2021 Symposium on Education in Entertainment and Engineering

SYMPOSIUM BOOK

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ORLANDO, FLORIDA

PURDUE UNIVERSITY | Fusion Studio for Entertainment and Engineering

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Welcome to the 2021 Symposium on Education in Entertainment and Engineering!

Hello friends!

It feels so long ago since we held our inaugural Symposium on Education in Entertainment and Engineering in 2019 when we were so warmly greeted by so many of you on the Purdue University campus. We are thrilled at the opportunity to meet with you all face–to–face again this year after our online event in 2020 amidst the pandemic. The 2021 symposium, held in partnership with the Themed Experience and Attraction Academic Society (TEAAS), offers an opportunity to rekindle connections with professional acquaintances and form new relationships across the broad and diverse field of "engineering immersive entertainment".

The Purdue University Fusion Studio for Entertainment and Engineering was formed in part with a mission to foster connections between industries, practitioners, educators and students. This annual symposium provides a venue to not only make connections within this community, but to bring forth the scholarly advances and instructional practices that will lead the industry forward in professional competencies, workforce development, and in imagining the future of the industry.

Authors selected for this year's symposium address important scholarly topics ranging from developing distanced instruction with accessible maker labs, to facing the challenges of interdisciplinary project work at the nexus of technology and art, to professionally preparing students for the so-called "wicked challenges" found in the world of practice, and managing limitations of technology in the world of live performance. We couldn't be more proud of the significant advancements these works have made and will make amongst our community.

As we celebrate this year's event, we are already looking ahead to the 2022 Symposium on Education in Entertainment and Engineering. We encourage each of you to consider contributing to next year's event as we press the boundaries between education, practice, engineering and the technologies that continue to emerge around us.

Rich Dionne

Mary Pilotte

Participants in the 2020 Symposium share words and phrases that reflect their experience of the first day of sessions.

Symposium Co-Hosts

Rich Dionne
Purdue University

Rich Dionne is an Associate Professor of Practice and technical director in the Department of Theatre in the Patti and Rusty Rueff School of Design, Art, and Performance at Purdue University. He specializes in scenery automation and show control systems while also serving as the department's production manager. He has a passion for both the art of theatre and the science and engineering of making theatre happen. Rich is a founding Faculty Fellow of the Purdue Polytechnic Institute, and has served as the technical director for numerous productions in the Department of Theatre. He teaches courses in structural and mechanical design for the stage, automation controls and show networks, project planning and advanced arena rigging to students in theatre and theatre engineering.

Prior to coming to Purdue, Rich was the production manager and resident sound designer at The Shakespeare Theatre of New Jersey, where he mounted numerous productions at various indoor and outdoor venues, including a nationally-recognized educational touring company. Additionally, he has served as the technical director for Berkshire Theatre Festival, Alpine Theatre Project, Weston Playhouse Theatre Company, and Dorset Theatre Festival, mounting critically-acclaimed productions including *The Whipping Man*, *Barefoot in the Park*, *Amadeus*, *Night of the Iguana*, *Avenue Q*, *The Illusion*, and *Death of a Salesman*. Rich's book, *Project Planning for the Stage: Tools and Techniques for Managing Extraordinary Performances*, focused on the application of project planning techniques for theatrical production, was recently published by Southern Illinois University Press. The eighth edition of *Theatrical Design and Production*, for which he is a co-author with Michael Gillette, was recently published by McGraw-Hill.

Mary K. Pilotte
Purdue University

Dr. Mary Pilotte is an Associate Professor of Engineering Practice and is also Director of the School of Engineering Education's Undergraduate degree programs in Interdisciplinary Engineering Studies and Multidisciplinary Engineering.

She teaches varied topics across levels of student development, from professional development to engineering economics and Senior Capstone Design. Outside of the College of Engineering she instructs project management and consulting approaches for the Global and Executive MBA programs at the Krannert School of Management at Purdue, and heads corporate workshops based on her book *Millennial Reset* (2018) and on Intentional Learning.

Her research interests include engineering work culture including generations-based engineering practices and norms, examining what it means to identify as "multidisciplinary", and exploring new approaches and dynamic strategies around increasing workplace diversity, especially for the neurodiverse, and those with invisible differences.

Prior to her roles in the academic setting, she worked professionally for more than 20 years in the automotive, aerospace, airline, and commercial products industries, holding a variety of titles. She lead high performing teams in manufacturing, design-engineering for new product and process development, and ultimately in plant management and finance completing strategic mergers and acquisitions.

Presentation Abstracts

in alphabetical order by the lead presenter's last name

Timing, Latency and Live Performance*

Robert Klimek, Catharine Skokan, Colorado School of Mines

How important is synchronous timing in a performance? In the world of science, engineering and the arts, we cannot avoid it. In the arts, it is a living and vital concept between composer, performer and audience. During the pandemic, with an increase in virtual meetings and performances, made us more aware of timing issues and introduced us to a path with many questions about latency and affect between audience and performer. The hand waving, head nodding and eye gestures of Renaissance musicians led eventually to the classic conductor's baton. These all helped ensembles of dissimilar instruments and/or voices, conquer problems of 'sounding' simultaneously, in order to create accurate harmony. Music performers, of all styles and types, consistently alter their attack times to create a synchronous performance for not all instruments/voices immediately sound out a fully developed tone at the same time. Recording techniques (one solution) can 'doctor' this problem, as sound engineer realigns tracks, and starting points, when necessary. But are there other new latency solutions available to us today and discovered during the pandemic year and a half?

Catenate: Creating an Interdisciplinary Art Project

Brian Phillips, Melissa Eddings Mancuso, Emma Sherban, Ohio Northern University

This paper will present the rationale for, the challenges of, and successes encountered in the formation process of an interdisciplinary Visual & Performing Arts Project, Catenate, at Ohio Northern University's School of Visual & Performing Arts.

* *Because of travel limitations, authors could not present at the Symposium, but their work is still presented in this book.*

Studio D Institute – Making at a Distance and the Impact of Collaboration

Marlo Ransdell, Robert Coleman, Florida State University

This paper focuses on two themes: the development and implementation of virtual studio and remote makerspace interactions in a small, focused fabrication shop for design prototyping; and a reflection on how these strategies may be employed by much more complex technical theater fabrication shops. The shop that will be the focus of the case study is Studio D, which is a design and fabrication lab in the Department of Interior Architecture and Design at Florida State University. It collectively houses the Studio D woodshop (est.2012), Studio 3D lab (est.2017), and the Materials and Objects Testing Lab (est.2019). The mission of Studio D is to provide learning opportunities for interactive and experiential learning in person and remotely for prototype development of designed objects. Studio D supports critical thinking through problem identification, context research, ideation, development, and solution testing for real-world design problems. The Studio D Institute summer residency program was launched in the summer of 2021 to bring academics and professionals from various fields into the virtual studio and remote makerspace through sponsored design residencies. This experience has led to collaborations with the MFA Technical Production Program at Florida State University's School of Theatre and has impacted the future directions of thought on the opportunities of making at a distance for creative and experiential fields. This paper will outline the development of Studio D by Marlo Ransdell over the past two years and conclude with a reflection by Robert Coleman on how this can adapt to larger and more complex remote interactions for the Technical Production aspects of the live performance entertainment field.

ABSTRACTS

Developing Soft Skills with Interdisciplinary Teams in the First Year: Lessons Learned

Christian Rogers, Indiana University-Purdue University Indianapolis

The academic structure of most universities dictates that a student work with those of their own program and in conjunction with a program that is tangential to theirs. Interdisciplinary educational experiences that provide students with the opportunity to develop soft skills (such as communication, empathy and problem solving) are considered rare but are much more common in the working environment. As an example, working environments such as Universal Creative are comprised of multiple disciplines (i.e. civil engineer, mechanical engineering, illustration, user experience design, etc.) A function of working in an interdisciplinary team can also be to work on unknown or "wicked problem" that has no defined answer. This presentation will provide an overview of the Jag Challenge, an innovation sprint experience for incoming students to the university. Students work in teams of three as they are provided a challenge space, find specific problems within that space, conduct stakeholder interviews, develop empathy maps, ideate, conduct secondary interviews and then present their final solution. In fall of 2019 over 210 incoming students participated from eight first year experience course sections. In 2020 over 350 students participated in a virtual or hybrid format of the Jag Challenge. While one section may be comprised of mostly engineering students or business students most sections were interdisciplinary (i.e. a nursing student working with an education student).

The Three-Year Capstone: A Progression of Learning in Purdue University's Theatre Engineering Program

Leigh Witek, Wenger | J.R. Clancy/Purdue University

Purdue University's Theatre Engineering Program capstone combines the yearly production work of the College of Liberal Arts with the final senior design format used in the Colleges of Engineering. By starting their production work after gaining admission to the program, students work on progressively more involved projects throughout their time at Purdue. This poster presentation will examine the lessons learned and challenges faced by Leigh Witek, a recent Theatre Engineering graduate, as she completed each role in the program. She will share how each project informed her understanding of the design process and how a three-year immersion in production work benefitted her final project. The roles held by students as they progress through the program begins by working in the scenic shop. As carpenters, deck carpenters, assistant technical directors, and technical designers, students grow from building the designs of peers to creating designs of their own.

Experiencing the design process in stages leads to an understanding of the impacts of design and prepares Theatre Engineering students for the intensity of their final project. This format also encourages students of all years to interact with each other and provide a perspective from every role. The format of this process and program encourages a community within Theatre Engineering that fosters mentorship among the student cohort. This poster will present a student's perspective of the effectiveness of this process and provide insight for how learning objectives are received and interpreted.

Presenter and Panelist Biographies

in alphabetical order

Robert Coleman, Florida State University

Robert H. Coleman, MFA Technical Production Program Director, has contributed to over three hundred dance, opera, and dramatic theatre productions. He was Director of Production at the Opera Festival of New Jersey at McCarter Theatre in Princeton, NJ during the summer season. During his tenure, the Opera Festival presented several world premieres and was considered by Opera News and Money to be among the top ten summer festivals in the U.S. and in the top twenty worldwide.

Robert worked professionally for a number of years before a desire to teach led him to graduate school for his MFA. He attended Ohio University for a year before transferring to the Yale School of Drama in 1995. He graduated from the Yale School of Drama with an MFA in Technical Design and Production in 1998. He was the Head of the Technical Program at the University of Tennessee for three years and served as the Technical Director for the school and the Clarence Brown Company, the University of Tennessee's LORT theatre company.

