

Exploring Biopolitics Through Design Fiction

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Abstract. This paper presents a set of research efforts that leverage HCI-based speculative design to explore the sociopolitical impact of current and near-future biotechnologies. Our studies focus on genetic engineering-supported processes, of which we present two fictional services that have proved being effective as tools for unearthing previously hidden oppressive processes. While fictional, our designs adhered to strict feasibility requirements and were shown through the implementation of interactive mock-up services.

Keywords: Biotechnology, Design Fiction, HCI, Genetic Engineering, Biopolitics.

1 Introduction

Genetic engineering –the modification of organisms by manipulating their genetic material– is not a recent development. If we consider selective breeding and similar forms of intervention, humankind has been practicing some forms of genetic engineering for centuries [1].

A paradigm shift occurred when, two decades after the DNA model was introduced, recombinant DNA was discovered [2]. By the early 1970s, researchers had developed techniques to isolate DNA sequences from a variety of organisms and insert them in bacteria, enabling the sequences to replicate as the bacteria multiplied [3].

These techniques blurred the frontier between applied and basic research in biology. Genetics, a field once confined to academia, became the seed of immense biotechnology industry that exists today [4].

Research in genetics has quickly advanced since then. [4]. In 1983, the first genetically engineered plant was produced by inserting an antibiotic-resistant gene into tobacco [5]). Also in 1983, Kary Mullis, developed the Polymerase Chain Reaction (PCR), a technique that revolutionised genetic research by enabling the easy replication of DNA [6].

In 1985, the discovery of Zinc Finger Nucleases (ZFNs) marked another significant milestone. Zinc fingers are proteins that recognise specific DNA sequences, allowing precise targeting of genetic material. Their discovery opened the door for “reverse genetics”, a method used to help understand the functions of a specific gene by studying the phenotypic effects of targeted genetic mutations [7].

1.1 CRISPR/Cas9

Many advances in molecular biology have occurred since the 1970s with profound scientific, social, and economic impact. The biotech market is now predicted to soon reach a value of \$775 billion [8].

Of particular significance is the 1983 discovery of CRISPR (clustered regularly interspaced short palindromic repeats) and their function by Francisco Mojica. CRISPR are DNA sequences acting as a form of genetic “memory” for bacteria, enabling them to recognise previously encountered viruses and direct the Cas9 protein to cut the viral genome [9].

This bacterial defence mechanism was adapted by different researchers –most notably Jennifer Doudna (UC, Berkeley), Feng Zhang, (Broad Institute of MIT and Harvard), and scientists in George Church’s lab (Harvard University)– into a genetic engineering tool able to make precise, targeted cuts in DNA, radically simplifying genetic engineering while significantly reducing costs—experiments that previously cost thousands of dollars can now be conducted for as little as \$30 [10]. Moreover, the accuracy of this tool has reduced unintended off-target effects, enhancing its safety and efficacy [11].

In 2018, while US companies began the first human trials using CRISPR [12], Chinese researcher He Jiankui reported the germline editing of two human embryos. This announcement sparked international outrage due to its ethical implications, underscoring the urgent need for a global regulatory framework.

In the words of Jennifer Doudna, He’s “reckless experimentation on the girls” proved “human embryos editing is relatively easy to do but incredibly difficult to do well,” adding that He’s work “will likely be remembered as one of the most shocking misapplications of any scientific tool in our history” [13]. Margaret Riley further emphasised that He’s work “has changed the nature of the ethical discussion”, introducing the complex question of how society should treat beings created via genetic engineering [1].

2 Design Fiction

Genetic engineering techniques like CRISPR/Cas9 have had profound and rapid impact on biotechnology. While they have been widely embraced by academia and industry, their broader societal implications remain uncertain, especially in light of the absence of robust legal and ethical frameworks.

Design fiction –the creation of fictional products, processes or services– enables a shift from short-term utility-driven research to the exploration of more complex, long-term challenges [14]. Additionally, it draws upon a rich tradition of technical, literary, philosophical, and artistic explorations of emerging and future technologies. As Bruce Sterling describes it, design fiction is “the deliberate use of diegetic prototypes to suspend disbelief about change” [15].

