Table of Contents

Cultural Heritage & Museums ........................................ 4

Workshops .................................................................................................................. 4
Introduction to Unreal for Museum Exhibition (11/29/18, 12:30) .................................. 4
XR for Teaching Practice: A Design Thinking Workshop (11/29/18, 12:30) ............... 4
Unsolved Mysteries of Color in Head Mounted Displays ((11/29/18, 2:00) ................... 4
Cultural Heritage & Discoverability (11/29/18, 3:30) ............................................. 4
Introduction to Unreal for VR Storytelling (11/29/18, 3:30) ....................................... 5
Cultural Heritage and Discoverability (11/29/18, 2:00) ............................................ 5
Trends in Museum VR/AR (virtual presentation) .......................................................... 5
Immersive Analysis of 3D Cultural Heritage Artifacts ................................................. 5
Low-Cost End-to-End Spectral Imaging System for Historical Document Discovery .... 6
The Challenges And Opportunities Of Merging Historical Content With 360 Video ...... 6
Welcome (11/30/18, 9:00) ...................................................................................... 7
Wild Energies: A Framework for Culture in the 21st Century ..................................... 7
Applications & Case Studies (11/30/18, 11:00) .......................................................... 7
Real Time Examples of Extended or Augmented Reality ............................................... 7
Understanding VR/AR/MR through Differentiation, Design & Case Studies ................. 7
The Design of Interplay between VR and AR: A Case Study of VRsus guARdian ............. 7
My experience shoehorning VR on a MacBook Pro ....................................................... 8
Advertising Through Augmentation .............................................................................. 8

Education (11/30/18, 11:40) ................................................................. 9

STYLY: Non-coding Gateway into VR Content Creation .............................................. 9
Social and Tactile Mixed Reality in an Undergraduate Chemical Engineering Laboratory .... 9
Mixed Reality Ideation ................................................................................................. 9

Health and Behavior (11/30/18, 1:40) .................................. 10

Reshaping cognitive neuroscience with virtual reality .................................................. 10
Using virtual reality with integrated eye tracking for visual rehabilitation ................ 10
Social Augmented Reality ........................................................................................... 11
Creating an immersive social scene to measure self-regulation and social motivation in children with autism spectrum disorder

Storytelling and Interactive Media (11/30/18, 2:00)

- Fictionality and Mixed-Reality Storytelling, Before and After XR
- Experimental Analysis of Spatial Sound for Storytelling in Virtual Reality
- The Ghetto Girl: An Experiment in Transmedia Storytelling
- Experiments in Interactive VR Storytelling: Structuring Space and Time

Optics and Vision (11/30/18, 3:00)

- Relative Impact of Key Rendering Parameters on Perceived Quality of VR Imagery Captured by the Facebook Surround 360 Camera
- Color and Object Appearance in Augmented Reality
- Schultz: Bridging the Industrial and Consumer Markets for AR Technology
- Transverse Chromatic Aberrations in Virtual Reality Devices
- A Comparison of Colorimetric Performance of Oculus and HTC Virtual Reality Headsets
- Hyperion: A 3D Visualization Platform for Optical Design of Complex Folded Systems

Live Performance (11/30/18, 4:00)

- Adjusting the Margins: harnessing the foundations of American Sign Language for VR
- Display and Control of virtual stage effects in Mixed Reality Theatre
- Facial Avatars in Live Performance (Unabridged Emotions)

Demos (11/30/18, 5:30)

- Beat the Blitz
- Virtual Reality Concerts with Immersive 3D Audio
- Hyperion: A 3D Visualization Platform for Optical Design of Complex Folded Systems
- Ego and the Dreamwork
- Creating an immersive social scene to measure self-regulation and social motivation in children with autism spectrum disorder
- Spoons
- Dear Angelica
- Arctic LiDAR
Indoor Navigation and Tour Guide with an Audible Line in the Air Based on Augmented Reality ................................................................. 23
Hardware Maintenance in AR ........................................................................................................ 24
Virtual tour Guide ............................................................................................................................ 24
Augmented Reality Comic Captioning .......................................................................................... 24
VRsus guARdian ........................................................................................................................................ 25
Catch the Thief: sound localization game using augmented reality (AR) technologies to improve auditory localization skills (poster) ........................................................................ 25
Aria: Live Motion Visuals for Dance Performance ........................................................................ 25

Sponsors ........................................................................................................................................... 27
College of Liberal Arts ....................................................................................................................... 27
College of Art and Design .................................................................................................................. 27
College of Science ............................................................................................................................. 27
Gleason College of Engineering ......................................................................................................... 27
School of Individualized Study ............................................................................................................. 27
Center for Engaged Storycraft ............................................................................................................ 27
Department of Performing Arts and Visual Culture ........................................................................... 27
B. Thomas Golisano College of Computing and Information Sciences ........................................... 27
MAGIC ............................................................................................................................................... 27
Thursday, November 29th

Cultural Heritage & Museums

Workshops

**Introduction to Unreal for Museum Exhibition (11/29/18, 12:30)**
Elizabeth Goins
Rochester Institute of Technology

In this one hour workshop, participants will learn the basics of using the Unreal 4 game engine to create a virtual gallery space for the HTC Vive and the Oculus Touch. Using free demos from the Epic Marketplace and VR templates, participants will download images from open access museum resources to create their own virtual museum.

