# Wearables in the Performing Arts:
# An RFID Primer for Arts Managers

**Rod Gingrich**

Arts Management & Technology Laboratory

Carnegie Mellon University

# INTRODUCTION

Arts Managers, like those in any other field, face a bewildering array of new tools and technologies that seems to expand every year. The constant flurry of innovation presents a conundrum. On one hand, each new tool promises that something useful might get done easier, quicker, or with greater impact; on the other hand, these new tools may not work as well as promised or offer a reasonable return on investment. Deploying new technology creates the risk of unforeseen consequences, such as incompatibilities or quick obsolescence. Arts managers have to weigh these risks, often on tight budgets.

Wearable technology is among the emerging technologies that an arts manager may want to consider. Wearable technology is frequently based on RFID (Radio Frequency Identification) technology. This report describes the capabilities of RFID and provides a quick overview of it's many uses. It will give special consideration to those within the entertainment and performing arts sphere, where increasingly creative deployment is adding value to large-scale events for both the audience and the presenter. Note: AMT Lab contributor Anne Marie Padelford has written about RFID technology in museums. From education and engagement to ticketing, museums are using RFID to connect with and better understand their visitors.

In the last few years, wearable RFID technology has found many uses in the arts, culture and leisure spheres. Particularly since 2014, it has become nearly ubiquitous at large music festivals. Vendors who cater to the logistical needs of large-scale events claim that festival organizers reap multiple benefits when deploying RFID technology, including:

- Increased Revenue – Industry claims of 15-30% increases in revenue are not uncommon.[1]

- Improved Customer Experience – RFID can help reduce the time people stand in line, especially to get into a venue.

- Social Media Engagement – RFID enables various audience engagement strategies that create value-added marketing opportunities

This report will focus on how RFID technology creates these, benefits and will probe the future of RFID while considering its potential use on a smaller scale relevant to most arts organizations. It will also provide perspective on the basic cost factors involved in implementing and RFID system. While the economics of smaller scale deployments provide obstacles, there are developments – and alternatives – on the RFID horizon that promise the benefits on more economical terms. This report also provides many real-world examples that describe the creative uses that have been made of RFID across many industries. These examples, however disparate from the work of an arts organization they may seem, are intended to inspire the imaginations of arts managers, for whom the story of "RFID in the performing arts" is yet unwritten.
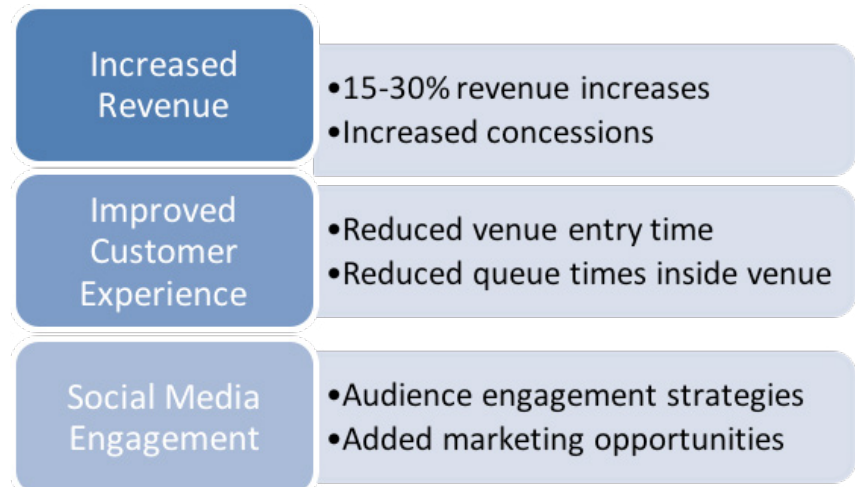


*Figure 1. Vendors who cater to the logistical needs of large-scale events claim that festival organizers reap multiple benefits when deploying RFID technology. Source: Author Research.*

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1  Intellitix. "Considering RFID Technology for your Next Event?" intellitix.com. 2016. http://get.intellitix.com/cashless-101-rfid-ebook/ (accessed March 22, 2017).

## Understanding RFID

The world has become saturated with the surprisingly pervasive presence of RFID technology. It is increasingly hidden everywhere, counting and measuring and tracking everything… and everyone. It's likely that RFID (Radio Frequency Identification) technology is already part of everyday life, even if you don't notice it. If a car zooms through tollbooths, it is because it has a transponder in the car using RFID technology. RFID is used in retail locations, protecting merchandise from theft. It's also used in the warehouses and transport systems that bring that merchandise to local stores. Indeed, the applications for RFID technology are manifold, from rock concerts to museums.



*Figure 2. RFID is a wireless communication protocol that comes in many varieties and intermingles with many other technologies to form real world applications. Source: https://blog.silverstaranalytics.com.*

A recent example of its use in the arts is when the Children's Museum of Houston began using the technology in 2016 to engage children with a gamification strategy. Their membership has increased ever since they implemented an RFID-based scavenger hunt. The activity is aimed at kids age 6-12 who undertake a series of "missions" on multiple visits to the museum. Participants receive an RFID wristband known as a Codex. "Initially a participant pays a fee—$20 for the first mission and $10 for each subsequent ones… Every time a child completes a mission correctly, he enters the data required for that task

into an RFID-enabled kiosk and this information is stored, along with his wristband ID, so that he can be directed to the next assignment."[2]

### *Just Enough Technical Background on RFID*

So, just what is RFID? Short for Radio Frequency Identification, RFID is a wireless communication protocol that comes in many varieties and intermingles with many other technologies to form real world applications. As market research firm IDTechEx explains, "There is no universally agreed definition of RFID and matters are now made more complex by the practicality that WiFi, WiMax, Bluetooth, ZigBee, DSRC and other short range wireless protocols are being used for RFID or incorporated in devices with RFID."[3]

It is useful to think of RFID as an umbrella term for a number of functionally and technically related technologies, rather than a single technology. As tech blogger David K. Hess explains, "The basic concept of RFID is that you can identify an object at a distance using some sort of wireless protocol. There are many different technologies and techniques for doing this but they all fundamentally rely on some sort of RF communication protocol."[4] This paper, insofar as it focuses on applications (rather than specifications) of RFID will consider RFID by this broad definition.

