Humanising the Digital Public

From User Models to Civic Systems

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Abstract

This paper proposes a paradigm shift in how digital publics are conceptualised and modelled. Current platform monetisation relies on reductive personalisation metrics that shape incentives across infrastructure, interface, and user interaction—producing systemic effects detrimental to civic resilience and information integrity. We argue for a reconceptualisation of digital publics as emergent sociotechnical collectives, drawing on modelling approaches from live event and civic design. We outline a multi-method programme combining tabletop games, megagames, and simulations to develop and test new metrics that support alternative incentives and human-centred platform governance.

CCS Concepts

• **Computing methodologies** → **Modeling and simulation**; • **Security and privacy** → **Human and societal aspects of security and privacy**.

Keywords

Agency modelling, digital public space, virtual civics, soft systems modelling, megagames

ACM Reference Format:
Carina E. I. Westling, Oscar Bjurling, Joshua Bronson, Peter Berggren, and Björn J. E. Johansson. 2025. Humanising the Digital Public: From User Models to Civic Systems. In *36th Annual Conference of the European Association of Cognitive Ergonomics (EACE) (ECCE 2025), October 07–10, 2025, Tallinn, Estonia.* ACM, New York, NY, USA, 7 pages. https://doi.org/10.1145/3746175.3746191

1 Introduction

Contemporary models of digital publics—understood here as datafied representations or 'digital twins' of internet users—monetise and incentivise processes that produce stereotyping and polarisation within the virtual public sphere. This includes the shaping of political and civic discourse on platforms that are free at the point of use, and operate through business models reliant on targeted advertising and behavioural prediction. Jürgen Habermas, leading theorist of the public sphere, has acknowledged its structural transformation by digitisation and platformisation [24], but the causes of these changes are not recent. They can be traced back over two decades to foundational decisions about how to conceptualise, model, and incentivise user interactions with digital platforms. Their systemic effects—now amplified by scale and entangled with public discourse—have become more visible in the past decade as platform architectures, data-driven logics, and algorithmic governance mechanisms have matured and consolidated.

The now-dominant model for representing human users on digital platforms constructs extensive 'data surfaces' designed to enable programmatic, personalised advertising. The same 'surfaces' are readily used for targeting individuals and, by extension, their communities and societies with personalised discourse manipulation by hostile state and non-state actors [45, 62]. The incentives created by this system environment promote polarisation and churn, or intensified traffic that can be monetised by advertising or data brokering, but also filter bubbles, exponential growth of disinformation, a proliferation of bot accounts, extremism, and populism, all of which are well-documented [6, 12, 13, 38, 40–42, 46, 47, 49, 54]. Early efforts to moderate abusive or illegal content soon became too costly, and the effectiveness of moderation at the current scale of the problem is limited by design. Platform providers are dependent on the business model that generates the problem [31]; the proliferation of user accounts, whether authentic or inauthentic, and the volume of churn that they produce.

New legislation in the European Union and the United Kingdom introduces liability for platform providers and demand transparency, for example of recommender algorithms that promote harmful content [17, 23]. Over time, this may course-correct the virtual public sphere, but the attention economy in its current form depends on the mechanisms that create the issues. The models, metrics and incentives that pervade the free-at-the-point-of-use platform environment, and which create the structural changes of the digitised public sphere [24], require systematic interrogation.

We argue that the current approach to modelling human users creates the stereotyping and polarisation that others have addressed

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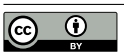

ECCE 2025, Tallinn, Estonia

ACM ISBN 979-8-4007-2033-8/25/10
https://doi.org/10.1145/3746175.3746191

[10, 58]. Conceptualising users as individuals interacting with machines rather than crowds flowing within a designed space can only produce, via the metrics afforded by that model, incentives for the type of behaviours and structural changes that Habermas observes [60]. We propose a paradigm shift in how our digital twins, or rather the virtual publics that they form, are modelled to change systemic conditions of possibility via alternative metrics and the incentivisation mechanisms they produce. Towards this, we introduce a comprehensive research programme, detailed below, to a) create an integrated theoretical framework and ontology of the problem space, b) map the incentives cascades that flow from existing and alternative models and the metrics they produce, and c) identify a range of new metrics of digital publics and scope the systemic incentives they will produce, at scale and over time.

