One Week in the Future: Previs Design Futuring for HCI Research

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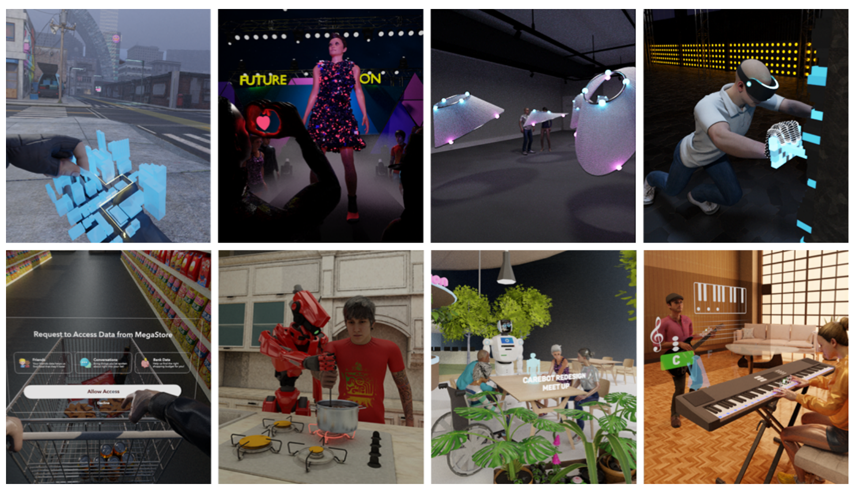

Fig. 1. Frames from previs animations produced during each of our eight collaborative 1-week design sprints. These animations envision the future of (first row) mixed-reality worlds-in-miniature, e-fashion audience interactions, visualizations of gender gap data, heavy haptics for VR, (second row) privacy policies, social robot interactions, co-design for senior care, and music theory education. Full concept videos available via the @future.interaction handle on TikTok and Instagram.

We explore the use of cinematic "pre-visualization" (previs) techniques as a rapid ideation and design futuring method for human computer interaction (HCI) research. Previs approaches, which are widely used in animation and film production, use digital design tools to create medium-fidelity videos that capture richer interaction, motion, and context than sketches or static illustrations. When used as a design futuring method, previs can facilitate rapid, iterative discussions that reveal tensions, challenges, and opportunities for new research. We performed eight one-week design futuring sprints, in which individual HCI researchers collaborated with a lead designer to produce concept sketches, storyboards, and videos that examined future

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applications of their research. From these experiences, we identify recurring themes and challenges and present a *One Week Futuring Workbook* that other researchers can use to guide their own futuring sprints. We also highlight how variations of our approach could support other speculative design practices.

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

Additional Key Words and Phrases: design futuring, prototyping, previsualization

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1 INTRODUCTION

Speculative design futuring and design fiction have become increasingly popular approaches for human-computer interaction (HCI) researchers interested in generating and communicating new ideas, as well as considering the future social and technical implications of human-centered systems [1, 18]. As Blythe and Encinas highlight, these explorations can take a variety of forms, ranging from text, images, and audio to interactive prototypes and events [5]. One increasingly common approach involves the creation of visual artifacts, including sketches [25], concept videos [10], and short films [21], to motivate new research directions and prompt critical discussions. However, these artifacts vary greatly in both visual fidelity and production time. Low-fidelity (lo-fi) sketching and prototyping approaches can make it easy to rapidly generate and consider new ideas, but often lack sufficient detail to ground nuanced discussions of the technical, social, and interactive systems they envision. Meanwhile science fiction films and industry concept videos (including highly-influential early examples like Apple’s Knowledge Navigator and Sun Microsystem’s Starfire demos [3]) have inspired generations of creatives and researchers. Fully-realized depictions of interactive systems blur the lines between fiction and reality, envisioning worlds with stunning detail, to the point where viewers can forget the technologies depicted do not yet exist. High fidelity (hi-fi) artifacts like these have also been proven to be rich sources of inspiration for HCI research, supporting detailed critique and discussion of interface design and interaction opportunities, such as in Shedroff and Noessel’s *Make It So* [31]. These kinds of video prototypes and promotional videos can also facilitate broader social conversations about possible future technologies—as exemplified by Wong and Mulligan’s discourse analysis of media coverage surrounding Google Glass and Microsoft Hololens product videos [42].

Producing high-fidelity videos comes at a price, however, with large creative teams often spending millions of dollars across multi-year production cycles to produce them. To mitigate these costs, directors, cinematographers, and artistic teams in the film industry often rely on a variety of lower-fidelity “pre-visualization” or *previs* approaches during a film’s production. Tools like sketches, storyboards, and computer-generated *animatics* (which preview the motion, character interactions, visual layout, and style of a scene), allow teams to quickly explore, plan, and test video sequences before committing to costly filming or effects production. Unlike the final effects and animations depicted in a film, previs renders serve as a “blueprint for production” [29] and often exclude detailed lighting, 3D model textures, or intricate character movements in order to enable rapid production cycles and feedback. Recently, with the widespread adoption of open source animation tools such as Blender [13], individual creators have also begun to dabble in this space, creating short-form futuring videos intended for social media [22, 37].

While lo-fi and hi-fi prototyping have become commonplace in HCI research and speculative design practices, medium fidelity (mid-fi) depictions and prototyping methods, which go beyond lo-fi prototypes without excessive hi-fi prototyping resources, are scarce. Taking inspiration from the film industry, we explore how rapid previs futuring exercises might play a role in HCI research—helping researchers imagine, evaluate, and consider the implications of future interactive systems and research practices. Over a three-month period, we conducted eight one-week design futuring sprints, in which the lead author (an HCI researcher with a background in art and design) collaborated with individual HCI researchers to produce storyboards and 3D animations depicting future applications of their research. In each sprint, the collaborators sketched design futures, developed storyboards, and then used open-source tools and free assets to construct short, social media-friendly animations depicting future HCI concepts. Unlike previous HCI design futuring exercises, our sprints produced higher-fidelity visions of future concepts with a relatively small budget and in a constrained amount of time. Based on a qualitative review of design notes, production screenshots, and post-hoc reflections on our sprints, we discuss recurring outcomes, themes, and challenges for rapid mid-fidelity futuring approaches. Building on these observations, we also describe the creation of a *One Week Futuring Workbook* that other researchers and designers can use to facilitate their own previs futuring exercises. The workbook follows a similar week-long futuring sprint format, with additional formalized canvas activities informed by moments of serendipitous exploration, speculative contestation, and collaborative problem solving throughout our sprints. While the workbook has not been extensively tested with other groups of designer-researcher teams, the document is hosted on an open source GitHub repository to encourage others to share their own experiences with previs futuring and ultimately contribute to the workbook's evolution over time. Finally, we reflect on opportunities for previs design futuring approaches that support other media types and address a wider range of research questions informed by our collective experiences within the sprints and the creation of our workbook.

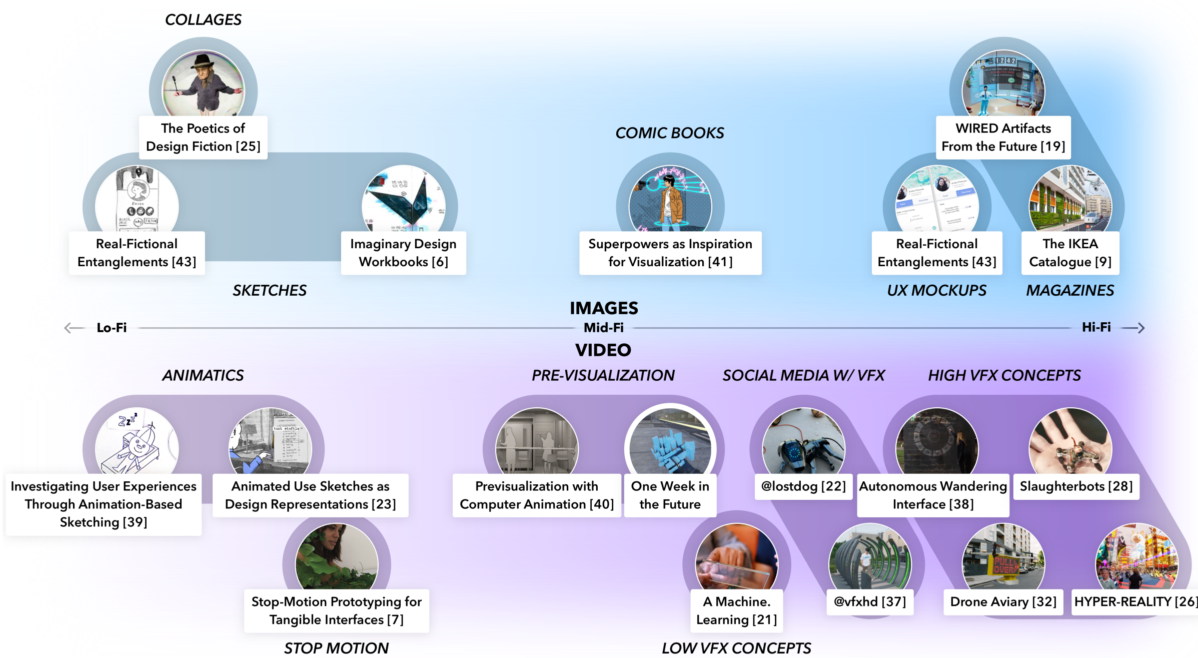

Fig. 2. Image (top) and video (bottom) design fiction prototyping methods across a lo-fi (left) to hi-fi (right) fidelity spectrum.