RFID is a relatively mature technology–it was developed during WWII by the British Air Force, and since then has crept into use by many industries. The concept behind it is simple. Radio waves are used to communicate between a "central command" and any number of small "receptors," each with it's own unique store of information. Because RFID systems can distinguish between individual "receptors," it is used often in inventory systems, including museums archives. For example, RFID

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2  IDTechEx. The RFID Knowledgebase. 2017. https://www.idtechex.com/knowledgebase/ (accessed April 7, 2017).

3  IDTechEx. RFID Forecasts, Players and Opportunities 2016-2026. Copyright © 1999-2017 . http://www.idtechex.com/research/reports/rfid-forecasts-players-and-opportunities-2016-2026-000451.asp (accessed April 7, 2017).

4  Hess, David K. The Economics of RFID Performance. September 6, 2013. http://www.tech-spelunking.com/home/2013/9/6/the-economics-of-rfid-performance.html (accessed June 3, 2017).

systems can track and identify cargo at a loading dock, or music fans roaming the grounds of a music festival.

## RFID Makes Many Things Possible

RFID is old school analog technology, but the information it transmits can be transformed into digital data for further analysis. Are you wondering how to track every visitor's path through a museum, including how long he or she views each exhibit? RFID in admission buttons or stickers can collect this data and feed it into a variety of software tools for analysis.

RFID technology is a wireless protocol that, at its baseline, transmits identification codes. It is well suited to tracking individual items, each with their own unique ID. This focused capability makes it a useful component in automated information gathering systems containing all manner of other technologies, such as digital converters and sensors of all sorts. Typically, these systems transmit their data it to a central computer, where it can be stored and analyzed, or trigger an automatic response of some kind. A few examples will make the capabilities of RFID easier to understand, and stimulate the imagination. Here is a robust application from the retail industry:

German department store AVA AG installed an experimental system in 2006 that tracks shoppers using RFID tags embedded in shopping carts. As customers pushed their carts through the store, their RFID tag would trigger ads on TV screens, selected for the individual cart, based on an analysis of the path the cart has already taken through the aisles. "The system combines TV, Internet, RFID, databases, and software under one umbrella, enabling the direct link between advertising and consumer analysis on site. The system impressively pushes sales and can instantly pinpoint the effectiveness of televised commercials with scientific accuracy based on a consistent method for data ascertainment."[5]

The Metropolitan Museum of Art is using an RFID based system to protect ancient artifacts from climate conditions. The Met "is employing battery-powered RFID sensor tags …to monitor changing conditions and adjust climate controls within its facility… IBM Research's wireless sensor platform was installed at "The Cloisters" which… includes approximately 3,000 works of art dating from the 12th to the 15th centuries, including paintings, polychrome wood sculptures and tapestries, has high ceilings, as well as an outdoor settings and gardens, with doors that frequently open and close. The artworks are extremely sensitive to environmental changes." The RFID tags transmit data that is collected by attached sensors back to a central server. Based on the data gathered, museum staff can take a variety of mitigation actions. [6]

## RFID is a Huge Industry

Large retailers, notable for analytical marketing savvy, also use RFID to tag items, such as apparel. IDTechEx estimates that this use alone will require 4.6 billion RFID labels in 2015, although only 15% of the apparel market is using currently RFID. Cumulative sales of RFID tags to all industries from 1943 to the start of 2015 are estimated to be 35 billion.[7]

Deployment of RFID technology is certain to grow tremendously in the next few years as more applications and innovative uses emerge. IDTechEx estimates the total RFID market (manufactures and suppliers of RFID technology) was worth $10.1 billion in 2015 and should exceed $13.2 billion by the end of the decade.[8] The transportation industry is the largest worldwide user of RFID, accounting for an estimated $3.5 billion in 2015. Healthcare appears to be fastest growing sector, projected to be worth S$620 million by 2020.[9]

5 Prosound Network. Tagged and Delivered: RFID Delivers for AVA AG. December 21, 2006. http://www.avnetwork.com/avnetwork/tagged-and-delivered-rfid-delivers-for-ava-ag/105072 (accessed April 7, 2017).

6 IDTechEx. The RFID Knowledgebase

7 Das, Raghu. "RFID: 2015 Review and Outlook to 2020." PowerPoint presentation, IDTechEx, 2015.

8 IDTechEx. RFID Forecasts.

9 Reportlinker. "Global RFID Market - Readers, Tags, Software and Services - Reportlinker Review." reportlinker.com. October 20, 2015. http://www.reportlinker.com/p02841920/ Global-RFID-Market-Read-ers-Tags-Software-and-Services.html (accessed April 7, 2017).

Arts Management & Technology Laboratory

Carnegie Mellon University
Heinz College

## Key Uses of RFID in the Live Music Industry

It is likely not surprising to the typical arts manager that the arts industry is a tiny RFID market sector overall. Across the arts, leisure and recreation markets, only the bigger events have significant experience using it. Recently, RFID technology has been extended in interesting ways that enable transactional capabilities and unique customer experiences. The relatively high cost of system deployment has limited its use to larger events, regardless of the low cost of the RFID tags themselves. A detailed discussion of cost factors is provided later in this paper, starting on page 14.

