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Creating Opera for Mobile Media

Artistic opportunities and technical limitations

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Abstract—Digital opera can be characterized as a burgeoning operatic form that emerges naturally from digital culture. Qualifying works exploit modes of collaborative production, music making and storytelling that rely on the computational advancements of the digital age. In recent years, digital opera has begun to extend beyond the boundaries of physical theatre and into web and mobile media. Resulting works interrogate how features typically associated with staged opera (e.g. vocal expressivity, a sense of scale, affective narrative) are retained or transformed when entirely mediated. This emerging subset of opera collides computing with any number of creative practices including composition and sound art, filmmaking, animation and games design. The fruits of such a collision are by nature interdisciplinary, and as a result, poised to embody the concept of creative computing.

This paper describes the development of a prototype opera for smartphones called *Fragments* from the perspective of its lead artist. Told through a combination of binaural sound, video and songwriting, *Fragments* reveals the story of a virtual protagonist who wakes to find himself slumped on a park bench with little recollection of the previous evening. Participants are cast into the story world directly, and tasked to help the protagonist piece together memories that are scattered across the city. *Fragments* is used as a case study to identify a number of features and artistic opportunities that opera for mobile media presents. These features, in part, address the revised role of the audience member as participant and how headphone targeted sound and music might promote an enhanced sense of narrative immersion. As a counterpoint, some limitations of this emerging genre are introduced. Such limitations relate to topics of access, obsolescence and curatorial control.

Keywords—digital opera; fragments, locative media

I. DIGITAL OPERA

Digital opera is an unexpected juxtaposition of terms. It is a challenge to appreciate how a mode of transmission and information storage (digital) can interact naturally with an art form that spans centuries of cultural history (opera). For this reason, digital opera as a descriptor is perhaps too awkward or incomplete to endure. As a catalyst for creativity however, the label is fruitful. It requires us to contemplate meaningful collisions between the old and new - the traditional and the cutting edge. Digital opera inspires a set of new means and new meanings [1] where familiar features of staged opera are reconfigured, reimagined or removed when collided with computing. A digital opera suggests a new operatic form that is “intrinsically digital from conception to finished outcome” [2], requiring its creators to explore modes of expression that extend beyond the mechanics and conventions of the theatre. Qualifying works may instead engage attributes of digital storytelling such as non-linear narrative structures and networked creativity, as well as present to the user sound and image assets that are entirely computer generated. Composers, visual designers and directors will interrogate the boundaries of this new form, while striving to maintain the splendor and evocative nature of staged opera.

II. OPERA FOR MOBILE MEDIA

There exists a body of works that could be classified as digital opera. Web-based examples include the machinima inspired opera *Libertaria* [3] and *The Imaginary Voyage*, an interactive opera that operates on the principles of the semantic web [4]. Instances of digital opera however manifest mostly as stage works where computation is regarded as a key driver of artistic expression rather than a tool to enhance scenography. Such works include *Auksalaq*, a networked opera about climate change that encourages audience members to steer the musical direction of the work as a collective via a mobile app called Nomads [5]. A second example is an opera with no human actors or musicians called *The End*, which stars Hatsune Miku, a humanoid persona voiced by Yamaha Corporation’s Vocaloid 3 synthesizer engine [6].

