

Arts Management &  
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## Performing Arts in the Wearable Age

By

Thomas Rhodes & Samuel Allen

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## INTRODUCTION

According to Cisco, wearable computing devices are devices that can be worn on a person, “which have the capability to connect and communicate to the network either directly through embedded cellular connectivity or through another device (primarily a smartphone) using Wi-Fi, Bluetooth or another technology.” Such devices include fitness and health devices, smartwatches, and smartglasses, and are projected to grow from 36 million devices in 2014 to 177 million devices by 2018 (Cisco, 2014). Coupled with the fact that the wearable computing industry has grown 1,886% since 2010 and is expected to increase at an annual rate of 35%, wearable computing devices (or, wearables) may reach wide-spread adoption by the end of the decade (Bleeker, 2014).

The increased acceptance of wearables will have a profound impact on the performing arts. To better understand their possible applications and implications in the field, this paper examines current practices and challenges with which arts managers will have to contend if they are to integrate wearables into performing arts venues. This understanding is achieved by examining the future development of smartglass design, current experiments with wearable technology in the performing arts setting, possible future applications of such technology, and a look at the obstacles that wearables will face in performing arts venues. The analysis presented here focuses primarily on smartglasses as that sector is projected to be among the fastest growing within the wearables industry. Moreover, the functionality of these devices likely presents the best opportunities to enhance the performing arts experience.

<b>Wearable Technology Market - Worldwide</b>					
<i>Share of Unit Shipments (Percent)</i>					
	<b>2014</b>	<b>2015</b>	<b>2016</b>	<b>2017</b>	<b>2018</b>
<b>Smart Glasses</b>	1.7%	5.5%	7.3%	10.7%	14.2%
<b>Smart Watches</b>	19.4%	43.2%	55.5%	61.0%	63.5%
<b>Fitness &amp; Activity Trackers (1)</b>	46.2%	31.3%	24.3%	20.0%	17.1%
<b>Heart Rate Monitors (2)</b>	32.7%	20.0%	12.9%	8.2%	5.2%
<b>Total:</b>	<b>100.0%</b>	<b>100.0%</b>	<b>100.0%</b>	<b>100.0%</b>	<b>100.0%</b>

(1) Includes new fitness monitors such as Fitbit Force, Withings Pulse, Basis B1 Band, Nike and Polar Loop – plus all heart rate monitors, pedometers and sports watches.  
 (2) Primarily consisting of products that require the user to wear a chest strap, these devices are aimed at two quite different market segments: (i) Serious athletes : this segment includes professional and amateur athletes who are engaged on a structured training programme; (ii) Leisure users: those who exercise mainly for recreational reasons and for whom a heart rate monitor offers mainly novelty benefits.

Source: Generator Research Download data in Excel:  
[www.generatorresearch.com/share/74eeqq7](http://www.generatorresearch.com/share/74eeqq7)

## SMARTGLASSES

Smartglasses, also known as head mounted displays (HMDs), smart eyewear, and heads-up displays (HUDs), present the most opportunity for integration with the performing arts. These devices have the potential to incorporate both augmented reality (AR)—the overlay of digital images on a real world environment—or virtual reality (VR)—an immersive digital environment that is isolated from the real world. Companies such as Google, Recon Instruments, Samsung, and Epson are creating these devices with capabilities similar to smartphones, including connections to cellular networks, phone and text capabilities, applications, recording and photo capabilities, and audio and video playback. Smartglasses are controlled via vocal commands, touchpads, gesturing, and even blinking.