**XR for Teaching Practice: A Design Thinking Workshop (11/29/18, 12:30)**
KristanaTextor
University of Rochester

**Unsolved Mysteries of Color in Head Mounted Displays ((11/29/18, 2:00)**
Michael J. Murdoch and Ricardo Figueroa
Rochester Institute of Technology

Attendees of this workshop will learn about the importance of color accuracy in displays and head-mounted displays (HMDs), understand the challenges presented by HMD optical systems, examine examples of color in current AR and VR HMD systems, get insights about white point in HMDs vs. traditional displays, and even help solve these mysteries by brainstorming solutions for color, graphics pipelines, and applications. The workshop will demonstrate why and how display characterization models are built and used, and how they differ for display types including flat-panels, projectors, and HMDs. Discussion will cover measurement challenges unique to HMDs, due to their size, viewing geometry, uniformity, and paired use (two displays for two eyes, for example). Finally, the workshop will explore color management and correction solutions and their applicability to graphics pipelines.

**Cultural Heritage & Discoverability (11/29/18, 3:30)**
Juilee Decker
Rochester Institute of Technology

This session involves two demos that showcase opportunities for discoverability in libraries, archives, and museum. First, visitors will observe the imaging of a 15th-century Italian Palimpsest with a prototype low-cost multispectral imaging system. The goal is to show the capability of such a system to uncover the undertext. In the second part of the session, visitors will wear a VR headset and experience an interactive 3D rendering of RIT's Cary Collection, including handling a 17th-Century English
hornbook. After taking the virtual tour, visitors can view this and other artifacts. Session facilitators: Tania Kleynhans, Steve Galbraith, and Shaun Foster. **Note: this session takes place outside the Cary Collection on the second floor of Wallace Library. To attend this session, meet in the lobby of Magic Spells Studio no later than 3:25 pm.

**Introduction to Unreal for VR Storytelling (11/29/18, 3:30)**
Elizabeth Goins
Rochester Institute of Technology

In this introductory workshop, participants will use the Unreal 4 game engine for the HTC Vive or Oculus Touch to create their own virtual narrative experience. Experimenting with spatial storytelling methods, participants will use sound, lighting and movement to build their own environment.

**Cultural Heritage and Discoverability (11/29/18, 2:00)**

**Trends in Museum VR/AR (virtual presentation)**
Jack Ludden, Assistant Director
Head of Digital Experience & New Media Development
The Getty

**Immersive Analysis of 3D Cultural Heritage Artifacts**
Josh Romphf, Gregory Heyworth, Famous Clark
University of Rochester

The Lazarus Project, an interdisciplinary collaboration between ROCHESTER INSTITUTE OF TECHNOLOGY’s Center for Imaging Science and the University of Rochester, recently produced a 3D reconstruction of the New York Public Library’s Hunt-Lenox Globe, which dates from ca. 1510. In addition to the Hunt-Lenox, the team has also completed a high-resolution reconstruction of the Globus Jagellonicus from the Jagiellonian University Museum in Krakow, and is planning to image the Erdapfel from the Germanic Museum in Nuremberg. Ultimately this will result in 3D representations of all three of the world’s oldest known terrestrial globes.

As a means of providing access to these artifacts, the University of Rochester’s Digital Scholarship Lab is expanding upon the open source browser-based 3D viewer originally built for the Ward Project (another RIT / UR collaboration) to add features such as VR support, annotations, and surface painting.

The goal is to produce a presentation platform designed for 3D representations of cultural heritage objects that allows for virtual “guided exhibits” of the objects as well as independent exploration. The expanding toolset is designed to provide scholars with the ability to analyze these objects and disseminate their findings to a wider audience.
Special emphasis is being placed on features and formats that are integral to the study of cultural heritage artifacts, such as support for multi-spectral textures, metadata, measurement tools, and image processing shaders.

This short talk aims to demonstrate the software and discuss the challenges and goals of the project, which is still an experimental work-in-progress.

**Low-Cost End-to-End Spectral Imaging System for Historical Document Discovery**
Tania Kleynhans
Rochester Institute of Technology

Many research libraries and museums hold unique or rare items on which historically significant text is no longer legible due to damage from water or fire, deterioration, or erasure. Spectral imaging - the process of collecting images of objects in many colors or wavelengths of light, including parts of the electromagnetic spectrum that are not observable by humans but easily imaged by modern sensors (i.e., ultraviolet and infrared) - has become the “go-to” solution for recovering obscured and illegible text on historical materials. Hence, major research libraries are acquiring spectral imaging systems (e.g., the Library of Congress and the Duke University Libraries), and specialized organizations are offering spectral imaging services (e.g., the Center for the Study of Manuscript Cultures at the University of Hamburg, the Lazarus Project and the Early Manuscripts Electronic Library), all in an effort to attract new engagement with archives or special collections that have long sat unused and inaccessible because they are unreadable. This session is related to the workshop that follows “Cultural Heritage & Discoverability” which will be held at 3:30 on Thursday.

**The Challenges And Opportunities Of Merging Historical Content With 360 Video**
Josh Meltzer, Jenn Poggi, Ihab Mardini
Rochester Institute of Technology

This presentation will discuss an in-progress project that mixes historical still photography, audio and video with 360 video gathered using the first iteration of the Facebook Surround 360 camera. The project began as an extension of a traveling exhibition that explores New York City during the turbulent 1980s and 1990s as residents protested in response to social changes in their city, as well as national and international events. Ultimately, we aim to educate and enhance understanding for an audience that may know little about New York City and/or the events that are captured in the exhibition.

Our talk will detail the vision for this ambitious project and the various stages of production thus far as we work to complete stage one of the final deliverables. We will discuss the desired user experience, as well as the artistic and technological hurdles faced at each stage of production thus far. Finally, we will cautiously project ahead to future iterations of the work we hope to produce.
Welcome (11/30/18, 9:00)
President Munson
Rochester Institute of Technology

Wild Energies: A Framework for Culture in the 21st Century
Eli Kuzlanski
Managing Partner / Chief Strategist, Unified Field

Applications & Case Studies (11/30/18, 11:00)

Real Time Examples of Extended or Augmented Reality
Alan Willard
Senior Developer Relations Technical Artist at Epic Games

Discussion of the use of real time game design software in several multimedia industries.