1.1 Polarisation, fragmentation and disinformation in hybrid war

Without changes to the conceptual and mathematical models of digital publics, the efforts to prevent hostile actors from leveraging civic fragmentation towards their own objectives without compromising fundamental democratic principles are likely to continue to be a significant, growing, and ultimately overwhelming challenge. The incentivisation mechanisms and recommender algorithms that are designed to make online advertising and content intuitive, engaging, and compelling for available target demographics are open for overt and covert use by hostile state and non-state actors. Cybersecurity education, awareness raising, and training (CEAT) is vital, but a 2022 study of 80 nations of the Cybersecurity Capacity Maturity Model for Nations (CMM) revealed that only c. 30 percent of sampled nations had achieved maturity above the formative stage, and an even smaller percentage (6.25) scored as established [52]. Given that young people are targeted by online radicalisation, it is concerning that a 2024 systematic review of k-12 education around the world concluded that most aspects of cybersecurity are not being taught systematically [27].

The scale of the issue is a significant problem. 'Firehose of falsehood' strategies are used in hybrid warfare, which arguably includes election interference and other democratic processes [41] to overwhelm and skew public discourses. Disinformation, circulated online by networks of compromised individuals and reinforced by botnets of varying sophistication [1, 54], create the impression of grassroot support ('astroturfing'), which can skew reality perception, particularly in isolated demographics, and bleed into real-world election manipulation, voter disengagement campaigns, fringe activism, and populism [42, 46].

Exploitation of the affordances offered by our digital public sphere is well-documented [18, 37, 44] and theorised as a non-military aspect of hybrid or asymmetric warfare [3, 41, 42] with negative effects on social cohesion and resilience [47, 58]. Holistic responses can be effective, but require broad awareness and concerted efforts to educate and motivate the public [30]. While such efforts should undoubtedly be developed and integrated in our education systems, implementation is currently uneven and/or insufficient, while the problem is accelerating. Large language models and other artificial intelligence tools used to mimic human communication are increasingly plausible, and geopolitical tensions are escalating. We propose that the sheer scale of the problem can and should be mitigated by changing the systemic incentives that shape the digital public sphere. Awareness-raising and moderation will be more effective if applied to a platform environment that is tilted towards rather than against democratic societies and the processes that support their resilience.

1.2 Our digital twins and incentivisation in platform and interface design

Our digital twins are data objects based on mathematical models. These models rely on legacy concepts of system users and determine what types of actions or behaviours are 'computable' or visible and manipulable within the system environment [20]. Monetisation mechanisms such as Google AdSense and its derivatives rely on footfall- and attention metrics that make our presence and activities on digital platforms measurable. The metrics that they produce allow platform providers to monetise traffic and therefore influence operating models [31]. The prevailing monetisation mechanisms determine the incentives that inform design of software and interfaces, and especially the free-at-the-point-of-use platforms that the attention economy relies upon. The per-unit profit margins are tiny and the attention economy is reliant on volume, meaning that user behaviours that are profitable will be prioritised in software and interface design [5].

Our virtual representation shapes the incentivisation cascade from platform design to user behaviours via the metrics it affords, and which render us, and our online actions, computable. This user-driven data economy generates significant monetary value for platforms while extracting non-monetary costs from users, including reduced autonomy, stress, and diminished well-being, particularly through design strategies like infinite scroll and algorithmic pressure [39]. Users, in effect, give away personal resources such as attention, time, and behavioural data in exchange for access, bearing hidden costs that disproportionately benefit platform providers. How we are modelled, and what metrics such modelling allows, therefore determines the incentives that shape, and arguably distort the public sphere.