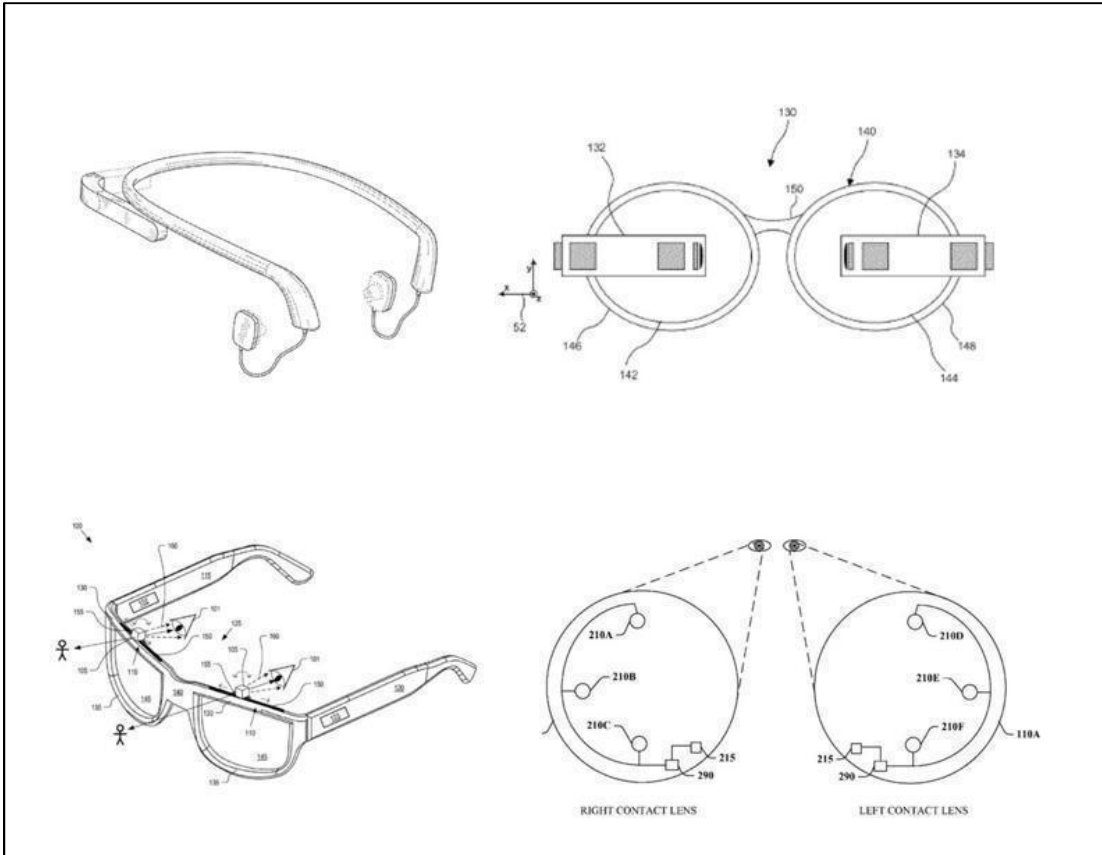
As opposed to smartphones, tablet devices, and smartwatches, smartglass screens are viewed via an optic prism or lens that is powered by an internal projections system. This type of display produces only a fraction of residual light output, making its use in a darkened theatre, for example, largely unobtrusive. The discrete design and user interface sharply contrasts the disruptive nature of other wearable technology devices currently on the market.

One such device is Google Glass, which became available to the general public in May 2014, following a beta test initiative called the Explorer program, in which invited participants had the opportunity to purchase Glass for \$1,500 per unit. It is widely suspected, although

not confirmed, that Google's decision to open the program to the public suggests a possible clearing of current inventory to prepare for the launch of a redesigned Glass 3.0, which may take place June 25-26 in San Francisco during Google's 2014 I/O tech conference.

Recent patent applications by Google give a glimpse as to how smartglasses may develop in the future. In Diagram 1 (see next page), the [device to the upper left](#) is essentially a streamlined version of the current model of Glass with integrated earbuds (Olsson, 2014). The design to the upper right, nicknamed the [terminator version](#), mounts two optical lenses directly in the middle of the user's field of vision (Braun et al., 2014). Dual optic lenses allow the user to have a more immersive experience, while also enabling realistic augmented reality (AR) capabilities.

The [bottom left design](#) most likely reflects Google's intentions in collaborating with the eyewear company [Luxottica](#) to create a "new breed of eyewear for Glass" (Luxottica, 2014). Notice in this design that the optic prism has morphed into AR optic lenses. Once this level of lens integration is achieved, the AR field of vision will be comparable to the field of vision for corrective eyewear. This lens integration will allow users to experience a truly immersive digital experience that blends the real and digital worlds. The lens integration also makes these smartglasses virtually indistinguishable from regular glasses, making detection of those using the device difficult, if not impossible.



