Backfiring and favouring: how design processes in HCI lead to anti-patterns and repentant designers

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Design is typically envisioned as aiming to improve situations for users, but this can fail. Failure can be the result of flawed design solutions, i.e. anti-patterns. Prior work in anti-patterns has largely focused on their characteristics. We instead concentrate on why they occur by outlining two processes that result in anti-patterns: 1) backfiring, and 2) favouring. The purpose of the paper is to help designers and researchers better understand how design processes can lead to negative impacts and to repentant designers by introducing a richer vocabulary for discussing such processes. We explore how anti-patterns evolve in HCI by specifically applying the vocabulary to examples of social media design. We believe that highlighting these processes will help the HCI community reflect on their own work and also raise awareness of the opportunities for avoiding anti-patterns. Our hope is that this will result in fewer negative experiences for designers and users alike.

CCS Concepts: • **Human-centered computing → HCI design and evaluation methods**.

Additional Key Words and Phrases: anti-patterns, design patterns, backfiring, favouring, design processes, anti-pattern mitigation, culpability, repentant designers

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1 INTRODUCTION

Human-Computer Interaction (HCI) is a design-oriented discipline. Much work in the area aims to develop innovative systems and better tools for people to perform tasks and activities. Many practitioners don't even 'do HCI' any longer, but rather consider themselves interaction designers or advocates of (future) end users. It is usually taken for granted (by researchers and practitioners, as well as by industry and society at large) that systems are developed to improve life for individuals, to improve effectiveness and efficiency of organisations, and to further societal goals. In fact, the first two *"general moral imperatives"* in the ACM Code of Ethics and Professional Conduct specifies that computing professionals will *"contribute to society and human well-being"* (imperative 1) and *"avoid harm"* (imperative 2) [34].

HCI's interest in social good goes back to the 1990s (see for example Friedman's work [41–43]) but with an increasing interest in 'doing good' [e.g. 1, 12, 30, 80] in areas such as ICT4D (see the proceedings of the ICT4D[1] and ACM DEV conferences[2]), sustainability [12] and in health and accessibility [89]. Most recently, there has been a rise in HCI research to do good by focusing on improving users' digital wellbeing [21, 74] due to concerns that technology design can impact users' mental health. This year's theme for NordiCHI is *"shaping experiences, shaping society"* to establish a focus on the experiences we create or enable for the *"ever more relevant discussion about carefully reflecting upon the consequences of our practices"* [2]. HCI design is therefore tightly interlinked with ethical issues, concerns and considerations. With this growing interest as a backdrop, we argue that there is an increased need for concepts and tools that help us better understand how and why problematic consequences form in design. How can we mitigate potential negative impacts, and ensure our design practices will lead to something that others will consider as good?

In that context, isn't it possible that we, at times, create systems that do more bad than they do good? That thought has a long history, stretching back at least as 40 years to Weizenbaum's [107] scathing critique of fellow Artificial Intelligence (AI) researchers working to create militarized cyborg insects. Weizenbaum was also dismayed and worried by the enthusiasm and willingness of others [23] to imagine that the simple AI 'chatbots' he had developed (e.g. ELIZA [106]) could eventually come to replace human psychologists. More recently, Kirman et al. [63] published deep and sweeping critique of large swaths of research within CHI that they consider harmful-bordering-on-evil (see also [68]). There is also long line of works that critically consider the (perhaps unintended) negative consequences of digital technology and design [5, 19, 46, 67, 73, 76, 85, 98, 102].

Despite this extensive research, our vocabulary in HCI is often limited to simple labels. How is it that design can create 'bad' outcomes, perhaps even with the best intentions? And how can such problematic consequences be avoided? We want to go beyond judgement calls about intentionality in design and whether specific examples or designs are 'good' or 'bad' and instead initiate a more refined discussion about processes that result in sub-optimal outcomes for stakeholder, be they designers, users, or other. The goal of this paper is thus to present a vocabulary that can improve discussions regarding 'bad' design. We do so by building upon work on design patterns and specifically design anti-patterns, focusing on how anti-patterns evolve and how these evolving design processes impact the ways in which anti-patterns might be mitigated. By 'design processes', we do not necessarily mean intentionally chosen design processes, but rather a series of actions or events that lead to a type of outcome (as one can talk about digestive processes or photosynthesis). This discussion paper therefore aims to more generally build on research which introduces normative, critical, speculative and reflective dimensions into HCI [10–12, 30, 31, 41, 57, 84, 91], and while we certainly do not have all the answers to eliminating 'bad' design, we hope our reflections will help the HCI community move towards a future where there are fewer negative experiences for computer system designers and users.

2 BACKGROUND: DESIGN PATTERNS, ANTI-PATTERNS AND DARK PATTERNS

Design can be described as a wicked problem [88]. That is, it is impossible to reuse (simple) solutions when solving complex real-world problems and there are no clear-cut answers when many different (perhaps conflicting) goals need to be taken into consideration. While solutions can not easily be reused, knowledge gained can be re-applied by way of developing suitable terms and methods. Design patterns are one such method and the basic idea behind them is to embody design knowledge from previous projects in a way that makes them explicitly accessible to both other designers and non-designers.

[1] ICT4D: **https://www.ict4dconference.org/**
[2] ACM DEV: **http://www.acmdev.org/**

Together with his colleagues, Christopher Alexander introduced the concept of design patterns in the 1970s [3, 4]. Design patterns were for them the result of trying to develop a language that professional architects and the people who would 'use' (live in) the resulting buildings could share. Taking a practical stance, Alexander et al. state that a pattern *"describes a problem which occurs over and over again in our environment, and then describes the core of the solution to that problem, in such a way that you can use this solution a million times over, without ever doing it the same way twice"* [4]. Design patterns have been applied in many different computer-related fields, for example game design [14] and HCI [15, 32], but have been particularly popular within software engineering [44].