He came to Tallahassee in August of 2001 to Florida State University's School of Theatre's nationally prominent MFA Technical Production program where he is an Associate Professor and Program Director of the MFA Technical Production program.

He continues his professional career, acting as technical consultant to a number of notable scenic designers and theatre companies. He was technical consultant to designer Kris Stone for the Abbey Theatre's production of Lolita. Robert was a fly-in technician (now referred to as Global Resources Services) for Cirque du Soleil's Dralion North American tour. More recently, he acted as interim assistant technical director for Cirque du Soleil's *Dralion* European Tour. in Vienna and Antwerp. He has worked in Global Resources Services for Cirque du Soleil, serving in Antwerp, Madrid, London, Barcelona, Rotterdam, Oostende, and Zurich, Geneva, Valencia, Malaga, Berlin, and Frankfurt.

Melissa Eddings Mancuso, Ohio Northern University

Emma Sherban is currently a senior at Ohio Northern University, majoring in International Theatre Production and minoring in Technology Systems. Emma has served as the scenery head at the Freed Center for the Performing Arts since fall of 2020 as well as being the assistant technical director for multiple productions for the School of Visual and Performing Arts. Her areas of interest include drafting, automation, and working in the shop. Emma looks forwards to either attending graduate school or starting her career in technical directions after earning her BFA in May 2022.

Emma Sherban, Ohio Northern University

Melissa Eddings Mancuso is a painter, illustrator, bookbinder, and aspiring cartoonist. When she isn't in her studio, or gardening, or spending time with her family, she is teaching at Ohio Northern University. She teaches beginning painting, drawing, life drawing, and all levels of printmaking and book arts. Melissa holds a B.F.A. from Ohio University in Athens and an M.F.A. from Edinboro University of Pennsylvania. In addition, she has served as the director of the campus' Elzay Gallery of Art since 2002. Recently curated exhibitions include Creativity Under Constraints and Mapping Katrina. Her work has been exhibited in museums and galleries nationally and internationally.

She happily resides in Ada, Ohio with her husband and two daughters.

Robert Klimek, Colorado School of Mines

Dr. Robert Klimek, BA, MDiv, MA, DA is a CSM Teaching Professor, musician, composer and clinician in ethnomusicology. Some of his past teachers include Aaron Copeland, Philip Glass and Donald Keats. His works can be heard worldwide and can be found in over 100 music collections. He has been a featured artist on a Grammy nominated album, as well as final nominee for the National Booksellers Gold Medallion Award. Currently, he is the director of the Music and the Performing Arts program at Colorado School of Mines, which offers a minor in Music, the Recording Arts and Technology. The program successfully produced its first full album in 2012, and was awarded the Recording of the Month (December) by the Independent Broadcasters Association. Dr. Klimek and Dr. Skokan have been leading international trips with CSM music/engineering students. Each of the experiences emphasized both sides of the student's skill set (engineering/music). All trips included music performances; ethno music instruction engineering lectures, industry tours, and community service projects. Dr. Klimek's hope, through these international experiences, is to create a pathway upon which the CSM student realizes that his/her technical field is an 'art form.' This art form enhances and enlivens both the student and the peoples and cultures visited.

Brian Phillips, Ohio Northern University

Brian Phillips is the Technical Director at Ohio Northern University. Prior to working at ONU, Phillips served as technical director for the Goodman Theatre in Chicago where he worked on more than thirty world-premiere productions. Phillips has continued his professional work, returning to the Goodman as technical supervisor for The Jungle Book in 2013, as technical director of The White Snake touring to China in 2014, and as technical supervisor for War Paint starring Patti LuPone and Christine Ebersole in 2016. Phillips, an ETCP-certified theatrical rigger, became an associate trainer with Chicago Flyhouse in 2017, providing training and equipment inspections throughout the world for companies such as Royal Caribbean, Celebrity Cruises, and Cirque du Soleil. He is an active member of the United States Institute for Theatre Technology and a member of the International Alliance of Theatrical Stage Employees, Local 24. When he is not in the theatre he can be found helping out at Gathering Volumes Bookstore, which is owned and operated by his wife Denise.

Brian graduated from ONU with a BA in communication arts-theatre and a minor in industrial technology, and he holds an MFA in technical direction from the University of North Carolina School of the Arts.

Marlo Ransdell, Florida State University

Marlo Ransdell, PhD, is an Associate Professor in the Department of Interior Architecture and Design at Florida State University. Her research focuses on creativity, digital fabrication, and critical thinking skills in the design field. She is also the founder and director of Studio D: Design and Fabrication lab at Florida State University. Studio D is a fully-equipped maker space that supports undergraduate and graduate furniture design prototyping. In addition to her role as director of Studio D, she is also a Faculty in Residence at the Facility for Arts Research, and is a certified Rhino software mentor and specialist. She regularly presents and publishes her work at national and international conferences.

Christian Rogers, Indiana University-Purdue University Indianapolis

Christian Rogers is the Associate Chair of the Computer Information and Graphics Technology Department as well as Director and Associate Professor of Computer Graphics Technology in the Purdue School of Engineering and Technology at Indiana University-Purdue University Indianapolis. He is also a faculty fellow in overseeing student innovation for undergraduate students within the Institute for Engaged Learning. He received his Bachelor's in Visual Communication and M.S. at Bowling Green State University, and a Ph.D. at the University of Toledo in the field of educational technology with a focus in media production. His teaching focus is on motion design and themed entertainment and conducts research in experiential learning, innovation education, and multidisciplinary teams.

Catharine Skokan, Colorado School of Mines

Dr. Catherine Skokan, BSc, MSc, PhD – Geophysical Engineering, is an associate professor emerita at the Colorado School of Mines and is the first woman to receive a graduate degree from this institution. Her technical interests include volcanoes, geothermal and energy resources, groundwater resources, and humanitarian engineering. Dr. Skokan has traveled extensively with student groups and she has led humanitarian engineering projects to the Americas, Europe, and Africa. She has also conducted workshops in Italy, Colombia, Tanzania and Zambia. Dr. Skokan is a regular lecturer for the Road Scholar

Program where she lectures on cruise ships. Her music interests include playing violin with the CSM orchestra, bassoon with the CSM band, and erhu with the CSM Chinese Ensemble as well as performing with chamber groups outside of CSM. With Dr. Robert Klimek, Dr. Skokan has led trips with Colorado School of Mines students over Spring Break. As a window into culture, Drs. Klimek (Director of Music) and Skokan (Engineering) organize trips to include technical tours and music experiences – both performance and as an audience. These trips have taken students to Italy, Peru, Jamaica, Ireland and Vietnam. With student groups, her passion is for travel and to share with others our beautiful world.

Leigh Witek, Wenger | J.R. Clancy/ Purdue University

Leigh Witek is a Controls Engineer at Wenger | J.R. Clancy. She graduated from Purdue University in December 2020 with a B.S.E. in Multidisciplinary Engineering (Concentration: Theatre Engineering) and a B.A. in Theatre Design and Production. As a student, she completed internships with PRG Scenic Technologies and Creative Conners. Her research with Purdue's College of Engineering Education investigated how institutional culture impacts pedagogical change in engineering colleges. This will be Leigh's 3rd time at SEEE and she is excited to participate as an industry professional!

TIMING, LATENCY AND LIVE PERFORMANCE

Robert Klimek
Humanities, Arts and Social Sciences
Music Program
Colorado School of Mines
Golden, Colorado USA
rklimek@mines.edu

Catherine Skokan
Humanities, Arts and Social Sciences
Music Program
Colorado School of Mines
Golden, Colorado USA
cskokan@mines.edu

Abstract— **How important is synchronous timing in a performance? In the world of science, engineering and the arts, we cannot avoid it. In the arts, it is a living and vital concept between composer, performer and audience. During the Pandemic, with an increase in virtual meetings and performances, made us more aware of timing issues and introduced us to a path with many questions about latency and affect between audience and performer. The hand waving, head nodding and eye gestures of Renaissance musicians led eventually to the classic conductor's baton. These all helped ensembles of dissimilar instruments and/or voices, conquer problems of 'sounding' simultaneously, in order to create accurate harmony. Music performers, of all styles and types, consistently alter their attack times to create a synchronous performance for not all instruments/voices immediately sound out a fully developed tone at the same time. Recording techniques (one solution) can 'doctor' this problem, as sound engineer realigns tracks, and starting points, when necessary. But are there other new latency solutions available to us today and discovered during the pandemic year and a half?**

Keywords—timing, latency, delay in sound

I. INTRODUCTION

In January 2020 MINES worked on the acoustical and digital challenges of timing through the shared experience of the production of 2 live 90 minute shows with the 2020 National Western Stock Show in Denver, Colorado. The task was to produce a seamlessly timed performance for a 20,000-person audience, using singers, concert instruments, a jazz band, horses, adult and children riders, and actors. Our task was to produce a seamless, "real-time", ebb and flow experience for the audience despite issues caused by curious young horses, to riders, and actors all having separate tempi, the task was to produce a seamless, 'real time,' ebb and flow experience for the audience.

COVID has made all performers hyper- conscious of timing and latency issues. This issue has always been a part of live, real time performances; however, quarantines, separation and isolation have spotlighted it. Now, instead of being something everyone does naturally, it must be factored into each rehearsal and performance. Without the push of COVID, Zoom might have been a handy program to use from time to time. But now it has become an office, a party room, a familydinner, and our local brewery. Zoom taugh us that sending signals back and forth over the internet took the analog precision of performance and timing away. Prior to Zoom, musicians needed to make sure their instruments were in tune, etc. With Zoom and COVID, one had to 'align' with the another. And the other, might have poor WIFI, a low-cost microphone and small or only computer-monitor speakers.

Can compositional or performance artistry overcome this problem? Can sound and electrical engineering eventually overcome this problem? What's been tried? What was seemed successful, but proved to be more costly? Will the return of live performances make everyone step back to prior times? Or, has something been learned during COVID which will drastically change how we run live and internet performance? What's next?