There is nevertheless a lack of opera for mobile media. A survey of the form reveals only two such extensions, both emerging from Finish theatre director Jaakko Nousiainen. Nousiainen's first interrogation of opera for mobile media, titled *Omnivore*, explores the topic of food, eating and culinary habits. Taking the form of an app for iOS and Android, the opera deploys a reconfigurable 'media manuscript' to serve short filmic episodes to users once per day at varying meal times [7]. Although *Omnivore* recognizes the 'always on' nature of mobile media, it does not exploit the geolocation services offered by today's smartphone devices. This is not an oversight by the director as such, but instead a symptom of the rapidly changing focus of mobile media, which at the time of *Omnivore*'s development (2012) was more about mass distribution of content than location awareness and social connectivity [8]. In response, Nousiainen's more recent work *You Are Here* deploys locative media in an attempt to abstract the concept of the opera house. Here, the interior spaces of Glyndebourne Opera are linked to impromptu performances filmed outside opera houses in Berlin including Deutsche Oper and Komische Oper [9]. By scanning QR codes, UK participants access virtual 'peepholes' that serve as a bridge between Glyndebourne and Berlin. Although Nousiainen's work provides insight into how an opera for mobile media might operate, it is clear that further practice-based explorations are required to help identify the inherent features and limitations of this underrepresented genre. Such an enquiry would be routed in Creative Computing, inviting the intersection of numerous disciplines from storytelling and music composition to interface design and software development. This paper presents the output of such an investigation, an original locative opera called *Fragments*.

III. FRAGMENTS

Fragments is conceived for mobile media. It is a personal operatic experience, set and delivered in the city of Bath with supporting media content presented via headphones and the smartphone screen. *Fragments* tells the story of an unnamed male protagonist who wakes early in the morning under the shadow of the Beau Nash obelisk in Queen's Square. Dazed and confused, he reaches for his iPhone to find several missed calls and frantic text messages from his partner, Lucy. He remembers relaxing in the city with her several hours earlier yet has no recollection of subsequent events. Lucy is nowhere to be seen, cannot be reached, and may well still be in distress. The audience member (or more accurately, player) enters the opera at this point, and is hurriedly encouraged to take responsibility for the protagonist's wellbeing. Armed with little more than an onscreen map marked with two waypoints, the player proceeds to guide the unnamed figure across the streets of Bath in search of lost memories. Each location visited reveals new information about the previous evening in the form of video 'flashbacks' and forwards additional narrative pathways to explore. The following list provides an overview of the narrative beats assigned to each location.

- Queens Square. Protagonist wakes to find missed calls from Lucy. Flashback time: the next morning. Theme: confusion.
- Turf Maze. Lucy and the protagonist playfully circumnavigate the maze. Flashback time: 5pm. Theme: daydream.
- St. John's Church. The couple is mildly intoxicated and attempts to enter a closed church. Flashback time: 8pm. Theme: mischief.
- Komedia. The couple queue to enter a club. An unknown character leers at Lucy. Flashback time: 10pm. Theme: jealousy.
- Chapel Garden. Lucy and the protagonist lay quietly in a sunlit park. There are moments of both love and boredom. Flashback time: 2pm. Theme: serenity.
- Bath Abbey. Protagonist experiences dizziness and confusion. Lucy is conscious yet unresponsive. Flashback time: 1am. Theme: disorientation.
- Argyle St. Fountain. Protagonist collapses near the water's edge. He stirs to see Lucy walking away slowly but is uncertain of her trajectory. Flashback time: 2am. Theme: helplessness.
- Walcott St. Car Park. Protagonist discovers Lucy crouched in a dark corner and comforts her. She looks behind him in panic. Flashback time: early am. Theme: terror.
- Sensory Garden. Protagonist flees towards the garden, yet Lucy is nowhere to be seen. He crashes head on into an iron gate. Flashback time: early am. Theme: chaos.