**Diagram 1**

Sources: (clockwise from upper left) Olsson, 2014; Braun et al., 2014; Miao, 2014; Hill-Room Services, Inc. 2014.

Finally, Google has a [patent pending for AR contact lenses](#) that incorporate a micro camera, depicted in the lower right corner of Diagram 1 (Hill-Room Services, Inc. 2014). Although these contacts are conceived as a patient/user interface that integrates with a medical care facility network, they point toward the continued miniaturization of AR eyewear and are a probable evolution of Glass. Based on this design, smart eyewear will likely continue miniaturizing until AR devices develop into ocular and/or cortical implants.

Although they currently only make up 1.7% of the total wearable market, Generator Research predicts that smartglasses will grow to occupy

14.2% of the wearable market by 2018 (see table above). According to an analysis by [Analytica](#), Google will likely lead the smartglass market as it currently dominates consumer awareness of wearables, garnering 33% of wearable industry brand attention in 2014, with Google Glass receiving 55% of product attention for the wearable market in 2014. In addition, according to [Adobe Digital Index](#), Glass is currently used 54% of the time as a media and entertainment device, suggesting that further analysis of this technology's potential impact on the performing arts is needed.

## EXPERIMENTS IN PROGRESS

Since the beginning of the Explorer program in 2013, the performing arts industry has experimented with Google Glass on several occasions. These experiments indicate potential future uses for wearables in the performing arts. Two examples are the evolution of digital scores and supertitles, profiled below.

## CONDUCTING AND DIGITAL SCORES

Cynthia Turner, associate professor of performance at Cornell University, has been working on using Google Glass as a conducting and music performance aid since the beginning of the Explorer program in April 2013. Her [blog](#), co-written with teaching assistant Tyler Ehrlich, details a number of these experiments, geared primarily toward conductors and instrumental musicians. These experiments include recording Point of View (POV) rehearsal videos to improve conducting technique and creating a new music notation system that Turner refers to as a “salient score.” POV rehearsal videos allow students to see the conducting work of their instructors from the instructor’s perspective, offering a more nuanced look at the techniques explained in the lesson. The salient score concept addresses Glass’s current inability to display a legible musical score by instead creating a simplified version of that score, boiling down the notation to its bare essentials: time signature, instruments playing, dynamics, and changes in tempo (Turner and Ehrlich, 2013-2014).

In the future, musicians and conductors could use smartglasses in place of physical sheet

music, but doing so will depend entirely on the scope of the device’s field of vision. This development could bring musicians even closer to the audience by doing away with the physical separation of the music stand entirely. It could also aid vocal musicians wanting to reference their score during musical rehearsals or when they receive a last-minute call to fill in for a role.

## SUPERTITLES

Since the publication of the authors’ [first paper](#) addressing audience engagement and Google Glass earlier this year, significant developments in smartglass titling have occurred. According to [The New York Times](#), On Site Opera is collaborating with Figaro Systems, inventor of seatback titles, to test the first multi-device, web-based, Glass-friendly supertitle system—MobiText—for the upcoming production of Rameau’s *Pygmalion* on June 19, 2014 (Kozinn, 2014). This performance will be the first of two MobiText tests, with the second happening at Wolf Trap Opera during its performance of *Carmen* on July 25, 2014.

In an email to the authors, Geoff Webb, president of Figaro Systems, explains MobiText as a website-hosted titling platform that functions as a “universal system that presents translations in any language on any mobile device or computer with a browser and internet connection in any venue.” He believes that this multi-device development marks a new generation of titling systems. As he describes, “First generation titles were projectors and LED panels; second generation titles are seatback displays such as Simultext; third generation

titles are mobile, wearable computers, and MobiText; and fourth generation devices will be cortical implants” (Webb, 2014). If successful, MobiText technology could also be adapted to present performance commentary, educational components, and assistive technology such as closed captioning. The MobiText system has been specifically designed to serve a number of mobile devices, including Google Glass, which will be a featured device for these tests.

## **IMPLICATIONS FOR THE PERFORMING ARTS**

The present uses of wearables within the performing arts and across other sectors provide indications of the potential uses for wearables in the arts industry in the future. From the box office to the control booth, wearables have the possibility of revolutionizing how performing arts venues operate. Among the potential implications they hold for arts managers are changes to front-of-house operations, audience engagement, and the infrastructure of performing arts venues.