2 RELATED WORK

Our rapid previs futuring sprints build upon the creativity exercises and design fiction research performed within the HCI community, practices in creative industries, and examples of artifacts developed by independent practitioners. Drawing on this vast corpus of examples, we review existing design fiction and prototyping research across a spectrum of fidelities from both academic and pop-culture sources to inform our approach (Figure 2).

2.1 Prototyping Futures

The production of design fictions has emerged as a method for envisioning future societies and artifacts across many different forms of media. To explore the value of design fiction practice, HCI researchers have fabricated imaginary abstracts [4], paper reviews [2], design workbooks [6], and even a fictional research conference [17]. From comic strips about future dating experiences [5] to tangible artifacts of Steampunk worlds [35], differing design fiction prototyping mediums and prompts affect the discussions they elicit. Seen through the lens of prototyping, these and other design futuring methods can be understood as approaches for exploring both the space of possible designs and possible futures—with each futuring approach encouraging different kinds of knowledge creation. As Lim et al. articulate in their *Anatomy of Prototypes* [20], the choice of prototyping medium and method has an impact on the subset of the design space a prototype can traverse—which they characterize as *filtering dimensions (appearance, data, functionality, interactivity, and spatial structure)*. These choices also affect the extent to which a prototype can manifest design ideas—which Lim et al. describe as *manifestation dimensions (materials, resolution/fidelity, and scope)*. This framing reveals a multitude of trade-offs between cost, effort, and the kinds of knowledge a prototype can produce, highlighting limitations of both lo-fi and hi-fi futuring methods.

In practice, lo-fi design fictions are often created using static visual materials, with examples including hand-drawn sketches [39] and collages of magazine cutouts (Figure 2). In Markussen and Knutz's [25] one-week design fiction workshop for example, 30 design students used a four-step prototyping method to produce lo-fi depictions of impossible man-made islands, skin-based bikinis, and more. While the resolution of these prototypes is low, they can quickly convey abstract ideas across a broad scope of concepts to spark early speculative discussions. When lo-fi prototypes are iterated upon further, their resolution increases as design details are solidified in intricate hi-fi mockups of future mobile apps [39], comic book illustrations [41], and magazine features like Wired's long-running *Artifacts from the Future*, featuring photo-realistic renders of future societies [19]. Similarly, the Near Future Laboratory's hi-fi future IKEA catalog features speculative details through alluring marketing language, fictional currencies, and depictions of anticipated societal values [9]. While convincing, these hi-fi prototypes with larger scopes often require great production effort to develop, as the details of their individual components can take time to create.

2.2 Video Prototyping

Similar trade-offs are also present in the use of video prototyping, with a wide variety of techniques and tools supporting the creation of both lo-fi and hi-fi design artifacts. In the 1980s, Vertenley outlined many of the lo-fi storyboarding, flipbook, stop-motion, and computer animation techniques used for video prototyping today [36] (Figure 2). These include lo-fi animatics [39] with moving cutout characters and collage-like backgrounds, which Löwgren praises as "*expressive* in terms of detailed design, *sketchy* in [their] expression, and *versatile* in [their] ability to create fictions" [23]. However, both the scope and fidelity of lo-fi animations are often limited by the tools and assets available. For example, Bonanni and Ishii's lo-fi tangible user interfaces prototyping framework advocates for the use of frame-by-frame stop motion photography of objects, clay, and people [7]. Meanwhile, hi-fi conceptual videos leverage story building techniques and modern video effects software to produce visually convincing footage of envisioned concepts [3, 26, 28, 32]. While creating hi-fi prototypes often requires a production team of skilled workers, the rise of accessible video effects tools [13] and short-from video social media platforms has nurtured a space for independent content creators to create and share these kinds of explorations [22]. @vfxhd's TikTok profile for example, has over 2.5 million followers and features fictional metropolitan situations using recorded footage and video effects [37]. Using similar approaches, researchers have also begun incorporating higher fidelity concept videos into their work. This includes Vink et al.'s 2014 hi-fi Autonomous Wandering Interface concept video [38], which depicts a mobile drone projecting interactive user interfaces upon various surfaces. (By 2019, this initially fictional concept was realized as a functional prototype [10], highlighting the rapid pace at which futuring exercises can become reality.)

Medium-fidelity (mid-fi) video prototypes, meanwhile, include both lo-fi and hi-fi characteristics. In the short design fiction film, *A Machine. Learning* [21], themes of algorithmic prediction errors and data persistence are conveyed as the protagonist interacts with a virtual assistant through an abstracted glass device. Despite limiting the use of time-consuming video effects, the film successfully raises questions about human-technology relationships. Another mid-fi prototyping approach includes the production of previs renders. In animation, previs renders are used to preview scene compositions, lighting effects, and the textures of elements in an animated scene early on in production. To envision domestic lifestyles, a team of researchers interviewed homeowners and created a previs concept video of a future IKEA home [40]. Created in just 40 hours of production time, the resulting animation presents different arrangements of 3D furniture models and paper-like outlines of human characters in a monochromatic scene. We take a similar approach, embracing previs techniques for design futuring, while leveraging a wider range of assets that allow us to explore an expansive set of questions about interactivity, appearance, and functionality.

3 ONE WEEK DESIGN FUTURING

Taking inspiration from the rapid development of storyboards and previs renders in the film industry, we explore the use of medium-fidelity previs prototyping to fill the gap between the more common low- and high-fidelity formats, striking a balance between production time, cost, and visual complexity. To examine this approach, we conducted eight week-long design futuring sprints in which a designer and graduate-level HCI researchers worked together to produce a medium-fidelity concept video envisioning the future of each researcher's core area of interest. Variations of this sprint model, initially popularized by Google Ventures [14], is used in a variety of creative industries to foster a culture of rapid brainstorming, creation, and knowledge generation. While initially a business-oriented approach, creative teams across the world have adapted the sprint method—varying the duration, the roles of team members, and tool sets—to tailor the approach to their respective domains.

3.1 Goals

When considering the format of our design futuring sprints, we set out to satisfy three primary design goals.

G1. Create rich design futuring videos that encourage world-building and highlight interactions. Captivated by visually-rich corporate concept videos and depictions of future technologies from the entertainment industry, we aimed to maximize the fidelity of the prototypes. Since HCI research often has an interactive component, we decided that a video format which succinctly showcases sequences of events would be appropriate. Producing a video however, often takes a significant amount of time and resources. To reduce uncertainty about shooting locations, actors, and the wide potential range of compositing techniques, we decided to leverage Blender's 3D rendering tools [13] and freely available assets on SketchFab [15] to rapidly synthesize previs animations of future scenes.

