

A User-Centered Lens into Digital Excess: Exploring the Superfluity and Environmental Burden of the Digital World

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ABSTRACT

This article seeks to take a new view on the environmental burden of information and communication technology through the concept of *digital excess*. Our notion of digital excess draws from Georges Bataille's argument that the main problem of any economy is excess rather than scarcity. We take a user-centric lens into this concept and discuss various aspects of our digital lives that could be perceived not to carry meaningful value but appear as wasteful and superfluous, while also harming individuals, society, or the planet. We provide examples from digital media services where digital excess may be regarded as, for example, accumulation of self-created content with redundant copies or inattentive consumption of high-bandwidth streaming services. In consonance with related work in the Sustainable Human-Computer Interaction community, we encourage follow-up empirical investigations of the practical manifestations of this concept, which could help to further understand, problematize, and possibly also mitigate the growing energy use of ICT. For the design of digital services, focusing on digital excess offers a lens through which designers could simultaneously optimize multiple quality criteria that conventionally require trade-offs (e.g., environmental sustainability vs. lively user experience vs. economic viability).

CCS CONCEPTS

•Human-centered computing~Interaction design~Interaction design theory, concepts and paradigms

KEYWORDS

Digitalization, Digital world, Environmental sustainability, Excess, Waste, Abundance, Scarcity, Conceptualization.

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1 Introduction

Over the past decades, it has been well established that digitalization does not come without costs to the environment. In addition to the long-debated hardware-centric issues like short product lifecycles or insufficient management of e-waste [18, 21], we are seeing an upsurge of energy consumption caused by the infrastructures of our digital lives [9]. As a result, the share of the information and communication technology (ICT) sector in global greenhouse gas emissions is rapidly growing [2], adding up to estimates between 2.1% and 3.9% [4]. In particular, the energy consumption resulting from internet use tends to be overlooked [17]. Concerning digital media services alone, for example *streaming video* (i.e., video-on-demand services, social media services, games, porn, video conferencing) has been extensively problematized (e.g., [12]), highlighting the proliferation of their use especially during and after the COVID-19 pandemic. Masanet et al. [13] justifiably underline that this is more than the national energy consumption of many countries.

We echo the critique voiced by research agendas like *ICT for Sustainability* (e.g., [7]), *Sustainable Human-Computer Interaction* (SHCI; also *Sustainable Interaction Design*) (e.g., [25]), and *Computing within Limits* (e.g., [16, 24, 32]) and insist on recognizing the latent environmental burden and the material conditions of the digital world itself. We agree that, in addition to pursuing sustainability *through* digitalization, analysis of environmental sustainability *of the digital* is also necessary. More broadly, this article builds on broader discourses and problematization pertaining to technology, especially following the long traditions in Science and Technology Studies (STS), and argues for analysis of ICT artifacts both in terms of their positive implications and the potential harms to society, culture, and the planet (e.g., [19, 33]).

However, bringing about a systemic shift towards a more sustainable digital world is deemed very challenging and perplexed by value tensions (e.g., [32]). What is essential but somewhat evident by now is that minimizing energy consumption is generally not a key priority in the industrial production of digital services. Promising initiatives and design

methodologies have been proposed in design philosophy (e.g., [15]) and in different practitioner communities (e.g., UNEP's "Design for Sustainability"¹, Permacomputing², and "Planet-Centric Design"³), but such voices seem to represent the minority in the industrial praxis. An arguably central reason behind this is the economic incentives that are driving the digital transformation; after all, digitalization is largely motivated by dominant capitalist and extractivist interests [11]. In terms of priorities, system-level and long-term drivers like sustainability tend to remain behind the instrumental values of productivity and utility for the consumer and other short-term benefits [14, 28]. Therefore, the development of information systems and digital services primarily aim at, for example, efficiency of information flows, automation of tedious tasks, and convenience and user-friendliness in human-technology interaction.

So how to bring about a shift towards more sustainable IT? In this article, we approach this question by combining two approaches: (1) *transdisciplinary conceptualization work* to introduce the concept of excess from social theory and economics into the discourses of the LIMITS community, which could help also design practitioners to clarify their priorities, and (2) *autoethnographic observations* of the aspects of our digital lives that are excessive both for users and the environment. To these ends, we draw from Georges Bataille's [3] philosophical and anthropological argument that the *main problem of any economy is not scarcity but excess* and introduce our notion of *digital excess*.