This type of speculative exploration often enriches not only the understanding of contemporary technologies but also contributes to the reflection, testing, and simulation of plausible sociotechnological developments. These activities are increasingly crucial

for, as Dunne and Raby wrote, “we need to dream new dreams for the twenty-first century as those of the twentieth century rapidly fade” [3].

Fictional explorations of biotechnologies have often taken the form of dystopian extrapolations [16], frequently proposing a meta-level propagandistic discourse promoting or justifying within the biotechnology industry [17].

Notable examples are the explorations of genetic and environmental engineering found in Andrew Niccol’s film *Gattaca* and Aldous Huxley’s novel *Brave New World* [18]. Paradoxically, such works have often been employed to obscure legitimate concerns about these technologies.

Nevertheless, fictional and speculative narratives remain crucial tools for exploring possible futures. These explorations become essential if the political implications of scientific and technological advances are to be considered. As Gramsci argues, which notions are relegated to the ‘common sense’ and thus considered beyond critique or analysis, always constitutes a space of political struggle [19]. It is therefore necessary to engage in speculative reflection on both the immediate and longer-term effects of emerging technologies incorporating an “analysis of the political rationality underpinning them” [20].

2.1 A Political Framework for Design and Technology

Donna Haraway’s *Cyborg Manifesto*, first published in 1985, revolutionised feminist thought by recontextualising feminism as a political movement within the framework of technology and science.

Haraway’s revolutionary approach lies in her reclamation of feminist politics through the introduction of the cyborg, a construct that allows for a simultaneous gendered and genderless political reading. This dual perspective positions the cyborg as both a subject of political struggle and an object of reference for broader political needs. The manifesto proclaims a powerful call for “pleasure in the confusion of boundaries and for responsibility in their construction” [21]. Within the context of biotechnology, Haraway’s cyborg—conceived as the convergence of human and machine—can be interpreted as a human-made, purely biological being that embodies technology.

Contemporary perspectives on gender cannot be fully understood without incorporating a capitalist worldview, particularly in terms of ownership over the means of production and reproduction. Coherently, when integrating bioproduction into the praxis of HCI design, it is essential to consider the emergence of potential new ‘gender/political divides’ that distinguish between those with control over reproduction and those lacking agency in their relationship with techno-biological production.

Haraway’s call for political unity to effectively confront the dominations of “race,” “gender,” “sexuality,” and “class,” while framed through a now obsolete taxonomic lens, highlights the necessity of a political framework for addressing contemporary and future biotechnologies. As Jana Sawicki argues, “we can build political unities not on the basis of some naturalised identity as women, or mothers, but on the basis of common political opposition and affinities with other political struggles” [22].

3 Genetic Surveillance

Surveillance can be defined as ‘any collection and processing of personal data, whether identifiable or not, for the purposes of influencing or managing those whose data have been garnered’ [23]. Genetic surveillance, in turn, uses DNA samples (sources of which include not only solid tissues, but also blood, saliva, and any other nucleated cells [24]) as “genetic fingerprints” to identify a person or a group of people.

While legitimate uses for DNA-based identification do exist (for example, matching a sample obtained in a crime scene with an entry at a DNA database) [25]), genetic surveillance has been shown to have a profound negative social impact, exacerbating racial inequities, threatening privacy and dignity interests, and undermining the legitimacy of law enforcement [26]. States and private organisations have assembled massive genetic databases, whose mere existence subject individuals to a state of permanent and lifetime surveillance [27].

The oppression intrinsic to surveillance is epitomised by the “immediate indignity” of forced swabbings that used to obtain genetic material. These swabbings, even in countries where laws requiring consent exist, systematically end up with “police exert[ing] significant power over the targeted citizen”.

Genetic surveillance conveys the classification of the subject as a (potential) future criminal, justifying their DNA to be stored in eternity [26]. Genetic surveillance encodes *future surveillance*, entrenching conditions of structural injustice and oppression *in eternum*, normalising processes of dehumanization and depersonalization [26]. Moreover, it also operates as a deterrent of potential future political activities: “when your DNA is taken after an arrest at a political demonstration, it can have a silencing effect on political action” [28]. In this context the body itself becomes an instrument of surveillance, not only reinforcing conditions of injustice but also often rendering individuals and communities powerless against current and future oppression.