G2. Minimize researchers' time commitment. We were interested in a prototyping method that would not significantly disrupt the researchers' current practice. To minimize disruptions, a single designer facilitated each

Week	Researcher	Background	Position	Research Topic
All	Alexander	Design/Computer Science	Design Researcher	-
1	Kurtis	Computer Science	PhD Student	Interactive Worlds in Miniature
2	Sydney	Computer Science/Fashion	PhD Student	Participatory E-Fashion
3	Carmen	Architecture/Design	PhD Student	Immersive Data Visualization
4	Marcus	Mechanical Engineering	MSc Student	Virtual Reality Haptics
5	Kathryn	Art/Design	PhD Student	Algorithms in Society
6	Georgina	Health Systems/Design	PhD Student	Health Technology Co-Design
7	Tim	Computer Science	PhD Student	Social Robotics
8	Michael	Computer Science	MSc Student	Self-Directed Music Learning

Table 1. Authors who participated in our 8 one-week design sprints.

sprint and produced each animation within a single week. Using this approach, each researcher's involvement in the sprints was limited to approximately three hours of remote video collaboration across a five day schedule.

G3. Produce assets that can facilitate discussion and benefit future research practice. We set out to develop futures that could serve as an asset to the researcher after the sprint. Inspired by the kinds of fictional concept videos developed by a growing subcommunity of TikTok creators [37], we chose to create 15-second animations in a 1080×1920 vertical video format that could be easily shared on social media, as well as used in a variety of research settings.

3.2 Team and Roles

We conducted our explorations over a three month period, centered around a series of eight one-week design sprints within a large academic Human-Computer Interaction research lab. Two authors—the lead designer Alexander and principal investigator Wesley—developed the overall structure of the design sprints and managed the overarching process. Alexander, a design researcher with a computer science masters degree and a background in art and design, directly organized and executed each of the individual sprints. The other authors (Table 1) participated in a single design sprint which focused on a topic relevant to their current research. All authors also contributed to follow-up discussions and the preparation of this publication. Given the casual and collegial nature of these collaborations, and level of familiarity between authors, we refer to all authors using their first names.

3.3 Process

Our sprint format (Figure 3) includes three collaborative meetings with our lead designer Alexander and an individual HCI researcher across a five day period, plus additional time for rendering and posting the final animation to social media.

Day 1: Ideation Meeting - Each design futuring sprint began with a 90-minute remote video conference session between an HCI researcher and the lead designer. At the start of the session, the researcher provided a 15-minute overview of their current research area in an open discussion format. This helped the designer develop a baseline understanding of the research problem at hand and connect research concepts to additional inspiration sources. After the overview, the designer led a 30-minute rapid sketching activity with the researcher to envision future applications of their research across a broad scope of concepts. To conclude the first meeting, together the pair presented their sketches and identified potential themes appropriate for communicating in a previs video.

Day 1: Storyboard Sketching - After the initial ideation session, the designer developed 1-2 early storyboard concepts suited to a 15-second previs format. By combining and refining themes from the sketching activity into a coherent sequence of events, the designer highlighted multiple filtering dimensions of the envisioned

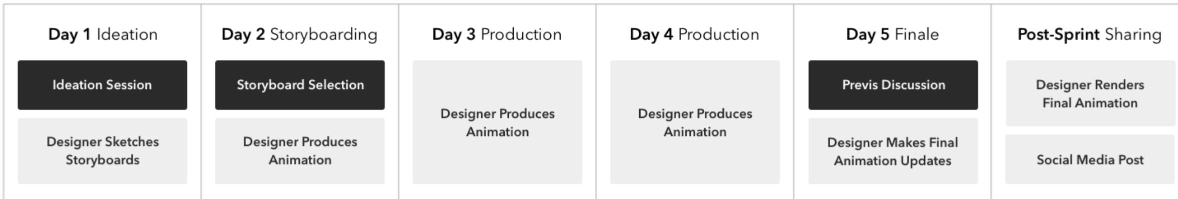

Fig. 3. A schedule of our One Week Design Futuring sprint format.

HCI research area within each concept. The designer also recorded annotations, technical questions, and notes regarding camera movements and character actions.

Day 2: Storyboard Selection Meeting - On the second day of each sprint, the designer pitched the storyboard concepts to the HCI researcher, evoking deeper discussions about the depicted world, concept details, and possible inaccuracies. To conclude the meeting, the two collaborators iterated on the storyboard concepts and selected an idea to develop over the remainder of the week.

Day 2-4: Animation Production - Over the next few days, the designer developed an initial render of the concept in Blender. The designer typically started this process by collecting relevant free assets available online and used these to quickly shape the scene's spatial structure. During the video's development, the designer also noted changes, creative decisions, and ambiguities that emerged as a result of their ongoing design decisions. At the end of the main concept production period, the designer rendered an early low-resolution draft version of the video to present to the researcher.

Day 5: Previs Discussion Meeting - With an early render of the video concept prepared, the designer played the draft video and elicited feedback from the researcher. After a thorough review of the concept, the pair agreed upon a set of minor updates to make before the final render. Closing the session, the designer performed a semi-structured interview to prompt the researcher to reflect on the sprint and suggest changes to its format.

Day 5+: Previs Updates, Rendering, and Sharing - In the final hours of each sprint, the designer made all remaining modifications to the animation and started the final render. Once the render completed, they shared the video with the researcher and posted it to social media with a brief description, relevant hashtags, and a background music track. At the end of the week, the designer individually reflected on the session by reviewing their notes and the final animation to inform the design of the subsequent sprint.

3.4 Documentation and Analysis

All collaboration sessions took place remotely via video conference, which allowed us to easily record both participants. We also used a shared Miro [30] whiteboard extensively throughout the entirety of all eight sprints—sharing all sketches, notes, and storyboards, as well as intermediate artifacts, models, and renderings, and ultimately the final videos. Both during and after the process we kept copious notes and annotations on the Miro board to document the process and capture contemporaneous observations and reflections. After both the fourth and eighth sessions, the first and last authors (Alexander and Wesley) organized and processed the design documentation, adding additional reflections to the Miro board. After all sessions were completed, Alexander and Wesley worked with each of the researchers to craft a 1-2 paragraph written description of their sprint. These summaries include details about the research background, filtering dimensions, and researcher goals, alongside important observations and insights the session produced. Alexander then segmented, coded, and clustered these descriptions to extract higher-level themes and opportunities, reported in the following sections.

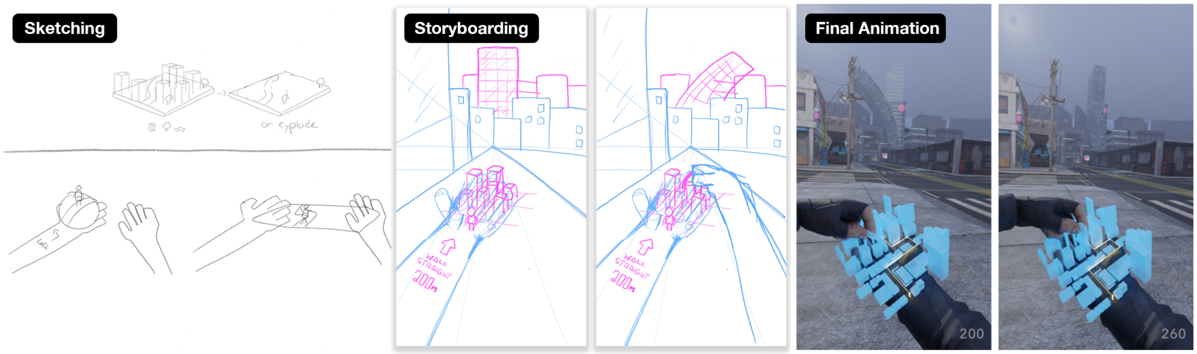

Fig. 4. Sketches, storyboards, and animation frames from Sprint 1, which examined mixed-reality worlds-in-miniature.

4 DESIGN SPRINTS

We ran our eight week-long design sprints in series over a three month period, allowing us to experiment and tune the format, while also refining storyboarding, previs, and documentation approaches. The following sprint summaries were each co-written by the designer and researcher who participated in the sprint (indicated by parentheses), then iterated upon with editing support and feedback from the other authors.

4.1 Interacting with Worlds in Miniature (Kurtis & Alexander)

The first researcher, Kurtis, is a second year PhD student exploring immersive interactions with Worlds-in-Miniature (WiMs), interactive worlds within a world that act as an overview and input space [11]. In the initial sketching and storyboarding sessions, several themes began to emerge, including the use of shape-changing WiMs and mixed-reality interactions that might allow WiM users to alter the visibility of buildings in their surrounding environment. During the storyboard selection session, questions about the situations for which these interactions might be most useful emerged, and the two decided to focus on exploring these bending interactions in the context of an urban navigation task.

