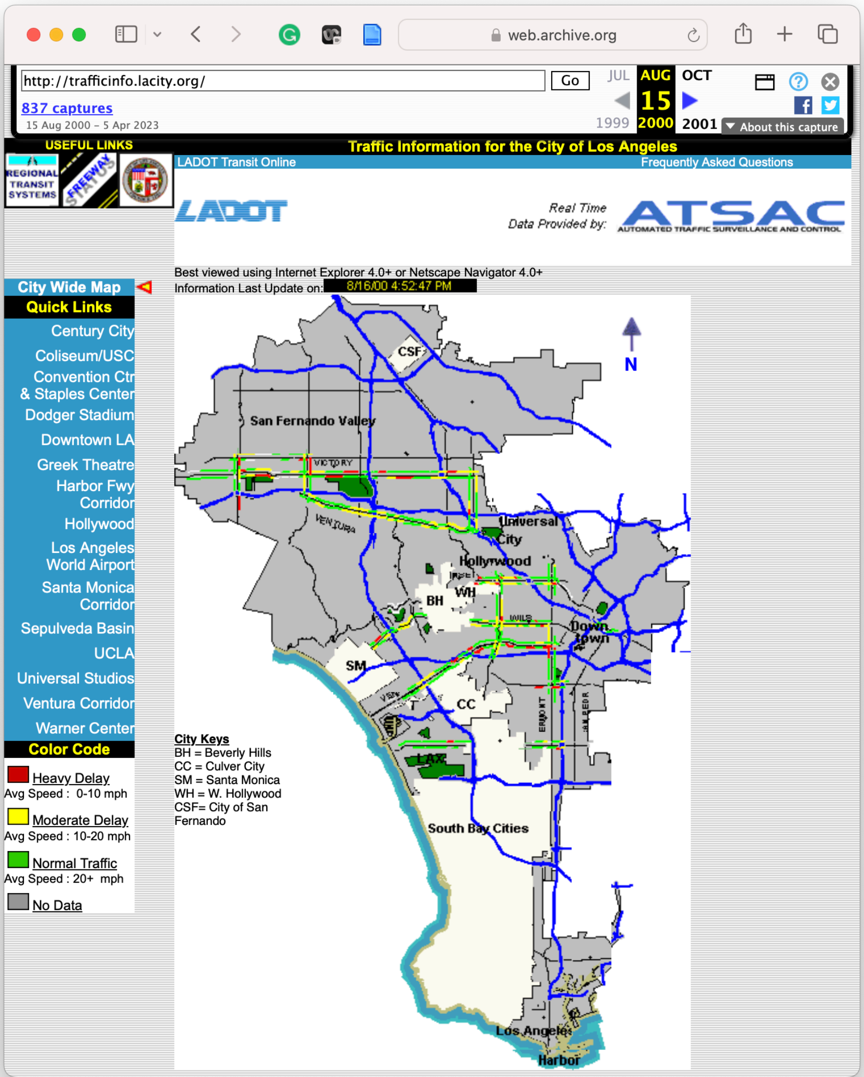

Figure 1: Archived screenshot of Los Angeles' live traffic info from August 2000. Source: Archive.org

intersections using induction sensors since the mid-1980s and processed this information to control traffic lights and visualise traffic conditions in real-time (see fig. 1). [3] These data, which could have served as a fascinating archive to study the history of traffic in Los Angeles, were not preserved by the city. Historical transaction records and traffic sensor readings are examples of what the big data industry calls *data exhaust*—data as incidental by-products of various activities within digital infrastructures; data that are no longer useful for the immediate purpose for which they were collected.

Opportunistic data sources As companies shift their revenue models from services to hoarding and monetising data, we can observe a shift from the explicit to the forensic perspective. In examples like the early eBay, a datum fulfilled an explicit function in a process. Once that process is complete, data are no longer useful and become data exhaust. The *Big Data* hype of the early 2010s discovered data exhaust as a profitable information source. Data are no longer only used for their original purpose but instead mined for clues about users, their behaviours and intentions. This is possible because digital data can also hold latent information, even if their sparsity and rigidity are no match for the richness and complexity of physical traces. Similar to how a digital audio recording of a busy street offers many clues about events that have taken place, any large and dense enough dataset, even if it only consists of a single variable, contains the imprints of the context of data generation. The nighttime glow of cities in satellite images, originally an unintentional outcome of military surveillance programs, is used as a proxy for measuring global economic activity (Hall, 2001; Offenhuber, 2017a). Search engine queries, which reflect the intentions of users and the issues affecting them, have been used to predict flu outbreaks; bad online reviews of scented candles point to the frequency of COVID-19 related loss of smell (Beauchamp, 2022; Lazer et al., 2014). Similar to the information recovered from Rathje's landfill excavations, such unconventional data sources can help estimate an otherwise unmeasurable phenomenon or offer a different perspective on a known issue.