The constituent parts that make up a design pattern have not been universally defined, but rather differ from domain to domain. According to Mor and Winters [75]: *"a design pattern is a semi-structured description of an expert's method for solving a recurrent problem, which includes a description of the problem itself and the context in which the method is applicable, but does not include directives which bind the solution to unique circumstances"*. In the online collection of nearly 600 design patterns for computer games,[3] a pattern contains a definition, a brief introduction, examples of games having the pattern, what to consider when that pattern is created in a game, consequences of using that pattern, and relations to other patterns (including potential conflicts). Pargman et al. [81], building on Laudrillard's [68] *"pedagogical patterns for learning"*, discuss the use of a board game in education in terms of origins, rationale, learning outcome, duration, setting, resources and tools. Yet another example is that of Knowles et al. [64] who adopt a format where each pattern has a reference number (for cross-referencing), a concise name, a description of the problem (the repeated design challenge), a discussion, an anti-pattern (a typical yet undesirable or counterproductive solution) and a pattern (an approach more likely to succeed in the situation).

In the context of software engineering, Brown et al. [17, p. 6] have defined anti-patterns as *"a commonly occurring solution to a problem that generates decidedly negative consequences"*. Kotzé et al. [66] instead define an anti-pattern as *"a solution that looks like a good idea, but backfires badly when applied"* and discusses how (or indeed even if) to use negative examples in HCI and software engineering education (e.g. whether there is or isn't a pedagogical value of saying *"don't do this!"*, see also [105]). Coplien also defines anti-patterns as patterns that *"encode practices that don't work or that are destructive"* [25, p. 27] — taking a view that anti-patterns can create negative impacts (like Brown et al. [17] and Kotzé et al. [66]).

Dark patterns can be seen as a form of anti-pattern, i.e. patterns where the results are at odds with, and directly clashes with what is in users' (or other stakeholders') best interest, but differ in that they do fulfill some goals (e.g. the developers' or the service providers'). The term 'dark patterns' was originally proposed by London-based UX designer Harry Brignull and later developed on his website `darkpatterns.org`. Brignull [16] defines a dark pattern as *"a user interface carefully crafted to trick users into doing things they might not otherwise do"*. Zagal et al. [109] apply Brignull's ideas to explore the area of game design. It is easy to understand that it can be in the interest of a game developer to entice players to (for example) commit more time to a game than what the player expects or plans, encouraging players to 'waste time' through behaviours such as 'grinding' (performing repetitive tasks) and 'playing by appointment' — requiring players to *"play at specific times (and or dates) as defined by the game, rather than the players"* [109]. These are two examples of 'temporal dark patterns' and Zagal et al. [109] also discuss 'monetary dark patterns' (getting players to spend more money than they expect or plan) and 'social capital-based dark patterns' (encouraging players to use their social capital to recruit new players).

[3] The wiki is managed and curated by Staffan Björk and can be found at: `http://www.gameplaydesignpatterns.org`

Brignull's work has been grounded for an academic audience [46], and researchers have built upon these taxonomies [16, 46] to identify dark patterns e.g. through automated website scraping and clustering techniques for online shopping sites [73]. Greenberg et al. [47] also take Brignull's collection of dark patterns as a starting point, but apply it for identifying problematic designs in the area of proxemic interactions (i.e. design related to how people make use of interpersonal distances to mediate their social interactions). However, they do not differentiate between anti-patterns and dark patterns, stating *"the difference between the two often arises from the designer's intent rather than a particular design feature. That is, the same pattern – depending on the designer's intent – can be viewed as either a dark pattern or an anti-pattern."* [47, p. 524]. We take a similar approach in this paper by focusing on anti-patterns and *how* they occur, rather than determining whether an anti-pattern was intended and therefore potentially 'dark'.

It is important to point out that something that distinguishes our understanding of patterns from that of many others is that we claim that *all* patterns – including anti-patterns – 'work' in a restricted way and in the specific sense that they *do* solve problems, at least for somebody. For example, anti-patterns in programming typically allow code to meet the (narrow) requirements of a task, but can cause problems in the future for system development or deployment. An inelegant solution can thus solve a programmer's immediate problem while simultaneously being unhelpful to the larger project or the system as a whole. The conundrum is that while anti-patterns *do* solve someone's (immediate) problem, they may still be highly undesirable as they simultaneously create other, probably larger problems for someone else. A computer program might for example crash under certain – perhaps very rare – conditions. Or the program might not (fully) work as intended, thereby causing problems for end users. Or it might solve a small problem *here* while simultaneously creating larger and/or more numerous problem(s) *elsewhere*; solve *my* problem while simultaneously creating larger and/or more numerous problems for *others*; or solve a problem *now* while simultaneously sowing the seeds of larger problems appearing down the road [86, 96]. The fact that anti-patterns, in a narrow sense, *do* solve problems helps explain – but not justify – why they exist.

The concept of anti-patterns can help HCI researchers and practitioners understand actual, as well as potential, design problems for both designers and users. An understanding of why anti-patterns occur can furthermore help designers avoid design processes that are likely to generate unwanted design solutions [93]. This approach contrasts with that of Nodder [78], who identifies and categorizes patterns according to the seven deadly sins in Christianity (with little further grounding in literature) and then settles for classifying them strictly based on how they (don't) work, rather than on why designers may use them and why they appear in the first place. We therefore explore two case studies in the next section to highlight how anti-patterns can occur — introducing a vocabulary for these two types of processes. This moves beyond what defines anti-patterns and the intentionality of such design and towards an understanding of how problematic consequences evolve, the stakeholders impacted and implicated in anti-pattern development, and how this might adapt anti-pattern mitigation strategies.