### **FRONT OF HOUSE**

On performance nights, front-of-house (FOH) staff are among the busiest personnel in the building. Ticket takers, ushers, box office staff, security agents, and house managers spend countless hours helping patrons navigate the venue and resolve problems. These endeavors rely on instantaneous communication between staff. In many spaces, each FOH staff member carries at least a walkie talkie; in larger venues, they may utilize numerous forms of communication, including walkie talkies,

computer stations, stage management headsets, and cell phones. Wearables represent a potential unification of these technologies; more importantly, they also represent the possibility of uniting a visual element with the audio communication that venues already use.

Although radios do the trick more often than not, their quality is notoriously shaky. Conversely, wearable computing would be able to utilize voice-over-internet protocol, offering an audio clarity unrivaled by traditional radio units or phones. House managers and ushers would not have to struggle to communicate to one another through the static and squawk of walkie talkies; instead, they would be able to benefit from the crystal-clean sound that one might hear on a Skype or GoToMeeting call, resulting in improved communication and quicker problem-solving.

Although the communication potential of wearables is not yet realized, the technology that other front-of-house situations require already exists to a certain degree. For example, Google Glass currently has the ability to read QR codes and to analyze printed text, suggesting it would not be much of a stretch to adapt the unit to read the barcodes present on tickets. Comparable handheld barcode readers for ticketing are already being introduced in venues, such as [ThunderTix's barcode sticker scanner](#).

Wearables also present significant opportunities in the realms of customer service. Virgin Atlantic



has been testing Glass in certain airport terminals since February 2014. Once the customer identifies themselves, gate agents and staff members can access flight information, seat details, and personal preferences. The result is streamlined, personalized service: the customer receives individualized information suited to her particular journey and needs, with the airline employee processing check-in more quickly and efficiently.

In a [Computing Magazine interview](#), Dave Bulman, Virgin Atlantic's Director of Information, remarked that the customer response to the Glass tests was "very positive." He explained, "[Customers] appreciated the fact that someone could have a conversation with them right there and then because before, they were used to having to go to one of the check-in terminals." With regards to the future, he remarked, "Something like [Google Glass], which lets [employees] quickly access information on customers, is going to be invaluable" (Palmer, 2014).

From these tests, it is easy to envision a day when FOH staff are equipped with smartglasses that identify patrons through facial recognition technology (FRT), which would then automatically pull their information from the organization's CRM database and store additional information as the interaction is taking place. Whether patrons are speaking with an usher or box office staff, wearables have the potential to help performing arts organizations provide greater assistance and service to their patrons.

Like any technology solution, wearables will only be one part of an overall IT and communication infrastructure within a performing arts venue. However, due to their being wearable computers, wearables will be much more closely integrated with an organization's patron management, ticketing, and communication systems than the headsets, radios, and telephones used by today's FOH staff. Wearables could offer the same advantages that the Internet brought to desktop computers—more information and communication at a faster rate than before.

## ENGAGEMENT APPS

Performing arts organizations could also use the advent of wearables to design complementary apps for smartglasses that enhance the performance experience for the audience. Some professional sports organizations are currently experimenting with similar projects. In January 2014, the Washington Capitals hockey club was the first professional sports organization to create a sports engagement Glassware, called [Skybox](#). With Skybox, the Washington Capitals aims to instantly provide fans with content they might want when going to a match: player stats, season highlights, player point of views, and instant replays of actions on the ice. The Skybox system relies heavily upon the IT infrastructure of the Capitals' home stadium in Washington D.C., the Verizon Center, which is alleged to be one of the most connected stadiums in all of professional sports (Monumental Network, 2014). The IT infrastructure of the stadium allows for the Skybox application to instantly access

databases in order to stream the stats and video content that fans want to see.