Understanding VR/AR/MR through Differentiation, Design & Case Studies
Shaun Foster
Rochester Institute of Technology

This paper will give a summation from personal case studies focused on technological and design insights. The source material is from three funded Augmented Reality and Virtual Reality projects and also on an in-progress sabbatical Mixed Reality Project. The paper will start by differentiating AR, VR & MR, then contrasting issues created by being an early technology adopter and finally describe some of the interaction design and experimentation problems and solutions while creating within these medium.

The Design of Interplay between VR and AR: A Case Study of VRsus guARdian
Tanat Boozayaangool
Rochester Institute of Technology

VRsus guARdian is a cat-and-mouse chase between VR and AR that was built to explore the connected play across different mediums within the VR/AR/MR space. In this game, one player utilizes an AR-enabled mobile device and plays the role of the guardian, while the other equips a VR headset and plays the role of a tiny infiltrator. The AR player (guardian) is then tasked to search for the other player and eliminate them, while the VR player (infiltrator) must snatch three different relics and escape unscathed.

By combining engaging narratives that complement the different ways in which each medium immerses its participant and presents its interfaces, VRsus guARdian is able to build an experience that is greater than the sum of its parts. For example, the game
often brings the VR player through different camera angles by placing objectives and threats in different relative elevations to portray a sense of scale and insignificance throughout the game. Meanwhile, the AR experience layers stylistic assets over the real-world environment to reiterate a fantasy of invasion within the overall narrative. As each medium frames their respective narratives, the social nature of this multiplayer game helps produce a seamless and accessible experience for a wide audience. Lastly, the dependency that VRsus guARDian has on Unity, a game engine with prominent platform-agnostic capabilities, can be indicative of the types of features we can expect to see from asymmetric games like this.

My experience shoehorning VR on a MacBook Pro
Mark Reisch
Rochester Institute of Technology
Virtual reality has begun to make inroads with personal computers running Microsoft Windows Operating system. Making a MacBook Pro laptop work with Vive and Oculus headsets has been a challenge but it is working (mostly).

Advertising Through Augmentation
Damian Kwiatkowski
Technical Artist, The Mill
http://www.themill.com/

Join Damian Kwiatkowski, Technical Artist from Creative Technology and VFX studio The Mill, as he delves into his work on some of the company’s latest immersive projects. Find out about the latest developments in real-time animation, creating filters for Facebook’s AR studio and what it takes to bring VR video games to life.
**Education** (11/30/18, 11:40)

**STYLY: Non-coding Gateway into VR Content Creation**
Michael Waite,
Global Manager, STYLY, Japan
https://styly.cc/

This talk introduces STYLY, an easy to use web based VR content creation tool. STYLY makes it easy for beginners to start creating content for any major VR headset. No coding is needed to use STYLY making it an accessible tool for everyone from game design freshmen to the humanities classroom. Non-technical tools such as STYLY allow students to begin their educational journey into VR content creation. STYLY then soon segues into and links up with other tools such as Unity, Blender, Maya, etc.

**Social and Tactile Mixed Reality in an Undergraduate Chemical Engineering Laboratory**
Paul Herbert
University of Rochester

Mixed-reality (MR) brings uniqueness into higher education due to its social and tactile features. To understand whether and how an MR system could enhance undergraduates’ learning in chemical engineering, our team created an MR table and conducted this quasi-experimental study. Specifically, we recruited eight senior chemical engineering majors from U of R and randomly assigned them into two groups: one experimental group and one control group. Each group engaged in an open-ended, real-life chemical engineering problem that required them to implement problem-solving strategies based on knowledge had taught in class. The experimental group was asked to complete the task using a MR table while each member of the control groups performed the same task using a computer with software that visually mimicked the MR table screen. Primary data sources included pre- and post- assessments, audio recordings of the tasks activity and focus groups. Compared to the control group, we identified three positive effects on student learning brought by MR, including engaging in more cognitive activities, experiencing more chances of collaboration, and showing more risk-taking behaviors when initiating new trials. Our next step is to consolidate the results from this pilot study by expanding the number of control and trial groups.

**Mixed Reality Ideation**
Ralf O Schneider
Syracuse University

This project demonstrates a multistep approach to the MR ideation process. Analog or digital sketching on equirectangular templates result in the simulation of a 360-degree environment. Three-dimensional VR sketching with the programs Google Tiltbrush and
Gravity Sketch enable a more detailed understanding of an idea in space. Sketchnoting as a means of storytelling and the translation of key moments into Unity in either a VR or AR setting allow for communicating the design intent at a high resolution. Iteration on all levels of this refinement process and critically assessing the merit for the end user accompanies decision making along the way.

**Health and Behavior (11/30/18, 1:40)**

**Reshaping cognitive neuroscience with virtual reality**
Duje Tadin, Erin P. Tepesch, Olga P. Pikul, Dane R Johnson, Jamie Moran, Jeffrey B. Nyquist
University of Rochester

Cognitive science has two key goals: to understand and improve cognitive function. After decades of groundbreaking research, we excel at measuring and modifying cognitive function in the lab. However, it has been challenging to move from the lab to real-world contexts. VR offers an elegant solution to this problem. Highly controlled testing environments are critical for generating reliable cognitive data, but usually come at a cost of highly constrained measurements. In the real world, however, responses are not artificial keyboard presses; they are interactions with objects and people. Here, VR allows us to develop naturalistic measures of cognitive function, while retaining a high degree of experimental control.

Immersive VR environments, moreover, are great for development of highly engaging cognitive measures and interventions, which contrasts with typically boring and repetitive lab-based tasks. Finally, cognitive research has been plagued with issues related to small sample sizes, including replication problems. Because VR testing environments are easy to duplicate (one just has to get the same headset), it is much easier to scale up studies to large numbers of subjects.