2014 was a watershed year. Walt Disney World began deploying its "MagicBand" wristbands to park guests.[10] Large music festivals, and the vendors that service them, also began deploying RFID technology. They have been at the forefront of functional and creative uses for RFID in the entertainment sphere: Gating, Cashless Payment and Brand Amplification.



*Figure 3. Walt Disney World began deploying its "MagicBand" wristbands to park guests. Large music festivals, and the vendors that service them, also began deploying RFID technology. They have been at the forefront of functional and creative uses for RFID in the entertainment sphere: Gating, Cashless Payment and Brand Amplification. Source: https://disneyparks.disney.go.com*

### *Gating*

Since 2014, RFID bracelets have become the new ticket into many music festivals, usurping paper and mobile phone based systems. The technology enables multiple entry gates that reduce queuing times. As described by one of the largest music industry suppliers, Front Gate Ticketing Solutions, LLC on their product description, "long line ups are the #1 complaint of event-goers. With RFID you can reduce wait time by up to 15 minutes!"[11]

RFID vendors claim that swiping a bracelet at an entrance point not only gets people into the festival quicker, but also reduces ticket scalping. "RFID (radio-frequency identification) allows for the most secure event access control in the industry, hands-down," according to Front Gate Tickets.[12] Ticket fraud can cause huge revenue losses for festival organizers, and RFID access control potentially eliminates ticket fraud. The following example from well-known conference and festival South by Southwest (SXSW) illustrates why this may be the most compelling reason for festival organizers and arts institutions to use RFID wristbands: to combat ticket scalping.

> "In 2003, SXSW counterfeit wristbands were sold with a total face value of as much as $500,000. Since the implementation of PDC Smart Band RFID Wristbands counterfeit activity has been eliminated. 'Smart Band is practically counterfeit-proof. It is nearly impossible to duplicate an RFID chip and then place it on a wristband,' says Douglas Bourque, PDC RFID Market Development Manager. 'The RFID readers used at the event are programmed to detect fraudulent RFID wristbands eliminating loss of revenue and unexpected overcrowding due to counterfeit sales.'"[13]

Another benefit of RFID wristbands is the ease with which varying levels of access can be granted to individuals. Uses for this include VIP seating, backstage access, special service areas, and ADA access points. It can potentially reduce the overall number of staff needed at access points, lowering festival expenses and potentially raising

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10 Swedberg, Claire. MagicBands Bring Convenience, New Services to Walt Disney World. June 16, 2014. http://www.rfidjournal.com/articles/view?11877/ (accessed May 30, 2017).

11 Front Gate Ticketing Solutions, LLC. RFID Technology. 2014. http://weare.frontgatetickets.com/solutions/rfid (accessed April 1, 2017).

12 ibid

13 IDTechEx. The RFID Knowledgebase.

revenues. As expressed by digital event promotion company Eventbrite, "RFID… opens up new doors to drive revenue by offering on-site VIP upgrades… use RFID to let General Admission attendees instantly upgrade their access level to gain entry to a VIP area. That means happier attendees, and more revenue in your pocket."[14]

## Cashless Payment

The RFID system knows who is wearing each bracelet, and it can connect purchasing activity to the wearers' credit card number. Festivalgoers link their credit card to their RFID bracelet through a festival website beforehand, and their RFID bracelet becomes an instantaneous payment method. Merchants inside the festival are all given equipment so that customers can scan their wristbands. Swiping their RFID bracelet is even quicker than paying in cash. Just as the gating capability reduces the time spend waiting to get into a festival, cashless payment reduces the time spent in line waiting for concessions.

RFID vendors mention point-of-purchase efficiency, but they also taut impressive statistics to show how cashless payment entices people to spend more at the event. Canadian RFID vendor Intelletix claims, "RFID wristbands allow you to go 'cashless'. Letting your patrons make purchases using their wristbands generate revenue increases of between 15-30%!"[15]

As the following example shows, there is a powerful psychological component in the cashless experience: When the 2015 Squamish Valley Music Festival went cashless, festivalgoers were able to pre-load money onto RFID wristbands for use at more than 160 cashless point-of-sale terminals set up throughout the festival. "I think there is a bit of a psychological sense that once the money is loaded on their wristband and has left their bank account, they view that money as practically spent - even though we provided refunds… Guests would come up to

booths and say, 'I still have 20 bucks to spend.' We definitely saw an increase in how much was spent on things like merchandise," said Paul Runnals, Senior Vice President of Creative & Production for brand. LIVE.[16]

## Brand Amplification

"Brand Amp" moves RFID into the marketing realm. Just as RFID bracelets can be linked to your credit card, they can also be linked to your social media account. Many festivals offer interactive stations that automatically post a "souvenir" picture to your Facebook feed, complete with festival and sponsor branding. Production teams are finding novel ways to "gamify" RFID technology by creating participatory activities, tracking scores, ranking users, and posting it to your social media along with their branding. Festivals all around the world are moving towards this technology to engage with their audience on an unprecedented level, nab in-depth customer data, and streamline access to their events."[17]

The importance of social media is not news to anyone in marketing, but its social significance for festivalgoers runs deep. As stated by CNBC reporter Everett Rosenfeld, "Social media makes sense as a natural extension of earlier concert culture… because it is a "way to translate the badge of honor" of attendance formerly signified by a t-shirt."[18] Every year the capabilities and creativity seem to grow, as festivals compete to up the ante with tighter social media integration, greater interactivity, and increased individualization.