To elaborate on the transdisciplinary move, we aim to build new bridges between social scientific accounts of information technology and fields operating with digitalization and study of IT artifacts at the grassroots level (e.g., Human-Computer Interaction, Consumer Studies, Design). First, we discuss the concept of excess as it appears unestablished in the professional lingo in HCI and other fields related to design and development of ICT. Second, we seek to offer user-centered perspectives to what could represent excess in the digital world, hence potentially broadening the theoretical coverage of the concept of excess, which tends to focus on the material world. We believe that research communities and traditions that build on empirical data on user-product relationships—such as HCI—can help concretize and contextualize an abstract concept like excess by offering micro-level analysis of experiences of what users perceive as excess.

Concerning the building blocks of ICT applications, the notion of digital excess places the focus *on services, software, and data*. This broadens the conventional and much-studied hardware-centric harms, such as scrap metal as residue, costs of mining rare resources, or the issues concerning insufficient recycling (e.g., [27]). We argue that the underlying *raison d'être* of the hardware and infrastructure remain understudied—i.e., for what purposes and functions they exist. In other words, it

appears that the excess originating from software and especially internet services (e.g., [17]) lacks theorization.

Against this backdrop, the key proposal of this article is that empirical analysis of *digital excess* could help to recognize what in our digital lives might appear most irrelevant or unnecessary, thereby underlining elements to minimize. Section 2.1 seeks to justify this argument by offering a conceptualization of digital excess. In Section 2.2, we discuss the user-centric lens into digital excess. We aim to offer examples of excess where the potential for decreasing energy consumption seems substantial enough, while also having minimal detrimental effects to economy or user experience. This is followed in Section 3 by our suggestions for a research agenda towards a more empirically grounded insight into what digital excess might be and why it matters.

2 Excess in the Digital World

The dynamics of capitalism in the digital world appear to be characterized not so much by the lack of resources as by over-accumulation and insufficient means to manage it [6]. To shed light on how this comes forth in everyday interactions with the digital aspects of our lives, this article establishes a *user-centered lens into digital excess*. We therefore define digital excess to cover the aspects of our digital lives that are *subjectively perceived not to carry meaningful value but, rather, appear as wasteful and superfluous, while also causing harm to individuals, society, or the planet*. This section first defines conceptual foundations to elaborate this definition, followed by examples of how digital excess may manifest in everyday interactions with digital services.

2.1 Conceptual Foundations and Relevance

Representing one of the transdisciplinary moves in the article, our take on digital excess is inspired by philosopher Georges Bataille's [3] theory of general economy. The notion of *excess energy* can be regarded central to Bataille's thinking. For example, organisms may have an excess of energy available, and this may be used productively for the organism's growth, but whenever that is not possible, it needs to be lavishly expended (i.e., wasted). Bataille insists that the wasting of the extra energy would be considered as luxury, and the role that luxury is given in a society defines the fundamental characteristics of that society. For the purposes of this article, we scale down Bataille's general philosophical and anthropological argument to an individual user's perspective, and refer with excess to *having problematically high amounts of something* [1, 26]. This contrasts with *scarcity* (i.e., having too little of something) and *abundance* (i.e., having a sufficient amount that causes no problems).

¹ <https://www.unep.org/resources/report/design-sustainability-step-step-approach>

² <https://permacomputing.net/>

³ <https://planetcentricdesign.com/>

To connect with central concepts in the sustainable HCI community, the notion of excess relates to the “Cornucopian paradigm” [20]: the increasing use of digital services and the accumulation of data motivate investments in increasing capacity of the internet infrastructure, which then allows for the innovation of new services that can utilize this capacity (e.g., high-definition video, livestreaming). This brings about a snowball effect where both demand and supply of digital consumption are rapidly increasing, which unavoidably leads to ever-increasing energy consumption. In this systemic phenomenon, we regard digital excess as a key factor of the increasing demand—*demand that is in fact unnecessary and therefore fallacious*.

Further, drawing from anthropology and evolutionary perspectives, managing material resources is very different from managing digital resources, and cultures have not yet developed effective practices for the latter [22, 30], also because of the *seemingly de-material* and *unlimited* nature of the digital. We therefore argue that digital excess can help to shed light on the fundamental chasm between how the material and digital realms are viewed by both individual users and service developers.