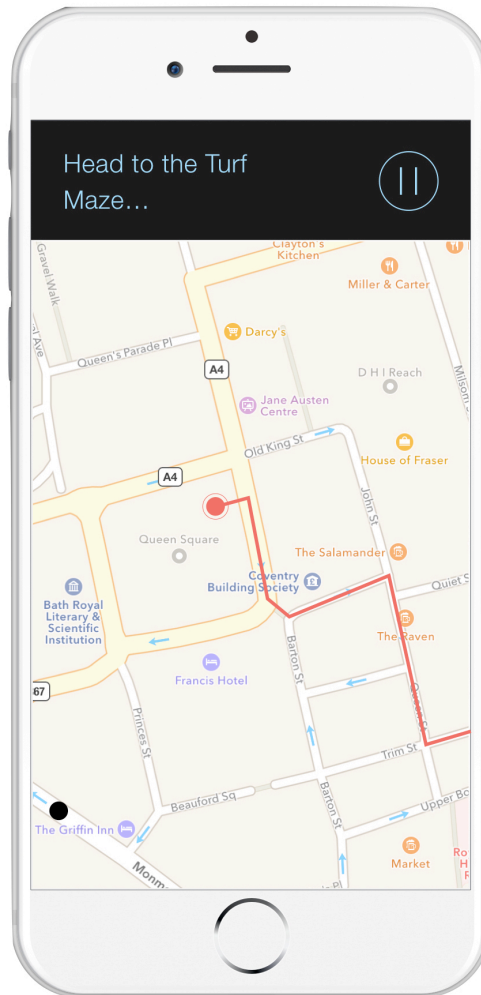


Fig. 1. *Fragments* map interface describing a route to the Turf Maze

Fragments is told through video flashbacks, sound design, binaural soundscapes and music in the singer songwriter tradition. Following a short video prologue, the player is given a choice of two locations to visit. The app, built using Apple's Swift 3 programming language and deployed to iPhone 7, accepts a selection and presents a suggested route (see Fig. 1). Proceeding to follow the route, the player encounters the protagonist's reading of the situation through song. This introspection of sorts is followed by playback of binaural recordings of Bath city at night that flux in and out of audibility. These soundscapes forward a sense of fractured temporality, echoing the disorientation experienced by the unnamed protagonist. During media playback, a combination of Swift's MapKit and geofencing functionality tracks the player's location and listens for their arrival at the selected waypoint. Upon entering the target region, the app alerts the player to the imminent serving of a video flashback via vibration delivered by the iPhone's Taptic Engine. The player is instructed to head to a specific position (e.g. a bench) and asked to orientate towards a particular direction (e.g. looking out at the river) before being prompted to initiate playback of the flashback video. Once viewed, the player is asked to select another location to visit. This routine of location selection, then song, then soundscape and finally video flashback continues until the player has successfully navigated a route through the opera.

IV. INTERACTIVE STORYTELLING

The development process of *Fragments* and its resulting prototype provide an understanding of how opera might be transformed when delivered via mobile media. This section identifies some of the artistic opportunities, linking opera for mobile media to concepts of interactive storytelling, narrative immersion and headphone sound.

Interactive storytelling refers to mechanisms that allow audience members to influence the evolution of a story. The distinction from traditional storytelling is that consumers become "active agents in the narrative" [10] by contributing

media assets (i.e. sound, image or text) or making decisions that direct story events. The concept of interactive storytelling and the audience member as contributor is not unfamiliar in the context of opera, with one of the earlier attempts being Henri Pousseur's *Votre Faust* (Your Faust). In a 1969 staging, audience members were encouraged to interrupt proceedings by exclaiming the word "no!" each time they wanted to alter the course of the plot. Pousseur's intention was to disrupt the traditional hierarchy found in opera where the director or composer dictates what attendees see and hear [11]. His approach nevertheless turned out to be rather farcical. Perhaps realizing that granting audience members control over the structure of opera was desirable yet unpredictable in a live setting, Pousseur instead elected to offer the illusion of an interactive opera by planted actors in the stalls to shout "no!" at prescribed times.

The opportunities afforded by technology allow digital opera to deploy strategies for interactive storytelling that are altogether more predictable. Being opera, such strategies tend to focus their attention on how audience members might contribute directly to a work's musical landscape. Tod Machover's *Brain Opera* forwards a reasonable model for contribution that both encourages participation yet retains a level of curatorial control. Attendees of *Brain Opera* begin their experience not in the auditorium, but in a large chamber called the Mind Forest [12]. This space offers a collection of curious musical interfaces (known as "Hyperinstruments") that include the Gesture Wall, a Theremin-like device that maps hand movements to musical timbre, and the Rhythm Tree, a rig of pressure-sensitive pads that enable up to fifty players to create collaboratively chains of rhythm and spoken word derived from the opera's libretto [13]. Interactions with the Mind Forest generate original music that is organized by Machover and included in the proceeding live performance. *Brain Opera*, as well as works that deploy similar strategies such as *Auksalaq*, have the capacity to be rather compelling as participatory experiences. The social aspect of opera is reinforced as audience members delight in hearing their contributions sounded amongst those of their peers. Such strategies are nevertheless limited in that the musical and narrative decisions made by the audience are done so as a collective. No single attendee can steer the evolution of *Brain Opera* for instance. Extending opera to mobile media has the capacity to mitigate this constraint. The participant enters into a more personal, one-to-one relationship with the opera that gives rise to numerous opportunities for creative control.