This state of permanent supervision and oversight, however, is often the product of implicit asymmetries, rather than responding to explicit decisions of a centralised, official, controller. Thus, instead of a genetic panopticon we often find a complex array of “people, technologies and organizations that become connected in ‘surveillance assemblages’ [29]”.

These complex networks do, however, respond to the *established power*, understood as the set of interrelated forces that manifest in larger constructions of material, economic, social, and symbolic relationships [30]).

Speculative projects need to, at the very least, to be aware of how complex is to model power distribution and negotiation. Once again, speculative explorations are often able to simulate potential future distributions of power providing valuable insights on future needs and struggles.

An “unslakable thirst for massive amounts of clinical and genotypic data” has become pervasive in contemporary societies [31]. For example, some American states have already implemented systematic genetic screening of newborns [32], and several countries are considering the implementation of universal biometric registries [29].

To understand these “technologies of power” it is necessary to analyse the “political rationality underpinning them” [20], as well as the “discursive field in which exercising power is rationalized” [20].

That mandatory requirement since 2015 for all citizens and residents in Kuwait to submit tissue samples for DNA screening and storage under penalty of imprisonment for noncompliance [33] underscores the urgent need for designers to disentangle privacy rights from property rights [34]. This highlights the importance of moving beyond simplistic, techno/market-optimistic approaches that often disenfranchise individuals lacking the political, social, or economic contexts necessary to exert ownership as a means to secure their rights.

3.1 Subversive Fictions

Biotechnologies bring into question deeply rooted perceptions of life, identity, the self, and the position of the human regarding other living beings and the environment [35].

Speculative designs have already been instrumental in the establishing of new places of dialogue, sometimes also playing an educational role withing society.

Heather Dewey-Hagborg’s artwork *Stranger Visions* consists of 3D-printed faces created from DNA extracted from “genetic artefacts: cigarette butts littering the sidewalks, chewing gum, hair [36]”. Although the faces were, *strictu sensu*, fictional, the artwork had a noticeable impact (although perhaps transitory) in genetic privacy’s social relevance. Earlier, Dutch artist Jalila Essaïdi proposed creating bulletproof skin by seeding human skin cells with spider silk; a purely symbolic gesture that was understood by many as real action [37]. Other artists, designers, and activists, such as Ionat Zurr, Oron Catts, Steve Kurtz, Heath Bunting, and Rachel Baker, have also explored the fertile space of art, design, and activism in the context of biotechnology [38].

4 Race

The Human Genome Project, a 13-year international scientific research project funded mainly by the US Dept. of Energy and the National Institutes of Health, successfully achieved its objectives of identifying, mapping, and sequencing all the base pairs that constitute human DNA, as well as locating and cataloguing all human genes.

The project’s findings have had enormous impact in different areas, from purely theoretical (e.g. it drastically improving our understanding of evolution and mutations) to practical applications such as genetic tests that reveal predispositions to numerous diseases.

Moreover, this comprehensive analysis of human DNA unequivocally demonstrated the absence of any genetic basis for race. Instead, it confirmed that race is entirely an “invented, fictional form of identity” [39].

4.1 Scientific Racism

Scientific racism refers to a pseudoscientific ideology that posits that the human species is composed of biologically distinct groups or “races” hierarchically ordered according to biology or natural law [25].

Various forms of scientific racism were widely accepted from the 1600s onward. Influential early works, such as François Bernier’s *New Division of the Earth by the Different Species or ‘Races’ of Man that Inhabit It* (1684), Richard Bradley’s *Philosophical Account of the Works of Nature* (1721), and Lord Kames’s *Sketches on the History of Man* (1734), identified differing racial categories but consistently upheld a Eurocentric worldview, asserting the supposed superiority of the white race.

Modern scientific racism emerged in the 19th century when evolutionary thought was paired with ideas promoting the supremacy of northern European races. This ideological shift catalysed the eugenics movement, profoundly influencing Western perceptions of race [40].

Key figures such as Francis Galton successfully advanced eugenics into the scientific canon by the early 20th century. Under the guise of improving humanity, eugenics promoted selective breeding based on race, simultaneously legitimising and naturalising colonialism, slavery, forced sterilisation programmes, genocides, and apartheid regimes.