II. CSM INTEREST IN LIVE PERFORMANCER ISSUES

Synchronous timing of performances is an engineering issue as well as an artistic issue. The Colorado School of Mines (Mines) is a public research university devoted to engineering and the applied sciences. Our degree offerings are all technical. However, approximately 15% of the students also participate in the performing arts: Band, Orchestra, Choir, Jazz Band, Theater, and small ensembles. This unique combination has taken an interest in the topic of timing, especially during 2020 and COVID challenges.

At Mines [1], our degree offerings include the traditional earth sciences which serve as our historic foundation, as well as engineering and science/math arenas. These include geologic, geophysical, mining, and petroleum engineering as well as materials science (metallurgy), computer science, mathematics, and chemistry. Degrees are also offered in the traditional engineering topics of civil, mechanical, electrical, and chemical engineering, to name a few. Our students must complete a humanities component in their engineering curriculum, and many chose the performing arts to partially fulfill this requirement. The performing arts fall under the non-technical department umbrella called Humanities, Arts, and Social Sciences (HASS). This department offers courses in language, international affairs, ethics, music and performing arts, literature, and philosophy. In addition to the performance opportunities, Mines also offers individual music instruction, classes in music theory, composition, and history Our students can receive a minor in Music Technology or integrate a focus in music technology as part of a general B.S. in Engineering degree.

As a highly selective school, one in ten applicants enroll at Mines. The student body includes about 4900 undergraduate and 1500 graduate students. Almost 30% are female and 11% are international. Minorities count for 19% of the student population. Our performing arts classes draw from the entire student population and often attract higher percentage of females than the school average. Our music classes are popular, usually fully enrolled, and often have a waiting list. During non- COVID times, the class sizes range from 35-45. Our band has 115 students, orchestra has 78 students, and choir with 75 students. The theater class regularly enrolled 30 students and had a waiting list. During COVID, the class sizes have been smaller because many students chose to remain remote for engineering classes.

III. HISTORY OF CAUSING AND SOLVING 'LATENCY' PROBLEMS

Early, small ensemble, instrumental music began and ended through the simple use of eye contact or casual gestures. One member simply volunteers for this role. As Baroque music became more complicated and ensembles grew larger, it soon required a musician whose sole purpose was to keep the tempo of the music consistent — a conductor. One of the earliest was the Baroque composer Jean-Baptiste Lully (1632–1687). He would stand before his orchestra with a heavy, spiked staff, beating time by pounding the staff on the floor of the conductor box.

The heavy staff proved to have two disadvantages. It was annoying to listeners and ultimately ended in Lully's death. A distracted Lully accidentally pounded his foot, which eventually turned gangrenous. The spiked staff was quickly replaced with a rolled-up score, much softer and less dangerous, and finally a much small version of Lully's staff, a baton. Something unique in 'real time' performance began to take place.

The baton allowed for more graceful gestures, and thus the conductor took on a more central role in music performance. The conductor could shape the music, adding another ingredient to performance – interpretation. Most orchestras play 'behind' the conductor. In short, they wait a little for the conductor indications before they sound their instruments. So, the conductor no longer 'beats' the tempo to keep the instruments together. Another 'real time' understanding of live performance was created.

Consider this thought: large ensembles began to deal with the geography or placement of their membership on the stage. Sound travels to the listeners ear from the musicians closest to the front then the instruments in the back. The speed of sound in air is about 343 meters per second [2]. Therefore, sound travels about one meter in 3 milliseconds or in one foot per millisecond. The human ear can discern a lag over 20 to 30 milliseconds or a distance of 20 to 30 feet from sound source to ear. Major symphony orchestras have a space of about 35 feet by 35 feet or more. Orchestra musicians are aware this lag, as well as that of their instrument response. The attack, decay, sustain and release (ADSR) is different from instruments to instrument. For example, a violin's attack is most immediate, a bell is even quicker. The tuba and bassoon have a lag time from the moment the air enters the instrument until a sound is produced. Musician's, with the conductor, adjust, in real time, to compensate for this situation. Composer's use groups of instruments to cover over this problem in their orchestra of works. Audiences accept the blending of differences in orchestration. Our brain compensates for slight differences in timing. Without these compromises and shifts, harmonies would be hard to achieve. Melodies would not hold together.

IV. A LIVE PERFORMANCE MODEL FOR HOW MUSIC IS CREATED AND RECEIVED

In the world of physics and engineering, we think of a pebble dropping in a still pond and creating expanding concentric circles according to Huygen's principle. Now, think of a pebble dropping in a still pond and creating four concentric circles. The center circle, caused by the pebble striking the water is the Music itself, the created art before it is performed. The next circle is the performers. The next is the Audience. The final is Time and Space in which the performance occurred. As in the energy passing back and forth from the ripples cause by the initial pebble strike, each of the components back of a music performance have a similar energy that must pass back and forth to make the performance in 'real time.' "Music is not something "given" but…that which…rests on (the back and forth) agreement…(between)…composer, performer and listener." In order for music to achieve a 'live 'performance' model it must be able to move and affect the performer to the listener and again.

The composer starts out with a desire to be heard, with a desire to move a performer to eventually perform their concept so that their music 'moves' a people to experiencing an expected response. Affective music performance is akin to what happens when one drops a pebble into a still pond of water. The pebble creates a series of outgoing concentric circles. From middle moving outwards, these concentric circles can be labeled composter, performer, audience and historical moment. From one circle to the next and back again, there is movement. As in the pebble drop image, 'latency' rules or 'on-time rules' that are agreed upon in between these concentric circles (composer, performer, audience and historical moment of performance). The performers and listeners do not, "discuss them…rather…they have absorbed them. "And by continual group practice they agree to them."

This agreement of playing together, in time and starting and stopping as one, is also something the audience agrees on hearing. The audience comes to the performance knowing they will hear something new, but this new is within the agreed upon structure of the performers. Will this be a parade with a marching band? Will this be a jazz rendition in a smokey club basement? Will this be a choral and string piece in low ceiling church, or a gothic cathedral? All these historic places carry with them a memory and history which also empowers or affects back to the audience, the performers and finally the composer. The ripple 'affect' you see, moves back and forth in 'real' time.

As music became amplified and played in large arenas, amplification came to be part of the concert presentation. Massive audiences wanted to get the most 'bang' for their buck, and performer's amplification came to be a part of 'rock' concerts. Now a "disembodied voice, coming through a machine…remains enigmatic to the audience." "In time" music takes yet another step forward with the introduction of personal playback machines and ear buds. Now the listener has no 'affective' connect with the performer, nor does the listener give any affective feedback to the performer. The composer only gets a royalty check to let them know how well they are doing. The historical moment can be in a gym lifting weights or a walk about a park while reading text messages. Again, what makes the music real and 'in time' is no longer present. This was happening prior to COVID, which now has added another layer of complexity.

Finally, music becomes fully electronic (Electronic Dance Music EDM), and the light show become a most important source of 'entertainment'. The performer moves dials. Someone else runs the lights. The audience acts upon agreed rules, but unlike a live performance of jazz improvisation, things can be easily and exactly repeatable. Some come because they already know the product. They like that. However, the first model we used of a community hearing music is far from this model.

So, the latency of choirs and organs and instruments in resonant renaissance cathedrals is solved partially by learning to play and sing without your ears, and much of the 'latency' or real time performance affect, is accepted by the audience, in a large part due to the historic place and moment of the performance. It was agreed on by performers and audience how this would sound and take place. Musician and audiences, however, could still in a sense 'ripple' back and forth and support each other to make the music present and in real time.

Network Produced Music (NPM) posed and even more unique problem. There are no ripples, and everything now depends on your computer, your computer speed, your headset or speakers, your microphone; your interface; how far away you are from each other electronically.

In the recording or transmission of sound, latency can become a difficult issue. This has become especially evident as we have relied on internet communication platforms such as Zoom during COVID. Our sound is produced and picked up by a microphone. We can get the microphone close to the sound source to minimize delay. The sound is then converted from an analog signal to a digital signal. Software engineers have been successful in minimizing this delay. Then the signal is sent through a transmission medium such as the internet. The signal is then converted back to an analog signal and through a speaker to our ear. Latency is a function of the slowest of the units, in this case the transmission medium. A delay of over 100 or 200 ms or more is not uncommon. This delay is easily recognized by the listener.

In COVID, new questions about putting together live ensembles became important to consider. The only other option, besides ZOOM and similar programs was that of silence or nothing at all. In short, COVID was the death of live performance. No one wanted to go to that funeral.

V. TWO QUESTIONS STAND OUT

So, the problem with following the 'in time' live performance (pebble drop in quiet pond concentric circle affective performance model) lies in two areas and with two questions needing an answer. First, music prior to the COVID period strove to always fulfill the pebble/concentric circle model of live performance in one way or another. Post-Covid performance is already showing us that this model is changing rapidly, even when face- to-face performance is again possible. As an example, bands now can be made up of a single person recording in his/her bedroom, with no thought of live performance. An actual 'live' band doesn't exist in this case. How will this affect how we understand live music performance in the future?

Next, as has been done in the past, do composers need to learn how to create a new type of music composition that considers the latency problem and works with it? Surely, composers can, and have during COVID, found a way. They, like the organists and choirs in large cathedrals, produce music that will bring performers and audiences into a 'real time' music performance moment. Already, composition students are tackling this problem, knowing the pre-COVID model is not dead, but no longer the only 'affective' model of 'present' 'real time' music performance. New music (non-pop forms) has always found it difficult to find an audience. This could now be an opening. A single performer could stand in your home and perform, while the rest of the ensemble joins them remotely, through the use of specific software and a mixing board. In this way, the pebble/concentric circle model is present.

Another question lays on the engineering side. How do we arrive at an acceptable latency to create a live 'real time' performance? Can engineers, through technology, overcome the latency problem of a lack of presence between performer and audience? What was tried? How successful were those tries? COVID changed many things. If those changes remain, how will this problem of timing be solved so the audience can feel the presence of a caring performer? We also might find out that the advanced world of technology cannot replace the sensory attuned performer artist. An endless supply of thoughts about the challenges of latency, working around it, and some possible working solutions, have arisen. Here are a few pertinent ones, from a very long list. [3,4,5,6,7,8,9,10,11,12,13]

VI. CSM PARTICIPATES IN A 'REAL TIME" LEARNING PERFORMANCE EXAMPLE

All this thought brings us to the Denver, National Western Stock Show 2020. The Colorado School of Mines Concert Band, Concert Choir and Jazz Band were invited to supply the music for their Night of the Dancing Horses show. In Denver, this would become one of the last live full audience performances for over a year and a half. It also gave our students an authentic experience in varying latencies in 'real' time. The object was to accompany a spoken narrative track, trotting horses of different types, live on horse performers, as well as ground performers from the ages of 6 to adulthood, and ethnic and classic dancers. This was performed in a sonically challenged arena with dirt floor, steel roof, an array of 12-inch speakers throughout the ceiling and a band split into three to fit into the arena. To add to the disorder of sound was a crowd passing through the upper part of the building to adjoining arenas. To this, the music was to bind everything together so that to the audience would perceive a single, choreographed, real time performance experience. Sound from the stage could only be heard from the ceiling speakers. The arena absorbed most everything from the stage. Even at fff, the Concert Band was barely heard 3 feet from the stage.