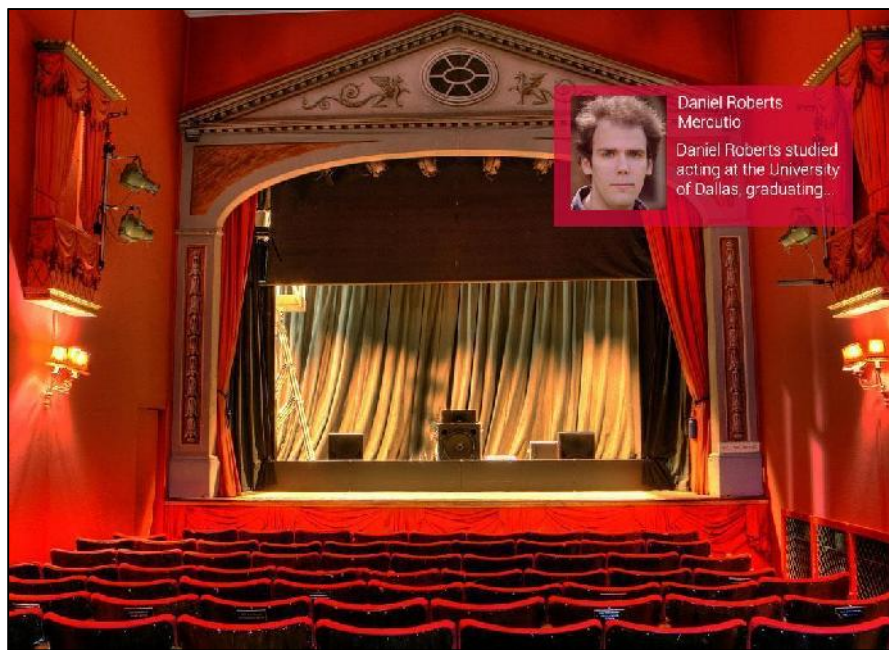
Similar wireless infrastructures would be necessary for any venue wanting to create such a service. Within the performing arts, second screen content could stream annotations, commentary, and performer biographies to patrons directly through devices like Google Glass. Patrons often want information and facts, as well as entertainment, before the performance, which currently is provided largely through the use of playbills and concert programs. These pieces offer large chunks of information that typically require a good deal of time to read, making them difficult to enjoy during the course of the performance. Wearables have the potential to solve this problem by offering patrons short blasts of information about performers and the production in real time.

## CHANGING PERSPECTIVES

Wearable technology carries additional potential for the performing arts by introducing an ability to create soundscapes, perspectives, and realities that immerse audience members in new performance experiences. Immersive audio, augmented reality technology, and point-of-view perspectives are three specific endeavors with potential to engage performing arts audiences in new ways.

### Immersive Audio

Immersive audio is a manufactured soundscape designed and engineered in such a way as to completely inundate the listener with sound and perception. Rather than sound coming from a set of stereo speakers, or a conventional surround sound system, immersive audio may come from any number of angles and sources, much like the ambient noise of the real world.



"Google Glass Preview in Theatre," a derivative of "Theater" by Alan Cleaver.  
"Theater" used under [CC BY](#), "Google Glass Preview" licensed under [CC BY](#) by Samuel Allen.

The first live immersive audio performance, Invisible Cities, was produced in the Fall of 2013 by The Industry's Artistic Director Yuval Sharon. The opera took place in Los Angeles's Union Station and was billed as "an invisible opera for wireless headphones." Vocalists were positioned throughout the train station and their individual performance was captured by wireless microphones that broadcast their signals to a mixing station. Once mixed and balanced, the performance was broadcast to audience members that wore wireless headphones provided by Sennheiser.

### Point of View

Point of view (POV) technology lets one party see through the eyes of another. One of the most exciting potential uses for smartglasses is the ability to record and/or broadcast POV content for audience members. Some patrons know what it is like to sit in the nosebleed seats, others are familiar with the feeling of floor level seats, while others will have experienced looking out from the stage during a performance. Wearables on actors, singers, and musicians allow a glimpse of what it looks like on the other side of the footlights or from alternate locations within the venue.

Indeed, some institutions have already experimented with these kinds of performances. Using four Glass devices, the [Kansas City Symphony](#) worked with Engage Mobile Solutions to record a rehearsal of Beethoven's Fifth Symphony in March 2014. Over the course of the rehearsal, the recording cuts between perspective views from the conductor, violin,

horn, and bass. Across the pond, Berlin Philharmonic horn player [Sarah Willis](#) worked with the BBC to create a short film featuring the National Youth Orchestra of Great Britain and Google Glass.