4.2 Personal Genomics

The Human Genome Project, along with subsequent advances in genetic testing technologies, catalysed the rise of a new industry: personal genomics. In 2008, the company *23andMe* was named Time Magazine’s Invention of the Year [41], marking the emergence of a direct-to-consumer service industry that expanded dramatically over the following decade. As noted, “after gardening, genealogy is the most popular hobby in the U.S., and direct-to-consumer genetic testing services have undoubtedly played a role in that popularity” [42].

While these companies initially marketed their services as tools of consumer empowerment—providing access to genetic information without the mediation of healthcare providers [43]—they also systematically serve as mechanisms that reinforce prejudices and enable racial discrimination by presenting biases as if they were objective facts supported by science.

Even though there cannot be a genetic definition of race or ethnicity (it would be akin to proposing a genetic definition of nationality), it is possible to find some statistical correlations between genetic composition and socially defined ethnical groups. This narrative is actively marketed by personal genetic companies that offer a genetic analysis of their users’ ancestry (see Figure 1).

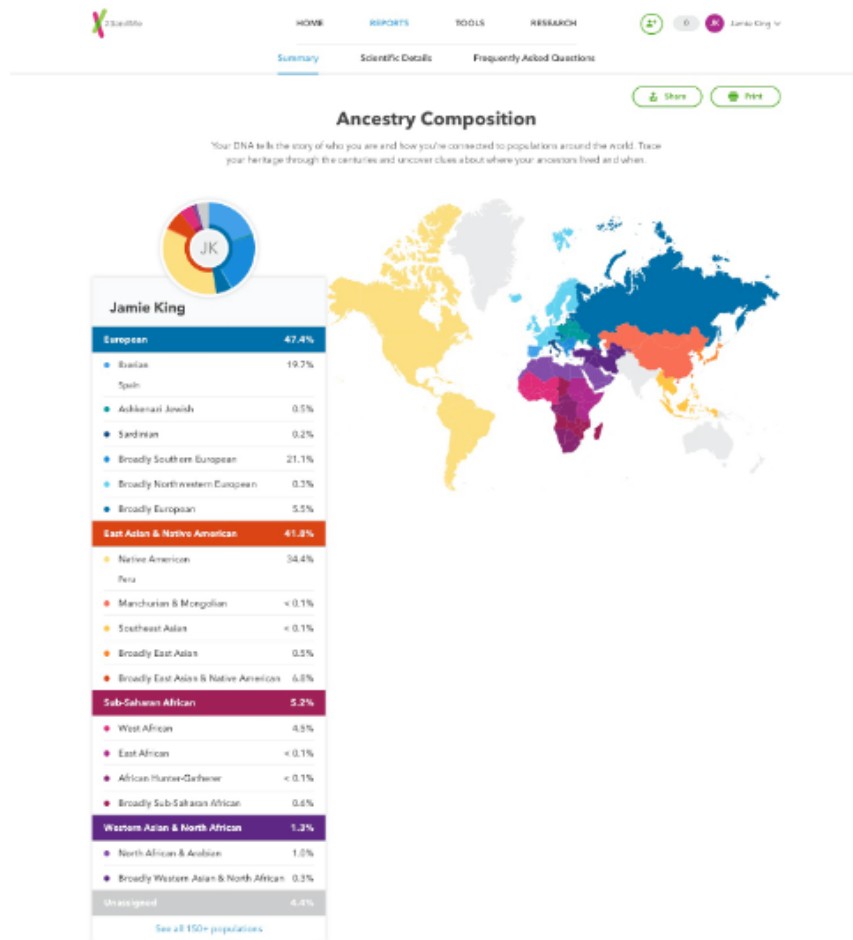


Figure 1. 23andMe's ancestry report © 23andMe.

Aside from their inherent inaccuracies—overlooking crucial data such as population migrations and the evolution of genetic markers over time [44]—these tests perpetuate and amplify false notions about human races. The spurious correlation they suggest between genetic makeup and ethnicity not only misleads individuals but also serves as a source of self-validation for racist groups [45]. These ideas have been taken to extremes, with some states using DNA ancestry as a form of social policing.

Research detailing methods to “sort people by ethnicity by screening their genetic makeup” has not only been published but also implemented by the Chinese government. China's *Physicals for All* has involved coercive measures such as DNA swabbing, blood collection, facial scanning, and voice recording. This initiative has amassed biometric and genetic data from nearly 36 million individuals in the Xinjiang region.