1.3 Bad data: reducing agents to stereotypes

Under the present paradigm, our digital twins can be described as identities, 'enriched' with recursively granular, stereotyped behaviours formulated to support the predictive algorithms that underpin personalisation [19, 31, 53]. These virtual populations are a key commodity in the attention economy, and platforms and interfaces are designed to generate data about their behaviours that a) is intelligible to the system and b) supports design for generation of further, system-intelligible actions in service of marketable predictions and promotion of predicted behaviours. Such data is the 'bread and butter' of the attention- and data economies, and incentivisation cascades can be regarded as partially designed, and partially emergent functions of these economies that have developed in response to a combination of technological and ecological opportunities, limitations and pressures.

Agent-based modelling necessarily reduces system users to data objects, albeit ones that are enriched or personalised with behaviours

that are also stereotyped by demographic categories. It cannot represent individual human agents in the truest sense, that is, as entities with emergent, unscripted agency [60]. It can be a sufficiently sophisticated approach to modelling agents such as viruses for the purpose of epidemiological simulations, and can even be effective for modelling human-computer interaction where the human actor or actors can be relied upon, via training, observation, or moderation, to behave within relatively predictable parameters. It is ill-suited for mass population modelling for several reasons: it invites surveillance and recording of individual behaviours at scale [8, 11]; it incentivises design of platforms, interfaces and affordances around identitarian stereotypes and behavioural cues [60]; it creates massive exposure of individuals [35] and, on an exponential scale, the societies that they comprise [15, 61] and the 'data objectification' process is systematically disempowering [60].

Importantly, the prevailing approach to conceptualising and modelling digital publics is not only reductive but also arbitrary. There are no fundamental reasons to model and monetise 'individuals' who 'press buttons' instead of flows moving within designed environments. Well-established alternatives to design thinking and user concepts that migrated unchallenged from machine design to design of virtual environments exist in live events design for mass audiences [60] and in civic design, where evolving ideas of publics have shaped architecture and urban development from antiquity to the present [14, 16, 21, 34, 48, 50]. These fields treat publics as dynamic, context-dependent collectives rather than aggregated stereotypes, with an emphasis on flow, density, movement, and collective interaction. In contrast, agent-based approaches reduce individuals to predefined data objects, incentivising surveillance, identity-driven affordances, and behaviourally skewed system feedback. Such models are structurally disempowering, distort public discourse, and expose both individuals and their societies to increased systemic risk. To address these challenges, we propose a paradigm shift grounded in ecologically aware, collective-level models of digital publics, capable of supporting both civic resilience and viable platform governance. This reorientation sets the stage for a new conceptual framework, introduced in the following section.

2 Rethinking Digital Publics

2.1 Modelling collective agency, not individual agents

Macrocosmic concepts of publics are well-established in design for civic spaces and live events, where they have long supported good design within stringent public safety, ethical and aesthetic parameters. In such domains, live publics are conceived as dynamic flows [26] within designed spaces [60]. In dynamic fluid modelling terms, this closely maps to the Eulerian (or macroscopic; [4]) paradigm for describing the behaviour of fluids: as masses or bodies of fluids within an environment. By contrast, the Lagrangian (or microscopic; [4]) paradigm in dynamic fluid modelling focuses on the properties of fluid molecules. The Lagrangian paradigm is akin to how virtual publics are conceived and modelled today, in contrast with the Eulerian paradigm that is well-established in civic and live events design.

If digital publics were conceptualised and modelled according to the Eulerian paradigm, it would produce a different range of metrics for understanding their behaviours within platform environments. As in live events with mass audiences, these might measure flow rate, pressure, velocity, turbulence, volatility, viscosity, or describe various wave patterns that are indicative of how well the totality of the design is working in an ecological perspective. If such measures were implemented in place of existing footfall- and attention metrics, they would be equally monetisable, but generate different systemic incentives.