Brand Amplification helps festivals promote themselves and create many sharable posts that have an impactful afterlife on social media. Commercialization of this concept is inevitable and well underway with sponsorship deals encompassing RFID-based interactivity now commonplace at these types of events. Exploiting this has great potential to increase sponsorship revenue at many festivals.

14  Eventbrite. "The Event Organizer's Comprehensive Guide to RFID Technology." eventbrite.com. 2017. https://www.eventbrite.com/blog/academy/rfid-technology-events/ (accessed April 1, 2017), 7.

15  Intellitix. "Considering RFID Technology for your Next Event?" intellitix.com. 2016. http://get.intellitix.com/cashless-101-rfid-eb-ook/?utm_source=intellitix&utm_medium=optin (accessed March 22, 2017).

16  IDTechEx. The RFID Knowledgebase.

17  Front Gate Ticketing Solutions, LLC. RFID Technology.

18  Rosenfeld, Everett. http://www.cnbc.com/2014/07/21/future-of-concerts-social-wearables-and-interactive-light-shows.html. July 21, 2014. http://www.cnbc.com/2014/07/21/future-of-concerts-social-wearables-and-interactive-light-shows.html (accessed May 1, 2017).

For instance, inside the Bonnaroo Music and Arts Festival 2013, there were 22 Intellitix Live Click stations that served a variety of purposes. At some stations, visitors could snap pictures of themselves, and tap their wristbands against a reader to post the photographs on their Facebook pages. At other stations, they could share a music playlist on Spotify with their social-network contacts, send a Tweet, or indicate they 'liked' a particular program.[19]

Additionally, a 2013 SXSW concert with DJ A-Trak featured "bio-reactive" RFID wristbands that collected and visualized crowd data and measured audience interaction in real time. The system "measured audience members' biometrics by tracking them with motion, volume and temperature sensors. Sponsored by a partnership with Pepsi, audience interaction was ranked on a screen at the front of the room. Certain levels of dance interaction "unlocked" rewards, such as Pepsi refreshments."[20]

### Data Capture and Analysis

RFID systems can capture accurate, extensive, individualized data in real-time. This provides many benefits. For organizers, accurate attendance and sales figures have both financial and safety implications. Capacity counts are automated through RFID systems. Real-time sales data is captured for vendor reconciliation. Sponsors get measurable ROI. Additionally, the real-time data collection capabilities allow event staff to make quicker, more informed decisions, and better plan for next year's event. Brand Amplification provides sponsors with a "long tail" benefit that allows them to maintain a social media connection with festivalgoers long after the event. As explained on Intellitix's website, "the biggest benefit of RFID technology is the wealth of data collected on the platform including engagement levels tied to audience demographic information reported in real-time on custom dashboards. Armed with rich audience insight and measurable ROI, organizers

and sponsors can take their fan engagement to the next level with targeted post-event brand content."[21]

The depth of information RFID systems can gather creates layers and layers of potential that the industry will spend many years learning how to fully exploit. There is still a great deal of untapped analytics potential. Festival organizers aren't typically staffed to do this kind of analytics. Instead, this is a service area that providers like Intellitix and Front Gate Tickets can exploit to increase their revenue.
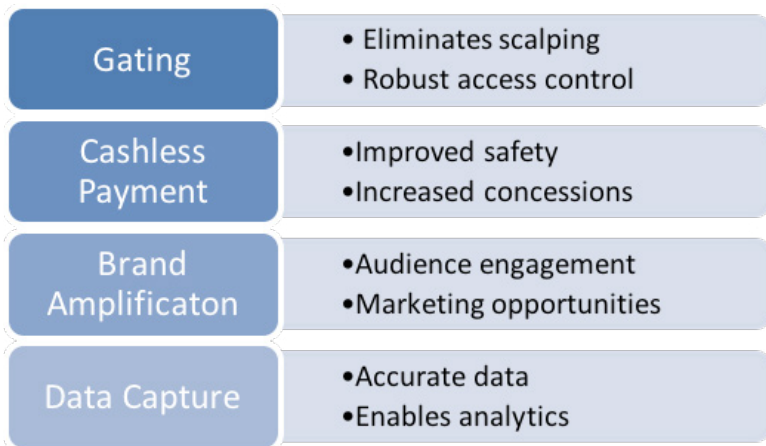


Figure 4. The depth of information RFID systems can gather creates layers and layers of potential that the industry will spend many years learning how to fully exploit. Source: Author Research.

Gating and Cashless Payment demonstrate that RFID is a mature technology. It is secure, programmable, and capable of feeding data into sophisticated analytics software. Insofar as it has achieved these capabilities, it is a stable technology, not changing all that much from year to year. Today, the real action in RFID is not on the technological frontier, but in the various uses that organizations are making of its capabilities, such as brand amplification. There is reason to believe that the creative use of RFID is just getting started.

### Where Next for RFID and the Arts?

Where will the creative use of RFID go next? No doubt music festivals and other large events will continue to push the envelope, creating ever-greater

19  IDTechEx. The RFID Knowledgebase.

20  Weaver, Hilary. Music Festivals Bring Wearable Tech To The Forefront Of Concert Experiences. PSFK LLC. July 7, 2014. https://www.psfk.com/2014/07/wearable-concert-tech.html (accessed March 23, 2017).

21  Intellitix Holdings. 10 Popular RFID Brand Activations For Sporting Events. 2017. https://www.intellitix.com/en/10-popular-rfid-brand-activations-sporting-events/ (accessed April 1, 2017).

spectacles, audience interactivity and sponsor tie-in. Big events are always invested in the novelty that comes with outdoing previous events, so scaling up RFID technology will lead to more exciting developments.