While implemented in China, this utilised equipment produced by *Thermo Fisher*, a US company, and data provided by Kenneth Kidd, a geneticist from Yale University [46]. US Senator Marco Rubio publicly condemned *Thermo Fisher*'s involvement, describing it as “grotesque” and accusing the company of “helping Xinjiang authorities conduct mass detention and brutal suppression of Uyghur Muslims by selling them DNA sequencers.”



Figure 2. *Ethno.life*'s homepage, supposedly in private beta.

5 *Ethno.life*

Ethno.life is a fictional service (see Figure 2) that employs CRISPR/Cas9 technology to artificially alter the results of genetic ancestry tests. For instance, a customer wishing to receive a test result indicating 100% White Western European ancestry could order a personalised genetic vaccine that modifies their saliva to produce the desired outcome (see Figure 3).

The basic use case of *Ethno.life* operates as follows: a customer submits a DNA sample via a saliva swab after enrolling in the service. *Ethno.life* then synthesises a viral vaccine tailored to the requested ancestry profile and delivers it to the customer. The vaccine is injected into the salivary glands, and after a brief period, the customer is ready to take an ancestry test, which will yield the customised result.

This design fiction project explores the social implications of ancestry tests along two key dimensions:

1. *Ethnicity as a Social Construct.* The project reclaims ethnicity as a socially constructed and fictional category, decoupling it from any biological basis. Here, the body becomes a medium for the expression of self-ascribed identity rather than a “truth-telling” entity, aligning itself with the individual's desired social group. This reimagining challenges the idea of biological determinism in ethnic identity.

2. *Capabilities and Ethics of Genetic Engineering.* *Ethno.life* examines the possibilities of genetic engineering, including in vivo modifications in human subjects. While the technologies enabling such interventions are available, the associated ethical, legal, and procedural issues remain unresolved. The project aims to provide a space for dialogue involving a diverse range of stakeholders to address these complex questions.

Additionally, *Ethno.life* seeks to create spaces of uncertainty, challenging conventional narratives and opening pathways for resistance against oppressive regimes. By presenting a speculative instantiation of these ideas, the project invites critical engagement and fosters discussions about the broader societal, ethical, and political implications of genetic technologies.

5.1 *Ethno.life's Feasibility*

Related work exists that shows *Ethno.life's* feasibility. For example, the patent *Activation of taste receptor genes in mammalian cells using CRISPR-Cas9* [47] describes the use of CRISPR/Cas9 to modify human perception of sweetness, as a strategy to combat obesity. The patent proposes a similar protocol as the one imagined for *Ethno.life*, as follows:

- (i) providing a culture of mammalian cells, the genome of said cells comprising at least one sweet receptor domain;
- (ii) designing at least one type of single-guide RNA (sgRNA), the 10 to 30nt guide sequence of said sgRNA being complementary to stretches within the non-coding and/or putative regulatory region upstream of the translation start codon of at least one sweet receptor gene;
- (iii) preparing a vector comprising an expression cassette encompassing at least one optionally modified CRISPR-Cas9, preferably CRISPR-dCas9VP64, and at least one optionally modified sg-RNA optionally containing aptamer structures for binding activator proteins;
- (iv) transfecting said culture of mammalian cells with said vector to target the genome for the presence of a DNA sequence that is complementary to the 10 to 30nt guide sequence of said sgRNA; and
- (v) measuring the transcriptional enhancement of the sweet receptor mRNA by quantitative RT-PCR.

In the case of *Ethno.life*, it would be necessary to previously reverse engineer the tests that the different personal genetics company follow, identifying the markers they use.

Databases of ethnicity markers exist. For example, the aforementioned Chinese genetic surveillance project, “contributed the data of 2,143 Uighurs to the Allele Frequency Database, an online search platform run by Kidd that was partly funded by the United States Department of Justice at least until 2017. The database, known as *Alfred*, contains DNA data from more than 700 populations around the world” [46].