Sarah Willis, French horn player for the Berlin Philharmonic, wearing Google Glass with the National Youth Orchestra. Source: [BBC Blogs](#)

Sharing POV through Glass became easier in April 2014, when [Livestream](#) announced the launch of a Glassware that broadcasts live streaming video from Google Glass. Although users can already broadcast video via the Hangouts app on Glass, Livestream Glassware differs in that it uses Livestream's existing live broadcasting network. This means that performers and audience members alike will be able to share their POV live with anyone, part of Livestream's mission "to democratize live video broadcasting and provide the tools to bring every event live online"—including live performances throughout the arts community.

### Augmented Design for the Virtual Audience

One of the front runners in the virtual reality (VR) industry is Oculus VR. Founded in 2012,

the startup soon produced a VR headset called the Rift, which creates an immersive VR experience for the user. In March 2014, Facebook purchased Oculus VR for \$2 billion (Luckerson, 2014). After the purchase, Facebook founder and CEO Mark Zuckerberg stated that Oculus VR's Rift headset offers "immersive, augmented reality [that] will become a part of daily life for billions of people" (Zuckerberg, 2014). Immersive, however, is something of an understatement, as the Oculus Rift device completely obscures the user from the outside world, submerging him instead into a computer-generated landscape.

When accompanied with an appropriate audio background, Rift users can feel entirely transported from their own physical world. This immersion potential was demonstrated by a touring exhibition of material from the television series Game of Thrones, where one part of the exhibit used Rift to transport users to the top of a 700-foot wall that serves as a setting in the show. One user reported the experience was so realistic that it caused his stomach to drop (Aguilar, 2014).

Presently, Oculus VR is touting the Rift as a "3D gaming headset." While the Rift is poised to find its initial market in the gaming industry, the merger of realistic VR design and AR smartglasses may one day enable stage designers to create realistic AR environments with which performers can interact. Once AR reaches this level of sophistication, the concept of a performance space will be entirely fluid. Venues will be able to digitally present

performers not present in the actual physical space, stream entire AR presentations to audience members in the comfort of their own home, and genuinely put viewers into the "world" of the production.

## **VENUE AND INFRASTRUCTURE NEEDS**

If wearables experience the same explosion in popularity as smartphones, the world's bandwidth may need yet another growth spurt in order to keep pace. And indeed, [a report by Cisco](#) estimates that wearables will make up 61% of smartphone-based web traffic by 2018 (Cisco, 2014). For performing arts venues to provide reliable internet connection for wearables, they must invest in in-house WiFi access with increasingly larger bandwidth. While WiFi networks are relatively commonplace in performing arts venues today, the quality and reliability of these networks can vary widely. In older venues, retrofitting the space for a wireless network can be cumbersome and expensive, and in the worst case, entirely ineffective. But whether it's a lighting designer struggling with a light board or an assistant stage manager looking up Equity rules, modern performing arts venues must have connectivity in order to be viable spaces. In terms of future venue design, the most pressing matter will be optimizing buildings for widespread WiFi access. Regardless of how extensive a role wearables play in the performing arts in the future, productions will inevitably and increasingly rely on a performance space that is connected.

The resources needed to provide these networks may be extensive and costly, but it is worthwhile to consider the possibilities offered by a connected audience. In addition to the creative possibilities discussed in earlier sections of this paper, a monetization potential exists with in-house WiFi networks. An audience-accessible network could offer venue owners an additional opportunity to serve sponsored material to patrons, thereby opening up a new potential stream of revenue. More importantly, content on mobile devices and wearables will be actionable, making it possible for audience members to engage with the sponsor's promotional material. They can click on a banner ad, download a coupon, watch a video, or perform an action that the sponsor desires; meanwhile, the venue owner receives revenue from the ad impression.