The final animation (Figure 4) begins with a character stretching out their right hand in front of them to reveal a wrist-based interface, then opens their right hand to activate a holographic WiM showing their current walking route. As the character uses their free hand to grab one of the holograms to bend it to the side, the same bending appears to occur in the physical world to reveal the destination building. The aesthetic of the final animation—in which the wrist interface and WiM are abstracted, but the virtual distortion of the building is highly realistic—triggered discussions about the visual design of mixed-reality WiMs. The team then reflected on the specific technical challenges associated with creating such a system—which would require mixed-reality hardware capable of producing photo-realistic images as well as either highly-detailed city models or real-time image synthesis approaches to create the bending illusion. At the end of the sprint, Kurtis noted that an interactive prototype version of the system would be helpful for evaluation.

4.2 Immersive Runway Audience Interactions (Sydney & Alexander)

The second researcher, Sydney, is a third year PhD student whose research explores how fashion technologies can create empathetic responses in audiences. For her design sprint, Sydney aimed to examine how augmented garments and spaces might support new kinds of interactions between audience members and runway designs (Figure 5). The original sketching session produced several themes, including altering the appearance of the audience, the garments, or the environment based on data from the audience or the performer. With many distinct

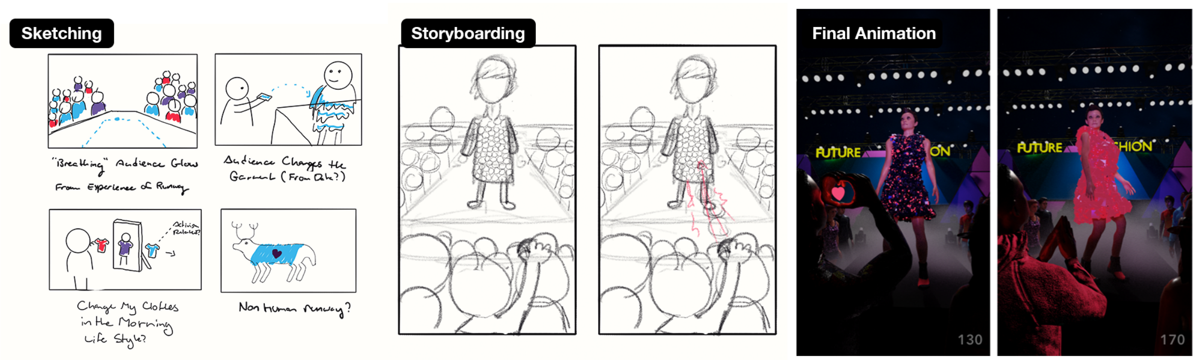

Fig. 5. Sketches, storyboards, and animation frames from Sprint 2, which explored immersive interactions for runway fashion.

concepts, the designer focused on storyboarding ideas that could communicate easily in a video format, including an example in which audience members tossed "reactions" at models. However, this led the two to consider a clapping and a heart hand gesture after the storyboards exposed possible negative connotations with throwing gestures —which drew comparisons to throwing fruit at a performer. When developing the animation, the designer sourced animated character models from Adobe Mixamo [16] and positioned them around a traditional runway stage design (rather than a possible futuristic one), focusing instead on realizing the audience interactions.

The concept animation presented on Day 5 depicted a hologram heart shooting from an audience member's hands onto a model's garment. Upon colliding with the heart hologram, the garment momentarily reacts to the gesture by emitting a bright red tone. This render led Sydney and Alexander to reconsider both the low-level details of the heart gesture, and the role and position of the audience. As a result of these discussions, the final animation included a number of visual changes to emphasize the interactions between the audience and garment.

4.3 Visualizing the Gender Gap (Carmen & Alexander)

The third researcher, Carmen, is a PhD candidate integrating architecture, data and human computer interaction to develop physical interfaces and 3D data physicalizations. Nearing the end of her PhD, Carmen used the sprint as an opportunity to explore future variations of a data-driven art installation she was currently designing

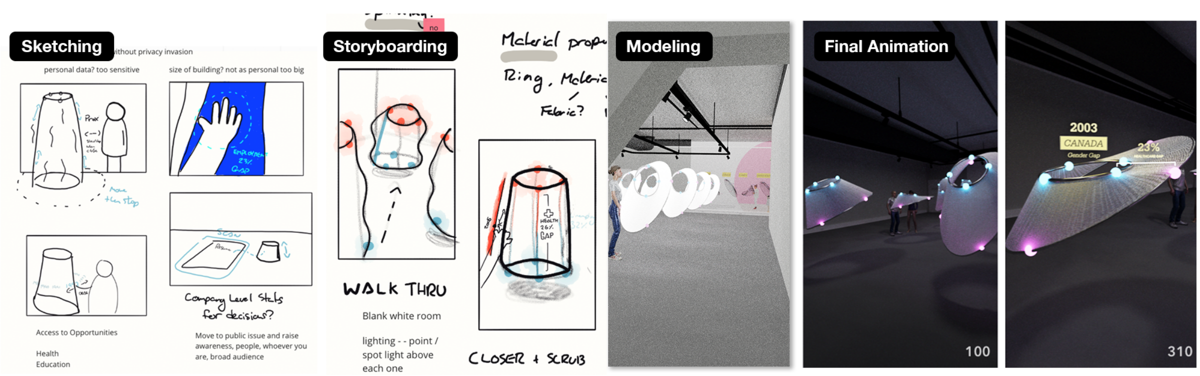

Fig. 6. Sketches, storyboards, modeling, and animation frames from Sprint 3, which imagined a future art exhibit.

(Figure 6). Because many aspects of the installation—which featured a set of tent-like structures visualizing global gender gap statistics—had already been established, much of the sketching focused on ways of adapting this design to support future audience interactions. This included superimposed holographic overlays around the tent structures. Coming from an architectural background, Carmen's early feedback primarily focused on aesthetic aspects of the design, including material properties and lighting.

After exploring a variety of cloth simulation and material options, by Day 5 the designer digitally recreated Carmen's existing physicalization concept and depicted a person walking through a gallery space filled with levitating gender gap tents. The character then interacts with a holographic overlay on one of the visualizations to show changes in gender disparities over time. These interactions differed considerably from the ones in the original sketches, as it quickly became clear during production that the proposed interactive regions would be difficult for characters in the scene to reach. Previously unconsidered decisions about how tent movements should progress and whether they should loop, alongside lighting and camera discussions, resulted in a number of alterations to the final video. Despite envisioning levitating and holographic elements that would be difficult to approximate with current technologies, the resulting animation was closer to a concept video than a piece of design fiction. However, Carmen found that the sprint was a productive exercise for envisioning how the visualizations might function and anticipates the rendering will be helpful for communicating her work to potential stakeholders before constructing the actual installation in the coming months.

4.4 Simulating Heavy Interactions in VR (Marcus & Alexander)

The fourth researcher, Marcus, is a mechanical engineer whose design futuring topic and masters research focuses on haptic force feedback systems capable of simulating interactions with heavy objects and walls in virtual reality (Figure 7). To begin, Marcus framed the design space using video, illustration, and screenshot resources from research and video games. Marcus and Alexander ideated and sketched device form factors including worn robotic arms, drone backpacks, and a spherical "hamster-ball". After sharing a storyboard depicting a person sitting on an actuated backpack that transformed into a rowboat, Alexander presented a variety of Adobe Mixamo animations that demonstrated characters exerting force. Marcus wished for the concept to clearly show a heavy interaction, so the team selected a Mixamo animation of a character pushing a massive object and ideated a new grounded pillar system to support the interaction.