To illustrate these benefits of VR, I will describe a VR based cognitive testing ecosystem for professional athletes. Top athletic performance requires great vision, quick decisions, and other cognitive abilities. I will present data from Major League Baseball player development that assesses these key cognitive functions. Finally, the benefits of VR for cognitive assessment also generalize to cognitive training. I will present data from VR-based brain training with both concussed athletes and older adults.

**Using virtual reality with integrated eye tracking for visual rehabilitation**
Catherine Fromm, Krystel Huxlin and Gabriel Diaz
Rochester Institute of Technology
A stroke affecting the visual areas of the brain can often cause substantial blind areas in the visual field, called cortical blindness (CB). These blind spots are not caused by damage to the eye itself, but by damage to the visual processing mechanisms in the brain. Although rehabilitation programs have been developed to help CB patients recover visual function, they are limited in the efficiency of the recovery. The first generation of recovery techniques are performed while seated at a desktop computer with the head immobilized in a chin rest. Eye tracking, which is essential to the successful completion of the training, is only done at the first training session supervised by an expert, and the absence of in-home eye tracking during the remainder of the training leads to many wasted trials. Additionally, the training target is very simple, and does not fully stimulate the regions of the brain that enable the recovery. Our aim is to improve upon previously demonstrated training efficiency by leveraging emerging virtual reality (VR) technology with integrated eye tracking. Our new VR-based system is cost effective, can be deployed at home, and facilitates more natural, head-free behavior. The proposed work is a first step towards the long-term goal of developing a more effective at-home rehabilitation paradigm that provides richer a richer stimulus, is more enjoyable, and can increase training efficiency, thus improving patient recovery of visual function.

Social Augmented Reality
René Stevens
Syracuse University

Have you ever been in the awkward situation at a social event where someone approaches you and despite your best efforts you cannot remember their name? This exact situation is what inspired the development of the mobile application, tagAR™. This is an immersive social application that provides a visual name tag into your augmented view, replacing the traditional “Hello, my name is” sticker version. It allows you to see the names of people around you tagged above their head at all times. This can help you find people in a crowded room (through the search feature) and remember someone’s name before and as you approach them in educational environments, conferences, meetings, social events and where people are connecting for the first time. The core concept behind tagAR was created to help those with dyslexia. The application provides a visual to a typically otherwise auditory introduction as well as an audio component to assist in accurate pronunciation. Though this inspired the creation of the application, the intended audience is broader including anyone in a variety of social environments, making it easy for those with a learning disability to receive assistance discreetly.

Creating an immersive social scene to measure self-regulation and social motivation in children with autism spectrum disorder
Jessica Keith, Jacob Cozzarin, Ben Mendelsohn, Claudia Paulson, Joe Tom Job, Ninad Ligade, Joe Geigel, and Loisa Bennetto
University of Rochester and
Autism spectrum disorder (ASD) is a neurodevelopmental disorder characterized by deficits in social communication and the presence of restricted, repetitive interests and behaviors. This study examines the impact of social stimuli on physiological and behavioral regulation responses, and how these responses relate to social motivation in children with and without ASD (5-7 yrs). To study these constructs in a methodologically rigorous and ecologically valid manner, an original 360 film with spatial audio was created to simulate a play group, where child actors become progressively more social with the camera/viewer. This video will be viewed through an Oculus Go headset while indices of autonomic reactivity/regulation (i.e., heart rate, heart rate variability, electrodermal activity) are concurrently measured using wearable sensors. Head movements toward and away from specific child actors/social actions will also be measured. These physiological and behavioral measurements will then be related to self-reported and task-based measures of social motivation. Findings from this innovative project have important etiological and intervention implications for individuals with ASD. This project features a novel and innovative application of 360 film technology to clinical research, as well as a collaboration between two universities and several graduate students from various programs. This presentation highlights this collaboration, as well as the potential utility of XR technologies within psychological research.
Storytelling and Interactive Media (11/30/18, 2:00)

Fictionality and Mixed-Reality Storytelling, Before and After XR
Laura Shackelford
Director, Center for Engaged Storycraft (CES)

The explosion of XR technologies and developments in their ability to generate fictional experiences in multiple domains, at once, continues to raise possibilities and pose questions about how these kinds of fiction-making practices continue, extend, or alter our capacities and inclination to feint, to pretend ‘as if,’ to play the game of fictionality in one of many ways. Such technologies are not, actually, unique in either their fictionality or their virtuality, per se, if one accepts that mental representations are also virtual. Instead, they are best understood as the latest phase in a longstanding tendency to “project a world,” to borrow Thomas Pynchon’s gloss on fictionality. Reflecting on Disney’s 3D Avatar Flight of Passage ride, in which one visually experiences flight on the back of a Banshee bird in the world of Pandora, and the mixed-reality storytelling of the Mohawk digital artist, Skawennati’s Futuristic World of Indigenous Avatars project, I hope to illustrate what is distinct about the emergent ways of fabricating and realizing fictional universes through immersive digital experiences. Situating such creative technological developments in XR within this larger domain of fictionality (a realm that bridges media, diverse artistic traditions, and speculative modes) helps creative technologists, storytellers, players, and educators gain insight into the social and cognitive contributions that playing ‘as if,’ playing the game of fiction can provide and allows us to appreciate the shared and discrepant forms that fictionality takes, especially if it is, increasingly, with an XR difference today.