At this point, it may be useful to briefly discuss the difference between data and information, which is often framed in the equation *information = data + meaning* (Floridi, 2005).[4] Data are always concrete material artefacts, such as holes in punch cards or magnetic charges on a hard drive. Associated with language and mental concepts, information is more incorporeal, even though material accounts of meaning have become more prominent in recent years (Latour, 2013; Peters, 2015). Any meaningful dataset can thus be thought of as embodying both explicit and latent information. Explicit information is what a datum is intended to represent through its value. Latent information, on the other hand, is relational; it is expressed in the internal statistical patterns and relationships among data points. A single GPS datum refers to a geographic location, but a million GPS points can reveal much more: for example, blurry areas may point to regions with poor GPS reception, such as streets surrounded by tall buildings. In this case, the two variables of latitude and longitude suddenly reveal a latent third one associated with the topography and the heights of the buildings, but only if enough data are available to let the clouds of uncertainty emerge. Just as the materialities of measurement inscribe themselves into the coordinates, no measurement only captures what is intended to be measured, but also countless other related aspects. Working with data proxies involves embracing outliers and artefacts as potential clues rather than errors that undermine the quality of the analysis.

The forensic principle of individualisation can be observed in the methods used by commercial data brokers, who integrate diverse sources that relate to the same individuals but offer little overlap otherwise. The results are new hybrid datasets whose scope and depth surpass each individual contributing source. This raises privacy concerns: while each

[3] See an archived version from August 2000 at (LADOT, 2000)

[4] In a critique of this formula, Floridi argues that a definition of information also needs to be contingent on its truthfulness - information that is not truthful would be misinformation.

contributing dataset may be anonymous and unproblematic in itself, the resulting dataset may not be. The controversial method of *digital fingerprinting* is used to identify visitors by combining harmless data points such as the user's browser version, timezone, or the list of installed fonts.[5] However, when taken together, they establish a unique digital context that allows identifying a digital device and tracking it across multiple websites. Any data source can potentially be used as a proxy, just as any discarded material offers clues about the activities and contexts of its use and disposal. Big data analysis of proxies is therefore not like searching for a needle in a haystack, but rather manufacturing a needle by extracting metal from a large quantity of hey.[6] To observe social behaviours and interactions, one can, in principle, start with almost any dataset available in large enough quantities, considering that almost any aspect of life, at least in the cities of the Global North, is somehow directly or indirectly connected to digital infrastructures that constantly capture data.

Informational waste reduction The notion that any data source can potentially be used and monetised as a proxy has led to indiscriminate data gathering and archiving, irrespective of their immediate purpose. Much like single-use plastic produced for the landfill, data exhaust is bulk material often generated without a clear purpose. If data are already created with a secondary use in mind, they are no longer strictly speaking *data exhaust*; the line between intentional data collection and data recycling becomes increasingly blurred. Its value for marketing or other purposes is often taken for granted and generally overestimated, but there is little intrinsic incentive for informational waste reduction. The principle of data minimisation in the GDPR policy is intended to counter such tendencies, serving as an informational equivalent to waste reduction. The German concept of "Datensparsamkeit," or data frugality, is not only a countermeasure to companies engaged in surveillance capitalism (Zuboff, 2019) but also to the widespread threat of data leaks that expose private information to scammers. In 2023, the national Austrian Broadcasting Corporation lost a dataset containing sensitive information about the entire Austrian population to hackers (ORF, 2023).