2.1.1 Moral foundations and related concepts

In terms of moral philosophical foundations, digital excess could be seen as a reflection of the moral virtue of *moderation*. A very relevant prior work by Widdicks and Pargman [32] considers internet use from the viewpoint of *moderation*. They present “a research agenda to create more moderate and less data-demanding use of the Internet to benefit both users and the environment, and move away from the Cornucopian Paradigm of increasingly data-intensive design”. Further, the authors dissect the practicality of such idealistic and normative ideas—which may be seen to make consumers and service providers responsible and thus create resistance—and lay out both idealistic and practical approaches to implementing changes with respect to, e.g., business models or individuals’ freedom of choice. While their work and the present work have much in common, we argue that the notion of digital excess can help to point to *what* in our digital lives could be considered through the virtue of moderation.

Contemporary movements related to *minimalism* in consumption and lifestyles also offer relevant starting points: being parsimonious about resources, avoiding waste, and focusing on the most essential and personally important things could be desirable also in individuals’ digital lives. Like in the material and social worlds, it would be universally desirable to eliminate or lessen extremes in the digital world (in this case the extreme *beyond abundance*), avoid selfish accumulation of resources, and to be concerned of the common good. Santarius and others [24] follow a similar line of thought by discussing “digital sufficiency”. *Sufficiency* (or frugality) refers to avoiding overconsumption while reducing the use of scarce natural resources and fossil fuel-based energy. The authors define digital sufficiency as “any strategy aimed at directly or

indirectly decreasing the absolute level of resource and energy demand from the production or application of ICT”. They further argue that sufficiency focuses on an absolute reduction of resource and energy demand while maintaining, or even improving, immaterial living conditions. For example, software sufficiency includes strategies that reduce data volume, traffic, and demand for computing power and that increase the service life of ICT hardware. All in all, digital excess builds on this kind of conceptual manifestations of the values of moderation and minimalism.

Further elaborating on the choice of terms, since it refers to something that is situated at the lowest rank of our value hierarchies, *waste* may appear as another relevant, almost synonymous term. However, because waste typically designates the *material* forms of problematic excess, we regard digital excess as a more apt term for characterizing the problematic de-material plentitude in the digital realm. Furthermore, some of that plentitude might not be considered waste at all but *unnecessary luxury* as implied by Bataille’s work.

2.1.2 Relevance to human-computer interaction praxis

But why is excess relevant to practical digitalization projects and service design work that HCI aims to inform? We argue that the relevance leans on the management of seemingly unavoidable *tensions* and *trade-offs* between criteria of goodness in design work. Inspired by Guattari’s [5] notion of three fundamental ecologies of *the environment*, *social relations*, and *human experience*, digitalization could be seen perplexed by perpetual tensions between *utility* and the various *detrimental effects* on these ecologies. In the development of digital services, these ecologies manifest as more specific quality criteria or key performance indexes against which products and services are optimized (e.g., maximizing user retention, minimizing customer churn, seeking appropriate levels of privacy and autonomy). The related balancing acts between the broad spectrum of quality criteria are typically challenged by necessary compromises and prioritization between conflicting values.

An example regarding what Guattari labels as “social relations” and “human experience” could be mobile wellbeing applications where the intention to support the user’s behavioral change necessarily reduces the user’s autonomy (i.e., freedom of choice) and jeopardizes security by accumulating personal data over time [23]. In the same vein, what is considered good for the environment often tends to require compromising in terms of user experience (e.g., reduced convenience due to lower quality of service) or economic feasibility (e.g., lower revenue due to smaller user population). This kind of inherent and practical trade-offs arise when service development pursues two or more conflicting criteria, all of which cannot be pursued simultaneously without a cost in some of them.

Consequently, the concept of excess underlies an assumption of the existence of ‘*sweet spots*’ where the different

criteria would not conflict with each other—i.e., design solutions where optimization in one regard would not require compromising in other regards. We believe that reducing excess would be simultaneously beneficial for user experience, economy of the service provider, as well as the environment.