RFID suppliers in turn have a business imperative to keep innovating. The field is lucrative and competitive, which breeds innovation. Raghu Das, CEO of IDTechEx, estimates there to be about 1,000 companies worldwide involved in supplying RFID at some point in the value chain.[22]  Analysts at Frost and Sullivan Asia estimate the event management software industry's total addressable market as of 2015 stood at $30.5 billion, and it's expected to grow to $31.9 billion next year.[23]

Southeast Asia has a burgeoning market of startups in the RFID space, including several companies that handle live events. One emerging leader is Pouch, from Singapore. "Not one company controls 12 percent of that market," Pouch CMO Graeme Perkins says. "We're a little surprised. There was more demand than we actually expected. Most of the experienced producers we came across have asked, 'where have you been? We've been looking for you.'" [24] Market forces are already pushing the creative industry toward innovative uses of RFID.

### Recent Innovations Focus on Audience Experience

Enhancing user experience at events has gained more and more attention over time. Practicality, rather than high impact excitement, is often the most important consideration. Recent deployments have emphasized things like "wayfinding (digital signage) for fans on site… and apps that tell fans on site who's playing where and when and can even be set up for digital "tip jars" for the artists."[25]

High impact applications of RFID are what music fans will actually remember once the show is over,

and there are developments in that area. Some concert tours have used audience-deployed wearable technology – controlled at radio frequencies, and possibly using RFID technology to create sensational results. As suggested by Jeffry Marlow in an article about the direction concerts are headed toward thanks to technological developments, "Audience lighting is becoming the next big thing… Concertgoers are integrally involved in the show, serving as a key part of the set design. It's something else for the audience to both be a part of, and to look at… The devices not only receive signals from a centralized control module, but they also can 'talk to' each other, enabling a range of node-based effects."[26]



Figure 5. Another existing possibility are wristbands with integrated LEDs that can be controlled via radio technologies and integrated with RFID. As explained by Xylobands, "ours were the first radio controlled LED wristband on the market and showcased by Coldplay during their world tour during 2012/13, lighting up the crowd in a way never seen before. They can be RFID enabled to enhance your corporate event, integrate social media and harness invaluable data." Source: http://xylobands.com/gallery/.

Another existing possibility are wristbands with integrated LEDs that can be controlled via radio technologies and integrated with RFID. As explained by Xylobands, "ours were the first radio controlled LED wristband on the market and showcased by Coldplay during their world tour during 2012/13, lighting up the crowd in a way never seen before.

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22  Das, Raghu. "RFID: 2015 Review and Outlook to 2020."

23  Frost & Sullivan. RFID in the Global Smart Cold Chain Market. Industry Analysis, New York: Frost & Sullivan, 2016.

24  Balea, Judith. Why live music is a gold min

25  Keene, David. SXSW and the Future of Music Festivals. March 23, 2017. http://www.avnetwork.com/avnetwork/sxsw-and-the-future-of-music-festivals/126077 (accessed April 7, 2017).

26  Marlow, Jeffrey. Can Technology Make for Better Concerts? Novembr 11, 2014. https://www.wired.com/2014/11/can-technology-make-better-concerts/ (accessed March 22, 2017).

They can be RFID enabled to enhance your corporate event, integrate social media and harness invaluable data."[27]  Another vendor, Glow Motion Technologies, describes a similar wristband offering: "Our custom-branded LED wristbands put 16 million colors on every arm in the venue. Made of silicone and powered by a single AAA battery, they are fully controllable, perfectly interactive, and offer your audience a lasting memento after the show."[28]

Systems like these use proprietary integrations of many different technologies beyond RFID to create their effects. RFID is capable of providing the real-time individualization that these systems depend on, although it is not the only possible technical solution. Systems that utilize all manner of sensors can take measurements of a limitless array of phenomena and transmit them to a server with linked software for in-depth analysis, or real time reaction.

London-based XOVIA has developed a unique "emotional technology" platform called XOX. In its earliest iteration it uses a wristband equipped with biometric sensors to measure crowd excitement. This raw data is processed in real-time on the wristband and then transmitted to a server. Deployed to an audience, it essentially captures the mood of the crowd in digital form. The system can react to the data in real time, visualizing it on screen, using it to alter controllable parameters such as lighting cues, and provide it as feedback to performers. The data can even feed into the audience's social channels.

> "The Sensory Wrist Band evaluated the electrical characteristics of a wearer's skin in real time and processes this to identify changes. The electrical properties of the skin (are) partially controlled by the sympathetic nervous system and is used by XOX to measure emotion and sentiment. The data from the XOX Emotional Technology Platform is real and real-time, meaning that an audience experience

can be tailored for in ways that have never been seen before. XOX breaks down the '4th wall' and allows artists and brands to get intimately connected to their fans."[29]

### RFID Will Migrate Onto Your Smartphone

The future of RFID will be shaped as much by creativity as by technology. For example," Kat Tooley, the Senior Director of Event Production at Superfly states, "you could hide certain 'Easter eggs' throughout the event site to open up content on your phone, or discover a surprise show somewhere. Or you could ditch the camera completely if there are cameras in the area — you'd just tag your wristband and get photos that way. This would allow people to put down their phone and enjoy the moment, because they know it'll be on their wristband."[30]

According to Rich Eicher, CEO of Skycore LLC, smartphones will eventually have built-in RFID capabilities in the form of NFC chips. (Near Field Communications is a variant of RFID that communicates only at very short range). He predicts, "in a few years virtually every smartphone will be NFC-enabled with tickets securely stored within the device itself. That will be the ultimate convenience for consumers and venues."[31]  Apple Pay is a form of cashless payment based on NFC technology.