The challenge was to make a real, in-time performance that would follow the concentric circle model of the performers affecting the audience in an historical place/moment with the ripples from the historical place/moment and audience filtering back to the performer.

The solution, in a nutshell was in finding the tempo of all the performers, as well as the speaker system.

The different breeds of horse trotted to different tempos. Young horses were mesmerized by all the instruments on the stage and forgot the performance entirely at points. The instruments on stage all sounded at different times, however, the sound system justified all their differences as their performance occurred not in the room ambience but in the microphone to speaker arena. Tempos were varied to move certain groups along. At times the tempo supported the dancers. At other times, the horses were supported. The synchronous moments gave an illusion to the audience that all parts of the performance were synchronous. The narration was patterned, timed, and practiced filling in moments when the music and the horses could not coordinate. Lighting effects pinpointed visual downbeats and covered over non-synchronous moments.

This YouTube clip shows the finale from the National Western Stock Show. (beginning at 4:38 provides best example)

https://www.youtube.com/watch?v=XOoNn4lN3q0

VII. NO COMPLETE SOLUTIONS, BUT PROGRESS IS MADE

All in all, real time latency was achieved despite 'real' live variables. In this same way, through new compositions that 'work out' the problem of latency, as well as finding new pathways on the internet and through innovation in Apps, music performers are again looking at a problem of realizing that "…music is a full-body sensory experience making full use of sight, sound, touch, and collaboration to produce a real time, concentric circle model, experience."[14]

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Catenate: Creating an Interdisciplinary Art Project

Brian Phillips
Technical Director, School of Visual & Performing Arts
Ohio Northern University
Ada, Ohio, USA
b-phillips.5@onu.edu

Melissa Eddings Mancuso
Associate Professor, School of Visual & Performing Arts
Ohio Northern University
Ada, Ohio, USA
m-eddings@onu.edu

Emma Sherban, ONU student, Senior, International Theatre Production, e-sherban@onu.edu

\Abstract— **This paper will present the rationale for, the challenges of, and successes encountered in the formation process of an interdisciplinary Visual & Performing Arts Project, *Catenate*, at Ohio Northern University's School of Visual & Performing Arts.**

Keywords—Student, production work, technical design, pedagogy.

I. INTRODUCTION

What if we created a safe space to explore, and fail, withoutfear?

What if we had a framework to create interdisciplinary works ofart?

What if we could use technology to fascinate the eyesand enthrall the ears?

What if we had a project that allowed you to ask, "What if?" *Catenate* is a project housed within the Ohio Northern University School of Visual and Performing Arts with a missionto allow the ONU community to create and explore the connections between performance, technology, the visual arts, and the human spirit. By supplying access to space, equipment, and mentorship, the participants (students and faculty) can explore the interrelations of sight, sound, and movement to develop new experiences outside the confines of traditional assessment models (concerts, shows, productions, etc.).

The stated goal of *Catenate* is to develop an environment within which the process, the collaborative journey, is the focus.

The *Catenate* space encourages cross-collaboration between the areas that make up the School of Visual & Performing Arts and acts as a path for students to create larger collaborative communities to enhance the scope of their practice. It also supplies an avenue to involve students and faculty from the Technological Studies program and the T.J. Smull College of Engineering to interact and take part in the visual and performing arts. After the successes of this first year, the participants are excited to continue the project and expand theirefforts to include a broader range of disciplines.

Catenate focuses on interdisciplinary practices and the continual inquiring of what art is and can be.

The *Catenate* project was created to answer three main questions:

1) Can an institution's historic departmental silos be dismantled by engaging in a collaborative project?
2) Is it possible to create an artistic outlet in response tothe workshops, concerts, and production canceled or significantly changed due to the Covid-19 Pandemic?
3) How do we explore the interrelations of sight, sound, and movement while developing new experiences outside the confines of traditional assessment models(course grades and credit hours)?

II. HISTORY

In the fall of 2019, the School of Visual and Performing Arts (SVPA) was created due to the Getty College of Arts and Sciences restructurings, merging the once separate Art, Music,and Theatre departments. A stated goal of the merger was to help a more robust collaborative artistic campus community. The reality of COVID -19 hit the campus in early March 2020,making online delivery the essential modality to complete the academic year.

On May 7th, ONU announced the intent to resume in-person residential education on campus in the fall of 2020. While the SVPA faculty were excited to return to campus with the students, many were unsure how different our programs wouldlook and how that would affect the student experience. How would we offer quality academic programming in our fields under the new COVID-19 restrictions?

Prof. Brian Phillips, Dr. Dave Kosmyna, and Prof. Melissa Eddings created the *Catenate* project in 2020. This project was driven by three main questions: First, is it possible to reduce the institution's historic silos created under the former department model? Second, is there a way to create an artistic outlet in response to the many workshops, concerts, and productions canceled or significantly changed due to the COVID-19 Pandemic. Third, is there a way for students to explore the interrelations of sight, sound, and movement while developing new experiences outside the confines of traditional assessment models such as the standard 3.0 credit hour course with a letter grading system?

To this end, in the Fall of 2020, *Catenate* secured

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funding, named student participants, and allocated space andequipment to allow students and faculty the opportunity to create and explore the connections between performance, technology, the visual arts, and the human spirit.

III. METHODS

The faculty intermediaries of the project identified eight studentsfrom each of the SVPA disciplines. It was vital to the project that all areas of the school (art, music, theatre) be represented in the student group. An informational meeting took place in early June 2020 via Zoom to introduce one another and outline details of the project. Zoom served as the primary platform for meeting and eventually migrated to Discord. The group used other media outlets to facilitate discussion, imagination, and visuals via videos and images on designated Pinterest boards, YouTube, and Vimeo channels. The faculty suggested that a shared theme or concept act as a focal point for the project and to overcome inertia. The students decided upon *Frustration Moving to Hope* as the conceptual framework. As chance would have it, the theme aligned with one of *Catenate's* initial goals as a creative outlet during a global pandemic and was apropos with how the students were currently feeling.

IV. PHASE 1 – ORGANIZATION

The next challenge was how the group would represent this theme and allow viewers to interact with the final product. The group liked the concept of creating a game or challenge for theviewer that would allow them to work individually or as a group. Would the final product be an interchangeable, automated form? Would programmable sound loops help motivate the process? How would light and shadow play a rolein this interactive process? How would the final project be documented as it transforms? These questions were at the forefront of the initial planning stage.

V. PHASE II – STAGE AUTOMATION LAB

As the College of Arts & Sciences implemented its restructuring plan in 2019, the Theatre program acquired space in the former home of the Technological Studies department in Taft Memorial.The Taft building was erected in 1929 and served as the university's gymnasium until 1972. As Theatre relocated into thefirst floor of Taft, room 114 was designated the stage automationlab and served as host to the *Catenate Project*. The 1600 sq ft labhas many benefits, namely, the abundance of power and a variety of smaller, unique rooms within the larger area. The one substantial drawback is that the lab is below ground level and only accessible by stairs.

The lab provides a location for installing a newly acquired stage automation system for training when not used for theatrical productions. This fact made it a healthy choice to share the spacewith the *Catenate* project. The group borrowed additional equipment from the areas of the SVPA to allow as much creative freedom and experimentations as possible (refer to the Appendixfor a complete list of materials).

A. Implementation

After classes resumed in January, the group made plans to create a regular weekly meetup for the project where students can come and go as their schedules allow. The first few meetings in the lab served to develop familiarity with the roomand the myriad of tools and processes available to the group.

While the group did not achieve the goal of creating a sharable "product," the project successfully exposed the participating students to a wide range of equipment and techniques they would have not otherwise had the opportunity to use. We started the physical aspect of this project by installing a decking system containing a basic theatrical deck track and a guide system that allows objects to move horizontally across the stage floor. The students installed a tracking system in conjunction with a deck winch run via Spikemark, the stage automation control software. They then hung several LED Source 4 lighting fixtures. We also experimented with the Mi-Light LED light bulb; with wireless- DMX controlled LED fixture with a standard/E26 base that allows you to install it into a standard lamp. We installed 16 of these in a single circuit festoon along the wall behind the platforming system. The lighting units were all connected via DMX or Wireless- DMX to the ETC Nomad, a computer-based light control program running the ECT Eos software.

We built a small rolling platform or "wagon" to use in conjunction with the deck track. Both control systems were networked together via the Labs Local Area Network (LAN). The students then experimented with controlling the lightboard with Open Sound Control Commands (OSC) sent from the stage automation software. This program allowed them to create both time and position-based queuing sequences. To further explore the ability to integrate the various unique control systems, QLab, a sound, video, and lighting controller for macOS, was brought in and added to the LAN. QLab allowed the participants to continue exploring using OSC protocol to control the installation adding the ability to interconnect. At this point, we invited a faculty member from the technology area over to discuss how we might work together and how we would utilize the Modbus communication features in the Spikemark software. In addition to this, Brian had been working on how we might incorporate patron I/O with the experience using the POE Arduino board andOSC.

Next, the group incorporated some simple pneumatics into the lab. A large rack and pinion achieved 'secondary movement' onan object traveling the track. The initial idea was to create a 'secondary movement' on an object that traveled along the track.A large rack and pinion were designed and cut using the theatre area's CNC router. The pinion and a small decorative screen were then attached to the Wagon with a slew ring for rotation. We then attached the rack to 3 pancake cylinder controls with a solenoid valve. The frame could now be raised and engage the pinion on the wagon, causing the screen to rotate as the wagon traversed the stage. At first, it was done by activating the valve manually but was soon wired in the Stagehand FX and controlledvia Spikemark.