3 CASE STUDIES OF HOW ANTI-PATTERNS EVOLVE

Drawing upon two 'real world' case studies, we explore how anti-patterns can evolve through two different processes: 1) backfiring; and 2) favouring. We utilise Toyama's experiences of educating the poor in rural India [99] as a case study for describing 'backfiring' design processes, which we define as *the design and uptake of a system that leads to an anti-pattern which does not meet, or conflicts with, the system's design purpose(s).* We then discuss Schüll's work on machine gambling in Las Vegas [90] as a case study for discussing 'favouring' design processes, which we define as *the design and uptake of a system that leads to an anti-pattern which may or may not have been intended but that aligns with the system's design purpose(s).* The choice for calling the latter a favouring design process is that by instantiating an anti-pattern that meets design purposes, it favours one stakeholder at the cost, or to the detriment, of others (e.g. service providers over end users).

3.1 Case study 1: Educating the poor in rural India

Kentaro Toyama's book *"Geek Heresy: Rescuing Social Change from the Cult of Technology"* [99] describes both a personal journey and a framework for thinking about the social impact of technology. Nurtured by childhood dreams of improving society by inventing brilliant technologies, Toyama helped launch Microsoft Research's new research center in Bangalore, India, in 2004. The task he set himself was to unleash the power of computing to improve the plight of the poorest, which can be seen as an example of research within ICT4D. However, what his book comes to describe is how his high-minded visions collided with on-the-ground realities in India.

An early project, 'MultiPoint', allowed for multiple mice per computer, making it possible for several school children to simultaneously engage with educational software (e.g. vocabulary drills) on a single school computer. As research projects go, MultiPoint was a huge success; a patent was filed, a free software development kit was released, awards were won and recognition was bestowed upon the researchers:

> *"Children inevitably smiled in front of new technology, and politicians loved photo-ops where they handed out new gadgets. I often found myself in teak-paneled boardrooms discussing technology strategy with government ministers, World Bank officials, and nonprofit luminaries. Our research seemed to offer proof that there were technological solutions to developing-world education"* [99, p. 4].

While MultiPoint was successful in trials (in well-funded private schools), it failed in underfunded rural public schools; this was arguably where the technology was needed the most. MultiPoint, no matter how brilliant in theory, failed to make inroads when the real problems were not to be found in the computer interface or the underlying system, but rather in indifferent principals and administrators, under-trained teachers or in fixed school budgets that could be stretched to buy hardware and software, but not to pay for the ongoing costs for troubleshooting, maintenance and repair. In one of the schools Toyama visited, the new computers had been incapacitated within weeks; power surges that rose to 1000 volts in the rural Indian power grid [95] were singled out as the most likely culprit. A pile of formerly-new PCs, keyboards and monitors were locked away in a metal cabinet, and that was the end of that story.

However, variations of the same story played out again and again. Despite heroic efforts of brilliant, earnest and enthusiastic young researchers, powerful computer-based technologies, and the very best of intentions, all of Toyama's interventions came to a halt after they left the stage of being hand-held by the researchers. Toyama himself gradually realized that the technological inventions he touted were for the most part insignificant compared to the challenges that poor rural schools in India face: *"Each time, we thought we were addressing a real problem. But while the designs varied, in the end it didn't matter – technology never made up for a lack of good teachers or good principals"* [99, p. 6].

Even worse was that investments in computers, while photogenic, often ran the risk of siphoning off scarce funds from more basic school needs: textbooks or toilets for students, decent salaries for teachers, and so on. In this case, design solutions which seemed appropriate from a limited understanding of rural India were shown to create anti-patterns in the sense that the technology actually *worsened* the situation it was supposed to improve due to the associated costs. This case study perfectly describes the process of *backfiring* in design. The system does work in a technical sense (i.e. there are no bugs in the code), but the outcome is different – and in the worst case the *opposite* – to the initial system design purpose(s). Even if the designer has the best of intentions with the design and uptake of a technology, the design fails the users and perhaps the designers themselves as well.

3.2 Case study 2: Machine gambling in Las Vegas

Anthropologist Natasha Dow Schüll's 2012 book *"Addiction by design: Machine gambling in Las Vegas"* [90] was almost 20 years in the making and touches upon most aspects of slot machines and machine gambling: from architecture and marketing, to mechanical engineering and data mining. Slot machines have become the workhorses of the gambling industry and almost all of the industry's profits originate from them. So what is the problem with gambling machines? From an Internet site for gambling addicts, a female gambler asks:

> *"Have others experienced the same inability to move? Why does that happen? Can anyone explain the paralysis? The hypnotic effect it has on you? This is not my imagination; for me it was very real – I could not get up off my seat. Do you understand how powerful that is? I didn't even have the strength to go to the bathroom!"* [90, p. 103].

Schüll adds that interviews with casino slot floor managers gave that machine gamblers could be *"so absorbed in play that they were oblivious to [. . .] fire alarms that blared at deafening levels"* and that she saw a casino surveillance tape of *"a group of gamblers unaware of their immediate surroundings, each other, and even a dying man at their feet"* [90, p. 35].