Also relevant for this brief feasibility study is the work of Wang et al, which used CRISPR/Cas9 to reduce xerostomia (the dryness of the mouth product of diminished function of the salivary glands) [48]. In this work, the researchers were able to enhance the expression of a specific gene (AQP1) using a cytomegalovirus vaccine, verifying

that “the altered cells demonstrate a change in their permeability mimicking a restored salivary gland state”.

Finally, the researchers indicate that in addition to their target application, “the methods presented provide an efficient approach to treat other human diseases or side-effects of treatments.”

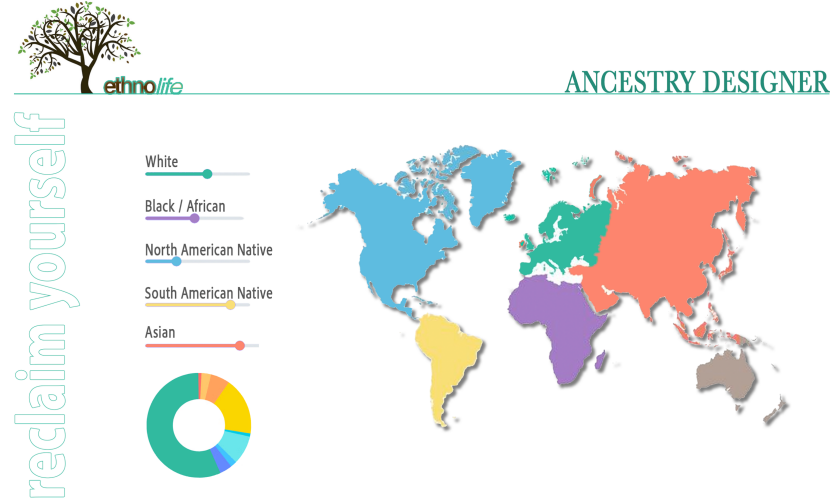


Figure 3. *Ethno.life's* Ancestry Designer.

5.2 Discussion

Design fiction projects range from prototypes of products that could feasibly be developed in the near future to entirely fictional constructs that may never be realised. In all cases, design fiction has been shown to create spaces for reflection and discussion, contributing to a deeper understanding of both future potentialities and present realities.

These “mental simulations of possible techno-social futures” assist designers and users in broadening their considerations of the “impacts and consequences of technological infrastructures” [49]. Specifically, as a tool for sociopolitical reflection, design fiction’s projections often enhance the “tangibility” of oppressive or discriminatory processes that affect distant social groups –whether socioeconomically or geographically– that might otherwise be ignored or overlooked.

The main objective in designing *Ethno.life's* fictional service was to develop a tool that could engage with contemporary debates on genetic surveillance, highlighting potential threats to human rights and increasing awareness of existing practices that utilise genetic information for discriminatory or oppressive purposes.

Ethno.life's design, particularly when presented without context, risked being perceived as either a provocation or a satirical proposal. To mitigate this, a technically plausible design was developed alongside an interactive mock-up prototype (Figure 3).

The prototype was presented to twenty participants: ten biologists specialising in genetic technologies and ten academics from unrelated fields. In each instance, the project was introduced informally, with its fictional nature initially withheld. This approach produced a consistent initial reaction from all participants, who unanimously regarded the proposal as lacking any real purpose.

Following this initial feedback, the project's fictional nature was clarified, and its social and geopolitical significance was explained. Only when explicitly framed as a design fiction project *Ethno.life* became an effective tool for reflection and discussion.

An informal evaluation of the project revealed its high effectiveness in fostering engaged and meaningful discussions. Among biologists, the feasibility study proved particularly effective in enhancing interest and engagement. Conversely, for academics from other disciplines, the mock-up prototype was pivotal in eliciting initial engagement and stimulating speculative thought. However, further exploration is needed to assess the influence of the author's institutional affiliation, as most of the presentations occurred while the author was a visiting scientist at the Broad Institute of MIT and Harvard.

6 Transgenerational Psychogenetic Therapy

The second design fiction project presented in this paper adopted a distinctly different approach: instead of proposing a plausible and feasible service, it focused on a purely speculative concept that surpassed existing technological capabilities. Rather than addressing the immediate sociopolitical impacts of a specific technology, the project sought to spark broader, philosophical discussions on a particularly complex and challenging topic.

Despite its speculative nature, the project aimed to encourage critical analysis and dialogue about contemporary perspectives on the interconnections between biology, society, and technology.