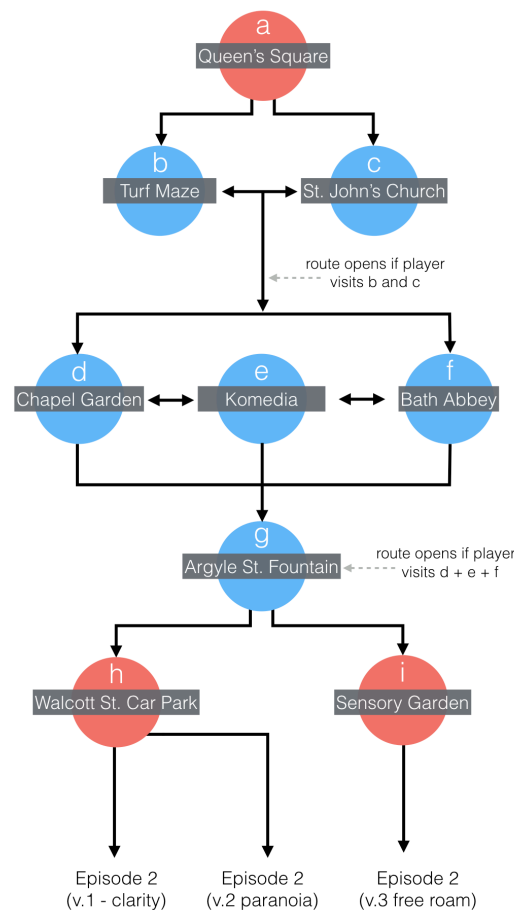


Fig. 2. Narrative structure for episode one of *Fragments*.

Fragments is concerned primarily with offering control over how the opera is navigated. By establishing the player as solely responsible for the protagonist's route through the city, it seeks to stress that every ill-considered fork in the road might lead to an unfavorable conclusion of the drama. Player choices lead ultimately to three narrative outcomes: Lucy is found safe and well; Lucy is found close to death; or the protagonist descends into madness during his search. For its non-linear design, *Fragments* adopts algorithms that drive the structure of many games and interactive narratives. These include the if-then construct, branching structure and critical story path [14]. Fig. 2. describes the narrative structure for episode one of *Fragments*. For the most part, this first installment follows a tight critical story path that requires the player to encounter all video flashback events and song introspections, but in no exact order. Like *Votre Faust*, this supplies only the illusion of agency while also ensuring that the volume of audiovisual material required to tell the story remains manageable. The structure of the first episode however shifts towards its conclusion, presenting the player with a genuine branch in the plot. Following the Walcott St. Car Park scene, the player must choose to track either Lucy or a suspicious character seen in earlier sequences. The consequence of opting for the later initiates a route through episode two that is overwhelmed by paranoia and obsession. Electing to follow Lucy in contrast immediately casts away such discord and leads to a more objective continuation of the story. A third pathway emerges should the player opt to visit the Sensory Garden instead of Walcott Street. In this scenario the protagonist loses track of Lucy's movements entirely and begins episode two with no clear indication of where to search next.