Now, what concrete examples of digital excess are there in present-day digital services? In what follows, we offer examples from digital media services as a broad category of IT. While it self-evidently does not cover all possible forms of digital excess in terms of services, software, and data, we argue that it well exemplifies some of the typical issues of the present-day digital world from the end-user's viewpoint. Especially digital media services, such as video-on-demand services, social media, and games, are dominated by commercial logic that tends to lead to lack of boundaries, plentitude of alternatives, and a lively user experience based on continuous expansion and updating of the service.

2.2 User-Centered Examples of Excess in Digital Media Services

The following examples are based on somewhat informal autoethnographic observations by the authors during the preparation of grant proposals on the topic of digital excess in 2022–2023. Therefore, the following are intended as preliminary and anecdotal examples of excessive elements that *might* be recognized by and relevant to larger user populations. In fact, what counts as digital excess arguably depends on the user and their personal characteristics as well as various contextual factors. Consequently, it appears inexpedient to specify ontological categories of what would be universally regarded as excess.

2.2.1 Excess in content consumption

To first focus on the production of digital content, for example multimedia content typically aims to maximize the aesthetic quality or to showcase technical excellence. One oft-debated issue is unnecessarily high resolution of videos and images when considering the context of use. For example, user-created content tends to be stored in much higher resolution than the user considers necessary, and streaming maximally detailed video on entertainment platforms might not match the capacity of the user's output devices. While this has been studied, for example, in terms of optimizing video encoding for mobile devices, everyday experiences of such unnecessary luxury appear common to us. Furthermore, we speculate that a significant share of the content played on various video services is not paid much attention (e.g., inattentive consumption due to competing attention grabbers and parallel activities) or the service is running in the background to create a cozy atmosphere (i.e., inconspicuous consumption due to habitual behavior). A related issue is the hoarding lists of to-watch content on streaming services: while the existence of such list is perhaps insignificant in terms of computation, this

illuminates our profound challenges in terms of dealing with the plentitude that the digital world has to offer.

2.2.2 Redundancy of content as excess

In terms of *redundancy* as excess, many of us possess multiple copies of the same multimedia content and different versions of documents we have produced. The dynamism of service providers and the related vendor lock-in effects have taught many users to not trust merely one platform to preserve their personal data. It can therefore be appealing to store the most valuable digital content on multiple platforms: redundancy can be motivated by secure and robust preservation of sensitive personal files or cultural memory at the level of collectives. While this decreases the risk of losing the data, it effectively also multiplies the required storage capacity, as well as the continuous synchronizing of the online and local repositories. To speculate somewhat idealistically, perhaps some of the most important data could be archived on specifically tailored digital repositories rather than stored on cloud services for day-to-day use? This could be beneficial for the *individual user* (feeling of security in terms of data storage), the *service provider* (multiple sources of income from services for different purposes), as well as the *environment* (less data transfer from daily synchronizing and redundancy).

Another form of redundancy as excess is the long lists of installed applications that however remain unused, as well as the regular forced updates of these applications. The updates cause recurrent data transfer and battery use, while the benefits tend to remain marginal. On the one hand, this may be explained by insufficient human capacity (i.e., motivation, competence, time) for managing plentitude. On the other hand, the business incentives of the platforms rather aim to maximize user attention than help them to manage and prune their digital repositories. In other words, the service provider's priority to continuously provide the most up-to-date, secure, and intriguing service tends to be put above the user's view of the necessity of the update—let alone the question if they are using the service anymore.

2.2.3 Excess is encouraged by commercial incentives

Many of the previous examples imply that excess is often encouraged or even enforced by the commercial interest of the service provider. For example, personal cloud storage services typically encourage persistent storage and continuous accumulation of data instead of minimizing and organizing it. When the limits of the free plan are reached, storage services eagerly encourage users to upgrade and buy more space as the primary option. Allured by the imaginary of unlimited digital storage space and the significance of one's files, many users are easily convinced by this industrially crafted need. Instead, perhaps it would be beneficial for the user and the service provider (and in terms of energy consumption) to identify and help reduce content that has low value in terms of personal meaning or instrumental usefulness, thereby offering a better user experience worth paying for?