Machine gambling is a solitary, continuous and rapid activity and it is possible to complete a game every three to four seconds [90, pp. 17-18] so that *"The solitary, uninterrupted process of machine play [. . .] tends to produce a steady, trancelike state that 'distracts from internal and external issues' such as anxiety, depression, and boredom"* [90, pp. 18-19]. While the industry talks about 'problem gamblers' and blames individuals for their poor impulse control, Schüll describes how every part of the casino, the machine and the gambling experience is designed to extract the maximum 'revenue per available customer' (REVPAC) and to not let go of a player until they have gambled away their entire salary (or life savings). Casino management consultant Leslie Cummings [28] describes how 'gaming productivity' can be 'expedited' by accelerating play, extending its duration and increasing the total amount spent. Replacing slot machines' gear-driven pull-handles with push buttons made it possible to increase the number of games from 300 to 600 per hour. Replacing mechanical reels with video technology further accelerated play, allowing experienced gamblers to complete 900 to 1200 games per hour [90, pp. 54-55].

When physical reels with a limited number of stops were replaced by 'virtual reels', mathematician and inventor Inge Telnaes wrote that it was important *"to make a machine that is perceived to present greater chances of payoff than it actually has"* [33]. The same technique has later been used to create a disproportionate number of 'near misses', with winning symbols showing up far more often *just above* or *just below* rather than *right in* the slot machine's central payline [90, p. 92]. With networked machines and loyalty club cards, massive amounts of data that tracks players in combination with data mining techniques allows for detailed analyses and tailored offerings to increasingly narrow players segments. Based on players 'predicted lifetime value', more profitable customers get quicker customer service since callers are placed in a queue based on their value tier [90, pp. 153-154]. Given the innovations discussed here do not cover the last 5-10 years, the gambling industry will have likely benefited from a decade of additional innovations in computing.

Conversations at conference panels and in trade journals are upfront about discussing how to get people to gamble longer, faster and more intensively and about the challenges of converting casual players into repeat players. Despite this, designers and industry members manage to fashion a mental chasm between such objectives and the potentially harmful effects of their efforts on players [90, p. 21] by framing their work in terms of 'enhanced consumer experiences', 'user-centrism' and (especially) 'player-centric design'. This case study perfectly describes the process of *favouring* in design. The system design works as intended but results in an anti-pattern where the user (i.e. the gambler) can face significant negative impacts financially and potentially detrimental impacts on addiction and mental wellbeing. The line between whether the designer intends to provide 'an experience' to users or the designer actually plans to bankrupt them is blurry; yet designers continue with improving the design regardless of the outcome (i.e. more gambling and therefore more income) and this corresponds with the overall business goal of the gambling industry.

4 HOW ANTI-PATTERNS EVOLVE IN HCI

Through our case studies, we have described how anti-patterns can emerge through two processes: 1) backfiring (i.e. *the design and uptake of a system that leads to an anti-pattern which does not meet, or conflicts with, the system's design purpose(s)*); and 2) favouring (i.e. *the design and uptake of a system that leads to an anti-pattern which may or may not have been intended but that aligns with the system's design purpose(s)*). These case studies offer an understanding of why anti-patterns occur in scenarios involving technology and computer systems, but how are these processes specifically relevant and useful for the HCI community? In this section, we explore how the two processes we have identified can occur in HCI. We apply our vocabulary to examples of social media design and highlight how evolving anti-patterns can lead to potentially problematic consequences in this domain. These examples are not intended to be exhaustive of how social media anti-patterns arise from backfiring or favouring, but rather exemplify how these processes can occur in HCI more generally so that designers can better relate to anti-pattern formation and reflect on their work (past, present or future).

4.1 Backfiring in social media design

In 2004, Mark Zuckerberg developed Facebook, and his idea for the service was sparked from seeing physically printed sheets that profiled Harvard University's students and staff [83]. Facebook has since grown dramatically from the university-focused service, to maintaining 100 million active users worldwide in 2008 and 2,498 million by the end of 2019 [94]. A large number of social media services have since been developed such as Instagram, Twitter, and LinkedIn, as well as chat-focused applications such as WhatsApp, WeChat and Snapchat. Alongside maintaining relationships, online applications also exist to bring new people together, either for dating (e.g. Tinder, Bumble) or making friends (e.g. Bumble BFF, Badi).

Social networks, at their core, offer the service of bringing people together online. They enable significant positive impacts to society, with family, friends, colleagues and more being able to connect remotely and keep up-to-date on each other's lives. Viewing popular social network's 'about' pages online: Facebook aims to *"build technologies to give people the power to connect with friends and family, find communities and grow businesses"* [35]; Instagram strives to *"bring you closer to the people and things you love"* [56]; and Twitter allows users to find out *"what's happening in the world and what people are talking about right now"* [104]. It is clear that these services were born out of a need for facilitating instant connections and updates online, and are perhaps key for maintaining long-distance relationships, avoiding issues such as loneliness, and keeping in touch with the world — not the least during the coronavirus pandemic [24, 51].

Despite aiming for facilitating positive connections and relationships, social media companies have come under much scrutiny due to anti-patterns that have arisen from design backfires. With the enablement of photo sharing on Instagram, graphical images of self-harm were able to be shared; this is thought to have led to tragic consequences of suicide due to exposure of this content [72]. The ability to share content like this at any instant shows how social media – and more generally, HCI designs – can shape society with problematic consequences. Not only is social media now a facilitator for harmful content sharing, but it also enables fake content. Flintham et al.'s survey study revealed that 65%

of 309 respondents access news via Facebook feeds at least once a day (particularly breaking news), and that 37% of respondents had come across fake news in some form [36].