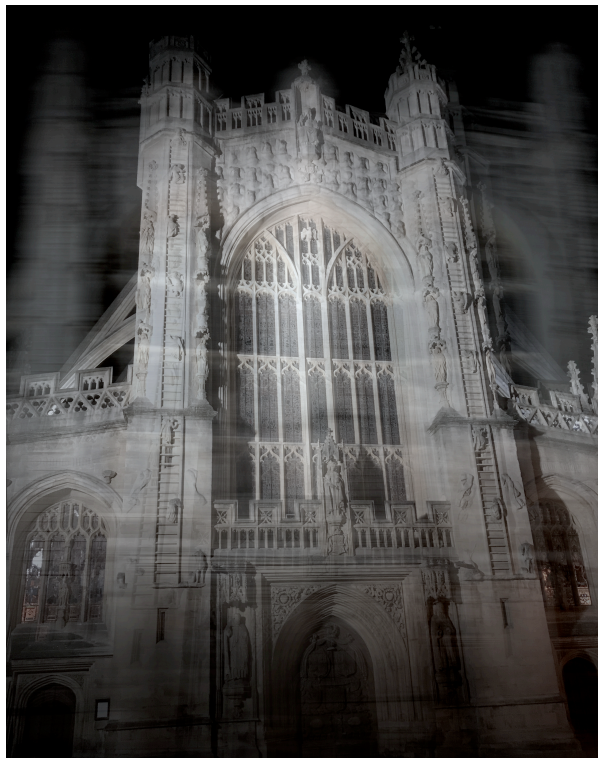


Fig. 3. Still frame of the Bath Abbey scene

V. NARRATIVE IMMERSION

One of the key features of *Fragments* is that it is set and delivered in the city of Bath. The site of performance is transposed from the opera house to the physical streets, positioning the comings and goings of urban life as an intrinsic component of mise-en-scene. Mobile computing, GPS communication and mapping technologies supply the means to forward this new form of locative opera, serving audiovisual content and narrative decisions to the player as they enter and exit specific regions of the city. In *Critical Play: Radical Game Design*, Mary Flanagan suggests how locative media experiences such as those staged by artist group Blast Theory embed meaning into spaces through acts of exploration and play. Noting similarities to the Situationist movement and the practice of psychogeography, Flanagan describes how locative projects promote new perspectives on city life through a more mindful interaction with the spaces in which they are set [15]. In many ways, *Fragments* relies on this phenomenon. Both heartfelt and darker beats

in the plot modify the player's perception of city activity, much like how the sentiment of a song heard through headphones can color the environment that the listener is moving through. An example of this occurs in the Bath Abbey scene. Normally this space is unthreatening, and is much of the time animated by busking musicians and other street performers. Yet Bath Abbey adopts a more sinister tone in *Fragments* as joyless song and gyrating video sequences position it as the site where the story takes a darker turn.

Janet Murray in her book *Hamlet on the Holodeck* likens narrative immersion to being "surrounded by a completely other reality, as different as water is from air, that takes over all of our attention, our whole perceptual apparatus" [16]. In short, we buy into the reality portrayed – we suspend disbelief. In the theatre, audience members must make a leap to look past the simulated realities of scenography and the presence of other spectators in order to suspend disbelief. Barriers to narrative immersion in *Fragments* are however arguably weaker because players encounter story events in the same spaces in which they are set. Scenes on screen echo those in the player's field of vision, encouraging them to read the significance of landmarks and objects in a new way. This occurs particularly in the final flashback of episode one. In first person perspective we see the protagonist bolting towards the Sensory Garden, as if being chased. Urgent sound design and unsteady video intensify the scene until the action climaxes with the unnamed figure crashing uncontrollably into an iron gate. This uneasy scene contrasts sharply with the player's live view of the garden, which is typically serene and untroubled. The player is prompted to re-evaluate the tone of the space before them, as well as look beyond the confines of the screen into the physical world to visualize what may have happened next.