The materiality of informational waste

Since all data are material entities, informational waste has a material dimension. Challenging characterisations of digital data being efficient and clean, researchers have tried to quantify the significant environmental impact of data infrastructures such as server farms, data warehouses, or cloud computing resources. Elettra Bietti and Roxana Vatanparast describe the concept of data waste as "the carbon emissions, natural resource extraction, production of waste, and other harmful environmental impacts directly or indirectly attributable to data-driven infrastructures. These include platform-based business models, the programming and use of AI systems, and blockchain-based technologies" (Bietti and Vatanparast, 2020). Estimates suggest that digital infrastructure generates between 3 and 4% of global greenhouse gas emissions, a figure higher than that of global commercial aviation (Ferreboeuf et al., 2021).

Physical friction The explicit material dimension of data can be illustrated through the process of bitcoin mining. The Cambridge Center for Alternative Finance tracks the electricity consumption of the bitcoin network, which in August 2023 amounts to an estimated annual 139.3 Terawatt hours (TWh)—higher than the annual energy consumption of all global gold mining operations, and about the same as the total annual

[5]For an explanation and evaluation of the own digital fingerprint, see for example (Electronic Frontier Foundation, 2023)

[6]This metaphor is not as absurd as it might seem. Artist Cecilia Jonsson harvested 24kg of grass from a contaminated mining site and forged an iron ring from the metals absorbed by the plants (Jonsson, 2013).

electricity consumption of Sweden.[7] This number is so high because the purpose of bitcoin mining is literally to waste energy. To create material friction[8] in computational networks that slows down information transfer just enough to make it prohibitively difficult for attackers to falsify transactions on the bitcoin blockchain; a security principle described as *proof of work*.(Nakamoto, 2008) Transactions are encoded in nested cryptographic calculations that require significant computational effort to solve. As more miners participate in the process, the difficulty of these calculations increases (fig. 2). As a result, it always takes about 10 minutes for a solution to be found and a new block with consolidated transaction records to be added to the blockchain. Remarkably, the vast number of cryptographic values computed during that process are largely meaningless - the goal of the process is arbitrarily set to find a highly improbable pattern of leading zeroes. Since a higher value of bitcoin attracts more miners, value is implicitly related to the energy wasted during mining. *Proof of work* is ultimately about friction in the physical world.

In a space where information is purely abstract and the physical effort of computation negligible, no encrypted communication would be safe from attacks. Cryptography hinges on the material nature of data; on the fact that it takes a certain amount of time and energy to decode messages, guess passwords, and break into systems. But cryptography and bitcoin mining are not the only areas where digital technologies depend on analogue friction precisely because they are constrained by it. The rationale for physical friction is more layered in the case of useless information clutter on the web. A primary goal of digital sludge, such as online advertisements and AI-generated filler text, is to extend the time a user spends on a page by obstructing them from satisfying their informational needs. Time spent on a page directly translates into advertising revenue, and data clutter achieves this not only by distraction and obfuscation but also by technically overwhelming and consequently slowing down the user's browser with bloated content. However, most web content is not made solely for human users. Before a user can spend time on a page, it must first be discoverable in search results. Search engine algorithms and other indexing bots are a second important audience that ad-revenue-seeking website providers need to cater to by simulating rich content and relevant connections to other sites. A third layer of friction is the measurement of attention itself, facilitated through hidden processes of data-sharing, bidding, and surveillance that are activated once a user visits a page. Since an online advertiser cannot directly measure a visitor's attention and interest in a web advertisement, ad revenue is determined based on convoluted proxies that measure time, interactions, and traffic. However, these proxies can be easily gamed by both users and website providers. Engagement metrics do not always correspond to real user interest but are often manipulated through web design tactics, automated bot networks, and click farms—facilities where low-income workers earn their income by clicking on thousands of ads per day on a wall filled with mobile phones. On all these layers, the production of informational clutter generates monetary revenue, albeit at the expense of natural resources, energy, and a corresponding carbon footprint.