The resulting animation depicts a person pushing a heavy haptics pillar device with gloves and shape-changing voxel-like handles, inspired by Suzuki et al.'s Dynablock [33] system, for localized haptic feedback. The haptic and VR accessories disappear as the scene transitions to a virtual world view in which the pillars are replaced by

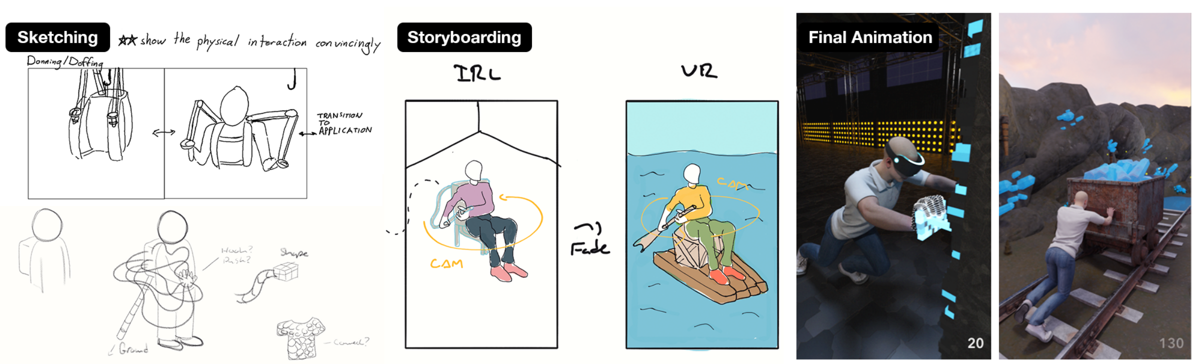

Fig. 7. Sketches, storyboards, and animation frames from Sprint 4, which explored heavy interactions in VR.

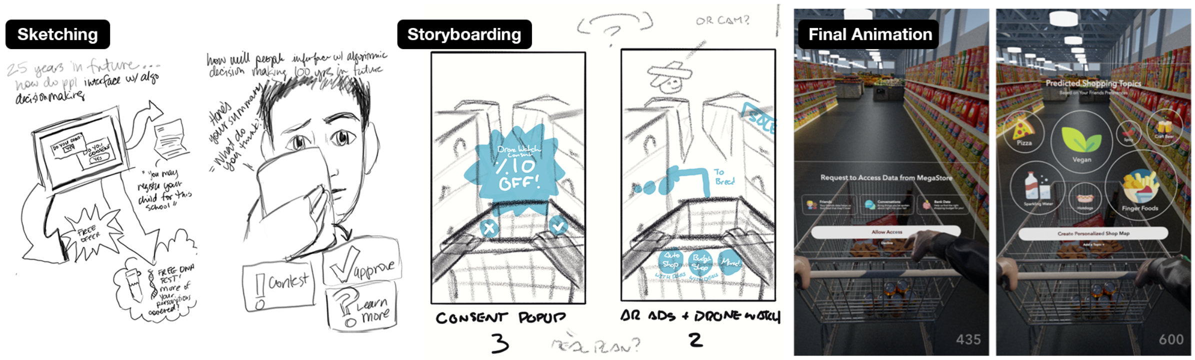

Fig. 8. Sketches, storyboards, and animation frames from Sprint 5, which explored personal data privacy.

a cart full of gems. After discussing the animation at length, Marcus noted insights about the challenges with the presented implementation, and requested changes to the pillar wheel configurations, the shape-changing handle, the ceiling pillar mounting system, and the movement of the pillar across the room. However, time constraints made it impossible to incorporate the diagonal movement in time for the final render. While seeing the concepts as sketches and storyboards clarified some of their associated challenges, Marcus had already considered many of them. He found reviewing the Mixamo character animations during the storyboarding session was especially helpful for developing a new intuition about the external forces that act upon the body.

4.5 Personal Data Privacy (Kathryn & Alexander)

The fifth researcher, Kathryn, is a PhD candidate in media design whose research uses participatory art to explore the role of algorithms in society. During this sprint, the designer introduced a structured sketching method in which the two collaborators envisioned the future of algorithms and data privacy at different projected dates in a series of 5-minute sketching intervals. This approach produced considerably more sketches than previous sessions, although Kathryn suggested that more rapid and diverse prompts to encourage deeper world-building might result in additional creative outcomes. Inspired by Keiichi Matsuda's concept film *HYPER-REALITY* [26], the designer produced storyboards imagining data privacy issues in a future supermarket. The collaborators iterated on this concept to center questions about future citizens' data relationships with corporations. Before production, the team decided to eschew flashy advertisements in favor of present-day design patterns that integrate promotions into and alongside user content.

The resulting animation showed a person yielding their personal data, through a set of holographic menus, for a personalized shopping experience. To clearly present the multi-screen menus, the final animation was more than double the target duration, leading to rendering time increases. Rather than the conceptualization of specific technologies, Kathryn enjoyed the back-and-forth iteration throughout the design process, because it provided an opportunity to confront contemporary data privacy issues and imagine the social implications of a privacy-invasive society.

4.6 Social Robots (Tim & Alexander)

The sixth researcher, Tim, is a computer science PhD candidate who hoped to use this sprint to examine challenges surrounding intelligent social robotics, especially in contexts where design decisions can help robots feel less threatening or foreign to humans (Figure 9). Using the same near and far-future prompts as in Week 5, the two examined robot interactions across a variety of physical form factors, intelligence types, and relationships to

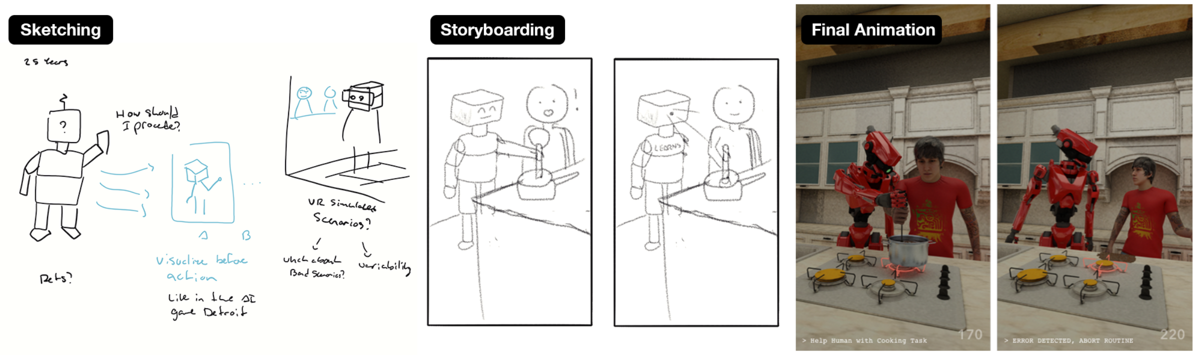

Fig. 9. Sketches, storyboards, and animation frames from Sprint 6, which explored feedback mechanisms for social robots.

humans. Sketches imagining futures over 50 years out included soft alien-like entities with general AIs, while near-term futures highlighted weak AI robots with specific use cases, such as drones. Afterwards the team chose to focus on examining specific kinds of robot behaviors that might cause awkward and difficult interactions between the robots and humans, then Alexander created several storyboards. One depicted a human correcting a robot stirring a kitchen pot with an upside down spoon, sparking comparisons to present-day social interactions with roommates, dogs, and robotic vacuum cleaners.

Exaggerating the stirring error, the animation presented on Day 5 imagines an overly helpful robot attempting to help a human stir a pot of soup. Unfortunately, the robot's quick intervention startles the human causing the soup to spill. Unlike most of the previous animations, this one showed a negative and more provocative outcome, which triggered discussions about how the video might be interpreted by outside audiences. In response, the final version of the animation included a heads-up display overlay to make the robot's intents more apparent. The social media posts for the video also included an open ended question ("Where did the robot make a mistake helping in this kitchen?") intended to provoke questions and reflections about robot autonomy and the design of interactions with social robots.

4.7 Co-Designed Senior Care (Georgina & Alexander)

The seventh researcher, Georgina, is a first year media design PhD student with a background in biomedical ethics and health systems research. For her design sprint, Georgina chose to imagine future co-design practices that might allow older adults, family members and healthcare workers to play a more prominent role in designing the tools used in elder care (Figure 10). As in Week 5, this prompt aims to change the culture surrounding elder care, rather than directly designing novel technologies for older adults. The designer started the week's ideation using an updated set of sketching prompts — six 5-minute rounds that focused on positive and negative outcomes in near-term, distant, and mid-term futures. In practice, the exercise saw the two millennial collaborators sketching potential future care for their own retirement. Similar technologies and collaborative healthcare scenarios appeared across all three eras of sketches, with negative depictions often resembling exaggerated inversions of the positive drawing rounds. The sketches led to numerous storyboards, including a telepresence collaborative care scenario and a depiction of a group of elders collaborating with a robot host a community garden design.