### Is RFID Right for Your Organization?

But can RFID also scale down? Can smaller arts and cultural institutions get in on the game? Can they be just as creative on their own, less commercial terms? The answer lies somewhere in the crossroads between the economics that make it affordable to smaller budgets, the utility and information it can create, and the aesthetics that make it a desirable way to manage the user experience in a performing arts setting.

### RFID Deployments Will Trickle Down to

27  Xylobands. Our Technology. 2016. http://xylobands.com/our-technology/ (accessed June 3, 2017).

28  Glow Motion Technologies. Wristband. 2017. http://www.glowmotiontechnologies.com/products/wristband (accessed March 12, 2017).

29  XOVIA. Introducing XOX. 2015. http://www.xoxemotionaltech.com (accessed April 1, 2017).

30  Grate, Rachel. How Radio Concert Wristbands Can Scale For Smaller Shows. January 12, 2017. https://www.eventbrite.com/blog/rfid-concert-wristbands-ds00/ (accessed March 22, 2017).

31  Eventbrite. "The Future of Concert Technology: 20 Tastemakers' Predictions." eventbrite.com. 2017. https://www.eventbrite.com/blog/academy/concert-technology-music/ (accessed April 1, 2017).

## Smaller Scale

Venues are starting the take notice of the benefits, including analytics, which come with deploying RFID systems. Implementations that are reusable have the potential to offer acceptable ROI. As mentioned, museums have been using RFID for decades in inventory systems and are increasingly using audience-facing technologies as part of gallery experiences. As the technology becomes cheaper over time, it can scale down from festivals to tours, and then to venues, and eventually to the smallest venues, including arts organizations.

However, it is still not leveraged by all who could benefit from it. As explained on Eventbrite's blog, "despite their prevalence at festivals, RFID wristbands haven't yet caught on at concerts. Since the wristbands aren't cheap, many venues aren't sure how to make the investment worthwhile. But that might be about to change. In a survey of 50 music venues from across the country, 80% believed capturing more data about fans with RFID would be impactful in coming years. Two thirds were interested specifically in fans paying for drinks with RFID technology."[32]

As the following example illustrates, RFID technology doesn't only take the form of wristbands. It is often fitted into badges, cards, lanyards, and even valet tickets. A two-week trial was conducted in 2013 at Singapore nightclub Zouk enabled parking attendants to identify inebriated patrons. A system known as "Pee Analyzer" fitted urinals inside the nightclub with RFID-enabled devices that measure the blood-alcohol content.

> "Male patrons who arrived at the club were provided with a valet ticket containing an… RFID transponder. As that customer used the urinal throughout the evening, the sensors in the toilet determined the amount of alcohol in his urine… [The system] wrote that information to the patron's ticket…For those over the legal alcohol limit, the system displayed an alert on a video monitor above the urinal, stating: 'You may have had one

too many to drive. Call a cab, or use our drive home service'. Another [scanner] at the parking area… reads every male patron's card, and a screen displayed any warnings of high blood-alcohol levels, enabling the valet staff to determine whether or not to turn over each individual's car keys. If the measured alcohol level… was too high… that patron was offered a ride from the drive-home service." [33]

Conferences offer another example where RFID technology has taken a foothold, because they have logistical issues similar to music festivals, such as access and vending. In this context, the RFID tags are more often embedded in credential badges that facilitate networking. Conference attendees fill out a survey prior to the event, and RFID tags in the badge help them identify other people with similar interests. A Montreal marketing and communications firm specializing in product launches began using RFID technology for its functions in 2012. As explained in the RFID Knowledgebase, "at a recent event, featuring local band St. Ange… the band's lead singer, Angela Galuppo, greeted every guest, many by name. The greetings were conveyed through the use of video and RFID technologies. Each visitor was provided with a "welcome" card… that could be used to receive the greeting and to trigger St. Ange music videos."[34]

RFID is finding its way into smaller events such as beer and wine tastings, where access and age identification are important liability issues. A well-designed system can virtually eliminate the possibility of under age drinking at an event. RFID's ability to identify individuals accurately has many applications in the service industry, and can ensure a frequent client gets VIP treatment.[35]

## The Cost of RFID

The cost of deploying an RFID system is based on what the system needs to accomplish. One aspect of this is the actual cost of the tags that are deployed

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32  Grate, Rachel. How Radio Concert Wristbands Can Scale.

33  IDTechEx. The RFID Knowledgebase.

34  ibid

35  ibid

Arts Management & Technology Laboratory

Carnegie Mellon University
Heinz College

to the things you want to track. A simple inventory application, for instance, can use inexpensive UHF (Ultra High Frequency) tags, with a price point low enough to be considered disposable. On the other hand, gating and cashless payment systems require HF (High Frequency) tags, which are more expensive, but support the security features needed for these applications.[36]

Let's make this a bit more concrete for arts managers. Here are a few bottom line "rules of thumb" to give you perspective on cost, courtesy of a sales representative from industry leader Eventbrite[37]:

- Basic Tyvek wristbands with no technology cost about 30 cents per attendee

- Typical RFID wristbands cost about $1 per attendee

- RFID wristbands can be customized in many different ways, all of which increase the cost per attendee.