VI. HEADPHONE SOUND

One of the more dominant strategies *Fragments* uses to entangle the story world and physical world is the use of binaural sound. This is a form of headphone-targeted audio that intends to reproduce accurately the acoustic properties of the space in which it was recorded. The result is a 3D sound experience that aims to situate the listener at the site of capture. A function of binaural sound in *Fragments* is to superimpose the past on to the present in an overt manner. Major audio- based memory events present at several points during the opera, with one of the more critical instances occurring on the route to Komedia (a night club in the center of Bath). When approaching from the east side of the city, the player first hears the dull thud of club music in the distance. They continue towards Komedia, eventually entering a sound world that is vibrant with the movement and chatter of a busy Saturday evening. The kineticism of the aural environment contradicts the lazier daytime scene that surrounds the player visually, however the effect is not otherworldly. The architecture of the seen space is confirmed by acoustic cues present in the binaural recording. It is only the sonic activity within the space that the eye cannot resolve. What is put forward is an impression of temporal (rather than spacial) dislocation that is common to many locative experiences that deploy binaural recording such as Janet Cardiff and George Miller's *Alter Bahnhof* [17]. The second function of binaural sound in *Fragments* again deals with fractured time, however the results are subtler. Here the intention is to advance short moments of temporal flux that focus on isolated sonic events. A player for example might hear a cyclist sounding a bell as they pass by in close proximity, yet in the physical world no cyclist is present. Such moments provide bursts of disembodied presence amongst an otherwise unremarkable ambient landscape that aim to jolt and confuse. The listener is continually caught off guard, helping them identify with the tension and turbulence felt by the protagonist.

Binaural content was captured using a 3Dio Free Space microphone. This device consists of two silicon ears with internal capsules that preserve the way pinnae manipulate incoming sound waves. Convincing localization of sound is achieved by separating the silicon casts by the width of a human head in order to maintain typical delay times between the sound source and each ear (i.e. interaural time difference). All routes between flashback locations were walked and recorded by lead artist Lee Scott and sound designer Yans Lee between two time frames. These comprise 6pm - 2am on a Saturday night and 12pm - 3pm on a weekday afternoon, and are referred to as 'flashback time' and 'player time' respectively. Walks were paced at around 3 mph, which is typical of navigation through a moderately populated city center. As some routes share sections, it proved more efficient to divide the audio capture into blocks that could be organized and triggered as required during the opera. The following sequence details how binaural sound blocks and song introspections are sequenced across the route between the Turf Maze and St. John's Church (see also Fig. 4).

1. The player exits the Turf Maze, triggering playback of both the protagonist introspection (song) and the first binaural sound block associated with this route. The introspection for this route is 3 minutes in duration and is expected to conclude between the boundaries marked "Song Ends".
2. The binaural soundscape is at first muted then made audible when playback of the introspection has concluded. This is to ensure continuity of sound should the player travel more slowly than expected towards the area marked "region 1".

3. Binaural sound block 2 commences playback upon player entry to “region 1”. The binaural audio track again remains muted until playback of the introspection has concluded.
4. Binaural sound block 2 continues to be audible until the player enters the area marked “region 2”. Playback of binaural sound block 3 commences at this point.
5. Binaural sound block 3 continues playback until the player reaches St. John’s Church.
6. Should steps 1-4 represent the first stages of another route in the opera (e.g. between the Turf Maze and Komedia) then a different binaural sound block will commence playback upon player entry to “region 2”.
7. If step 6 is true, then the player will continue to trigger binaural sound blocks at regular intervals until they reach their intended destination.



Fig. 4. Sequencing of audio between the Turf Maze and St. John’s Church

VII. ACCESS

Opera for mobile media presents technical and conceptual challenges that must be considered at the point of conception. This next section describes limitations related to access, obsolescence and curatorial control that were identified during the design and development of *Fragments*.