The production of informational waste closely follows the organisational logic and funding mechanisms of tech companies. Author Cory Doctorow observed that digital platforms like social media sites or marketplaces often become less useful as they mature. He coined the provocative term "Enshittification" to describe their lifecycle, driven by intentional management decisions (Doctorow, 2023). In his interpretation, digital platforms initially try to lure users by offering them a valuable service. Once they have established a large user base, they shift focus, prioritising value for businesses such as advertisers and retailers. Eventually, the platform aims to maximise value for its shareholders, to the detriment of both regular users and business clients. At this point, the life cycle is complete, and the platform dies. In Doctorow's account, the first step for users typically means content they

[7]As of Fall 2023, for current numbers, see (Center for Alternative Finance, 2023)
[8]See Paul Edwards' concept of computational friction (Edwards, 2013: 84)

did not ask for, more ads, paid articles, and informational clutter. Over time, these materials become the dominant elements on the users' screen, overshadowing content they originally hoped to find. In the second step, advertisers and businesses become dependent on the platform, which increases their prices and plays them against each other. This dependency gives rise to another form of informational waste: arcane practices of search engine optimisation (SEO), by which businesses and advertisers try to outsmart the platform's algorithm by flooding it with keywords, tags, and other metadata in the hopes of gaining visibility. However, their attempts are ultimately futile because the platform operators can manipulate the algorithm at will. Today, most online content is tainted with useless and misleading metadata and descriptors, adversely affecting AI and machine learning models trained on content scraped from the internet.

Considering the recurrent theme of machines generating informational clutter for other machines, one is reminded of the concept of *interpassivity.* Introduced by philosopher Robert Pfaller, who describes the strange phenomenon of machines consuming media on behalf of the user, illustrated by the canned laughter in a sitcom or a video recorder that tapes shows that are consequently never watched by the owner. In Pfaller's interpretation, the laugh track laughs and the recorder watches so that users don't have to; it consumes on their behalf (Pfaller, 2017). Much of the internet's infrastructure now operates on this principle: browsers fill their caches with preloaded information that a user will never see; how-to pages are cluttered with AI-generated paragraphs designed to draw out the time a user seeking information has to spend on a page. Operating systems are pre-filled with bloatware - useless software cluttered with features that are rarely useful but occasionally spy on the user in the background. As excessive data hoarding has become a common corporate practice, it is worth speculating how much of the previously undervalued data generated by computing infrastructures, now collected in big data repositories, may be overvalued—with machines analysing data for its own sake, its results never reaching decision makers.

Data materiality is again the relevant framework for analysis. In the previous examples, it is raw computing power and volume rather than the semantic information content that matter. While the value of information is subjective and context-dependent, the material aspects of information waste can be expressed in terms of carbon emissions, resource extraction, and hazardous waste production. Any account of data materiality must include the physical human labour, from miners in murderous cobalt mines to workers in click farms, and the global inequalities and environmental injustices that typically accompany resource extraction and waste disposal. In his geological account of digital media, theorist Jussi Parikka links data infrastructures to the geological formations that store the fossil fuels that power them and those that harbour their refuse, such as carbon emissions and electronic waste (Parikka, 2015). The loop is closed by technologies of remote sensing and geophysical modelling that are used to discover and extract new geological deposits of energy used to produce diesel, batteries, or photovoltaic elements.

Wasting to slow time As the proof-of-work blockchain and the clutter of information on the web illustrate, waste and monetary value are inextricably linked, with value being the product of waste. The bitcoin network wastes computational resources to slow down the block generation time, thereby producing scarcity and security; many websites, and even search engines like Google itself, generate revenue by wasting their users' time and patience as they try to maximise the time spent on their site. But this may sound more polemical than it really is. The slowing of time through computational friction plays a profound role at the interface between the analogue and digital worlds.

To understand this, one has to realise that in purely digital systems, temporality does not

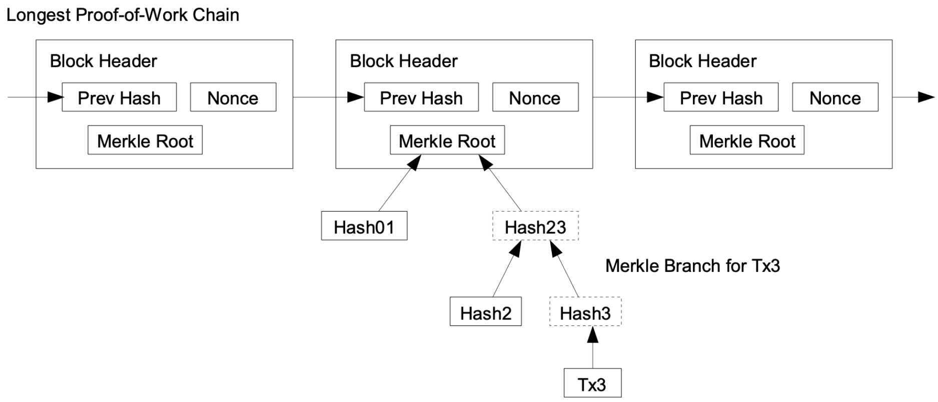

Figure 2: *Proof of Work* - structure of the bitcoin blockchain (Nakamoto, 2008)