Experimental Analysis of Spatial Sound for Storytelling in Virtual Reality
Saylee Bhide, Elizabeth Goins, Joe Geigel
Rochester Institute of Technology

Virtual Reality leverages our cognitive and perceptual abilities to provide immersive experiences that recreate both the visual and aural elements of real spaces with a high degree of realism making it a suitable delivery platform for conveying narratives through games and films. Spatial sound is useful in enhancing immersion and presence of the user in a virtual world. This audio design allows the game designer to place audio cues that appropriately match with the visual cues in a virtual game environment. These localized audio cues placed in a story based game environment also help to evoke an emotional response from the user and construct the narrative of the game by capturing the user’s attention towards the guiding action events in the game. Our work currently involves a thorough literature study on the significance of debating the usefulness of spatial sound. Our future work involves conducting a user study for analyzing the same i.e. understanding how spatial sound improves user performance and user experience in a virtual game environment. Furthermore, with the help of the relevant subjective and objective inferences that will be collected from the user study conducted on four different evaluation models, our work will also analyze and establish the potential of spatial sound as a powerful storytelling tool in a virtual game environment.
The Ghetto Girl: An Experiment in Transmedia Storytelling.
Ambarien Alqadar
Rochester Institute of Technology

Unfolding as a video game of *The Ghetto Girl*—the protagonist—includes themes of looking across cultures. The girl’s escape from Delhi culminates in her meeting the masked woman in New York. The figure of the ‘masked woman’ is based on the Fearless Nadia, a famous Indian film actress and stuntwoman who is most remembered as a masked, cloaked adventuress in *Hunterwali* (1935, The Princess and the Hunter). Obsessive cinephilia links the girl to Fearless Nadia. It is interesting to note that Fearless Nadia was actually Mary Ann Evans, born to an Australian family. She came to India when her father, a volunteer to the British Army was sent to India. The project in that sense points to the global histories of evolution of cinematic cultures. It combines video, text, location sounds, animation, maps, staged enactments, photographs and graffiti. In following the video game model of entry and exit points, the project provides interactive nodes through which the user selects, omits and navigates the Girl’s history and times; a cinematic experience and an interactive map.

Experiments in Interactive VR Storytelling: Structuring Space and Time
Elizabeth Goins
Rochester Institute of Technology

This talk discusses the application of interactive game structure to VR storytelling by building on Jenkins’ ideas of spatial, or environmental, storytelling and. Environmental storytelling is mapped to LeFèvre’s triad and ideas of socially constructed space. Some of the main implications from the theory are applied to a current project in development on the HTC Vive, *Ego and the Dreamwork* as well as commercially available VR experiences. This talk concludes by providing practical suggestions of incorporating spatial storytelling into game design practice for VR

Narrative in Virtual Reality: What Works, What Doesn't
Trent Hergenrader
Rochester Institute of Technology

This short talk will focus on three different types of virtual reality narratives: VR stories, immersive narratives, and open-world adventures. These broad categories have fuzzy borders, but are distinguished by the amount of control the user has over the experience. In VR stories, the user has little control over the narrative, limited to changing camera angles or zoom levels. Immersive narratives, however, allow the user to explore more of the virtual space and manipulate the environment, which can deepen engagement in interesting ways, regardless of whether it alters the narrative outcome. Open-world adventures, which are usually ports to VR from other platforms, provide a more comprehensive experience, but may in fact overwhelm users with clumsy controls and elaborate navigation options that serve to break any sense of immersion in the
narrative. This presentation argues that, given the current state of technology, the most successful type of VR narrative actually limits the amount of interaction or exploration with the world, and instead focuses on creating a more condensed and controlled environment. The talk will focus on three approaches to storytelling in *Kingdom City Drowning*, *The Gallery*, *The Invisible Hours*, *The Solus Project*, and *Fallout 4* among others.
Optics and Vision (11/30/18, 3:00)

Relative Impact of Key Rendering Parameters on Perceived Quality of VR Imagery Captured by the Facebook Surround 360 Camera
Nora Pfund, Nitin Sampat, J A Stephen Viggiano
Rochester Institute of Technology

High quality, 360 capture for Cinematic VR is a relatively new and rapidly evolving technology. The field demands very high quality, distortion free 360 capture which is not possible with cameras that depend on fisheye lenses for capturing a 360 field of view. The Facebook Surround 360 Camera, one of the few “players” in this space, is an open-source license design that Facebook has released for anyone that chooses to build it from off-the-shelf components and generate 8K stereo output using open-source licensed rendering software. However, the components are expensive and the system itself is extremely demanding in terms of computer hardware and software. Because of this, there have been very few implementations of this design and virtually no real deployment in the field. We have implemented the system, based on Facebook’s design, and have been testing and deploying it in various situations; even generating short video clips.

Color and Object Appearance in Augmented Reality
Michael Murdoch, Nargess Hassani, and Sara Leary
Rochester Institute of Technology

This presentation will summarize recent work on the visual perception of color appearance and object properties in optical see-through (OST) augmented reality (AR) systems, which use a see-through display system to superimpose virtual content onto a user’s view of the real world. With careful tracking of both display and world coordinates, synthetic objects can be added to the real world, and real objects can be manipulated via synthetic overlays. Because an OST system mixes foreground (virtual) objects and background (real) objects, the background bleeds through the foreground and distorts its color. Ongoing research in RIT’s Program of Color Science studies how the combination of real and virtual stimuli are perceived, how users’ visual adaptation is affected, and in what situations the background bleed-through can be cognitively discounted, or ignored. In one set of visual experiments with color matches, combinations of foreground and background colors have been used to test and improve the predictions of color appearance models. In another experiment with object lightness matches, real 3D cubes were combined with AR overlays in a variety of sizes and alignment, in order to understand in what cases observers can discount the overlay. This work continues with the end goal of enabling AR systems to present viewers with robust, predictable color and appearance.
**Schultz: Bridging the Industrial and Consumer Markets for AR Technology**

Robert Schultz  
Vuzix

Vuzix has been making head-mounted displays for the industrial, consumer, and military markets for over 20 years. We will take a brief look at the history of HMD development at Vuzix and the evolution of the design space that brings us to the Vuzix Blade. Looking at use cases and real world applications for VR in the industrial space, we will look at the overlap with the consumer space and the challenges in developing a product that the consumer market will adopt. Along the way, we will look at the differences in optical design, industrial design, and software that are needed for mass acceptance.