## HURDLES

### PRIVACY

Sophocles once stated, "Nothing vast enters the lives of mortals without a curse." Technology is no exception. One of the most commonly cited concerns with the growing spread of wearable technology is privacy—specifically, the privacy of the people around the wearer. Whereas point-and-shoot cameras require a kind of ostentatious and obvious physical movement in order to operate—one must take out the device, queue up the camera, and take the picture—devices like Google Glass eliminate much of this spectacle. With the base operating system, one needs only to briefly touch a button above the right ear in order to record a photo or video. With a small software modification, the camera

can be activated by stating a simple phrase. Glass is even experimenting with a wink activated photo capture (Google, 2014). To date, the increased ability to take a clandestine photograph has resulted in Glass being banned from numerous public places, including a number of bars and restaurants in San Francisco, Seattle, and New York (Finney, 2014).

In January of this year, NameTag announced the creation of a Facial Recognition Technology (FRT) Glassware that quickly came under criticism in a [letter written by Senator Al Franken](#) for crossing a "bright line of privacy and personal safety." In reply to this letter, NameTag's parent company, FacialNetwork.com, CEO Kevin Tussy decided to delay the application's release until "best practices are officially established" (Tussy, 2014). On the device-supplier side, Google's Chief Marketing Officer [Ed Sanders observed](#), "Accepting this sort of stuff is coming" is part of the larger cultural acceptance of wearables. He emphasized Google's willingness to be "really forthright about having the debate around it and being proactive around listening to people, about their concerns and fears and trying to address them" (Ward, 2014).

The privacy backlash against wearables is already strong and palpable in the public sphere; how it will be received by a performing arts community that has historically prided itself on pushing the envelope and challenging society is unknown. The performing arts venues of the future may implement measures across

both personnel and design to enforce the privacy of their patrons.

## UNIONS AND INTELLECTUAL PROPERTY

Presently, the largest hurdle for using smartglasses in a performing arts setting is that many smartglasses are equipped with recording devices. Due to intellectual property and employee protection concerns, many unions have negotiated specific recording/media agreements with arts organizations. The American Guild of Musical Artists negotiates agreements with each performing arts organization and has no standard video capture agreement for the music performance industry. Likewise, the International Alliance of Theatrical Stage Employees outlines agreements with employers and has no document outlining industry standards for the performing arts sector. The Actors Equity Guild is one of the few performance unions that outlines an [Association of Non-Profit Theatre Companies Rulebook](#), which standardizes video recording rules for non-profit theatres. In all of the above examples, the recording agreement exists between the performance company and the unions representing the artists.

Audiences, on the other hand, have no agreement between unions or performance venues, with the exception of pre-show announcements that usually contains a variation of “the use of cameras and/or recording devices in the theatre is strictly prohibited.” Legally speaking, it could be said that the patron’s continued attendance of the event is an implicit agreement to abide the prohibition of recording

devices. This policy has been widely adopted to prevent the release of bootleg recordings that infringe on intellectual property and copyrights.

A clear divide, however, exists between nonprofit and commercial entertainment regarding the use of recording technology by attendees. Commercial entertainment industries, such as the popular music and sports industries, actively encourage smartphone photography and recording during live events for the purpose of social network exposure. For instance, large musical festivals like Austin City Limits and Lollapalooza provide their own hashtags for fans to use for concert photos (#aclfest and #lolla, respectively). Conversely, nonprofit entertainment restricts such recording due to intellectual property constraints.

Smartglasses present new opportunities for video capture due to their discrete design and user interface. Since these devices already contain recording technology, the performing arts will want to address this issue soon. With the advent of discrete wearables that cannot easily be detected, content capture and creation will be taken out of the control of performing arts organizations and placed squarely in the hands of the audience. Once this point is reached, recording and streaming within performing arts venues will become increasingly commonplace. As an industry, the performing arts can either reject this shift and potentially alienate a portion of its audience, or it can seize this shift as an opportunity to proactively renegotiate union agreements and establish new intellectual property policies.

## CONCLUSION

The performing arts, and indeed the marketplace at large, are just in the beginning stages of wearable computing technology. Those wearables currently available are but the foundation of what is to come; how performing arts venues adapt to wearable technology today will inevitably affect how they are poised to leverage that technology in the future. To seize

that potential, performing arts organizations should acknowledge that wearables will increasingly be present among their audiences in the years to come and begin to devise new opportunities to provide value and augment meaning in the experiences of their patrons and artists through wearable technology.

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