Our research observes that current methods for modelling our digital twins a) maximise systemic exposure, b) are arbitrary, c) create conditions of possibility that favour cybercrime, polarisation and exposure to hybrid warfare, and that d) feasible alternatives:

(1) already exist in design for physical mass audiences, which
(2) can be adapted for the data economy by using existing methodologies in computational fluid dynamics.

Based on these observations, we propose a paradigm shift in how our digital twins are represented mathematically within digital systems to minimise exposure without sacrificing connectivity, innovate how the data economy generates revenue from our online interactions, and embed virtual civics in digital infrastructures to enhance resilience in our digital public sphere. This will be done by facilitating new models and metrics through large-scale serious gaming and virtual simulation, resulting in tools that are actionable and aligned with ethical and civic principles to support and future-proof democratic processes.

2.2 Building an ontology

A Eulerian approach to modelling digital publics at a collective rather than individual level, and in an ecological perspective (that is, in relation to its environment) requires the development of new ontological descriptions. Specifically, the concept of a digital public collectives must be detailed in terms of how they are constituted; what is a digital public collective if not an aggregation of individuals? Intentional collective behaviour can be described as more than simultaneous and coordinated individual efforts where everyone intends only to do 'their part' in the collective activity [22, 36]. Rather, intentions can form at the 'we' level [57], like a football team outmanoeuvring the opposition, or an orchestra performing a musical piece [51]. But how could collective intentions and behaviours be analysed if they are somehow not reducible to a conjunction of individual intentions, interactions, and behaviours in a Lagrangian model of the collective and its individuals?

An ontology of digital publics (the defined relationships and structures of the platforms software) based on Eulerian modelling would have epistemic effects on the design of digital systems and services. Depending on the capacity of digital publics to collectively perceive and disseminate information, make and act upon decisions, and react to external stimuli, different centralised and decentralised control mechanisms and guardrails could be needed. For instance, through which social mechanisms does the digital public system self-organise and course correct as it engages with different forces and disturbances, both internal (e.g., reaching consensus) and external (e.g., identifying bad faith actors and misinformation)? A central issue and challenge here is to strike a balance between transparent top-down and bottom-up influence of the digital public collective

on the one hand and, on the other hand, ensuring that individual anonymity is maintained and safeguarded.

Based on a revised ontology of digital publics, new metrics for describing and quantifying their behaviour and performance can be developed. Such metrics should reflect population-level behaviours. Lagrangian metrics could include, for example, the positions of individuals within an area, their velocity and acceleration, social forces, or the path efficiency of individual trajectories. Eulerian metrics, in contrast, could include flow rate (number of individuals passing through an area per unit time), crowd density distributions, velocity fields, pressure fields, and so on, to describe holistic properties and emergent features of digital publics [4]. Such metrics could be instrumental in understanding collective dynamics and guide digital management strategies.

2.3 Digital publics as complex sociotechnical systems

In addition to reconceptualising digital publics as unified collective entities rather than mere aggregations of individuals, digital publics can also be understood as complex sociotechnical systems [56], composed of heterogeneous yet interdependent elements; human actors, artificial actors, technical infrastructures, algorithmic mediators, and economic logics. These components co-evolve in dynamic interaction, giving rise to emergent phenomena that cannot be reduced to the sum of their parts [29, 32]. For example, the rapid formation of digital flash mobs, the viral spread of misinformation, and the coordinated response of online communities to political or social events all exemplify system-level behaviours that emerge from localised, decentralised interactions among actors embedded in a shared technical and communicative environment.