The video would be the next element added to the lab. Two standard projectors were acquired from the university surplus, installed, and connected to the QLab computer. The projectors allowed the students to explore how to map and track video in conjunction with the system. The final element that we added to the lab was MIDI hardware. We borrowed a MIDI interface and controller from the theatre area and purchased a MIDI-to-DMXinterface. Further exploration of the two MIDI interfaces wouldhave to wait as the semester ended.

As the semester progressed, the number of students working on the project at any one time during scheduled hours would ebb and flow. Students were most productive *actively* doing something (building, assembling, dismantling, etc.). Towards the end of the 15-week term, it was apparent that the student's attention was elsewhere. Of the initial group of eight students, 2-3 consistently showed up to work during the entire semester.

During the 14th week of the 16-week semester, the faculty met with the student group to get their feedback on the process and the project. The discussion at the meeting centered on the buy- in and motivation of the student group. Although one of the project's goals was to eliminate the concept of working towarda passing grade or obtaining credit hours, the external motivators were lacking. This issue becomes a 'goal vs.catalyst' problem.

VI. REFLECTION / ASSESSMENT

A. *Successes*

The stated goal of Catenate is to develop an environment within which the process, the collaborative journey, is the focus. By reflecting on the three main reasons this project was conceived,we were able to recognize the following successes.

1. - The desire to break down the historic silos.

The most tangible of our successes was the ability of the project to provide a forum for the participants to interact with people outside their academic programs yet within the School of Visual& Performing Arts. This helped establish the viability of the Catenate project as the one tool to be used in the process of breaking down the former department silos. Students and faculty were in an environment working together in ways that would not have happened otherwise. As a direct result of the interaction brought about by this project, students reported that their interpersonal interaction continued outside the lab. At the most basic level, it increased the number of hellos and smiles students received when walking across campus. This increase infamiliarity was not limited to the student-to-student relationship. Professor Phillips noted that, when offered the opportunity to speak and both the Art & Music area student meetings at the start of the 2021-22 academic year, the ability tostrike up a casual conversation with student participants of the project made him feel like a part of meeting not an interloper. The faculty members involved with the project also reported in increased ability to freely communicate with each other. This was in large part because relationships, that had once been collegial and professional, became friendships because of their collaborative work towards a shared goal.

These evolving relationships caused Catenate to become an opportunity for thinking about a larger creative community, the School of Visual and Performing Arts, and brought awareness to the variety of programs within the school. Students and faculty looking for ways to engage with other members of the SVPA can now do so through the Catenate project

2. - To create an artistic outlet in response to the many workshops, concerts, and production canceled or significantly modified due the Covid-19 Pandemic.

The participants were offered many opportunities to create, shareand learn. While a "finished" project is still a way off, both students and faculty were allowed to expand their experience with new techniques, technologies, and areas of study. Some of these opportunities included:

~ An introduction to and practical experience with theatricalstage automation equipment and software.

~ ~The use of paper and paper manipulation to create works of art.

~ Practical experience with syncing video, lighting, and automation equipment to achieve an artistic event.

~ The use of Arduino micro controllers to explore how the "internet of things" might be applied to an artisticinstallation.

3. - To explore the interrelations of sight, sound, and movement while developing new experiences outside the confines of traditional assessment models

Because there was no hard deadline, students could expand on skills and concepts learned in class that would not have been possible during the regular academic setting. The students were allowed to determine the rate of progression. Their understanding of a process set the pace, not a syllabus, gallery opening, or performance schedule. This enabled the students to dwell on interesting discoveries for as long as they like, setting the pace for learning new material. As one participant stated "it felt like itdidn't matter how far we got that day and that as long assomething got accomplished the day was successful. The meetings became my relaxation time. Everything in school and the shows I was working on were so high pressure the automation lab became the place where all pressure was off. It was a space where the time could be taken to explain things where in other situations that would not be possible or would take too much time."

We were also fortunate to experience a little serendipity while working on Catenate. One such success was in the utilization of the inherited space of Taft 114. The age of the building allowed for a carefree and inventive approach to how the project evolvedand helped create a workshop vibe that would have been hard toreplicate in a newly constructed lab. The physical location of thelab was a boon as well. The proximity to the art and music buildings facilitated easy interaction and helped further breakdown perceived silos.

B. *Challenges*

An issue that looms large in the minds of the faculty was the student selection process. Individually, each faculty member hand-picked students from their respective areas based on their performance in those areas. There was little to no consideration given whether these students would work well as a group, let alone feel comfortable doing so. The group dynamic could have played a large part in the lack of engagement as the semester progressed. Buy-in at the student level is crucial for a project of this kind to be successful. As mentioned above, the project purposely

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was without external motivation (grade, credit), assuming students would be relieved by this fact. However,

based on students' feedback at the end of the term, the Catenateproject was too open-ended and vague. Mourtos [1] states that engagement is attention, which comes because of a perceived need or purpose in the first place. There was not an established need or purpose, at least on the part of the students. The faculty intermediaries felt an ardent desire to instigate this project but failed to get total buy-in from the students who were "chosen" by the faculty. Students wanted tighter parameters and clarity offocus. They desired more structure and a set problem to solve. Cambourne [2] lists engagement as one of the seven conditions that must be satisfied for true learning to occur. The ideal environment for engagement is immersion and demonstration. The Catenate lab was immersive with a variety of technology, tools, and materials available to students to use at will. What theproject lacked was a distinct demonstration process regarding the technology, tools, and materials. Although Professors Phillips and Eddings were available in the lab during open hours, a formal demonstration process was not implemented.

The comfort level of the immersive studio varied with each student group. Technical theatre students were comfortable withmuch of the software while lacking knowledge of the use of traditional studio art materials. The reverse was evident in the attitudes of the art students regarding technology and automation. Once engagement occurs, Cambourne explains, students can try to emulate without fear if their attempts are not "correct." While the students were excited to participant, they needed the "first link" to connect their ideas. Reframing the opportunity inherent in this type of project and clearly demonstrating the software, the technology and lab materials may engage more students. The most cumbersome aspect of the whole project was the scheduling. There is a myriad of ways to do this differently. Although a weekly schedule was established through numerous Doodle polls sent out throughout the semester, this tactic proved ineffective in getting a more substantial number of students involved.

VII. SUMMARY: MOVING FOWARD

As the project moves forward, several improvements and

adaptions will be pursued to improve the project's reach and outcomes. Firstly, we will reevaluate how participants are being recruited and develop a methodology to prevent unintentional exclusion. Secondly, we will create regular scheduled meeting times to help encourage student comments and schedule the project into their busy lives. Lastly, we will look at ways for the faculty to provide the missing first link. This can be accomplished by starting the school year with a faculty drive project that the students could build from. This will be the demonstration model that will encourage engagement and therefore the potential for deeper, more committed collaboration.

In all, the Catenate Project was viewed as a success by those who participated. That students were able to get first-hand experience in the creation of a collaborative project was worthwhile. While it did have its obstacles, there are plans in place to mitigate those in future iterations. This project has cultivated additional ideas, such as engaging a guest artist to lead our students through the process of creating an inter-arts installation within a gallery on campus. This example illustratesto us how one idea begets another, linking to the one before it, creating a continual chain of creative expression representative of all disciplines within the School of Visual & Performing Arts.

Appendix 1 – Equipment Used

Lighting
- ETCNomad
- ETC Gadget II
- ETC Source Four LED Series 2 Lustr
- Mi-Light Wireless DMX Light Bulb

Sound
- QLab 4 (also used for Video)
- Focusrite MIDI Interface
- Akia MPK mini–MIDI Controller

Automation
- Creative Conners Stage Automation
  - Spikemark Pro
  - Pushstick Mini
  - Spotline Mini
  - Spotline
  - Stagehand FX

Other
- DecaBox Midi to DMX Controller
- Assorted Arduino Boards
- Assorted Hand and cordless powertools
- Video Projectors

Appendix 2 – Glossary

Arduino. An open-source hardware and software company. They design and manufactures single-board microcontrollers and microcontroller kits.

CNC. Stands for Computer Numerical Control. Anautomated means of controlling machining tools via computer.

DMX. Stands for Digital Multiplex. The standard communication protocol for lighting controllers and equipment. For more information see ANSI E1.11-2008(R2018) available for free at https://tsp.esta.org/tsp/documents/published_docs.php

ETC. Stands for Electronic Theatre Controls. An international leader in events lighting technology. Moreinformation can be found athttps://www.etcconnect.com/

ETCnomad. Lighting control software by ECT that is installed on a computer and enabled by a USB dongle. This dongle is compatible with Eos, Cobalt, and Hog 4 family software and allows a computer to be a lighting controller.

I/O. Stands for Input/Output. Allows for switches and sensors to be connect to various control devices.

LAN. Stands for Local Area Network. A collection networked devices connected within a limited area.

LED. Light-emitting diode

OSC. Stands for Open Sound Control. a music- oriented electronic communications protocol used in computers and multimedia devices. More information can be found at http://opensoundcontrol.org/

PoE. Stands of Power Over Ethernet. Allow for the distribution of both power and data over standard ethernet cabling.

QLab. Is a sound, video, and lighting control software for macOS by Figure 53. More information can be found at https://figure53.com/

Spikemark. Scenic automation control software by Creative Conners, Inc. Used to program, cue and run Creative Conners scenic automation. Available for free at https://creativeconners.com/products/software/

Source 4 LED. A theatrical lighting instrument manufactured by Electronic Theatre Controls (ETC) using an LED light engine.

Stagehand FX. An I/O controller by Creative Conners designed to work with their stage automation system.