The resulting animation built on the latter concept, envisioning a collaboration space at a future care facility in which a group of elders meet to discuss the redesign of a healthcare robot. Finding good character models of senior citizens was challenging during the animation's development, leading the designer to grey the hair color of Mixamo characters to adjust their perceived age. The senior collaboration space itself started from a

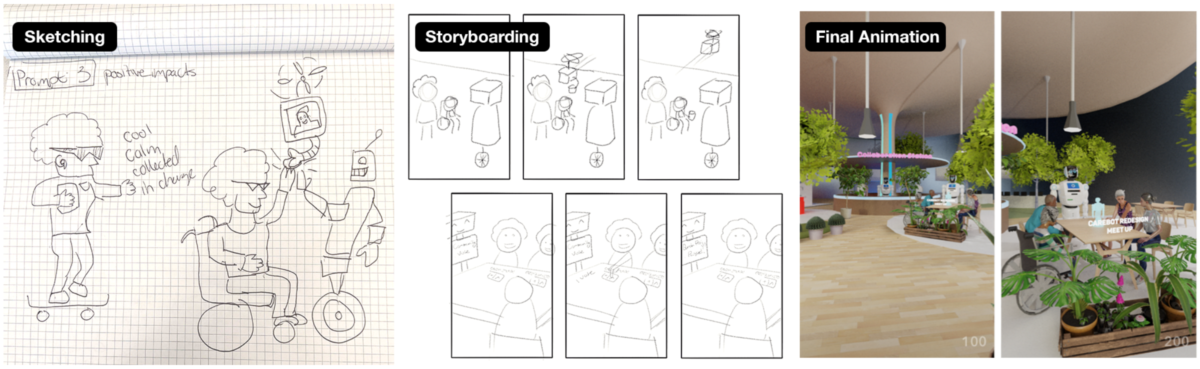

Fig. 10. Sketches, storyboards, and animation frames from Sprint 7, which explored co-design for senior care.

Google campus asset, then was adjusted to create more accessible spaces. Due to time constraints, one character in the animation also used an anachronistic wheelchair asset. These asset issues frustrated the design of the final animation, but also triggered additional discussion between the collaborators about seniors' access to future technologies and role in designing them.

4.8 Music Theory Education (Michael & Alexander)

The eighth and final researcher, Michael, is finishing their Computer Science Masters degree on understanding how technology can support music theory education for hobbyist musicians. He chose to use the design sprint as an opportunity to envision future music learning tools (Figure 11) based on his previous work. The initial ideation sketches varied considerably due to the difference in prior music experience between the two collaborators. As a result, Michael's concepts largely extrapolate from his thesis findings, while Alexander sketched for his own future self as a hobbyist. Generally, the two found it difficult to sketch distant and negative futures regarding informal music education; they agreed that popular instruments and music theory concepts were unlikely to change dramatically in the coming decades [34]. The two also agreed that advancements in AR technologies might best facilitate collaborative learning environments. This focus on collaboration manifests in one of the main sets of storyboards depicting two musicians improvising together with support from a shared hologram.

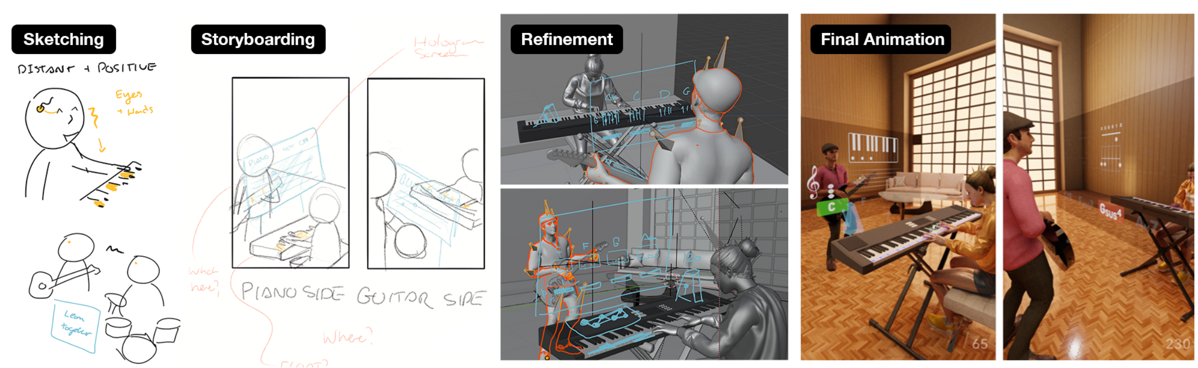

Fig. 11. Sketches, storyboards, and animation frames from Sprint 8, which explored music theory education.

The final animation pans across two separate perspectives in a jam session between a pianist and a guitarist. The collaborators worked more closely throughout development than compared to previous sprints due to requiring additional expertise for an accurate music notation. As a designer themselves, Michael also felt eager to help more with the artifact's development and volunteered to produce a short audio clip to accompany the animation. Upon reflecting on the animation, the two discussed how such a tool might scale for additional learners and speculated on the kinds of feedback that could enhance synchronicity amongst musicians.

5 REFLECTIONS: IDEATION, FOCUS, AND RESEARCH OUTCOMES

Each of our eight design sprints was unique in terms of its focus area, filtering dimensions, outcomes, and challenges. To reflect upon and identify emergent themes across the sprints, each sprint's participants first produced a document summarizing the process, reflections, and outcomes from their week. We then examined these summaries and extracted a collection of 52 unique observations, which Alexander then clustered into 3 overarching themes. These clusters formed the basis for an initial written discussion, after which all co-authors were invited to add reflections documenting their personal sprint experiences. Across the futuring sessions, these themes showcase how previs approaches to design futuring can (1) support ideation, (2) focus design effort, and (3) produce outcomes that connect to present-day research.

5.1 Supporting Ideation

Across our sprints, we documented several techniques that supported the generation of new research concepts and challenged our existing notions of the future—all of which suggest opportunities for new futuring activities.

Introducing new sources of inspiration. Throughout our ideation and storyboarding sessions, Alexander noted teams frequently introduced new pieces of related work, example images, and 3D assets to encourage additional ideation. The impact of these materials was particularly salient during the heavy haptics sprint, where Marcus noted how Alexander's initial sketches drew heavily on references from comics and other media (including the robotic backpacks in Figure 7, inspired by Spider-Man villain Doctor Octopus). Similarly, Alexander found that the introduction of Adobe Mixamo character assets and animations during the sprint inspired a shift to an entirely new heavy haptics form factor, leading Marcus to eschew the earlier backpack-like designs in favor of a room-scale haptic pillar system. Unlike sketchy lo-fi approaches and intricate custom modelling present in hi-fi prototypes, considerations for rapidly producing a previs concept video led the designer to discover and advocate for the use of readily available existing materials early on in the design process.

Envisioning future selves. Repeatedly, Alexander observed that the teams' choice to envision themselves in the context of future scenarios helped generate ideas that felt more credible and evoked empathy for the characters in the scenes. Georgina recalled this taking place while generating ideas for her co-designed senior care concept when the millennial-aged collaborators tried to predict their personal retirement preferences, extrapolating from their own present-day values, interests, and fashion styles. Meanwhile Michael noted scenarios that connected to the collaborators' personal hobbies and activities also encouraged particularly productive idea generation. This was typified in his music education sprint, where the team (who are both musicians) built upon their personal experiences at jam sessions to inform their visions of music education. As Alexander then transformed the music concept into a previs render, he pulled from his personal experiences of connecting audio equipment to fill in details absent from the sprint's lo-fi storyboards.