- A basic deployment suitable for a music festival would require a minimum expenditure of about $25,000

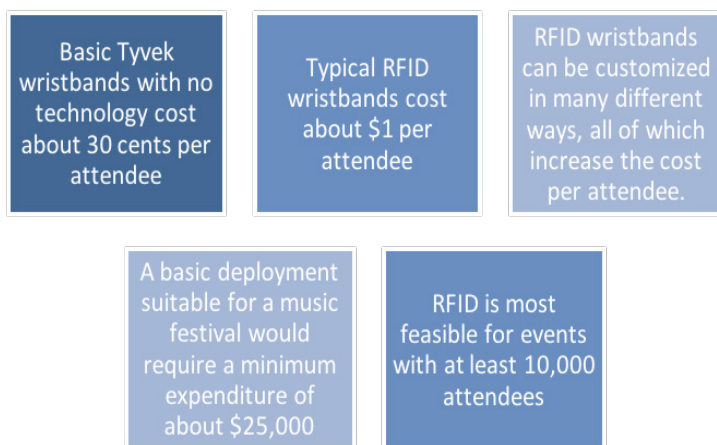- RFID is most feasible for events with at least 10,000 attendees



*Figure 6. 5 bottom line "rules of thumb" for the cost of deploying an RFID system, which is ultimately based on what the organization needs to accomplish. Source: Author interview with Eventbrite sales representative.*

36  IDTechEx. RFID Forecasts

37  Author interview with Eventbrite Sales representative. (Representative 2017)

For some performing arts organizations, an entire season – or multiple seasons – of ticket buyers and memberships may bring the economics of deploying an RFID system to a feasible scale, where total attendance starts to reach numbers that make it cost effective. Implementing an RFID member card can provide all sorts of benefits – if the cost is reasonable. Determining whether the cost is reasonable is thus a key question.

Many companies offer turnkey RFID solutions. Implementations tend to be customized installations tailored to the specific needs of an organization, as opposed to a simple product purchase. It is more like installing a computer network than buying a stand-alone computer or copy machine. The cost of an RFID system is hard to generalize because there is a high degree of customization involved, and is most practically ascertained through a competitive bidding process.

RFID systems consist of several different hardware components that need to work together. South Carolina based RMS Omega Technologies offers a good explanation of a basic system on their website, "RFID solutions have three main hardware components. Desktop or handheld RFID printers encode accurate and complete data into the RFID tags. RFID tags or labels are available with many options depending on aspects such as storage capacity, substances in the environments, reading distance, volume, and more! Handheld or fixed readers collect data from the tags and are available with several options depending on volume, configuration, storage facility, the density of data, and more."[38]

While these individual components are in theory easy to price, making them work together as a customized system implies other costs. In "The Cost-Benefit Models for RFID Investment," authors Alp Ustundag and Serdar Baysan give an overview of the systemic costs of RFID systems. "A general classification suggests three cost categories as follows; (i) Hardware cost, (ii) Middleware cost, and

38  RMS Omega Technologies. RFID Technology Solutions. 2017. http://www.rmsomega.com/rfid-technology-solutions/ (accessed June 4, 2017).

(iii) Service cost. Hardware cost category covers the costs of tangible elements of RFID system, such as tags and readers… RFID middleware fills the gap between enterprise resource planning platform and RFID hardware. It connects software and services, administrates hardware, and processes tag data… Service Cost includes system design, customization, and configuration cost."[39]

The article goes on to detail approaches to cost benefit analysis that would be of interest to an organization researching an implementation, but typical arts organizations would rely on outside consultation to determine the cost side. The benefit side is, in many respects, a more subjective issue for each organization. This paper has detailed many, but certainly not all, of the potential benefits already, such as the elimination of scalping to increased concession revenue.



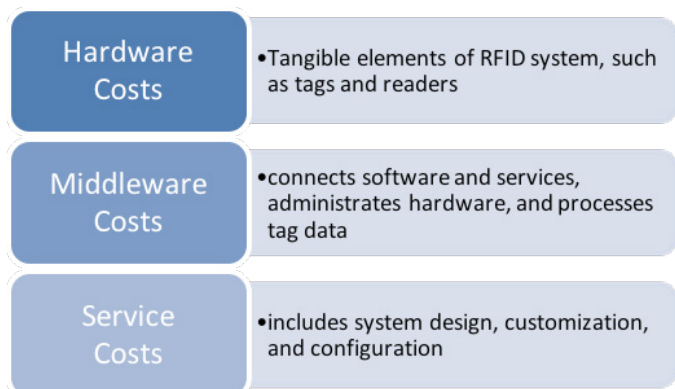| Hardware Costs | • Tangible elements of RFID system, such as tags and readers |
| Middleware Costs | • connects software and services, administrates hardware, and processes tag data |
| Service Costs | • includes system design, customization, and configuration |

*Figure 7. A general classification suggests three cost categories as follows; (i) Hardware cost, (ii) Middleware cost, and (iii) Service cost. Source: Ustundag, Alp, and Serdar Baysan. "The Cost–Benefit Models for RFID Investments ." In The Value of RFID: Benefits vs. Costs, by Alp Ustundag, 176. London: Springer, 2012, 14-15.*

Taking music festivals as a model, what goes into the cost of RFID deployments that makes them such a big expenditure? Organizers pay for the services and equipment as a package deal, more or less as a rental. Costs include hiring a team to set up and monitor the equipment, but also to train festival staff how to use the equipment during the festival. The RFID vendors provide staff during the festival primarily for monitoring and troubleshooting, but the festivals provide the staff that actually man the access points and do the work of running the festival.

To the festival itself, RFID vendors are renting the capabilities of the RFID system, the equipment needed to run it, and the training and support to ensure it works. Part of that guarantee is that the systems will operate fully and flawlessly with or without Internet access, which can be erratic at large festivals. Considering all that, it is not surprising that the investment is substantial.