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Studio D Institute – Making at a Distance and the Impact of Collaboration

Marlo Ransdell, PhD
Associate Professor
Director: Studio D: Design and Fabrication
Department of Interior Architecture and Design
Florida State University
Tallahassee, FL, USA
b-phillips.5@onu.edu

Robert Coleman, MFA
Associate Professor
Director: MFA Technical Theatre Program
Department of Technical Theatre Production
Florida State University
Tallahassee, FL, USA
m-eddings@onu.edu

Abstract—**This paper focuses on two themes: the development and implementation of virtual studio and remote makerspace interactions in a small, focused fabrication shop for design prototyping; and a reflection on how these strategies may be employed by much more complex technical theater fabrication shops. The shop that will be the focus of the case study is Studio D, which is a design and fabrication lab in the Department of Interior Architecture and Design at Florida State University. It collectively houses the Studio D woodshop (est.2012), Studio 3D lab (est.2017), and the Materials and Objects Testing Lab (est.2019). The mission of Studio D is to provide learning opportunities for interactive and experiential learning in person and remotely for prototype development of designed objects. Studio D supports critical thinking through problem identification, context research, ideation, development, and solution testing for real-world design problems. The Studio D Institute summer residency program was launched in the summer of 2021 to bring academics and professionals from various fields into the virtual studio and remote makerspace through sponsored design residencies. This experience has led to collaborations with the MFA Technical Production Program at Florida State University's School of Theatre and has impacted the future directions of thought on the opportunities of making at a distance for creative and experiential fields. This paper will outline the development of Studio D by Marlo Ransdell over the past two years and conclude with a reflection by Robert Coleman on how this can adapt to larger and more complex remote interactions for the Technical Production aspects of the live performance entertainment field.**

Keywords—education, digital fabrication, design, theater

I. INTRODUCTION

The past year has brought unexpected and sudden changes to the use of physical learning environments. This is especially true of experiential learning spaces, such as performance, studios, makerspaces, and equipment-rich environments like that Studio D presented here, that practice and rely on in-person demonstrations and interactions. Experiential learning spaces are essential aspects of higher education learning as they support "communities of practice," which foster learning beyond the classroom (Kolb & Kolb, 2005). Rethinking the use and pedagogical approach of "hands-on" was paramount recently and maintaining the investment in this physical and equipment-rich environment, the transition to a hybrid system became more critical than ever. The shift in the makerspace's physical use and its newly found remote relationship to the virtual studio at Studio D evolved over the past year. This case study will focus on the organization of this small-scale virtual makerspace and the implications for other experiential learning spaces to incorporate hybrid and remote strategies.

II. BACKGROUND

During the spring of 2020, the makerspaces at Studio D found themselves in a limbo state with no activity for six weeks. The use of software and technology to accomplish the final course goals was reactionary and strictly facilitated the virtual studio's minimum levels of success. The immediate needs that arose in spring prompted the development of a pilot study during the summer of 2020. The pilot study successfully connected four design professionals in different locations in the virtual studio and with the remote makerspace in real-time for process and product development. The lessons learned from these experiences formed the fall 2020 hybrid approach for graduate students, which successfully navigated in-person as well as remote studio and makerspace activity depending on the current day or student needs. Access to the equipment that students were using was available through webcams in real-time allowing students to view their production from anywhere. Logistics included remote file sharing, on-screen critiques, production files checks, machining toolpath setups, animations of production, and final prototype production. The results from the past year show that students can involve themselves in all studio and makerspace activities at Studio D in real-time regardless of their in-person or remote class status.

III. CASE STUDY APPROACH

Managing the virtual studio's relationship and the remote makerspace led to the launch of Studio D Institute in the summer of 2021. There existed a field-wide gap Studio D was uniquely positioned to fill as there are currently very few opportunities for general design residencies within the field. Studio D is working to become a unique leader in this field by using the makerspace to bring together design professionals and academics in a creative "virtual" residency program.

The architecture and design fields see limited collaboration opportunities between academia and the professions to learn together, and further, the design field relies on experiential learning and interaction, which has been limited. The virtual Studio D platform (video conferencing) allows collaboration to the remote Studio D makerspace for ideation and testing. "You can be anywhere, but I can still help you create and produce your works in Studio D." The pandemic has challenged design professionals and academics, who are used to hands-on learning, teaching, and professional work but, to this point, little remote collaboration. Studio D is meeting this challenge through the creative use of remote and hybrid-in-person spaces to accomplish design goals. We now must reinterpret what we do and how we do it under these new circumstances, viewing it as an opportunity.

IV. IMPLEMENTATION

The Studio D Institute summer residency program for design and design-related academics interested in digital fabrication prototyping was conceived and pilot tested over the spring and summer of 2021 after the success of the 2020-2021 academic year. The goals were to provide a supportive community, expert guidance, and remote access to digital fabrication equipment for creative and research related projects; all of which were not readily available to participants in their home locations. Academics in allied creative fields such as art, theater, and dance regularly attend summer residencies as a means of focused professional and career development (Dawson & Kelin, 2014). Residencies can offer dedicated time to further individual creative projects and research agendas over an extended period within a supportive environment and community of practice (Elfving, Kokko & Gielen, 2019). Application for the summer residency program were accepted online for six weeks during March and April, and follow-up virtual interviews with all applicants took place over two weeks in May. Of the 16 applications, four were appropriate in scale, scope, and need for support in the pilot program. The participants represented interior design, product design, visual art, and dance and were in Florida, Ohio, Illinois, and Argentina. Each participant received a mailed "welcome package" that included samples of materials available for projects along with fabrication examples from the machines available. Weekly meetings and mailing of process work were facilitated by the program lead and assistant and took place over eight weeks in June and July at the participants' convenience. The overall budget for the project was minimal at $6000; this covered modest salaries for staff, appropriate stipends for participants, and all material and mailing costs. This convergence of digital software, machines, and the creative person happened daily over the two-month span and drove the institute's trajectory during the summer of 2021.

V. CONCLUSION

The goal to fill the void for academics and professionals in the design field during the summer months by providing access to not only the machines, software, and materials for making but the expertise developed over the past decade of teaching making within the Studio D labs. Makerspaces and the experiential pedagogies they support present a unique opportunity in the era of authentic and meaningful distance learning.

VI. REFLECTION ON FUTURE WORK

The following is a reflection on the Studio D virtual studio and remote makerspace and the impact that could be seen in the field of Technical Theater Production by MFA Technical Production Program Director, Robert Coleman.

I have learned many things to my benefit as well as the benefit of the MFA Technical Production Program for the School of Drama I direct at Florida State University through my collaboration with Studio D and Dr. Ransdell. Among those things is that the pedagogy around which I designed our program—coursework supported by practice—has a name. We now refer to that pedagogy design as experiential training. Perhaps we always have identified this method as experiential; still, it is a relatively new term for me. Dr. Ransdell and I identified a commonality between our work methods. That coupled with an awareness of Dr. Ransdell's deep experience in developing techniques to support remote making alerted me to the possible benefits to both our programs Studio represents in current and future work.

Initially, I did not recognize the flow of the development of methods and technology to facilitate creative activity at a distance, the value of sharing the equipment and expertise demonstrated through chosen projects, and how that offered expanded opportunities for individual makers. What was a challenge for me was how to employ what I then considered the reverse flow- using the techniques in collaborative and tradition-steeped technical production practices in my field, traditional theatre.

Let me take a moment to outline our scenic production process. Our students are assigned progressively greater responsibility over their 3-year course of study supported by progressively more rigorous and specialized course work. An example of such course work would be Structural Design for the Stage, a 3 semester, 45-week series. By or before the 3rd year, the student act as Technical Director for one or more of our productions, having progressed from Assistant Technical Director for several productions previously. A note: we have no staff technical director at the School; our students are assigned that responsibility. They also act as Assistant Production Managers and various other roles as appropriate.

The challenge for me was how we might productively apply Studio D's methodology –a methodology that was clearly effective supporting chosen—often individual--creative activity—to a more defined, collaborative, production process. While we commonly work remotely with the 'creative' contributors—the Stage Director, Lighting Designer, the Sound Designer, et c.—how do we apply remote making to the more 'hands on' activities such as shop management, technical direction et c.? And frankly, given our traditions, why would we work that way?

To answer the 'why'—a couple of reasons come to mind. If the pandemic has taught us anything, it is that must be prepared to work and communicate in ways other than face to face. We need to continue to identify the numerous ways in which remote interaction might be an improvement on traditional methods. We will count discovery and implementation of new and effective remote management and collaboration in the future as a primary goal.

We will continue to adopt and 'beta test' Studio D's experimental work in our more defined and practice-based

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technical production processes. We will discover new economies by developing further collaboration. For one example of possible economy through collaborative remote use of equipment, our Technical Production Program has a technically advanced Computer Numerically Controlled (CNC) router—2 actually—coupled with hard-earned expertise in its operation at our School. While often used in our production process, there are periods of down-time. Why would other theatre groups in Tallahassee—or in any area to which shipping is economical for that matter—invest roughly $65000 in this equipment when accessing it might be as simple and economical as sending a computer file by email? Our future work will include exploring and promoting this aspect of practice-based remote making informed by the more experimental results of Studio D's work.

Let me now cite another important focus of our current and future research. I, like many of you, have been involved on live performance entertainment for roughly 35 years. In that time, I have never seen such high demand for employees, particularly management level employees, across such a wide spectrum within respected institutions, institutions with historically low staff turnover as exists at present. The pool of well-prepared candidates for these positions has always been shallow. I invite you to develop a substantial list of experienced and demonstrably capable Props Masters, Costume Shop Managers, Scenic Charge Artists—managers without whom we cannot operate effectively—but only if you have a high tolerance for disappointment and frustration – they are very hard to find.

How can we adapt what we are learning about remotely guided management from research to broaden and more efficiently utilize our limited management resources? And I assure you, these resources will continue to be limited for the foreseeable future. On the one hand, programs such as ours only turn out 4 or 5 candidates annually. That's in our case and the number is generally lower in most other cases. On the other hand, evidence- admittedly anecdotal in nature-- gleaned from conversations among my circles on the subject we might call "Where the heck did all the theatre folk go?" indicate that many of our colleagues just didn't come back to theatre after the pandemic. Apparently, some close to retirement elected to take retirement; some found other work with perhaps greater benefits –including being at home evenings and weekends; some are unsure of the safety of returning to our industry without greater assurance that the risk of illness is very dramatically reduced.

Therefore, we will add to our research foci discovering answers to questions such as "If we are familiar and comfortable with interacting with our Scenic Designer remotely, why not our Technical Director, our Costume Shop Manager, or our Scenic Studio Manager given our enhanced technology coupled with experience gained during the continued pandemic? Why couldn't we remotely share those limited management resources with several institutions?"

At first blush, it seems like the basic requirements to achieve these goals are improved scheduling and time management and a fresh examination of traditional practice to include remote making.