Perhaps one of the most influential political stories of the decade has been the revelation of the Cambridge Analytica scandal. Data analysis techniques were used for gathering and understanding Facebook user data, which was then used to create targeted adverts for voters in both Donald Trump's US election campaign and the UK Brexit vote (i.e. the vote on whether the UK should leave the European Union) [18]. Whilst Facebook keeps economically viable through the use of adverts, it was perhaps unforeseeable that this feature could have such a profound impact on society and shape our political systems. Yet now, this has opened doors for further anti-patterns to evolve from backfiring. For example, Twitter's feature allowing users to change their display name allowed for the UK Conservative Party to change their name to 'factcheckUK' during a leadership debate — an act which Twitter accused the party of being misleading to users [82]. These are all examples which highlight backfiring in HCI, given the design and uptake of social media has led to anti-patterns which do not meet, or conflict with, their design purpose(s).

Given this, social networks are now taking steps to redesign their services — aiming to mitigate against such anti-patterns which have distanced the services from their core purpose of connecting people and keeping people up-to-date. Instagram are banning self-harm images and drawings to prevent the normalisation of such harmful and tragic activities [27, 72]; political adverts are banned on Twitter [108]; and Facebook are committed to ensure its users access accurate information and stop the spread of misinformation, e.g. for the coronavirus [58]. Zuckerberg has even called for 'big tech' platforms to be more regulated in four key areas: elections, harmful content, privacy and data portability — ensuring private companies are not in control of making important society-shaping decisions online [110].

4.2 Favouring in social media design

Whilst social media services aim to provide users with information and content from their friends and family, some of the features designed into the services which explicitly offer this content could be seen as anti-patterns. Clear examples of this are infinite scroll and video auto-play. With infinite scroll, unlimited new content is provided to the user on their social network so that they are able to scroll 'infinitely'. Similarly, video auto-play works by continuously providing users with *yet another* film clip for them to watch after one finishes — allowing 'endless' video streaming sessions. Both of these features could be seen to provide *value* to users given they are offering users *more* of what the service aims to provide. However, there are concerns that social media – and therefore designs like infinite scroll and auto-play – are purposely made addictive so that users spend more time on the services to view more advertisements. A former Facebook employee, Mr Parakilas, describes this: *"You have a business model designed to engage you and get you to basically suck as much time out of your life as possible and then selling that attention to advertisers."* [6].

Researchers have been studying issues of technology addiction, overuse, compulsive use or problematic use [e.g. 9, 22, 29, 50, 55, 97] — with Ding et al. finding that social media and communication services are considered the most addictive types of apps on smartphones [29]. Studying Facebook specifically, more time spent on the site has been found to be a component of problematic Facebook use [70] and those who experience negative impacts (e.g. on their relationships or work) due to *"voluminous time and attention spent on Facebook"* are more likely to consider or actually deactivate their account [13, p. 80:14]. Surveying 604 social media users, Sleeper et al. found users' perceptions of use differ based on the social networking site itself: 21% of each of the Instagram and Twitter participants wanted to increase their use of the sites, yet 41% of their Facebook participants wanted to use the site less [92].

With rising concerns over problematic technology use, HCI research in recent years has begun promoting, or designing for, 'digital wellbeing' or enhanced 'self-control' [21, 69, 74]. In this space, technology use interventions have been: designed or experimented with in HCI [26, 60–62, 65, 71, 100]; deployed within operating systems (e.g. Apple [8] and Android's [7] digital wellbeing tools) or online services (e.g. Facebook and Instagram screen time tools [87]); or offered separately as online apps and services (e.g. Forest [39], Freedom [40], Cold Turkey [101], Hold [54]). Reviewing commercial digital wellbeing apps, Roffarello and De Russis found that they mostly focus on tracking but that many of them also include app-level usage timers (31% of digital wellbeing tools) and blockers (26%) to reduce usage of addictive applications [74]. Lyngs et al. also found that digital self-control tools focus on the *prevention of non-conscious habits* (e.g. app usage limits) and utilise *action schema competition* to control user behaviour (e.g. app removal) [69]. These app usage and blockers can be used for all types of services — not just social media. However, they specifically contradict and contend with the underlying purpose of infinite scroll and auto-play features, given they push for *less* time on online services rather than *more*.

Social media sites themselves have introduced features that help people spend less time on their services (e.g. Facebook and Instagram's screen time tools [87], as mentioned above), yet infinite scroll and auto-play features have not been removed from the services. This is despite the growing interest in digital wellbeing tools, alongside calls for regulation to ban these features in the US [53]. Even the creator of infinite scroll, Aza Raskin, feels guilty of the invention due to its habit-forming nature [6], and has co-founded the 'Center for Humane Tech': an organisation aiming *"to drive a comprehensive shift toward humane technology by changing the way technologists think about their work and how they build products."* [37].

Researchers at Facebook have found that problematic use on the site is more associated with browsing profiles and messaging others than *"because of hours of unintentional scrolling or serially watching videos"* [22, p. 8] — a potential reason for which infinite scroll and auto-play have not been removed on the service. Regardless, in this case, social media services continue to keep the features of infinite scroll and auto-play; leaving it up to users, designers who regret their innovations (like Raskin), other service designers, and policy makers to mitigate the anti-patterns. This is an example of favouring in HCI, given the design and uptake of social media can lead to anti-patterns on user wellbeing which may or may not have been intended, but align with the system's design purpose(s) of keeping users' attention and interaction.