exist. A digital device is an analogue device that has eliminated time[9]—digital algorithms can distinguish between before and after but lack any concept of duration. A digital system cannot discern whether a step takes 5 milliseconds or five years; it has no bearing on the result. In order to generate clock time, digital computers, therefore, rely on analogue components such as quartz crystals or analog resonators. Time has to be brought back in from the physical world. But clocks can be manipulated and timestamps falsified. By pushing computing hardware to its physical limits, the computational friction of *proof-of-work* couples the digital back to the physical world, where time cannot be negotiated. There is a natural limit to how many calculations can be completed and how much energy can be mobilised, even if this limit changes over time. A purely symbolic world has no friction - the theoretical model of a Turing machine can calculate any computable number (Turing, 1936), but its physical implementation would require a lot of patience. In other words, the abstract variable of time, which can be modified at will, is replaced by physical change, which is bound to physical limits. But computational friction has another consequence since the ability to enact physical change is also the ability to mobilise energy, labour, and resources. While a cheap computer will eventually reach the same result as a more expensive one, the computational friction of *proof-of-work* strongly favours those with access to resources that can push computation to its limits. Re-introducing time brings back the power relationships of the social world.

However, slowing time is a difficult task in an environment of constant acceleration. For the past 50 years, Moore's Law has provided the roadmap for exponential growth in the processing speed and complexity of integrated circuits, accompanied by an equivalent growth in users and computing resources. In the example described, this requires that even more energy be expended to slow down computational processes in order to create value. Just as industrial capitalism depends on the generation of physical waste, the dialectic of computational capitalism requires an increase in informational waste. In the case of the blockchain, the wasteful mining process re-introduces the power relationships and economic inequalities of the physical world into the symbolic space of information: miners with access to resources such as cheap electricity, space, and the ability to access and purchase the newest and fastest mining hardware in large quantities dominate those with less resources.

[9]See Norbert Wiener's comments at the Macy Conferences "Every digital device is really an analogical device which distinguishes region of attraction rather than by a direct measurement. In other words, a certain time of non-reality pushed far enough will make any device digital." (Pias, 2003: 159)

The preceding examples may seem related to the concept of the attention economy, which posits that in a state of general information overload, attention becomes the relevant currency (Davenport and Beck, 2001). In reality, it is almost the argument presented here is the exact opposite. The concept of the attention economy does not consider machine attention, which plays a central role in the examples discussed above. But more fundamentally, the argument presented here is not based on the concept of semantic information or the desire to extract rare insights from vast amounts of data. Time and attention are not treated as subjective but as direct equivalents of energy, shaped by machines as much as human experience. As Doctorow notes, there is no such thing as the attention economy since attention is not a medium of exchange or a store of value (Doctorow, 2023). Attention can only be monetised through observable data, which relies on technical proxies that involve a considerable amount of machine agency. The primary purpose of infotrash is not a struggle for human attention but the anchoring of an unmoored digital domain in the analogue world by spending material labour and energy.