To close, let me reiterate that important among the goals of our future research are:

- Enhanced utilization of human and technological resources.
- Greater access to, and support for, creative activity on both individual and collaborative levels.
- The development of further experiential pedagogy.
- And, of course, the incorporation of any discoveries we might make through our research into our continuing practices on a beta level-- with dissemination of proved practice through Symposia to which it is currently our privilege to contribute.

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Developing Soft Skills with Interdisciplinary Teams in the First Year: Lessons Learned

Christian Rogers

Associate Professor, Computer Graphics Technology
Purdue School of Engineering & Technology

Indiana University-Purdue University Indianapolis Campus

Indianapolis, IN, USA

rogerscb@iupui.edu

Abstract— **The academic structure of most universities dictates that a student work with those of their own program and in conjunction with a program that is tangential to theirs. Interdisciplinary educational experiences that provide students with the opportunity to develop soft skills (such as communication, empathy and problem solving) are considered rare but are much more common in the working environment. As an example, working environments such as Universal Creative are comprised of multiple disciplines (i.e. civil engineer, mechanical engineering, illustration, user experience design, etc.) A function of working in an interdisciplinary team can also be to work on unknown or "wicked problem" that has no defined answer. This presentation will provide an overview of the Jag Challenge, an innovation sprint experience for incoming students to the university. Students work in teams of three as they are provided a challenge space, find specific problems within that space, conduct stakeholder interviews, develop empathy maps, ideate, conduct secondary interviews and then present their final solution. In Fall of 2019 over 210 incoming students participated from eight first year experience course sections. In 2020 over 350 students participated in a virtual or hybrid format of the Jag Challenge. While one section may be comprised of mostly engineering students or business students most sections were interdisciplinary (i.e. a nursing student working with an education student).**

Keywords— innovation; human-centered design; empathy; soft skills, interdisciplinary learning

I. INTRODUCTION

Todays colleges offer defined programs that allow students the opportunity to engage deeply within their discipline. The ideal situation is that professors mimic the working environment of the discipline they will go into. As a college student continues to engage with their program they will face many complex challenges that reflect the industry they are entering both individually and in teams. The disciplines these students enter into may have structures that do not reflect the teams they found in their classes. Within the entertainment industry teams may be more diverse with multiple disciplines engaging in one problem. For example, within the field of themed entertainment, a team of engineers will work closely with concept designers, illustrators and financial executives from diverse backgrounds, cultures and ethnicities to develop a new attraction.

Students leaving their college careers are entering a workforce where they are not guaranteed to obtain a job or internship weeks or even months after graduating. A study conducted by AfterCollege found that 83 percent of students do not land a first job before graduation, or even months afterwards (Rutt, 2014; Johnson & Maness, 2018) There is a reason for this gap in employability of students. According to Spisak (2016), studies show that job/career success is based on 75 percent soft skills and only 25 percent hard skills. With the lack of soft skill development students end up falling behind. It was also found that professionalism, teamwork and interpersonal skills emerged as positive predictors of chances of getting a permanent offer of employment (Dabke, 2015).

Teams must be taught project management and execution within the constraints of a budget and timeline, how to inspire creativity (the creative process), and how to communicate with one other and deal with conflict. Employers are looking for students who can not only practice the skills of a discipline but also embody the soft skills that are needed to excel in the workforce. "Though the importance of soft skills is widely acknowledged, soft skills curricula are either non-existent or underdeveloped in most universities" (Hart Research Associates, 2015). Johnson & Maness (2018) continues this thought by stating that "Hard skills are essential for any career and they are very real. However, an employee's ability to effectively apply these skills in the workplace will depend on their ability to collaborate with other people on projects that further the goals of their organization". Employers want to hire people who can work with people from different disciplines and cultures and who are ready to apply hard skills with other people on complex projects. When starting a new graduate degree in entertainment technology Pausch & Marinelli (2007) visited potential employers. Their research asked multiple questions but primary why they would not hire a student. The unanimous answer was that students could not work effectively in interdisciplinary teams. University programs were not preparing students to work in these types of teams and students needed to not only work in these teams but be taught how to do so.

Interdisciplinary learning is where individuals from various disciplines must contribute to a shared goal. An individual from one team (such as an engineer) may work with an artist to complete a task or goal. Interdisciplinary teamwork rely on a common understanding and shared knowledge where individuals then work with each other on specific problems towards a solution (Research Development Office, 2020). Richter and Paretti (2009) define interdisciplinary teams as different domains collaborating as they identify, integrate, and value multiple perspectives and to learn from one another in ways that reshape their own understanding and practices. They go on to state that "interdisciplinary learning involve more than simply adding new content from other fields, but also understanding and integrating new values and approaches to problem definition and problem-solving" (Richter and Paretti 2009, 31). This definition aligns with Lattuca's concept of interdisciplinarity in which individuals from a team may continue to act as experts in their own domain but work together to integrate knowledge across those boundaries as they learn from one another (Hixson et. al. 2013).

Accrediting bodies for various disciplines acknowledge the need for interdisciplinary teams. For example, the Accreditation Board for Engineering and Technology, Inc. (ABET, na) requires that students have an experience with interdisciplinary learning. "It is a commonly accepted leadership principle that interdisciplinary teams will be more effective at achieving a desired outcome. Additionally, there are reports from several groups that describe improved outcomes from interdisciplinary design teams" (Blair 2021). Often, within engineering programs interdisciplinary teams are limited to one type of engineer working with another. Within certain fields (such as in entertainment) an engineer may be working closing with much more diverse disciplines such as an engineer working with a sculpture or 3D designer and thus need to experience working within an interdisciplinary team structure.

Currently, programs in higher education with interdisciplinary teams are limited but those that have an interdisciplinary component have seen positive results. Oden, O'Malley, Woods, Kraft (2012) presented results from their current course capstone in design engineering to evaluate the inclusion of interdisciplinary teams. "A wide variety of positive outcomes have emerged from combining our capstone design courses. First, students have been able to successfully tackle design challenges that would be quite difficult to accomplish with students of only one major." They go on to say that presenting problems to an interdisciplinary team allows for a more realistic representation of the design work that students will face in the industry. By positioning this within a class structure they have been able to incorporate business planning, market assessment and entrepreneurship into the class for all students.

A. *Pedagogical Underpinnings*

Constructivism and situated learning can be used to support interdisciplinary learning. Constructivist approaches emphasize the learner's active role in building new knowledge rather than passively receiving information (e.g., Duffy and Cunningham 2004). Situated learning emphasizes that knowledge is dependent on the context in which it exists (e.g., Greeno, Collins, and Resnick 1996). These theories point toward the need to engage learners in authentic activities in which the acquisition of knowledge and the application of that knowledge in "real- world" contexts are intertwined.

Another model to consider is the Spiral Curriculum, proposed by Jerome Bruner in the 1960s. The Spiral Curriculum "shifts education from a model in which content comes first and application second to one in which learners are engaged in authentic ("real-world") applications of knowledge at ever-increasing levels of complexity across a curriculum" (Bruner 1960). Although not stated explicitly, this framework underlies much of the recent curricular developments in engineering education. "For example, it stresses design across the curriculum in which design moves from being solely a capstone experience to one in which learners are 'doing' design consistently across the curriculum even as they continually acquire new knowledge that allows them to design increasingly complex products or processes at more sophisticated levels" (Hixson, Paretti, Lesko, McNair, 2013).

As more programs within the university system are developing interdisciplinary experiences faculty must have a clear understanding of how student teams should function and what should be taught in courses that have these types of experiences. Currently, little research has been conducted to understand how interdisciplinary teams can be taught. While this may be common in some industries there is little done within university classrooms to support the development of these types of skills.

II. METHODS

Indiana University-Purdue University Indianapolis (IUPUI) has a history of instilling highly engaging practices into the undergraduate experience. These are often categorized as high impact practices according to the work of George Kuh (2008). High impact practices are practices that are proven to be highly engaging and impactful experiences for students that are known to show higher numbers of retention. Examples of high impact practices are first year experiences, e-portfolio, undergraduate research, and project-based learning. The university also has a legacy of providing faculty with overarching learning objectives that give faculty a common target for classroom and pedagogical development. In 2018, IUPUI restructured these learning objectives into what is now known as the profiles of undergraduate learning. These are common profiles that allow students to become engaged in one of four areas which are community contribution, innovation, communication, and problem-solving. One of the primary high impact practices is first year experiences which comprise a Summer Bridge week before classes begin and a course during the fall semester.

Bridge week is a five-day experience where students are given an opportunity to learn about college life, familiarize them themselves with the University, develop new connections on the campus, familiarize themselves with the surrounding city of Indianapolis, and gain an understanding of what is expected of them when they enter college. To better align the profiles with the first-year programs a new experience was created. With the help of an internal grant Dr. Christian Rogers and Ms. Heather Bowman began the process of creating what is now known as the Jag Challenge experience. This experience provides students the opportunity to engage with five distinct learning objectives.

- Students learn to build empathy for target audiences from different "perspectives"
- Students can articulate a minimum of one strategy for solving a problem
- Students will be able to present idea through various modalities in a public form

- Students learn to leverage the skills and abilities of all team members including cross- disciplinary/ cultural contributions

The underlying purpose for choosing each of these objectives was to focus on soft skill development in an interdisciplinary setting of students from across campus.

A. Recruitment of faculty

In order to create a common experience for all students participating in the Jag Challenge it was important to identify faculty that were already familiar with human-centered design and were interested in engaging first year students as they went through the process. Thus, faculty were individually asked to join in the Jag Challenge (both in the 2019 and 2020 pilots). In 2019 eight sections (210 students) participated. This was done in a face-to-face format. In 2020 eighteen sections (357 students) participated. Due to the pandemic the Jag Challenge was placed with in the first semester and took place over a 10-week period in a virtual or hybrid format. Some of the sections were made up of students that were focused on specific areas (such as STEM) while others were comprised of multiple disciplines (i.e. nursing and education, creative writing and business).

B. PROFESSIONAL DEVELOPMENT FOR FACULTY

While some of the faculty understood human-centered design others did not. Human-centered design is designing based on the philosophy that empowers individuals or teams to design products or services for those that are experiencing the problem. For the 2019 pilot a training session was conducted to better support students going through the Jag Challenge (and thus engaging in human-centered design). Faculty learned about the processes and mindsets that the students will go through following human-centered design methodology. This training also served as an information session where instructors could ask questions and understand the learning objectives and value of this experience for the students. For the 2020 pilot (due to the pandemic) we were unable to do a common faculty training. An informational video was presented to faculty in leu of a training session.