**Transverse Chromatic Aberrations in Virtual Reality Devices**

Ryan Beams  
Food and Drug Administration

We demonstrate a method for measuring the transverse chromatic aberration (TCA) in a virtual reality head mounted display (VR HMD). This procedure was used to characterize the optical performance of the Oculus Go VR HMD. Results show a measurable TCA for angles larger than approximately 6° from the center of the field of view. TCA can be thought of as a wavelength dependent magnification, and as a result, the relative size of objects vary based on the rendering color. In addition, this leads to color changes in the image due to mixing with neighboring pixels, which impacts image quality. The test results for the Oculus Go show promise for characterizing TCA across different HMDs.

**A Comparison of Colorimetric Performance of Oculus and HTC Virtual Reality Headsets**

Morteza Maali Amiri, Kamran Binaee, James Ferwerda  
Rochester Institute of Technology

The colorimetric characterization of the two virtual reality headsets, namely, HTC and Oculus are compared to each other. In order to do that, first, a colorimeter is used to measure the colorimetric values of the primary ramps in a darkened and controlled environment. The colorimeter is pointed directly at the displays of the headsets, mimicking an observer looking through the lens at the displays, while the whole display outputs a particular color. It is observed that the two headsets behave more or less the same with HTC outputting an overall higher level of luminance and having more consistent right and left displays. Afterwards, to colorimetrically characterize the devices, weighted regression and a traditional method of characterization are used, and the results are compared. The outcomes show the superiority of the weighted regression over the traditional approach.
Hyperion: A 3D Visualization Platform for Optical Design of Complex Folded Systems

Daniel K. Nikolov, Li Zhang, Eleanor Haase, Yifan Niu, Nicole Naselaris, Adam Hayes, Jannick P. Rolland
University of Rochester

Hyperion is a 3D visualization platform for optical design. It provides a fully immersive, intuitive, and interactive 3D user experience by leveraging existing AR/VR technologies. It enables the visualization of models of folded freeform optical systems in a dynamic 3D environment. The frontend user experience is supported by the computational ray-tracing engine of Eikonal+, an optical design research software currently being developed at the University of Rochester. We have built a cross-platform light-weight version of Eikonal+ that can communicate with any user interface or other scientific software. We have also demonstrated an initial prototype of the Hyperion 3D user experience using an Oculus Rift and a Leap Motion hand gesture controller. Please, see the demo with the same name to try the prototype yourself.
Live Performance (11/30/18, 4:00)

Adjusting the Margins: harnessing the foundations of American Sign Language for VR
Luane Davis Haggerty
Rochester Institute of Technology

Del-Sign is a physical approach to acting that uses elements of Francois Delsarte mime techniques with the foundations of American Sign Language. This acting and presentational technique uses cross-cultural physical communication as a way to deepen an actors’ performance, support a presenters lecture, or can be used as a format from which to create animations that communicate with or without verbal language. It is a historical fact that Deaf actors using the foundations of Sign Language influenced the movie industry (Higgins). In silent movie infancy Deaf performers were brought in as consultants to insure that the gestures, relational positions, facial expression, camera angles and body language of the actors could have the strongest impact and the clearest meaning (Albert Ballin). At that time the standard acting technique was a codified movement study begun and refined by Francious Deslarte (1870-1890's Paris, 1880-1915 Steele MacKay New York). By blending these two structures we find that an outline is gained for creating movement, posture and gesture (MPG) that easily communicates meaning. The applications of this performance technique are many and varied. From the obvious acting for stage application to lawyers, teachers, priests or other presenters. Del-Sign can now bridge into adding technology to the mix allowing for this approach to be used when creating characters and movement for VR, AR or MR.

This 15 minute talk can explore the storytelling potential of how Del-Sign can be used to enhance and reinforce the development of plotlines and immersive narrative architectures. By discussing the history ASL has and Deaf cultural perspectives share with the movie industry this talk can also touch on cinematic explorations of storytelling, theatrical and performative practice in XR. This presentation will include both video and live performance examples of Del-Sign.

Display and Control of virtual stage effects in Mixed Reality Theatre
Advait Bhatwadekar, Gourav Acharya, Nibesh Shrestha, Jietong Chen
Rochester Institute of Technology

As XR technologies have evolved, they have opened the doors to creating experiences that can combine the real and the virtual to give rise to a new form of reality called Mixed Reality. Theatre, a live narrative experience is often constrained to use the props and visual effects that can only be made practically with tangible resources or using very limited digital projections. The Mixed reality theatre project aims to provide a way for the audience to experience the theatre magic at its peak with some props or practical effects replaced by purely virtual ones, that the audience can experience with a
HoloLens. The resulting performance would increase the amount of immersion in comparison to a normal theatre production.

The Mixed Reality theatre team would be giving a talk at the Frameless symposium along with projecting a live stream from two HoloLens worn by chosen members within the audience (mostly team members). The live stream would provide a small sample of the shared experience that the project aims to achieve in the theatre production while the talk would go into details about the project and what it aims to achieve along with the approach taken.

**Facial Avatars in Live Performance (Unabridged Emotions)**
Zhongyaun Fa, Lyss Bourgeois, Ashley Green, Danielle Benedetto, Kaitlin Hill, Jamilya Dudley “Daisy Spivey”, Department of Dance, The College at Brockport
Michael Francis, Mitchell Poon, Jonathan Schenk, Saylee Bhide, Joe Geigel, Marla Schweppe
RIT

*Unabridged Emotions* is a mixed reality dance performance that explores the expression of basic emotions through poetry, dance and facial expression. During the piece, facial avatars, controlled by users off-stage, are projected on stage while each dancer portrays a particular basic emotion. Users controlling the faces, experience the performance from stage view via the use of networked cameras connected to Raspberry Pis. A 10-minute preview of the piece will be performed.
Demos (11/30/18, 5:30)

Beat the Blitz
The Mill
The Mill teamed up with Gatorade, OMD, and VML to create Beat the Blitz, a Virtual Reality football game featuring former NFL MVP Quarterback and Gatorade partner Peyton Manning.