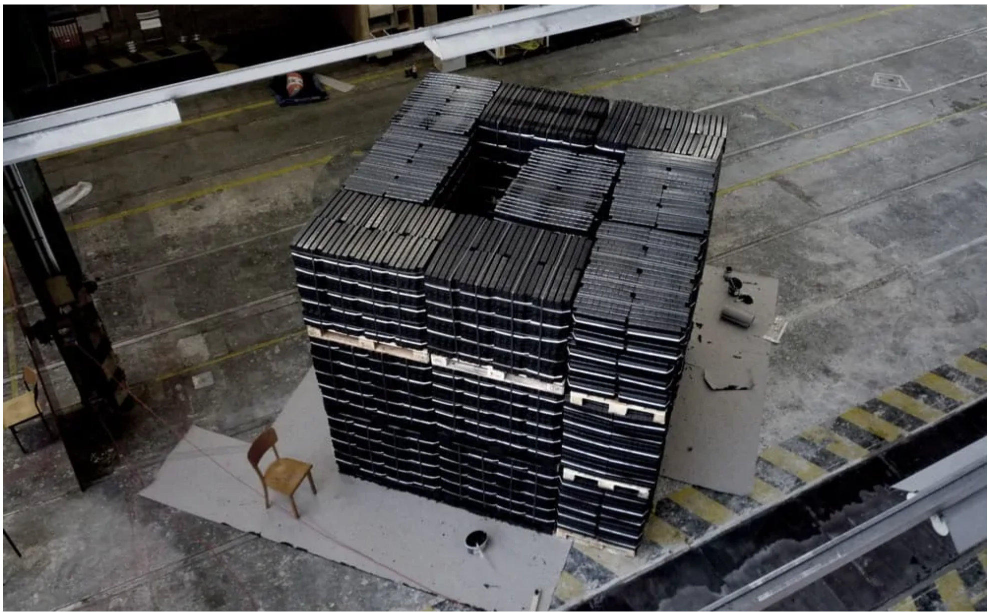

Figure 3: Michael Saup, AVATAR – incarnation cRdxXPV9GNQ, 2009

This perspective on informational waste can be illustrated by artist Michael Saup's coal sculptures, which he describes as avatars, that embody energy equivalents of online activities such as streaming a video of the movie "Avatar"(fig. 3). The avatar not only represents or references but manifestations through its physically stored energy. Just as geological formations and strata are manifestations of time and processes of erosion and accretion, the blockchain is a quasi-geological artefact that physically embodies carbon and human labour. As geological time leads to remarkable patterns and formations, the bitcoin blockchain boasts consistently and improbably low hash values in the block headers—one of the few persistent clues of the immense computational resources necessary to find these highly improbable results of a complex computational process that results in a deterministic, but unpredictable, usually large number. Considering the close entanglement with energy, it is perhaps not a surprise that the geopolitical relationships of geological resource extraction are partially mirrored in the global landscapes of mining for attention and value. While China has recently banned bitcoin mining, it is still the second-largest mining hub following the US. (Cambridge Judge Business School, 2022)

Sorting waste and information

As argued in this chapter, infotrash is not merely a side effect of cheap access to abundant information but is often deliberately generated to create physical friction in digital networks, which amplifies the influence of capital and power in the digital sphere. In this capacity, it counteracts the narrative of the inherently democratising effect of digital technology, which has dominated the discourse throughout the past decades. From desktop publishing in the 1990s to filmmaking, map-making, and data visualisation, the proliferation of digital tools has challenged the monopoly of experts. At the same time, we have witnessed a handful of companies seize control of technological practices—the sprawling landscape of blogs, Usenet, and independent web servers in the early 2000s has been all but absorbed into the platforms of social media giants. To parse this paradox, it is helpful to examine the material underpinnings of digital platforms. The most exclusionary technologies tend to be those that require vast resources in terms of energy, hardware, and expert labour, which only very few actors can afford. This is glaringly obvious in the most ambitious AI projects, which require such an immense amount of computational resources and labour—both menial data workers and highly paid scientists—that the most significant breakthroughs only tend to come from tech giants like Meta, Google, Microsoft (including its partnership with OpenAI), and Nvidia, sidelining academia to a secondary role. Similarly, the generation of informational waste increases barriers, creates frictions that demand more resources, and consequently favours those who can afford them. Considering that blockchains are essentially technologies of friction, which reintroduce the notion of the *original* into digital space through vast computational efforts, the promises of crypto-companies to decentralise the web have to be taken with a grain of salt.[10]

The interdependencies of waste and value, of materiality and temporality examined in this chapter show why critiques limited to examining the wastefulness of digital technologies fall short. As the experience with single-use plastics and physical trash can teach us, waste is not an incidental by-product of convenience, it is often the purpose that drives entire industries. This contradicts the traditional, essentially moralistic view of waste as an inefficiency, which, if eliminated by exercising restraint, would leave everyone better off. McGovern succinctly summarises this view, echoing environmentalist arguments: "Why? Because we can. Because it's easy. Because it's cheap" (McGovern, 2020: 27). A second lesson from waste management is offered by the complex infrastructure of the waste- and recycling system, in which the definitions of waste change frequently and often hinge on symbolic labels. Despite the visceral materiality of waste, what is waste depends on context. If 90% of data generated are crap, is a well-curated dataset that has never been analyzed, as McGovern suggests, infotrash because it takes up server space, consumes electricity and wears down hardware (McGovern, 2020: 23)? And does the dataset then cease to be trash once it is used as training data for an AI model—even if that process consumes vastly more energy?