Research areas and methodological assumptions. Alexander observed a significant factor that affected each previs concept was the researcher's area of study itself. He found that our design sprint format led to very different filtering dimension lenses depending on the researchers' objectives and approaches. For researchers whose work is already systems-oriented—for example, envisioning future WiM interactions (Kurtis) or heavy-haptics feedback devices (Marcus)— Alexander noted that successive rounds of ideation usually hinged on discussions of the practicality of the proposed systems as well as possible contemporary and future approaches for implementing them. When compared to their initial lo-fi sprint storyboards, previs concepts of these systems often lead to more deeper explorations of visual, spatial, and functional details. Meanwhile, Alexander found the sprints involving researchers whose work explores methodological approaches—such as Georgina's research into co-designed care facilities or Tim's work on prototyping for social robotics—tended to spend more time envisioning the societal changes that would occur as a result of their research. Given the tight production timelines, researchers' priorities often influenced the degree to which the ideation focused on the core concept versus situating that concept in an imagined future. Michael observed that the discussions during his sprint had a deep focus on music theory, and the team devoted considerable effort to ideating alternative notations and representations of musical concepts, but very little time making the apartment, instruments, or characters themselves seem futuristic. With limited production time, Alexander found the inclusion criteria of aspects explored within the scope of future-projected elements depended greatly on the researcher's area of interest. Alexander also observed that more methodologically-oriented researchers like Kathryn, Tim, and Georgina were also more willing to embrace and ideate negative scenarios, as well as encourage the creation of artifacts showcasing negative futures. Speculative futuring in HCI often attempts to encourage strong negative reactions and considerations of contemporary issues [43]. However, Alexander also noted that nearly all of the negative concepts that emerged were positioned in ways that motivated additional study in the researcher's domain. Examples like Kathryn's privacy invasive shopping-cart or Tim's overly-helpful cooking robot served less as warnings or provocations, but instead as illustrations intended to motivate for further discussion and research. Compared to lo-fi approaches, the mid-fi envisionment of methodological research led to an artifact highly suitable for sharing and communicating with potential stakeholders.

The impact of the designer. Alexander ultimately felt that his own personal perspectives and interests had a notable impact on both the ideation process and the technologies presented in the final animations. As an immersive technology enthusiast, many of his concepts included holographic displays overlaid upon the physical world. This use of holograms helped evoke the glowing AR-swathed aesthetic common in much of contemporary science fiction, and also made it considerably easier to introduce relevant signage and information displays to the scene. However, these visual approaches were somewhat conspicuous in videos where the technology itself was not the core focus of the research. Georgina saw this taking place in her own sprint. While her research focuses on co-design approaches for seniors care and involves little technical intervention, the final video still includes a variety of holographic elements. In retrospect, she noted this would not necessarily be the case if the sprint had been performed with a different designer.

5.2 Focusing Design Effort

Several factors, including the increasing fidelity of representations over the course of the sprints, the availability of appropriate assets, and the expectations of a social media audience served to focus our futuring practices and affected the overall design and aesthetic of the resulting videos.

Previs fidelity and attention to detail. Across our sprints, Alexander observed recurring shifts in the resolution, scope, and filtering dimensions of elements as the fidelity of their explorations increased. When reviewing early concept sketches at the start of the sprints, collaborators often discussed overarching societal themes and future technological advancements. However, Alexander often found that the development of storyboards forced him to make decisions about which characters, interactions, and viewpoints to consider further. He found these transitions generally pivoted discussions with the researchers to more practical aspects of the envisioned future, often with concrete research implications. Sydney recalled a moment during her e-fashion sprint when the storyboards revealed interaction challenges with an envisioned gesture. Although the team initially proposed an audience invoked throwing gesture to alter the model's garments, the development of storyboards triggered a deeper understanding of the gesture's negative social implications. Alexander found that the production of the previs animations entailed further, even more detailed, consideration of lighting, character interactions, and animation details. He also observed cases, like when rebuilding the models for Carmen's gender gap installation, where these early animatics revealed ergonomic or practical issues with the proposed designs that led to fundamental reconsiderations of the concepts.

Availability of assets. Ultimately, Alexander found the availability of appropriate existing models, 3D materials, and characters on sites like Sketchfab and in BlenderKit, heavily influenced the overall aesthetic of the animated scenes and helped narrow the ideation process—albeit in ways that sometimes ran counter to the collaborators' vision. While the use of free assets enabled the rapid production of animated scenes, Alexander recalled having trouble finding fictional variations of assets as the bulk of the available models depicted present-day technologies with limited customization options. This was sufficient for composing previs renders, but the limited vocabulary of assets made it more difficult to create background environments that situated the animations in more distant futures or include more diverse characters within the sprints. For example, when compared to the technology of the robot in Tim's social robotics video, all of the available kitchen assets had a dated and barren aesthetic. Similarly, while Adobe Mixamo supported the customization of animated actions across numerous character models, Georgina's elder care scenario required models of older characters for which assets were not readily available. While inconsistent visual resolutions across different elements can be unapologetically prominent in previs renders, minimalistic styling [40] can lead to more cohesive scenes.

Designing for social media audiences. Alexander also observed that the explicit goal of designing videos for sharing on social media served as a prominent consideration throughout the ideation and previs process, helping collaborators identify ambiguities and narrative gaps. When considering early storyboards and renders, discussions about these viewers often led to important new additions that examined the inner workings of future technologies and social interactions. Towards the end of his social robot interaction sprint, Tim decided it was important to communicate that the depicted robot was attempting to help the human by taking over a cooking task. While the body language of the characters in the scene somewhat implied this intent, the team ultimately opted for an explicit 2D text overlay description of the robot's inner subroutine processes for additional clarity. In general, Alexander found that across the sprints the constraint of social media helped encourage clearer, more self-explanatory videos, while also prompting the researchers to consider the perspectives of new audiences who might have little or no exposure to their research areas.

5.3 Linking Futures to Present-Day Research

Often, design futures and fictions are somewhat disconnected from reality, depicting scenarios that are unlikely to be possible due to the material and cultural constraints of our physical world [25]. In contrast, we found that researchers regularly found ways to connect their envisioned futures to their own near-term research projects.

The many lives of an animated future. For most of the researchers, the video animations themselves have proven to be a useful artifact for illustrating future research directions to collaborators, family, and others in their research community. For example, Sydney, who is in the early stages of designing a VR fashion runway experience, anticipates presenting the previs video at an upcoming design workshop with non-experts will further generate new design ideas in the field. Similarly, Kathryn plans to use her future data privacy video as a prompt to encourage discussions around present-day expectations of data security and access. Despite featuring fictional technologies, Carmen also intends to use her visualization of kinetic sculptures in a 3D space for communicating research to potential stakeholders and constructing a similar installation over the coming months. Kurtis, meanwhile, described using his video to explain the goal of his work to family members who had not previously been exposed to it. When lo-fi sketches are insufficient, previs animation can support in exploring and communicating complex HCI interactions with others.

Analogies to present-day systems. While many of the ideation sessions and videos focused on envisioning distant futures, all of the researchers readily connected the final systems back to challenges and opportunities in their current research. In practice, comparisons to current systems were also made easier by the fact that many of the videos—even ones that were initially conceived as distant ones—felt surprisingly contemporary in their final form. When asked to approximate the year of the final depicted previs renders, most of the authors unexpectedly estimated that the envisioned scenarios would exist within a decade. For Marcus, this question launched a conversation about not only when the depicted heavy haptics system might be possible to create, but also who it might be available to—suggesting that the military may have access to advanced haptics systems sooner than average consumers. Often, while the final artifacts or systems depicted in the scene were fictional or implied future technologies, learnings and design pivots from the sprint were equally applicable to present-day versions of the concept. For example, Michael reflected that the overall layout and design of the holographic music theory education application depicted in his sprint could be translated into an app appropriate for present-day tablets. In other cases, researchers connected their ideas back to present-day technologies that raise similar questions and concerns. For instance, when explaining HRI concepts and challenges to Alexander, Tim compared the behaviours of future robots to present-day social interactions with robotic vacuum cleaners and other automated systems.

Previs tools in the hands of researchers. Finally, while our sprints were many of the collaborators’ first introduction to either futuring or previs techniques, a number of the authors see clear opportunities for using these new design tools and methods in their own future research. For example, Sydney and Marcus both plan to use Adobe Mixamo character models and animations—which include catwalk animations and help illustrate the external forces applied by a variety of different human movements—to support upcoming e-fashion and haptic design tasks. More generally, we expect that the sketching, storyboarding, and previs methods embedded in our one-week futuring format may all be independently useful for more design-savvy HCI practitioners.