The platforms that host these publics—social media networks, content-sharing sites, and algorithmically curated news feeds—play a constitutive role in shaping interaction patterns. These platforms are not neutral intermediaries, but are designed and governed by business models that monetise attention and behaviour through the modelling and commodification of user activity [39]. The incentives of these models—optimising engagement, maximising advertisement revenue, and refining user profiling—shape the affordances of digital publics in ways that often obscure the systemic dynamics at play. Consequently, the feedback loops between user behaviours, platform algorithms, and monetisation strategies can produce both desirable outcomes (e.g., rapid information dissemination, collective mobilisation) and harmful ones (e.g., echo chambers, disinformation cascades, and the erosion of trust).

From a complex systems perspective, digital publics exhibit hallmark features of what are often referred to as 'soft systems' [9] characterised by ill-defined boundaries, multiple stakeholders, contested purposes, and no singular measure of success. In such systems, control is distributed, causality is non-linear, and outcomes are often unpredictable. This complexity presents a significant challenge for researchers, designers, and policymakers alike, who must account not only for the multiplicity of interacting variables but also for the normative commitments embedded in any intervention. It is not enough to study individual user behaviours or platform mechanics in isolation; instead, we need holistic frameworks capable of capturing the relational, emergent, and adaptive properties of digital publics as they evolve in real time.

One promising avenue for navigating this complexity is Soft Systems Methodology (SSM; [9]). SSM offers a way of structuring inquiry into complex human activity systems that defy reductionist analysis. By emphasising stakeholder perspectives, iterative learning, and systematically desirable and culturally feasible change, SSM—and frameworks inspired by it—aligns with the task of studying digital publics. This approach foregrounds the importance of transparency, resilience, and adaptability while acknowledging the ethical tensions inherent in designing or regulating systems that simultaneously seek to protect personal anonymity, uphold the integrity of collective action, and sustain viable business models. In this light, we argue that rethinking research approaches to digital publics through the lens of soft systems theory opens up new possibilities for understanding and influencing these evolving formations without imposing rigid or technocratic solutions. As the project aims to model dynamic relations rather than static structures, we need a modelling approach that allows us to create interactive, dynamic models that allow for exploration of new business models for online enterprises. To do this, we suggest a combined methodological approach based on large-scale serious gaming (megagaming) and simulation.

3 Planned Research Methodology

Our proposed methodology combines theory-driven metrics development with experimental testing using serious games and simulation. Specifically, we use tabletop wargames and large-scale social games or *megagame*s to iteratively identify, operationalise, and validate new Eulerian metrics for modelling digital publics as complex sociotechnical systems. These methods are well suited to exploring emergent collective behaviours in dynamic, uncertain environments with competing incentives.

Tabletop wargames—such as Risk or Pandemic—have long been used in research and planning contexts to study strategic decision-making, resource allocation, and crisis management in domains ranging from military operations to disaster response [2, 43, 55]. Megagames build on these principles by introducing large participant numbers (20-100 participants), layered roles, and evolving scenarios. They integrate elements of role-playing, systems thinking (including SSM), and collaborative problem-solving, simulating complex societal or geopolitical challenges through structured but open-ended gameplay [28]. Megagames are thus dynamic, interactive models of sociotechnical systems, or a living soft systems model, that can be used to explore the impact of new configurations of online business models.

3.1 Metrics Development and Pilot Testing

Our proposed approach begins by identifying a set of candidate metrics derived from a review of relevant literature on group behaviour, system resilience, and cognitive dynamics in digital environments. These metrics are initially tested through small-scale tabletop wargames with teams of players tasked with navigating simulated environments under varying constraints.

Pilot tests focus on emergent team-level behaviours such as collective decision-making, adaptability under pressure, and responses to external disturbances (e.g., disinformation or engineered conflict). The goal is to operationalise these behavioural properties as

quantifiable metrics—e.g., collective response time, cohesion under cognitive load, or resistance to manipulation—and establish their relationship to team performance. For instance, how might we measure the resilience of a virtual public to misinformation or internal fragmentation?