6.1 Transgenerational Trauma

Psychological trauma shared collectively by communities is known as collective trauma. When such trauma is transmitted across multiple generations, it is referred to as transgenerational trauma [50].

Numerous studies have established a clear correlation between the likelihood of children developing trauma-related psychological disorders and symptoms and their parents or grandparents having experienced extreme conditions such as war, torture, or famine [51].

Traditionally, the transmission of transgenerational trauma has been attributed to contextual factors—both immediate and social—shaping the environment in which descendants of trauma survivors are raised. However, recent research has identified the

role of epigenetic traits, which are triggered by conditions of extreme trauma. An epigenetic trait is defined as a “stably heritable phenotype resulting from changes in a chromosome without alterations in the DNA sequence,” often influencing the regulation of gene expression [52].

Evidence indicates that the chromosomes of descendants of trauma survivors carry a “kind of memory of what their ancestors experienced” [53]. However, fully understanding the role of these epigenetic mechanisms will require multi-generational studies and deeper exploration of how “individual, cultural, and societal experiences permeate our biology” [54].

6.2 Transgenerational Psychogenetic Therapy

This project introduced a fictional service designed to eliminate inherited epigenetic transgenerational trauma.

This concept extended far beyond the current state of the art. To avoid ethical and practical debates surrounding germline gene editing, it was assumed that the service would operate exclusively on adult subjects. Additionally, it was presumed that all epigenetic traits and their phenotypical impacts could be precisely identified and targeted.

The project aimed to provide a novel framework for discussing and processing transgenerational trauma. Due to the complexity and emotional sensitivity of the topic, the fictional service was presented to a small group of six participants: four descendants of individuals incarcerated and tortured during the dictatorships in Argentina and Uruguay, and two grandchildren of Holocaust survivors.

In all cases, the fictional service proved effective in facilitating conversations that might otherwise have been too sensitive, offensive, or taboo to approach directly.

Initially, the project sought to explore whether participants would hypothetically choose to use such a service. However, this question was soon deemed inappropriate, as it implied a sense of guilt or deficiency associated with their ancestors. As a result, the project shifted its focus to observing the effectiveness of the design in fostering deeply engaged and meaningful discussions.

7 Conclusions

This paper presents two HCI projects that use design fiction to introduce fictional genetic engineering services. These services were designed as tools to examine the sociopolitical dimensions of two critical applications of biotechnology: genetic surveillance and the transgenerational transmission of trauma.

Genetic engineering holds immense potential to “help humanity overcome some of the biggest and most persistent challenges in global health and development,” particularly benefiting vulnerable populations. Moreover, it is “accelerating research that could help end extreme poverty” by transforming various production parameters [55]. However, its more immediate applications carry significant social and economic risks, necessitating careful consideration. Here, HCI can play a crucial role in the administration and regulation of these technologies.

The two fictional services presented in this paper demonstrate that design fictions can empower HCI designers to address pressing and underexplored social issues. At the same time, they encourage the HCI community to work towards a more “explicitly articulated politic” [56].

Gramsci argued that the ruling class, “to maintain its hegemonic position, must legitimate and renew the common sense” either “through consent or coercion” [18]. In his *Prison Notebooks*, he wrote: “Philosophy and modern science are constantly contributing new elements to ‘modern folklore,’” as scientific opinions and notions—often distorted and removed from context—enter the popular domain and integrate into cultural tradition [19]. This process mirrors the black boxing seen in contemporary technologies [18].

HCI is particularly well-suited to challenge these entrenched notions of common sense by identifying needs and opportunities for technology use that disrupt dominant narratives,

Several critical questions remain unanswered when considering HCI’s potential role in genetic technologies: Can these technologies be subverted to empower the powerless? Can alternative narratives be presented that eschew frameworks of property and ownership? If, as Carol Hanisch states, “the personal is political,” what spheres of privacy must be reclaimed?

Furthermore, HCI and design fiction can help identify and critique technological solutionism. It is vital to construct narratives where potential tools for resistance do not inadvertently reinforce existing power structures by offering superficial solutions. The speculative exercises proposed in this paper aim to imagine a world where DNA manipulation fosters equality and justice rather than exacerbating inequality.

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