5 DISCUSSION

In this paper, our analysis of technology-related and social media case studies has enabled us to offer a vocabulary in HCI for discussing why anti-patterns occur and how they evolve; this adds to prior work on anti-patterns by moving away from specific characterisations or types of the anti-patterns themselves. We now build upon our analysis and case studies to discuss how anti-pattern mitigation strategies will differ based on the process (e.g. backfiring, favouring) in which anti-patterns occur. We then reflect on how the processes can be used for discussing culpability in HCI design and drive forward discussions of intentionally. Finally, we open up to the possibility of other processes existing beyond backfiring and favouring that result in anti-patterns, and prompt the HCI community to explore and reveal these through further analysis of case studies or reflection.

5.1 Anti-pattern mitigation: strategies and stakeholders

As we have highlighted in our case studies, the two different processes of how anti-patterns evolve – backfiring and favouring – could both arguably create anti-patterns that are a 'surprise' for designers and developers. These surprises might be considered 'good' or 'bad' to the initial designer or developer, and may be perceived differently across end-users and other stakeholders. Yet in both cases, different types of *strategies* and *stakeholders* were involved in mitigating the anti-patterns that arose. Thus, we argue that these strategies and stakeholders differ based on *how anti-patterns evolve*.

Beginning with backfiring, both our Toyama case study (see section 3.1) and our social media case study (see section 4.1) highlighted that the end system, due to the presence of an instantiated anti-pattern, was different – or even *conflicted* with – the initial design purposes. Toyama aimed to improve education in rural India, but in fact worsened the situation with added educational costs. Social networks such as Facebook, Instagram and Twitter strive to bring people together and keep people updated, but have become a hub for damaging and fake content. In the HCI and social media case, we begin to see how this backfiring process adapts in how the resulting anti-patterns are mitigated: the services *themselves* have begun to ban inappropriate content and are working towards better, and safer, platforms — perhaps 'inviting' other stakeholders to become involved (e.g. Zuckerberg's call for big tech regulation [110]).

For favouring, both our gambling case study (see section 3.2) and our social media case study (see section 4.2) showed that the end system, with the presence of an instantiated anti-pattern, *may* still align with the initial design purposes. The gambling industry offer enhanced entertainment for gamblers at the potential expense of the gamblers' financial stability and/or wellbeing. Social networks offer additional content to users at the potential expense of creating addictive and habit-forming designs. In the HCI and social media case, the strategies of mitigating this anti-pattern begin to emerge: the services themselves may design 'something' to mitigate the anti-patterns, but in fact, users, policy makers, other designers and even 'repentant' designers are perhaps more heavily involved in the anti-pattern mitigation than the initial (and potentially defiant) designers or developers. By repentant designers, we introduce this concept as *designers who (rightly or wrongly) blame themselves for the consequences of their designs or for the outcome from design processes they participated in*. We have already exemplified this with the creator of infinite scroll, Aza Raskin, who as a 'repented designer' also co-founded the 'Center for Humane Tech'.

As a result, we note that there are different strategies for various stakeholders in anti-pattern mitigation. For designers and developers that may create anti-patterns, there is an opportunity for them to engage in reflective design processes which aim to *prevent* the anti-patterns arising in the first place. Given the breadth of technology today and the different aspects of users' lives that it touches, this prevention of anti-patterns is no doubt difficult to do. Yet tools have begun to become available for helping designers and developers consider the broad ethical aspects of their work. For example, the Ethical OS toolkit [79] exists — offering technologies that *"anticipate the long-term social impact and unexpected uses of the tech we create today"*. In this toolkit, eight 'risk zones' (e.g. 'Truth, Disinformation and Propaganda'; 'Addiction and the Dopamine Economy') are offered for teams to understand the biggest areas of risk for their technology, alongside future scenarios to consider and ethical strategies to 'future-proof' designs [79]. Furthermore, the 'Centre for Humane Technology' offers a 'Design Guide' offering reflection on six aspects of human 'sensitivities' that are vulnerable to technology design — specifically our emotional, attention, sense-making, decision-making, social reasoning and group dynamics sensitivities [38].

These existing tools – alongside other ethical research and guidelines (e.g. the ACM Code of Ethics and Professional Conduct [34]) – can be drawn upon for anti-pattern prevention, and therefore are perhaps most relevant for designers and developers to avoid anti-patterns from backfiring. However, we believe more work needs to be done to help designers and developers in this space. Moving forward, the HCI community could look to create resources for specifically mitigating anti-patterns. These may include, for example: 1) a set of questions that designers should be able to answer *and live with* if an anti-pattern arose later on; 2) collections of commonly known dark or anti-patterns to avoid (building on those available for games in particular); and 3) how to role play various stakeholders with different (and perhaps 'evil') intentions. Such resources would help designers and developers more deeply imagine how a technology or service could be used in morally questionable ways.

Designers and developers could also utilise these tools and engage in reflective design to at least *understand* the potential anti-patterns from favouring — or perhaps even offer options for users to disable a feature which may only be seen as an anti-pattern for *some* users (e.g. an option to remove infinite scroll in the social media case, see section 4.2). Yet, given the case studies of how anti-patterns evolve outlined in this paper, it is perhaps more likely that *other stakeholders* will aim to mitigate the anti-patterns from favouring. This externality will make preventing an anti-pattern more difficult, meaning anti-pattern mitigation will most likely occur through *fixing* strategies. That is, other designers or developers may create applications which compete with those that have the anti-patterns and thereby aim to fix the associated issues, similar to how digital wellbeing tools have become relevant in HCI (see section 4.2). These 'other' service designers or developers may even include the repentant designers who initially *added* to the problem of anti-patterns (e.g. like Raskin).