A similar element of forced interactions is evident in push notifications as a potent category of attention grabbers. Notifications are often sent through multiple channels, such as in the case of incoming messages or edit notifications that a one receives from collaboratively edited documents. HCI and Information Systems research has extensively problematized push notifications in terms of information overload, technostress, and attention management; this requires effort and competence from the user in terms of managing such excess. However, more relevant to the present article, the ubiquity of notifications means that they also require significant computational effort and use of the internet, while the value to both the user and the service provider can often be questioned. From the service provider's viewpoint, we argue that the ubiquity of push notifications is a result of the cornucopian paradigm and general design conventions rather than design decisions that are carefully thought through or provenly commercially effective.

All in all, these preliminary examples of excess in the present-day digital media services remind us of the personal clutter that we as users need to adjust to, often causing both anxiety for the individual, computational costs for the service provider, and greenhouse gases from the required energy use. We focused on examples where the environmental burden would be relatively apparent due to the energy consumption resulting from data transfer, online storage, or computation-intensive tasks. These examples related to digital media use complement the categories that Widdicks & Pargman [32] discuss in their work related to moderate internet use (e.g., relationships, work productivity, privacy). That said, these examples are meant as indicative and preliminary, primarily intending to argue for the practical relevance of the concept of digital excess. We call for more systematic approaches to gather empirical data on experiences of digital excess at a large scale. Moreover, in terms of measuring the potential effect in terms of energy saving, calculations of the precise energy balance or the resulting carbon footprint are best left to future work by more well-informed researchers in natural sciences and engineering.

3 Future Research Directions

We argue that more elaborate, empirically grounded understanding of how people perceive digital excess, how they deal with it, and why it matters to different stakeholders would both be academically intriguing and help define more sustainable directions for the rapidly advancing digital transformation. Concerning transdisciplinary research, this would also allow another move: translating insight from empirical user research to social scientific theorizing through a more nuanced and contextualized understanding of excess. As for practical implications, we argue that it is crucial to grasp individuals' and collectives' understandings of the superfluous

elements in the current digital world in order to imagine more desirable alternative futures (e.g., [8, 34]). In what follows, we propose both *empirical* and *interventionist* approaches that could address these knowledge interests as well as encourage behavioral change and rethinking of design praxis.

3.1 Empirical Insight into Multiple Contexts and Stakeholders

In terms of empirical knowledge, scientific communities generally lack insight into the perceptions of and normative attitudes towards what is superfluous in our digital lives. To this end, we need empirical insights into how different actors—ranging from individuals to organizations—perceive the footprint of online media consumption, what might be the experienced elements of excess therein, and how the actors try to manage them. While the subjective perceptions of what comprises digital excess likely vary, we believe that common, cross-cutting categories could be reliably identified through empirical research.

To create a holistic understanding, we propose to research this phenomenon across a range of modern digital media services: from online news media, on-demand entertainment, and online gaming to social networking services, chat applications, and cloud storage services. While acknowledging that excess may be relevant in many other facets of the digital world, we propose to take this focus area as a starting point in the empirical analysis.

Further, we propose multi-stakeholder analysis on the perceptions and existing practices regarding digital excess—among digital media consumers, organizations, and industrial actors. First, consumers could be studied across different demographics, as both users of digital media services and contributors to the information landscape of digital services. Specific groups of interest could include content producers (e.g., social media influencers, semi-professional digital media experts), digital-media heavy users who tend to consume vast amounts of internet bandwidth through services ranging from video streaming to eSports, as well as digital minimalists who already have adjusted their digital practices to reduce environmental footprint.

Second, the digital media industry is relevant as they produce the infrastructures, devices, and digital services that enable the present digital reality and shape the behavioral patterns of users. Empirical investigation could be targeted at companies that represent different levels of the platform infrastructure [31]: from large global platform companies (e.g., Netflix, YouTube) to national-level streaming services (e.g., public broadcasting companies). Service providers and the digital media industry are relevant to study to connect the user-centered perceptions to the businesses' cost structures and attitudes towards minimizing the carbon footprint from computation. For example, it demands cross-disciplinary information exchange to understand, for example, what user interactions cause so-called idle computation and, more

generally, where the reduction of excess could lead to both cost savings, a better user experience, and reduced energy use.