Virtual Reality Concerts with Immersive 3D Audio
Ming-Lun Lee, Steven Philbert and Olivia Canavan
University of Rochester
It is impossible for a 360/3D video without immersive 3D sound to offer the viewer a full experience of virtual reality. Spatial audio, different from stereo sound, allows the viewer to localize the sound sources in a 3D space. Since September 2017, our 3D Audio Research Lab has recorded over thirty classical and jazz concerts with a variety of Ambisonic microphones, binaural microphones, and 360 VR cameras. With the 32-channel Eigenmike microphone array, we have been able to make Ambisonic recordings up to the 4th-order and convert them to head-tracking binaural audio for VR video or decode them for playing with a surround sound or immersive audio system. Our goal is to build a database of VR concert videos with high-quality spatial audio for 3D audio research, as well as to achieve the best workflows and techniques for professional 3D audio recording and reproduction. We would like to give a demo showcase of our best concert recordings at MAGIC Spell Studios’ MAGIC Movie Theatre, which has 50+ speakers for Dolby Atmos playback. With our high-quality 3D audio, we hope that we can make the MAGIC Movie Theater a virtual concert hall for the audience to experience high-quality 3D audio recordings.

Hyperion: A 3D Visualization Platform for Optical Design of Complex Folded Systems
Daniel K. Nikolov, Li Zhang, Eleanor Haase, Yifan Niu, Nicole Naselaris, Adam Hayes, Jannick P. Rolland
University of Rochester
Hyperion is a 3D visualization platform for optical design. It provides a fully immersive, intuitive, and interactive 3D user experience by leveraging existing AR/VR technologies. Please, refer to the talk with the same name for more details about Hyperion and the Eikonal+ optical design research platform that Hyperion is part of. The demo shows an early proof of concept implementation of Hyperion running on an Oculus Rift and using a Leap Motion hand gesture controller. The user can add, edit, move, rotate and delete freeform surfaces, change their shape by adding different Zernike terms, and change the perspective by rotating the camera and zooming in and out. A next generation of the software is currently being developed for the Hololens.
Ego and the Dreamwork
Elizabeth Goins
Rochester Institute of Technology

This is the current demo of the pre-alpha version of Ego and the Dreamwork for the HTC Vive. The game uses the theory of LeFebvre’s spatial triad to construct map sequencing, gesture tracking and interactivity to convey narrative. The demo is linked to the talk Experiments in Interactive VR Storytelling: Structuring Space and Time.

Creating an immersive social scene to measure self-regulation and social motivation in children with autism spectrum disorder
Joe Tom Job, Ninad Ligade, Jessica Keith, Jacob Cozzarin, Claudia Paulson, Ben Mendelsohn, Joe Geigel, Loisa Bennetto
University of Rochester and Rochester Institute of Technology

ASD or Autism Spectrum disorder is a neurodevelopmental disorder where the individual finds problems with social communication and interaction. This project aims at studying the behavioral patterns and understanding processes that underlie social motivation differences in children with autism by means of Virtual Reality. This is achieved by creating a 360° video which involves kids playing and interacting and then showing it to the kids and their reactions are recorded and studied. Different sensors attached to the viewer helps in recording various change in patterns in heart rate and other parameters. The video will include various levels of interaction. The video starts by kids playing around the room and slowly kids will interact with the viewer. The intensity of the interaction will be increased slowly. As the video is played in an Oculus Go, the viewer will be having a real-world experience and the viewer will have a live feel of things happening around him. This setup helps in simulating the same experience among different kids. The 360° video shot should be stitched and spatial audio should be integrated to it. This video will then be processed using unity and then rendered in Oculus Go as an application. The video lasts 6 minutes. This video can also help to improve the social communication and interaction skills of kids with autism.

Spoons
Kalila Shapiro

Spoons is a 360 video Virtual Reality experience designed to educate users about the realities of Obsessive Compulsive Disorder (OCD) by experiencing obsessions and compulsions first hand. According to the Anxiety and Depression Association of America, OCD affects approximately 2.2 million adults in the United States, however it continues to be one of the most misunderstood mental illnesses. Spoons seeks to change that by highlighting the often misunderstood parts of living with OCD - how overwhelming and sensory it can be, how inescapable it can feel, and how scary it can be in the moment. While watching, viewers will go through a typical OCD episode: obsessive thoughts, growing panic, compulsions, anxiety, and disappointing relief. This project runs best in Adobe Premiere Pro CC 2018, and is viewed with the HTC Vive.
**Dear Angelica**
Oculus Story Studio

From an Emmy award winning studio, Dear Angelica is the story of Jessica, a teenage girl looking back on the stories her mom told her as a child. As she recreates these vivid landscapes in her mind, you're pulled into the magical and dreamlike worlds of her memories.

Director: Saschka Unseld, Writers: Wesley Allsbrook (additional writing by), Angela Petrella.

Stars: Geena Davis, Mae Whitman

**Arctic LiDAR**
Daniele Profeta
Syracuse University

Abstract: ARTIC LiDAR is an immersive 360° Video Installation developed in collaboration with the STRELKA Institute for Media, Architecture and Design that will be exhibited at the 2019 ACCelerate Festival at the Smithsonian Institute. Using 3d scanning LiDAR to capture a series of remote locations along the Arctic Coast, the short movie becomes an immersive exploration of the quickly expanding logistic landscape of this region while speculating on its future. Part documentary, part projective narrative, this 360° video captures all the primary nodes of this far reaching infrastructure, ranging from Dry Ports to Ice Breakers and Rail Terminals, and re-assembles them in a composite, speculative landscape.