Users can then utilise such applications to mitigate the impact of an anti-pattern, whilst allowing other users who may not be negatively impacted by a service design to continue utilising the feature (e.g. continued use of infinite scroll and auto-play, in the case of social media design). Users may also develop their own ways of mitigating anti-patterns through fixing strategies. For example, to create a work-life balance, workers have been seen to deploy 'micro-boundaries' to technology use by splitting personal and work emails between different applications on a device — *"thereby limiting the temptation of checking work emails during non-work time"* [20, p. 3997].

Perhaps the best way of anti-pattern mitigation is through better regulation of the technology industry. If policy makers set out clear guidelines surrounding 'good' and 'bad' design, this would help designers and developers to mitigate anti-patterns evolving from backfiring whilst also keeping them in check for anti-patterns arising from favouring. Better regulation would therefore help to ensure both prevention and fixing strategies are employed — for example by enforcing certain standards on design and development (introducing *prevention* by default), holding designers and developers accountable for anti-patterns through penalties e.g. fines (economically forcing *fixing*), or even requiring external testing regarding these issues before products and services may be launched. Unfortunately, the HCI community is a long way off being able to offer policy makers suggestions of design guidelines given there are complications surrounding whether a design is in fact 'good' or 'bad', as well as complications in establishing some sort of 'blame' or culpability for an anti-pattern (which we discuss next). However, the HCI community could look to create ways in which the *public* would help enforce anti-pattern prevention and fixing, for example through an online tool allowing people to 'rate' technologies or services in terms of the negative impacts arising from anti-patterns. This would require extensive research into how technologies or services should be ranked, but the community would benefit from learning from similar mechanisms available today (such as Fairwork's ratings[4]) and the effort involved would help keep designers, developers and technology companies accountable for anti-patterns in a democratic manner.

5.2 Determining culpability

We have so far avoided making assumptions of whether the anti-patterns evolving from the processes discussed in this paper are classed as dark patterns, given that this is a matter of a hard-to-determine intentionality [47]. This can be problematized and Grauer [45] for example suggests that *"intent isn't always as clear when it comes to [anti-patterns,] sometimes it's just a really, really poor design choice"*. So how would you tell the difference? It would, truth be told, seem

[4]Fairwork *"rates and ranks platforms in the online gig economy to show how their working conditions meet"* their principles of fair work: **https://fair.work/ratings/**

to be hard to assess intent without further investigations, for example by interviewing designers (who might not answer such questions entirely truthfully). Turner [103] tries to dodge this particular problem of intent by coining the concept 'shady patterns', which they describe as *"a pattern that was problematic for users, but probably not due to evil intent on the part of the designers and developers"*. The dicey question of assigning blame poses less of a problem for Nodder [78], whose book is pointedly called 'Evil by design'.

We, on the other hand, argue that it is interesting to try to understand how anti-patterns happen, where they come from and their mitigation; with this understanding, we can aim to move the HCI community in the direction of being able to discern and discuss culpability as a way to ferret out problematic (designer) behaviours — thereby increasing the chances of rectifying them. With this, we do not necessarily envision blame upon individual designers or developers for the anti-patterns that can be the result of their efforts. For example, backfiring may occur from a team of designers and developers believing they know all relevant aspects about the design context, but may also result from not having enough resources to sufficiently study the context. For favouring, this may occur due to practitioners willingly participating in design processes they do know, or ought to know, will lead to bad or even 'evil' results; but they may also result from practitioners not fully understanding that they are partaking in such practices, or, having little say over the work they do in highly controlled and hierarchical organisations. Our anti-pattern design processes point at a variety of reasons for *why* anti-patterns occur, and it is impossible to lay the blame at the feet of any particular actor or professional group independently of knowing more about the specific case in question. It is however possible that blame should be assigned not just to *particular* actors, but that it should be shared among *various* actors.

One aspect of culpability is that other parts of society put responsibility for consequences on people even if no intention to create such consequences can be proved. That is, society expects people to actively avoid the risk of causing such consequences, and punish people who do. An example of this is the distinction between manslaughter and murder in legal systems: the intentional act of murder is a punishable offense, but so is the unintentional act of manslaughter. Given the permeation of interactive computer systems, HCI practitioners most likely need to find practices to mitigate anti-patterns or accept that other parties, e.g. lawmakers, could start to meter out punishments if the consequences are deemed severe enough. Punishments have occurred thus far, for example, in the form of a fine for Facebook due to the Cambridge Analytica scandal [52] — but, moving forward, specific rules might be established for culpability and punishment based on the outcomes of design processes resulting in anti-patterns (backfiring and favouring).

Perhaps what further complicates this issue of culpability is determining what exactly is 'in the user's best interest'. Juul [59] and Zagal et al. [109] point out that the general rule is that computer games are designed to frustrate players and to erect non-trivial barriers for them to overcome. If part of the experience of playing computer games hinges on meeting resistance and being thwarted, it can become both very complex and ethically challenging to determine exactly what is in the player's best interest. This is a line of reasoning that is further developed in [109].

The same is not true for productivity software (working with documents, spreadsheets, presentations, etc.), but other types of complications besides intentionally 'thwarting' users can instead arise. 30 years ago, Jonathan Grudin identified a significant challenge for Computer-Supported Cooperative Work (CSCW)/Groupware applications [48, 49], namely that there can be a disparity between those who do the work and those who reap the benefits: *"[An application can fail] because it requires that some people do additional work, while those people are not the ones who perceive a direct benefit from the use of the application"* [48, p. 86]. For more complex systems that involve many (different types of) users and stakeholders, the system could be successful for some users and for some purposes while simultaneously failing and creating negative experiences for other uses, thereby encoding *"practices [. . .] that are destructive"* [25].