6 THE ONE WEEK FUTURING WORKBOOK

To support other researchers in facilitating their own previs exercises, we created an instructional *One Week Futuring Workbook* (Figure 12). Building upon the format and reflections from our eight futuring sprints, the paper workbook serves as a guide for a complimentary lead researcher and designer team to follow together

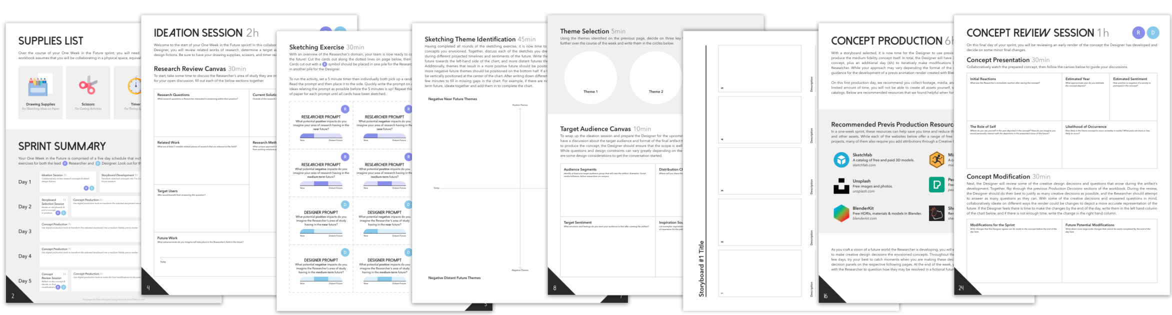

Fig. 12. Eight of the twenty-five pages in our *One Week Futuring Workbook*. The full version of the workbook is available on GitHub at: https://github.com/mr-sudo/One-Week-Futuring-Workbook

as they envision an area of future research. To develop the workbook, Alexander first revisited the complete collection of design notes, sketches, storyboards, and related work in our Miro workspace, along with each of the sprint summaries. From these, he identified moments where our free-form discussions lead to debates about future societies, the exploration of envisioned technologies, and promoted rapid iteration. These moments were then transformed into structured canvas activities, based loosely around our existing week-long sprint schedule. Similar speculative workbook-guided activities, such as Bespoke Booklets [12], have been found to be an effective method for generating ideas during collaborative speculative design tasks, while encouraging discussions between designers and participants using probes. Design probes can also help build trust and encourage a positive social dynamic during co-exploratory design exercises [27].

With a format similar to our own 5-day sprints, the first day of the workbook schedule consists of collaboratively reviewing related inspiration materials and rapidly envisioning the future of a research topic with the support of sketching exercise prompts. After modifying and selecting a storyboard informed by the sketches, the designer produces a medium-fidelity concept over the week. Alexander found that documenting creative decisions during previs production within our sprints invited productive discussions about future technologies and societies. To encourage similar discussions, our workbook includes a space for the designer to document creative decisions that arise during the exploration and development process. At the end of the week, the team collaboratively reviews the medium-fidelity concept, reflects on the designer's creative design decisions, then finally agrees on some minor modifications to the developed artifact. Across the entire week, the researcher can expect to commit 4 hours to the exercise, while the designer should allot about 35 hours for producing the artifact.

Unlike the more free-form format of our futuring sessions, the workbook features multiple structured activities to encourage thought-provoking conversations throughout the week. One of the first activities includes filling out a *Research Review Canvas* to gently introduce the designer to potentially unfamiliar research concepts. The canvas prompts the team to reflect on existing related work while speculating on future advancements in the field. After the Day 1 sketching activity, the workbook guides the team through a more structured *Sketching Theme Identification* exercise. Following the exercise, the team approximates the sentiment and time period of different common threads throughout the sketches and uncovers potential gaps in their depicted timelines. Just as designing for a social media audience in our futuring sprints motivated clear communication, the workbook concludes the first collaborative exercise by ensuring the team considers their target audience. To assist the designer with producing a medium fidelity concept, we recommend resources for previs production and provide ample space for documenting creative decisions throughout development. A collaborative *Concept Review Session* at the end of the workbook encourages reflection to guide final artifact updates. Inspired by critical discussions throughout our sprints, the workbook also prompts teams to imagine their future selves in the scenario, determine the year of the produced concept, and speculate on the likelihood of the envisioned future materializing.

7 FUTURING OPPORTUNITIES

Finally, our design futuring sprints and *One Week Futuring Workbook* suggest additional opportunities for incorporating medium-fidelity design futuring into HCI research practices.

7.1 Alternative Mediums and Concept Fidelities

With the introduction of natural user interfaces for previs tasks [24] and growing collections of freely available design assets, we anticipate that the fidelity of early stage renders will only improve over time. While our sprints and workbook primarily advocate for the development of previs animated scenes, our extensible design futuring format can support additional prototype form factors with minimal adjustments to the sprint. Instead of producing a 3D render, for example, a lower fidelity animatic concept video produced from a week-long storyboarding sprint could better support designers with limited 3D design skills and promote the exploration of different filtering dimensions. The format could also guide the development of high fidelity renders with larger scopes by including additional weeks of repeated production and feedback rounds. To experience some of our envisioned prototypes first-hand, Kurtis and Michael advocated for the rapid production of medium fidelity interactive scenes through a game engine. Unlike the passive experience of watching a video, virtual interactive environments encourage exploration and can support the rapid generation of multiple variations of a futuring theme.

7.2 Encouraging Futuring Discussions via Social Media

Despite having just 17 followers at the time of publishing this paper, our eight final previs renders had been viewed a total of 12,386 times across two public-facing social media profiles. This positive pressure of posting compelling online content led the team to strive to produce depictions that would elicit reactions from the public. While we did not receive substantial written feedback or comments on our renders, we anticipate there are additional opportunities for deeper collaborations with social media audiences within design futuring activities and greater research practices. A variation of our *One Week Futuring Workbook* could include guidelines for sharing social media updates throughout the sketching, storyboarding, and production process to help inform design decisions. Posting progress during artifact production could also provide a means to explore how different artifact fidelities affect audience engagement. While posting requires some knowledge of platform-specific norms and relevant hashtags to attract appropriate audiences, crowdsourcing allows for a more diverse sampling of ideas that could lead to new and exciting future scenarios that would otherwise not be considered. With a combination of academic articles and pop culture concepts informing the artifacts in our sprints, tapping into social media increases the pool of widely available research inspiration materials while connecting researchers to a network of related assets and academics through relevant hashtags and recommendation systems.

7.3 Rapid Scene Building Tools

The TV series *South Park* infamously produces each episode of their show in under one week [8]. However, without a full production team to produce an animation in such a short amount of time, a plethora of available assets is required to quickly flesh out the layout of a 3D scene. Over the course of our futuring sprints, we relied heavily on creative commons assets from SketchFab, Adobe Mixamo, and BlenderKit. Without these resources, it would be too timely or costly for an individual designer to produce similar animations within a week’s time. However, relying on preexisting assets also constrained the design of concepts, leading to less accurate depictions of the future. To support rapid medium-fidelity prototyping techniques for design futuring, we strongly advocate for the further development of customizable rapid previs building tools that include a wider range of customization options for medium-fidelity productions [24].

8 LIMITATIONS

Our explorations identify a set of potential opportunities, application areas, and methods for practicing previs design futuring. However, the effectiveness of these strategies in other institutional settings or problem domains remains to be validated. Similarly, these sprint outcomes may also depend heavily on the participants’ expertise, motivation, and existing relationships. The designer’s familiarity with Blender, for example, directly affected the ability to produce concepts within a week, and the social relationships between participants may have helped bootstrap productive brainstorms. By publicly sharing our *One Week Futuring Workbook*, we hope to encourage other academics and designers to test, modify, and iterate upon our sprint approach in their own research areas.

9 CONCLUSION

Ultimately, our experiences show how rapid ideation and previs activities can prompt both productive and provocative thinking across a variety of HCI research areas. In particular, we showcase how brief yet structured engagements with designers can serve as force-multipliers that build upon the creative abilities of more technically- or methodologically-oriented researchers. Moreover, focusing these engagements using medium-fideilty previs methods can result in compelling visual artifacts that propel researchers' vision for their work, highlight concrete challenges and opportunities, and facilitate public discussion. While widespread, the use of design futuring in HCI remains somewhat niche, despite great enthusiasm from its practitioners and evangelists. This may be due, at least in part, to the fact that most HCI design fictions and futures remain relatively inaccessible even to computing audiences, and lack the polished production and promotion of their commercial counterparts. However, we expect that embracing more collaborative, visual, shareable, and publicly accessible approaches to design futuring has the potential to bridge this gulf—helping HCI researchers more clearly envision futures for their own research and anchoring public discussions about both the promise and peril of the systems we study.

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