The machinic vision of the LiDAR scanner, capturing RGB values alongside a detailed 3d map of the surveyed site, brings the viewers in the automated landscape of logistics, where driverless trucks and robotic cranes operate through the dense point cloud. Moving across the territory, this operative mode of vision is slowly contaminated by atmospheric elements foreign to the machinic eye. The viewers are caught in an ambiguous territory where a bodily experience of this harsh landscape and its extreme climate re-asserts its presence in an otherwise human-less environment. And yet, their point of view is constrained to the rigid linear movement of what appear to be indifferent machines, reinforcing the agency of the automated infrastructure upon the construction of this territory.

**Indoor Navigation and Tour Guide with an Audible Line in the Air Based on Augmented Reality**
He Gong, Junbo Hu, Ziqiu Wu, Bai Zhen
University of Rochester

Indoor navigation is a hard problem unless you have built a 3D model of all the floors. The general solutions for indoor navigation are providing an illustration in each floor or asking a tour guide to lead you. Without the guide, many people will lose their original route when they return or go there for the second time. We propose a solution that we
can let the phone draw a line in the air automatically when we walk there for the _rst time and save it. Then we can share it on a platform with others so that they can follow the route. Maybe in the route we want to share some funny stories about some objects. In this situation we are the tour guide. We can speak something and attach the voice or text with the line in the air so that they will hear our stories when they stand beside the line.

**Hardware Maintenance in AR**
Jonathan Wong, Akash Eldo, Henry Wu, Sahil Pethe
Rochester Institute of Technology

Instructions and diagrams on a piece of paper is just not enough to describe the intricate parts regarding troubleshooting and training of complex hardware. We need some new method of interaction which will bridge this gap and make the learning curve easier. With the Hololens by Microsoft, we have created a tool that enables users to interact with the 3D world around them using voice commands and hand gestures.

**Virtual tour Guide**
Vedanth Srinivasan, Jinal Shah, Hao Su, Matthew Ku
Rochester Institute of Technology

Virtual tour guide" allows the user to navigate the surroundings of a particular location in an augmented reality experience. This project aims to create a virtual tour experience for the user with an augmented reality headset. It envisions the user walking through an environment as a "tour guide" shows them around each location. The tour guide is an augmented reality object that can emote, talk and guide you through the scene. This project is meant to display the effectiveness of augmented reality verses a real human being using an interactive experience. The project is divided into 2 independent steps and a third step that combines them.

**Augmented Reality Comic Captioning**
Dylan Bowald, Alex Hedges, Manan Joshi
Rochester Institute of Technology

When watching theater performances, deaf and hard-of-hearing people currently have limited abilities to understand the speech going on. Captioning is rare, and when it is provided, it is usually displayed away from the stage, which divides the viewer’s focus. We propose an augmented reality (AR) caption display system to solve this problem by displaying virtual captions above live speakers, in the style of comic chat bubbles.
VRsus guARDian
Tanat Boozyaangool
Rochester Institute of Technology

VRsus guARDian is the result of an amalgamation of two different gameplay mediums that challenged the gap separating different mixed reality platforms, namely virtual reality (VR) and augmented reality (AR). The game utilized each medium’s approach towards immersion as a design principle in building a natural, asymmetric play for both players. The game also constructed a compelling fantasy atop each medium’s unique interactive capability to build a dynamic narrative. Lastly, the cross-platform nature of VRsus guARDian caused the game to be highly dependent upon Unity, a game engine with highly accessible, platform-agnostic development capabilities.

Catch the Thief: sound localization game using augmented reality (AR) technologies to improve auditory localization skills (poster)
Jacob Cozzarin, Kyunghwan Sul and Sungyoung Kim
Rochester Institute of Technology

Audio engineers often undergo technical ear training practices involving spectrum identification (identification of frequency spectrum and their different characteristics), auditory localization (the ability to determine a sound source’s location relative to a listening position), and sonic discrimination (determining minuet differences between two different but similar sounds). Often these technical ear training practices are learned through trial and error when mixing/mastering music. The purpose of this project is to create an effective and entertaining game to help develop these important listening skills for aspiring audio engineers or anyone willing to improve their technical listening skills. Along with improving technical listening skills, keeping the users engaged is an important part so that they feel they are playing a game and stay active while they training their ears. Out of the three main ear training practices, localization training can be most beneficial using the augmented reality (AR) technologies that allow multimodal isomorphic mapping. Trainees can congruently map what they hear with what they see. “Catch the Thief” is the AR mobile game implementation that utilizes this project’s ear training framework. By combining entertainment and training, we expect not only to enhance educational efficacy but also to assist hard-of-hearing listeners in better separating a target sound from environmental noises. There are only thirty-six levels on the prototype but hundreds of levels can be added through different elements that impacts the games difficulty. This project has been implemented with Unity3D in combination with a MySQL database to keep track of users and game progression across multiple devices.

Aria: Live Motion Visuals for Dance Performance
W. Michelle Harris
Rochester Institute of Technology
Live motion visuals for a concert dance and music performance were generated by programming custom software for visualizing detected motion and blending the resulting imagery within software for multimedia performances. The OpenCV software library’s Optical Flow motion detection object is used to control visuals of blowing leaves or abstract splashes of water based on a webcam image of the dancers on stage. These visuals are mixed with richly textured video in Isadora software and then projected back onto the dancers' stage and backdrop. The resulting effect is one of dancers literally moving the space around them as they perform - kicking up virtual leaves in one scene or leaving behind a spray of water as they spin in another. For purposes of this installation, visitors can interact just as the dancers did - turning their movements into blowing leaves and water.
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