3.2 Interventionist Research to Encourage Behavioral Change

In regard to the relevance of HCI and service design, we propose to complement the descriptive empirical research with interventionist research studies that aim to imagine and design artifacts that support and encourage change towards the better. We regard that multiple stakeholders ought to take responsibility and pursue actions that could lead to more sustainable IT—ranging from private companies and professional associations to policymakers and educators. However, the following focuses on devising interventions to steer user behavior, simply to follow the user-centered lens in this article and to focus on the traditional strengths of HCI. We argue that incorporating intervention mechanisms into the digital infrastructure and user interfaces used on daily basis could effectively inform users and positively shape their behavior. That said, by no means does this imply that users alone should be made accountable and responsible for managing and adjusting to the excess in their lives.

We structure the interventionist research directions based on three high-level categories of how IT could constructively intervene or strengthen certain actions: 1) *increasing users' awareness of the environmental impact of IT*, 2) *helping recognize excess in one's digital life*, and 3) *helping to manage that excess*.

First, fostering increased awareness is the foundation of nurturing a sense of responsibility and eventually encouraging behavioral change. However, a key problem in terms of awareness is that many might be aware of the carbon footprint of their diet, household appliances, accommodation, and travel, for example, but they do not have the same knowledge about the environmental impact of their digital lives [17]. The same applies to organizations that struggle in shaping their digital services to meet the demands of policies on sustainable development and climate action. Therefore, all means would be welcome to generally increase awareness of the growing energy consumption and the required computation behind the use of specific services, for example.

As for interventionist HCI research, recent work has studied the influence of even the mundane user interface design decisions in increasing awareness and self-reflection as well as bringing about behavioral change (e.g., [10, 20]). To this end, we propose to explore and devise digital mechanisms that could increase awareness of and encourage self-reflection regarding digital excess. A user-centric example of a possible intervention could be a web browser plug-in that visualizes the overall footprint of specific digital media services in provocative ways and presents simulations of counterfactual scenarios. In particular, the complexity and fragmented nature

of one's personal digital ecosystem implies that it would be relevant to enable the user to understand what applications or services they are using, how much, and from where the most significant share of the footprint originates.

Second, awareness may lead to more detailed analysis of one's personal digital life and self-reflection regarding the forms of excess therein. However, few services support users to do that and rather try to maximize the attention from the user. In contrast, in personal content management services, recognizing digital excess could be supported by, for example, enabling visual zooming in and out of clusters of photos, hence helping identify irrelevant or unnecessarily copious content, let alone clear duplicates. Existing third-party emission assessment tools like Ecograder⁴ serve as inspiring examples of how users could somewhat objectively and more thoroughly measure the environmental burden of their digital lives.

Third, after recognizing the excessive elements, the management—including removal and avoidance of future accumulation of excess—needs to be made easy. Following a concurrent example in the Google Photos application, where old screenshots or images of physical documents or receipts are automatically highlighted as possible waste, this kind of minimalization-targeted automation would be welcome in many other applications, too.

Furthermore, many could benefit from having a universal tool for easily labeling content, files, or information sources in terms of personal priority, e.g., ranging from excess to most cherished items. In an automation-utopian scenario, the labels could serve as training data to a continuously learning personal assistant that would support the user in managing their digital life. Regardless of the most desirable role of technology, it is noteworthy that *labelling interfaces* have in general been shown to well support management of mental processes, such as emotion regulation [29], hence offering a promising line of investigation and design exploration.

4 Closing Remarks

The main contribution of the article is the introduction of the transdisciplinary concept of digital excess to the scientific discourses around sustainable HCI, as well as the user-centered account of what it could mean in practice. Digital excess offers a novel concept and viewpoint for problematizing the traditional understanding of the interplay between the dual transition of digitalization and decarbonization: the digital world might appear de-material only at the surface and comes with significant indirect environmental costs. We believe that future empirical user research about the various forms of digital excess could help us to better understand, problematize, and possibly also mitigate the growing environmental burden of IT.

⁴ ecograder.com

That said, we by no means argue that acknowledging digital excess would be a silver bullet to significantly reducing the energy usage of the IT sector. In a broad array of methods that could slightly reduce the costs, digital excess represents such categories of use that carry nugatory value to multiple key stakeholders. The concept underlines that certain aspects of our digital world are useful neither for the end-user nor the service provider, society, or the environment, and could therefore be reduced and avoided in design praxis. In other words, even if the environmental burden of the required energy production was solved by fusion energy or any other technological advances, reducing excess appears desirable also from social and psychological perspectives.