To overcome simplistic dichotomies of matter and information, this chapter differentiates between explicitly assigned and implicitly embodied information, which both apply to physical waste and infotrash. In the recycling industry, a simple label change can have far-reaching consequences. An old CRT TV set, deemed hazardous waste and banned from export in some states, becomes a donation for reuse that can bypass export restrictions. It makes a difference whether substances are disposed of or merely temporarily stored, even if the storage area is later abandoned through a planned bankruptcy. The categorisation and informationalisation of waste is a highly politicised topic. It is at the centre of informal labour and unionisation efforts in the global south and pollution controversies in the global north. With China recently banning the import of 32 categories of scrap materials

[10]This includes the less resource-intensive *proof-of-stake* protocols, which undergird web3 architectures, see for example (Edelman, 2021)

including papers, plastics, and other common household recyclables, it also has a geopolitical dimension (Wen et al., 2021). The informational-symbolic dimension matters for physical trash, just as the material dimension does for informational waste. Implicitly embodied information, which turns physical trash into traces and clues about human behaviours and past events, is also part of informational waste, where it incentivises massive data collection and retention in the hope of monetising insights about consumers. In this sense, data is not defined as a means to an end but as a potentiality: harmless browser configuration data can become useful for an entirely different purpose when linked with other datasets.

We can learn about infotrash from physical waste by considering the latter's informational rather than physical messiness. I have described the multiplicity of taxonomies of trash, their local differences and incompatibilities, and their temporal instability as a result of a messy political process that extends from the local to the global. In contrast, tech companies present their digital ecosystems as seamless, placeless, and logically consistent. The prevailing minimalist aesthetics of user interfaces conveys simplicity and universality. While the smartphone interface of the ride-sharing app Uber may look identical anywhere in the world, this seamlessness is a labouriously crafted illusion since the company has to painstakingly tailor its operations to comply with diverse local policies and labour laws. Tech companies equally tend to avoid revealing the messiness of human labour their services rely on. Sorting data exhaust requires human labour and attention in many different forms. Tasks such as data cleaning and labelling at various stages of training and validating AI models are often undertaken by crowd-workers, an invisibilised form of human labour (Gray and Suri, 2019). By foregrounding the agency of technology, tech companies deliberately downplay the substantial role of human tasks in their products and devalue these physically, emotionally, and intellectually draining activities as menial labour. Amazon's naming choice for its *microtasking* service is a self-ironic nod and a fitting metaphor—Mechanical Turk is a historical reference to a seemingly intelligent chess robot that was, in reality, driven by a human crammed into its belly.(Amazon, 2023a) The platform is indispensable for data labelling and AI model testing.(Amazon, 2023b) The worlds of waste management and AI labour come together in AI-driven computer vision (CV) systems, which are now commonly used for sorting in many recycling centres.(Recycleye, 2023) Just like traditional recycling centres depend on human labour for manually removing objects from the waste stream that cannot be handled by mechanical sorting methods, CV systems require manually annotating many images of waste, identifying their outlines and shapes and labelling their materials.(Keymakr, 2023) Just like social practices of sorting, separating, and reorganising materials can constitute a mode of material critique, focusing on the messy nature of digital work and its various materialities can help us overcome the false dichotomy perpetuated by the aesthetics of techno-minimalist design.

Finally, the promise of acceleration through immaterialisation is always accompanied by opposing practices of increasing friction and deceleration. While the newest laptop may be faster, lighter, and more powerful than its predecessor, it usually comes with a new OS version that requires more memory and processing power. Bloated software upgrades slow down older machines and make them obsolete, while the progress bars on new hardware seem to keep moving at merely the same pace. Excessive online ads and background code not only serve the purpose of spying on the visitors of a website but also of slowing down their online experience to boost ad profits. Producing obsolescence by managing time, informational waste echoes the temporality of physical waste, its decay and transformation. In this sense, informational waste re-introduces analogue time into digital space, thereby generating scarcity and friction that reproduces the power structures and inequalities of the physical world.

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