## Economical Approaches to RFID Deployments

Smaller scale deployments, such as wine tasting events, are feasible primarily because they shed many of the features used by the large festivals. These events benefit most from cashless payment, with its implicit ability to eliminate underage drinking while increasing per capita expenditure. They often forego having troubleshooting staff on hand, and other add-on costs such as detailed analytics.

Another strategy that can lower costs for smaller events is economies of scale, which can be achieved through service agreements that are shared by several organizations. As mentioned on Eventbrite's blog post about how RFID wristbands can be scaled, "since RFID concert wristbands could help rooms better track fan data, sell more drinks with cashless payments, and engage more sponsors, the benefits could soon outweigh the cost. Venues banding together to use the tech would only accelerate its adoption, especially as the wristbands become more and more affordable."[40]  In this example, several local venues create an opportunity for a startup in Baltimore in 2012:

Baltimore-based MissionTix tested reusable, re-wearable ticketing wristbands that offer ticketing to multiple venues. The wristbands can be purchased for a one-time nominal fee. When a customer buys an event ticket, the purchase is transferred to their wristband, which is scanned at the venue upon entry.  "This is the first time we've seen… a single,

39  Ustundag, Alp, and Serdar Baysan . "The Cost–Benefit Models for RFID Investments ." In The Value of RFID: Benefits vs. Costs, by Alp Ustundag, 176. London: Springer, 2012, 14-15..

40  Grate, Rachel. How Radio Concert Wristbands Can Scale.

secure ID [that] can be used for multiple events. We see this technology evolving into other value-add services, including stored value within the venue or with local merchants," said Rich Eicher, CEO of Skycore LLC.[41]

Thinking longer-term, technology tends to get cheaper and cheaper for the consumer over time. With that hope in mind, eventually the price of RFID deployments will become truly affordable to even small organizations, even as the capabilities of their systems become more robust.

Increasing production scale, widespread adaption and advances in technology will all play a role in making RFID cheaper. The seeds of this are playing out in factories and research facilities worldwide, as the race to innovate and capture market share incentivize both innovation and frugality. As stated by author Raghu Das of RFID: 2015 Review and Outlook to 2020, "earlier stage but demonstrated chip-less RFID in the form of printed transistor RFID can reduce the price even further, potentially. However, this technology has a longer timeframe to mature."[42] For example:

Researchers from the University of Washington, Disney Research and Carnegie Mellon University have created a system that responds to gesture commands using RFID tags that are stuck on, printed or drawn onto the paper to create interactive, lightweight interfaces. "PaperID" uses inexpensive, off-the-shelf RFID tags that function without batteries. Paper ID can detect nearby movement and track the velocity of objects and can feed that data into a system. For instance, it can follow the motion of a tagged paper conductor's wand and adjust the pace of music based on the tempo of the wand in mid-air.

### RFID in an Art Installation

So far, we have previewed a wide variety of RFID-related deployments, most of which created functional benefits, ranging from increased income and audience engagement to improved safety and data gathering. The potential use of RFID as a medium of artistic expression in and of itself should not be overlooked. Here is an interesting example:

At the 12 Biennial Symposium on Arts and Technology, New London, CT, mobile users experienced a constantly evolving wall of audio graffiti.

> "The installation is set within an indoor "audio augmented" environment, where users can create and explore a continually evolving wall of audio graffiti, by overlaying the wall with audio clips in their precise 3D location. Users are equipped with wireless headsets [that track users] as they move around the space. As the user approaches the wall a precise spatial location is registered when one of the programmable buttons on the tag is pressed and a sound clip is recorded and attached to the wall at that position. The sound clips form a 3D audio image of sonic content in space."

The project was collaboration between the iACT research group at the University of Montreal, the Centre for Intelligent Machines, at McGill University and tech startup Ubisense.[43]

### Now That You See the Big Picture, What Will You Do?

RFID in and of itself is a relatively simple technology, but the world of capabilities it enables has had staggering implications across every industry worldwide. Nowadays, it impacts our daily lives in mundane, nearly invisible ways. It lurks in our retail lives, even shaping what we purchase, and could be seen as a second "invisible hand" that influences us in ways we don't notice. How will it track us next?

Coinciding with that are spectacular, audacious displays of its impact, as in the music festivals that we attend by the millions. It can dovetail even our most intimate sensory feedback into visualizations on a giant screen, or post onto our social accounts almost without our input. Opportunities implementing creative new engagement on this old technology backbone seem limitless as costs

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41  IDTechEx. The RFID Knowledgebase.

42  Das, Raghu. "RFID: 2015 Review and Outlook to 2020."

43  IDTechEx. The RFID Knowledgebase.

decrease.

Its capabilities will continually evolve, and the creativity with which it is used will add dimension to our life experiences. RFID has the peculiar ability to track the individual item or person, then aggregate what it senses into an understanding of the crowd. It can see the forest, and it can see each tree, with equal accuracy. Its transformative potential is unleashed when a clever new thing is attached to it and a new insight is gained.

While economics remain an obstacle, that will change over time. Whether RFID becomes cheap enough to deploy, or is supplanted by a newer approach, the audience transformations it can impact will find their way into the hands of arts managers, who will, as they always do, turn its capabilities into a deeper understating of their art and their audience, resulting in a bigger impact within their communities.

## APPENDIX: VENDORS

- Intelletix: https://intellitix.com/en/
- Front Tate Tickets: www.frontgatetickets.com
- Eventbright: www.frontgatetickets.com
- Ticketfly: ticketfly.com
- Xylobands: http://xylobands.com
- Glow Motion Technologies: http://www.glowmotiontechnologies.com
- Doppler Labs: https://www.getdubs.com
- XOVIA: http://www.xoxemotionaltech.com
- RMS Omega Technologies: http://www.rmsomega.com

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