We hope that this article can spur discussion on how the subjective, experiential perspective to digital excess could help identify elements in our digital world to be pruned and better managed. With the user-centered considerations and examples of digital excess, we hope to offer new means for design practitioners to steer digitalization towards more sustainable trajectories.

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REFERENCES

- [1] Andrew Abbott. 2014. The Problem of Excess. *Sociological Theory* 32, 1, 1–26.
- [2] Anders S.G. Andrae. 2020. New perspectives on internet electricity use in 2030. *Engineering and Applied Science Letters* 3, 2, 19–31. DOI: 10.30538/psrp-easl2020.0038
- [3] Georges Bataille. 1949/1991. *The Accursed Share*. Zone Books.
- [4] Charlotte Freitag, Mike Berners-Lee, Kelly Widdicks, Bran Knowles, Gordon S. Blair, and Adrian Friday. 2021. The real climate and transformative impact of ICT: A critique of estimates, trends, and regulations. *Patterns* 2, 9. DOI: <https://doi.org/10.1016/j.patter.2021.100340>
- [5] Felix Guattari. 2000. *The Three Ecologies*. Athlone Press.
- [6] David Harvey. 2010. *The Enigma of Capital and the Crises of Capitalism*. Profile Books, London.
- [7] Lorenz M. Hilty and Bernard Aebischer. 2015. ICT for Sustainability: An Emerging Research Field. In: *Hilty, L., Aebischer, B. (eds) ICT Innovations for Sustainability. Advances in Intelligent Systems and Computing*, vol 310. Springer. DOI: https://doi.org/10.1007/978-3-319-09228-7_1
- [8] Sheila Jasanoff. 2015. Future Imperfect. In S. Jasanoff; K. Sang-Hyon (eds.) *Dreamscapes of Modernity*, pp. 1–33. The University of Chicago Press.
- [9] Nicola Jones. 2018. How to stop data centres from gobbling up the world's electricity. *Nature* 561, 163–166.
- [10] Joel Kiskola, Thomas Olsson, Heli Väättäjä, Alekski H. Syrjämäki, Anna Rantasila, Poika Isokoski, Mirja Ilves, and Veikko Surakka. 2021. Applying Critical Voice in Design of User Interfaces for Supporting Self-Reflection and Emotion Regulation in Online News Commenting. In *Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems (CHI '21)*. ACM, 1–13. DOI: <https://doi.org/10.1145/3411764.3445783>
- [11] Anthony M. Leveda and Dillon Mahmoudi. 2019. Silicon Forest and Server Farms: The (Urban) Nature of Digital Capitalism in the Pacific Northwest. *Culture Machine* 18.
- [12] Stephen Makonin, Laura U. Marks, Radek Przedpeński, Alejandro Rodriguez-Silva, and Ramy ElMallah. 2022. Calculating the Carbon Footprint of Streaming Media: Beyond the Myth of Efficiency. Workshop on *Computing within Limits*, 2022. <https://limits.pubpub.org/pub/calc/release/1>
- [13] Eric Masanet, Arman Shehabi, Nuo Lei, Sarah Smith, and Jonathan Koomey. 2020. Recalibrating global datacenter energy-use estimates. *Science* 367 (6481), 984–986.
- [14] Jessica McLean. 2020. Frontier Technologies and Digital Solutions: Digital Ecosystems, Open Data and Wishful Thinking. *Anthropocenes – Human, Inhuman, Posthuman*, 1, 1.
- [15] Jason F. McLennan. 2004. *The Philosophy of Sustainable Design*. Ecotone Publishing Company LLC.
- [16] Bonnie Nardi, Bill Tomlinson, Donald J. Patterson, Jay Chen, Daniel Pargman, Barath Raghavan, and Birgit Penzenstadler. 2018. Computing within limits. *Commun. ACM* 61, 10, 86–93. DOI: <https://doi.org/10.1145/3183582>
- [17] Renee Obringer, Benjamin Rachunok, Debora Maia-Silva, Maryam Arbabzadeh, Roshanak Nateghi, and Kaveh Madani. 2021. The Overlooked Environmental Footprint of Increasing Internet Use. *Resources, conservation and recycling* 167, article no. 105389.
- [18] Jussi Parikka. 2015. *The Anthropocene*. University of Minnesota Press.