3.2 Scaling via Megagames and Simulation Loops

Insights from the pilot tests inform a refined set of metrics, which are then tested at scale through the design and execution of a megagame. These are large-scale, social, table-top, tangible research instruments that help concretise analysis and iteration of complex systems modelling that require cross-disciplinary collaboration [28]. The megagame format has been successfully used in cross-disciplinary research to explore complex problem spaces with multi-dimensional dependencies and stakeholder relations, including societal transformation [25, 59] and in cybersecurity research [33]. In this environment, multiple teams pursue complementary goals while contending with dynamic challenges, resource constraints, and (potentially hidden) antagonistic actors such as 'troll farms' or disinformation agents. This setup allows us to observe how digital publics self-organise, respond to destabilising forces, and develop resilience across inter- and intra-group interactions. Participant selection will reflect a range of stakeholder perspectives, including end users, policy experts, and system designers, to simulate diverse roles and interests within the digital public sphere. There are thus two main uses for the megagame format: research through design of the megagame, and research through interacting with the megagame. Both uses will allow for counterfactual stress testing of hypothetical metrics, as the game will serve as a testbed for the ontologies.

Following the megagame, we propose the use of computational simulations to examine the systemic and temporal effects of implementing these metrics at scale. These simulations will explore how altered metrics may reshape incentive structures, influence platform and interface design, and modulate public interaction patterns over time. Simulation outputs will be fed back into further iterations of game-based experiments, allowing for continuous refinement of both theory and method. This cyclic integration of serious games and computational modelling maximises the potential of both approaches to explore the dynamics of digital publics in realistic but controlled scenarios [55].

4 Conclusions

Rethinking our digital twins and innovating how crowd dynamics are managed in the digital public sphere opens up possibilities for continued monetisation through incentivisation mechanisms that draw on existing praxis in live events and civic design to generate prosocial conditions of possibility. A more ecological understanding of crowd dynamics can also inform the design and control of artificial collective autonomous systems, such as robotic swarms [7].

Our project adapts existing methods in crowd modelling and computational fluid dynamics for virtual platform infrastructures, aiming to minimise data exposure of digital publics while enabling new pathways for monetisation and civic-oriented design. These innovations may also help platform providers comply with emerging implementation of legal frameworks such as the Digital Services Act (EU) and the Online Safety Bill (UK). Critically, alternative modelling practices offer the possibility of minimising individual and societal exposure to data-driven harm.

The dominant business models in the platform industry rely on complex incentive chains that 'nudge' user behaviour based on reductive representations [10]. These systems stimulate engagement and revenue, but often exacerbate polarisation and enable manipulation of public discourse. Our proposed paradigm shift—grounded in civic and event-based modelling traditions [60]—reconceives digital publics not as aggregated audiences, but as emergent, sociotechnical collectives. This vision is operationalised through a research programme combining serious games, megagames, and simulation loops to iteratively develop and validate new metrics of collective behaviour.

Drawing on the soft systems methodology [9], our approach embraces the complexity of digital publics by promoting stakeholder perspectives, iterative learning, and ethically viable system design. It offers both a theoretical reorientation and a practical path forward for developing digital infrastructures that prioritise civic resilience, interactional integrity, and human-centred governance. These are not just technical goals, but are central to cognitive ergonomics in future digital environments.

Future work will expand this approach to broader platform ecologies, including cross-platform dynamics and long-term simulation of civic impact, enabling an even deeper understanding of how alternative models might transform the conditions of possibility for digital public life. This may also support the development of new user interface designs that visualise collective behaviour and group-level dynamics such as flows, tensions, or emergent consensus, making the structure and state of digital publics more intelligible and actionable for both users and system designers.

Acknowledgments

We gratefully acknowledge the contributions to early ideas generation by Professor Anna Wåhlin, University of Gothenburg, Professor Marcin Budka, Bournemouth University, Professor Frank Kelly, University of Cambridge (Bennett Institute for Public Policy, Turing Institute) and the inspiration and opportunity for researching complex interactive systems for live mass audiences offered by Punchdrunk (punchdrunk.com).

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