Improving access is a recurring theme in opera. Physical disconnection from leading opera houses and high ticket prices can limit an individual’s ability to attend high quality work. Outreach initiatives including the Metropolitan Opera of New York’s *Live in HD* cinecast series curtail such geographical and financial barriers by offering an opportunity to attend opera performance locally and at the price of a standard cinema ticket. As a side affect, by screening opera in the same venue as mainstream culturing offerings such as Hollywood movies, initiatives such as *Live in HD* help “bridge the divide between high culture and mass entertainment” [18]. Opera for mobile media and

indeed the web offers the promise of even wider distribution. Presentation is only an app download or browser click away, from almost anywhere in the world, and most likely without a fee. Even *Fragments*, which is linked conceptually to Bath provides a technological framework for a smartphone opera that when supplied new audiovisual content could be reconfigured for city spaces across the globe. Taking this further, the qualities of availability, portability, collectivity and communication inherent to digital music [19] suggest extensive creative opportunities for opera that derive from improved access. Smartphone operas could in theory be ‘performed’ anywhere, and involve large numbers of participants that each contribute to the work on an artistic level.

Although all of this is viable, consumers of opera for mobile media face new barriers to access that are platform specific. Access to *Fragments* for instance is restricted to players with smartphone devices and a connection to a 3G or 4G telecommunications network. Without the later, the app may not track the player’s position to the required accuracy causing the opera to function erratically. In addition, a general release of *Fragments* would need to be adapted for multiple mobile operating systems and device types even to approach a state of universal compatibility. This is time consuming with respect to development and impractical in regard to testing, which feasibly could be only representative rather than exhaustive. Operas conceived for web dissemination experience similar access restrictions, yet must also negotiate variances in the technologies supported by modern web browsers. Online opera *The Imaginary Voyage* [20] for example is subject to restrictions that disallow playback of audio on mobile devices without an explicit user action such as a button click. This measure is put in place to limit unwanted data usage. As *The Imaginary Voyage* relies on procedural content generation to serve audio and visual materials dynamically to the viewer, this restriction means that the opera can only be experienced on laptop and desktop computers in its current form. Cross-browser support of experimental web technologies introduces an additional yet related problem. For *The Imaginary Voyage*, limited support of the web audio API at the time of creation (2012) ensured that features that might enhance the viewer’s engagement with the work could not be implemented without imposing sweeping access restrictions. Browser support for sound synthesis, convolution reverb and volume automation was minimal, so choosing to deploy them in the opera would have narrowed the target audience considerably. Creators of both web and mobile media must negotiate limitations such as those described above carefully. These challenges are not only technical but also conceptual, as the high-level design of the work must balance the desire for experimentation and progression with the practicalities of accessibility.

VIII. OBSOLESCENCE

Opera for mobile media is subject to another key feature of digital creativity: obsolescence. Like any digital artifact, this new form requires special effort to maintain and preserve as software and hosting hardware depreciate or become unavailable. Alain Bonardi and Francis Rousseaux’s virtual opera *Virtualis* provides a case in point for obsolescence in the context of digital opera. *Virtualis* is an open work for CD- ROM that is performed on personal computers by users who interact with fragments of text (read or sung), music and graphics [21]. Created in 2002, *Virtualis* presents a curious scenario where the opera technically still exists in its original form, yet it is becoming increasingly inaccessible to users. Many laptop and desktop manufacturers in recent years have abandoned optical drive technologies in order to conserve chassis space, and today the preferred method of data storage is solid-state media and the web. *Virtualis* as a CD-ROM opera is quickly becoming unreadable, and requires redeployment to more contemporary media in order to survive. Operas conceived for mobile media experience similar challenges. Indeed, the window of optimum performance without reconfiguration is arguably narrower as smartphone devices and mobile operating systems update very frequently. Jaakko Nousiainen’s *Omnivore* is one such casualty of technological change. Originally released in Autumn 2012, *Omnivore* was most likely deployed for Apple iOS 5 and Android Jelly Bean. However following discontinuation due to high server maintenance costs [22], the app is today unavailable for download and non-functional to users who have it already installed on their device. Attempting to access *Omnivore* under iOS 10 reveals notices of potential incompatibility with the host device, and the app crashes when attempting to serve video to the user. Aware of the impact of technological change, Nousiainen has compiled a web-based version of *Omnivore*. This however can only ever be an echo of the mobile opera - an archive artifact that provides only a “limited approximation of the original experience” [23]. *Fragments* is yet to experience the challenges of obsolescence faced by the creators of *Virtualis* and *Omnivore*, however such challenges are inevitable. Although the opera is currently fully operation as an iOS 10 deployment, it is likely that this will soon not be the case. Strategies therefore must be put in place to ensure the work exists beyond the lifespan of the technologies on which it is hosted currently.