- [19] Neil Postman. 1993. *Technopoly: The Surrender of Culture to Technology*. Vintage Books.
- [20] Chris Preist, Daniel Schien, and Eli Blevis. 2016. Understanding and Mitigating the Effects of Device and Cloud Service Design Decisions on the Environmental Footprint of Digital Infrastructure. In *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems (CHI '16)*. ACM, 1324–1337. DOI: <https://doi.org/10.1145/2858036.2858378>
- [21] Rahul Rautela, Shashi Arya, Shilpa Vishwakarma, Jechan Lee, Ki-Hyun Kim, and Sunil Kumar. 2021. E-waste management and its effects on the environment and human health. *Science of The Total Environment*, Vol 773. Elsevier. DOI: <https://doi.org/10.1016/j.scitotenv.2021.145623>
- [22] Tanya Richardson and Gisa Weszkalny. 2014. Introduction: resource materialities. *Anthropological Quarterly* 87, 1, 5–30.
- [23] Lambèr Royakkers, Jelte Timmer, Linda Kool, and Rinie van Est. 2018. Societal and ethical issues of digitization. *Ethics Inf Technol* 20, 127–142. DOI: <https://doi.org/10.1007/s10676-018-9452-x>
- [24] Tilman Santarius, Jan C.T. Bieser, Vivian Frick, et al. 2022. Digital sufficiency: conceptual considerations for ICTs on a finite planet. *Ann. Telecommun.* (2022). DOI: <https://doi.org/10.1007/s12243-022-00914-x>
- [25] Sabrina Scuri, Marta Ferreira, Nuno Jardim Nunes, Valentina Nisi, and Cathy Mulligan. 2022. Hitting the Triple Bottom Line: Widening the HCI Approach to Sustainability. In *Proceedings of the 2022 CHI Conference on Human Factors in Computing Systems (CHI '22)*. ACM, Article 332, 1–19. DOI: <https://doi.org/10.1145/3491102.3517518>
- [26] Stefan Schwarzkopf. 2020. Sacred Excess: Organizational Ignorance in an Age of Toxic Data. *Organization Studies* 41, 2, 197–217. DOI: <https://doi.org/10.1177/0170840618815527>
- [27] John S. Seberger and Geoffrey C. Bowker. 2021. Humanistic infrastructure studies: hyper-functionality and the experience of the absurd. *Information, Communication & Society* 24, 12, DOI: 10.1080/1369118X.2020.1726985
- [28] Katie Shilton. 2018. Values and Ethics in Human-Computer Interaction. *Found. Trends Hum.-Comput. Interact.* 12, 2, 107–171. DOI: <http://dx.doi.org/10.1561/11000000073>
- [29] Alekski H. Syrjämäki, Mirja Ilves, Joel Kiskola, Anna Rantasila, Poika Isokoski, Thomas Olsson, and Veikko Surakka. 2022. Facilitating Implicit Emotion Regulation in Online News Commenting—An Experimental Vignette Study. *Interacting with Computers*, 34, 5, DOI: <https://doi.org/10.1093/iwc/iwad010>
- [30] Frank Trentmann. 2016. *Empire of things: How we became a world of consumers, from the fifteenth century to the twenty-first*. Penguin UK.
- [31] José Van Dijck. 2021. Seeing the forest for the trees: Visualizing platformization and its governance. *New Media and Society* 23, 9, 2801–2819.
- [32] Kelly Widdicks and Daniel Pargman. 2019. Breaking the Cornucopian Paradigm: Towards Moderate Internet Use in Everyday Life. In *Proceedings of the Fifth Workshop on Computing within Limits (LIMITS '19)*. ACM, Article 2, 1–8. DOI: <https://doi.org/10.1145/3338103.3338105>
- [33] Langdon Winner. 1980. Do Artifacts Have Politics? *Daedalus* 109, 1, 121–136. <http://www.jstor.org/stable/20024652>
- [34] Johanna Ylipulli and Aale Luusua. 2021. In Search of the Alternative Future: Developing Participatory Digital Citizenship to Address the Crisis of Democracy. In *Extended Abstracts of the 2021 CHI Conference on Human Factors in Computing Systems (CHI '21)*. ACM, Article 100, 1–4.

Factors in Computing Systems (CHI EA '21). ACM, Article 91, 1–4.
DOI:<https://doi.org/10.1145/3411763.3441318>