As we have highlighted in this paper, there are examples of this occurring in social media design, e.g. the case of infinite scroll and auto-play where some may find value in additional content and others may find it habit-forming (see section 4.2). This makes it difficult to deem whether blame even *should* be assigned, given a design may have both positive and negative impacts. Regardless: designers that wish to make as 'good' designs as possible should arguably be reflective about reasons why their designs can have negative consequences. We believe the vocabulary of anti-pattern processes initiated in this paper, as well as discussion of their mitigation strategies, is one way that can help designers be more conscious of these issues when reflecting upon their HCI work (past, present, future).

Repentant designers also play a crucial role in such reflections and determining culpability since they offer insights and perspectives that otherwise would have been left to speculations about designers' intentions.[5] As discussed in section 5.1, these designers may also take it upon themselves to work against the creation of more instances of anti-patterns based upon their own personal experiences. While such commitment is praiseworthy, one hope of developing concepts such as backfiring and favouring is to raise awareness and avoid such issues *before* designers personally experience them, thereby reducing the number of design cases requiring culpability determination in the future.

5.3 Beyond backfiring and favouring

For people with previous experiences of working with design patterns (and anti-patterns), it might be confusing that we have introduced two processes of how anti-patterns evolve here, but have not identified specific (named) anti-patterns for those processes. There are several reasons for this, the main being that the same anti-pattern could evolve in different ways (e.g. through backfiring or favouring) in different projects. Besides this, as with other collections of patterns, there can exist a (very) large number of specific anti-patterns. To exemplify and enumerate just a few anti-patterns could give the impressions that these specific anti-patterns, and the ways in which they form, are the (only) ones to look out for. Even realising that there may exist other, not-yet-named anti-patterns, it would be more difficult to identify these without a more general understanding of how anti-patterns evolve — something we believe this paper contributes to. We have presented two processes leading to the creation of anti-patterns based on why they occur, thereby illustrating why design processes can lead to potentially 'bad' design solutions or negative implications for users and/or designers.

However, beyond the terms backfiring and favouring offered in this paper, other processes may exist that result in anti-patterns. For example, software design or development mistakes, or computing operation and use problems, that lead to significant consequences — such as those discussed in Neumann's book *"Computer Related Risks"* [77]. Neumann [77] provides detailed descriptions of a large range of threats and applications including for example: 1) *"the BMEWS [air] defense system in Thule, Greenland, mistaking the rising moon for incoming missiles on October 4, 1960"* [77, p.38]; 2) a Dutch chemical factory exploding in 1992 due to (a system that accepted) a typing error by a laboratory worker preparing a recipe, resulting in a reactor being filled with the wrong chemicals [77, p.61]; 3) the well-known Therac-25 *"computer-based electron-accelerator radiation-therapy system"* [77, p.68] which under certain conditions delivered massive and deadly radiation overdoses; and 4) the instantly tripled auto-insurance rate of a man who turned 101 years old and whose *"age was interpreted as 1, which fit into the program's definition of a teenager – namely, someone under 20"* [77, p.87].

These mistakes and errors would be another way in which anti-patterns take form, but we recognise that this process depicts a much simpler mitigation strategy than backfiring and favouring by 'just' ensuring proper design and testing development strategies. We therefore highlight that our introduction of the terms backfiring and favouring in this

[5] The decades-long investigation of Schüll [90] provides another route for how such argumentation can be made.

paper is not meant to be an exhaustive vocabulary of processes resulting in anti-patterns. Rather, we wish to initiate discussion in the HCI community for how more complex cases of anti-patterns emerge and how they may be mitigated. As a result, we call for HCI researchers to add to our discussion of anti-pattern design processes through additional analysis of case studies, or reflection upon their own work. Once we have a better understanding in the community of how anti-patterns evolve, we can better recognise the opportunities for ensuring our designs are in fact 'good'.

As a final consideration, there is an assumption that anti-patterns don't work i.e. that they *"encode practices that don't work or that are destructive"* [25]. Yet, in several of the case studies and processes we have highlighted here, anti-patterns *do* work from some perspectives. Given this, it might be impossible to make a hard distinction between patterns and anti-patterns. Some patterns may be easier to categorise as one or the other, but a pattern that is advantageous to one stakeholder group over others can potentially be 'dark' or create negative impacts for someone else. Given this, we wish to raise the caveat that our backfiring and favouring processes, as well as processes identified in future HCI work, could, from some viewpoints, be classified as ways in which design *patterns* – not *just* anti-patterns – evolve. While it is beyond the scope of this paper to explore these questions further, the approach used here is offered as a potential way to explore ethical aspects of design through a design patterns perspective.

6 CONCLUSION

In this paper, we have introduced two processes that result in anti-patterns: backfiring, and favouring. We have also introduced the concept of repentant designers. Our goal of introducing the processes is to help designers reflect on circumstances during design processes that may give rise to anti-patterns, and we have offered an understanding of potential strategies (preventing and fixing) for different stakeholders (the initial designers and developers, repentant designers, other designers and developers, users, and policy makers) to mitigate such anti-patterns *based on how they evolve*. By presenting these processes, we also hope to encourage discussions among design researchers about how well-intended design processes can result in design solutions that do not serve the needs of end users, and how this can help highlight culpability in HCI. We hope that the HCI community finds our vocabulary and discussion useful, and call for other researchers to add to this through reflections and analyses of other processes resulting in (anti-)patterns.

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