IX. CURATORIAL CONTROL

The reconfigurable, open nature of opera for mobile media is perhaps one of its most attractive features, however in many ways such possibilities pose the greatest risks from a curatorial perspective. Locative storytelling generally relies on substantial buy-in from users in order to uphold the flow of narrative. Put simply, they must go where they are asked to go, and when this does not occur, they may find that the experience becomes fractured and unsatisfying. *Fragments* is without question vulnerable to this scenario. Players can be directed to follow a given route or orientate themselves in a particular way during flashbacks, but ultimately they are under no obligation to do so. In a computer game this form of ‘abuse’ is less significant. The demand to progress the story is on the player rather than the mechanics of the game. For *Fragments* however, non-compliance is perhaps more damaging. Deviance from expected routes may result in long stretches of time that are devoid of sound, disrupting the sense of musical continuity that is expected of opera.

Risk to curatorial control is not limited to how *Fragments* is navigated. It manifests also in how and when the player chooses to encounter the opera. One important feature of *Fragments* is that it needs to be experienced within a particular time frame: on a weekday so the city is quieter, and while it is light outside. Should the player elect to enjoy *Fragments* on a Saturday evening for instance, they may misinterpret the prologue (where the protagonist wakes in Queen’s Square early in the morning) and find little distinction between binaural memory events the live sound of the city. This situation can however be mitigated by allowing the opera to be launched only during controlled hours. Less easy to handle elegantly is the player’s choice of listening volume and playback equipment. Playback on headphones with a non-flat frequency response may lead to poor reproduction of binaural sound. Equally, listening volumes that are overly amplified or attenuated could cause a discrepancy between the expected and actual intensities of city soundscapes. This would likely disrupt the illusion of temporal flux. Locative projects that deploy binaural sound such as *Alter Bahnhof* overcome these challenges by regulating the experience more closely. Viewers must encounter the work on terms set by the curatorial team who issue headphones and iPods that are sonically and dynamically balanced to taste. *Fragments* however is not intended to be disseminated in this way, and so can provide only guidelines and methods of calibration within the app itself. The creator must trust that the player will invest in the quality of their experience by following such advice.

X. FUTURE WORK

The next step for *Fragments* is audience evaluation. This will seek to understand how players navigate the work typically, but also how their reception of opera for mobile media compares to more traditional staged forms. Insights will be acquired via embedded data collection (EDC) techniques similar to those deployed in Sarah Atkinson’s interactive film, *Crossed Lines*, which uses scripts within the film’s software architecture to log precisely how long viewers engage each scene [24]. EDC techniques will be exploited in *Fragments* to trace player routes through the opera and to record key points of interaction. Resulting data will feed a series of self-confrontation interviews that present participants with a time-stamped overview of their experience using the actual sounds and images that they encountered. This method of mediated ‘recall’ is inspired by the Digital Replay System used by Blast Theory to evaluate *Rider Spoke* [25], and aims to generate verbal descriptions of each participant’s experience of *Fragments* at the level of affect.

XI. CONCLUSION

This paper has discussed some of the available opportunities and limitations of designing opera for mobile media. It is nevertheless important to note that the themes introduced within are illustrative, and only scratch the surface of what creative possibilities and technical challenges lay at the door of this exciting new operatic form. It should also be appreciated that *Fragments* acts only as a stepping-stone towards a fuller understanding of app-based opera. Scratchy and imperfect, it serves more as a vehicle to uncover potentials and problems than an exemplar of this emerging genre. In time, creators of opera for mobile media will develop storytelling conventions and modes of participation that afford it a clear sense of identity. This is the ultimate goal for the form, and one that that can only be achieved through continued enquiry and experimentation.

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