For supplemental support materials instruction was given to faculty in a PDF guide format (2019). In 2020, the instruction was further refined to include instructional videos and an online module that could be installed in individual course shells (via the Canvas LMS).

III. C. FORMAT

The Jag Challenge is a multi-step innovation experience done in a sprint format. Students are given limited time to complete specific tasks which is why it is often considered a sprint. For both the 2019 and 2020 pilot students followed a similar format. The steps are as follows:

- Challenge Space – Students are given one of multiple problem spaces. The problem spaces are designed to be highly ambiguous to allow for multiple problems to be found within that space
- Empathy – Students are individually given the task of finding one person who is a stakeholder connected to that problem space. They are given specific instructions on how to interview them (so as not to lead them) and find from their perspective what problems exist in that problem space. Students then meet with their teams to discuss the interviews and pick a problem. For the 2020 pilot students were given the additional task of developing a profile of the person who would experience that very problem utilizing an empathy map (see Figure 1).

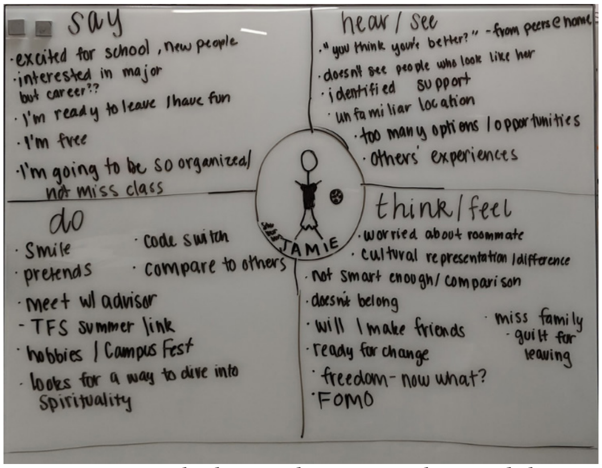

Figure 1: An empathy diagram depciting insights revealed through a student perspective discovery interview.

- Ideation – Students are led through a time activity to develop multiple solutions for this problem. Students generate multiple possibilities before landing on three possible solutions. They are then asked to go back to their original interviewee to obtain feedback on a final solution.
- Prototyping and Presentation – After conducting their second interview student teams come together to develop prototypes and presentations for sharing with their class and a final showcase experience. A prototype could be a working model of their idea (such as a mockup of a mobile app or technology or a physical model). Other students created posters or slide presentations to share.
- Reflection – Students individually reflected on their experience with Jag Challenge. They have to restate the problem space, discuss the results of their interview, present multiple possible solutions and discuss the final solution. They also reflect on their experience in being part of a team structure and their overall experience with Jag Challenge. This was added for the second pilot.
- Final Showcase – Students have to present their final prototype and presentation to their individual class and/or as part of a larger showcase. For the first year all students participated in a final showcase (similar to a science fair) on the last day of bridge week. For the second year the instructor for each section picked the best presentation to move forward to a virtual innovation showcase which took place online via Zoom and broadcast over YouTube Live (see Figure 2 & 3).

Figure 2: Students presenting at the 2019 Jag Challenge Showcase

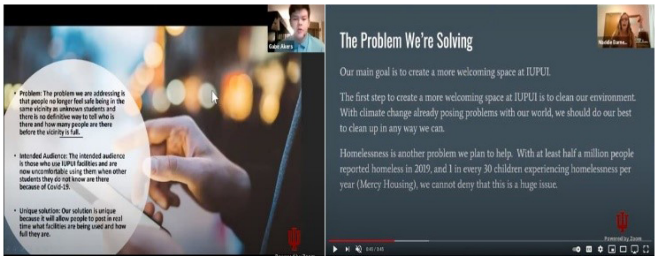

Figure 3: Students presenting at the 2020 Virtual Jag Challenge Showcase.

IV. RESULTS

The Jag Challenge is highly experimental. Very few (if any programs) exist like this within the first-year experience and include interdisciplinary teams working together to come up with innovative solutions after identifying their own problems. Many variables must be considered in the development of a high quality program for students. What follows is a discussion on some of the primary steps in the process that present evidence of skill development within interdisciplinary teams.

A. *Identifying Challenge space for students*

Students were given one of multiple problem spaces in each of the two pilots. Faculty could choose the problem space for their student teams or allow the teams to choose their own. For the first year pilot the problem spaces were (a) creating a more welcoming space on campus, (b) sustainability, and (c) improving the relationship between IUPUI and the city of Indianapolis.

For the second year of the pilot the sustainability problem space was dropped and two new problem spaces were included. They were (a) creating a safer space at IUPUI, (b) rethinking the university experience online. The purpose for the change in problem spaces was to align with the natural experiences that the students were going through as this was at the height of the pandemic with many of the students experience all of their courses online and face-to-face courses with safety precautions in place. Students within different disciplines often had to come to a decision on the problem space they would engage with which was a challenging experience for them.

B. *The first day*

During the 2019 pilot faculty met with all students who were participating in the Jag Challenge experience. Students were introduced to the Jag Challenge and a presentation was given on what the purpose of the Jag Challenge. The main pitch to the students was that they were now a part of the IUPUI community and as members of that community we needed their help and input to make IUPUI a better place. Students were immediately presented with their first step which was to conduct individual interviews. Students were given instruction to ask open ended questions of their interviewees about the specific problem spaces and to not ask questions about individual problems. This common presentation was not included during the 2020 pilot due to the various formats of each section. Instead, students watched a welcome video which presented the Jag Challenge to them with similar content.

C. *Team development*

Working with teams from different disciplines came with various challenges. For example, students who were considered exploratory (did not have a defined major) found it a struggle to understand the type of problem spaces they would want to work on. Students who had declared majors wanted to work on problem spaces that were tied closely to their major. Students also struggled with common team-based projects as some students did not pull their weight. Team members would work to engage less interested individuals but found it difficult. Team selection was often done at random by counting numbers but it was also different from section to section.

D. *INTERVIEWING AND EMPATHY MAP*

One of the greatest struggles for a student was to interview a stakeholder without the inclusion of any bias in the interview. Students were given the task of identifying a person (faculty, student, community member, staff) that was close to the defined problem space and conduct an interview with that person. They needed to ask open-ended questions and bring no actual problem to the conversation. The primary purpose for this interview was to find problems that exist within the problem space and bring those to the table with their fellow teammates. The second primary task was to create an empathy map that helped the students to categorize a person and create a profile for a person who might experience this problem. For some students this was their favorite part of the experience. For others it was highly confusing. It was found that much of this was dependent on how the instructor either taught or augmented the instructor videos that were given to students.

E. *Ideation*

Ideation was considered by students to be one of the most fun parts of the process. As students came up with ideas they had to share those ideas with their teammates and then add to those ideas to come up with as many as they could. For the 2019 pilot this was done face-to-face with sticky notes. Students were each given a stack of notes and had to write down as many ideas as they could within a timed format. They then moved to a "plussing" phase where students followed a "yes and" model. For example, a student may say that there should be a locking system for all doors at IUPUI and someone else may say "Yes! And we should use our student ID's to open them." The next phase was designed to eliminate some ideas and finalize three ideas to then share with their interviewees for feedback. What was found was that with some sections the instructors ignored the time allotted which did cause some confusion for students. In virtual sections (during the 2020 pilot) students used technology such as Google Jamboard which is a free platform

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for sharing virtual sticky notes.

F. Prototyping/Presentation

Students had to find a way to present their final ideas to their classes and a wider audience. For students in the 2019 pilot, they had the opportunity to utilize physical mediums to prototype such as construction paper, cardboard, markers, and posterboard (see Figure 4). For students in the virtual environment all presentations were slide presentations where students created a pitch presentation. Students had to consider how they would methodically present the problem space, the problem, the audience that would experience that problem and then why their solution was appropriate for the problem. Each solution varied on the level of innovativeness that was presented. Some solutions were highly innovative but ungrounded practically while other solutions were practical but not innovative (i.e. more police on campus or to hold classes outside). It was noticed that during the 2020 pilot the students struggled due to the pandemic and the level of innovative ideas dropped significantly.

Figure 4: Students preparing for their final presentation.

V. ASSESSMENT AND CONCLUSIONS

Having conducted two pilots of the Jag Challenge that were different in format (2019 within 5 days and face-to-face and 2020 virtual/hybrid over 10 weeks) much can be learned that is beneficial both to the future of the program and to programs that are feeders for industries that could benefit from interdisciplinary teamwork. While the Jag Challenge included students from various disciplines insights can be drawn for usage within entertainment and engineering programs as well.

A. Team-BASEd COMMUNICATION

As presented by Hart Research Associates (2015), there is a strong need for the development of soft skills. It was noticed during both pilots that students were given opportunities for develop in interpersonal communication skills through team introductions and development. As students engaged with each other from various perspectives each member had to understand how to come to consensus and work with each other. Even as teams were deciding on challenge spaces they would often want to choose a space tied to their discipline rather than be open to others (i.e. nursing students wanting to work on safety instead of considering another option). With varied individuals on each team they had to come to consensus on the challenge space as well as the ideas that were generated. Students also had to learn about each other by participating in various personality tests which helped them better communicate as a team and understand various roles.

Students also had to develop their ability to communicate publicly as they presented during the Jag Challenge Showcase. Students developed multiple ways to share their ideas. Some students created mock-ups of physical spaces. Other students created virtual prototypes (often called low fidelity prototypes) while others created posters or slide presentations. During the 2019 pilot the showcase consisted of presenting their idea to multiple individuals (including institutional administrators) in a science-fair style format. During the 2020 pilot the top teams from each class presented their innovations publicly in a virtual format (streaming over YouTube).

Students developed through their ability to research various challenge spaces. By conducting interviews and looking at various internet resources students needed to understand how to find specific problems but also understand the context of that problem and then create solutions to solve the needs of the people who experience that problem.

B. EMPATHY

As posited by Bruner (1960), the spiral curriculum proposes designing through throughout the course rather than learning and applying later. Students in the Jag Challenge had to continually design and iteratively build on previous insights. It was noted that as the students went from one interview to the next that their designs changed and shifted to accommodate the needs of those who experienced the problem. By conducting these interviews it led to greater empathy as students needed to solve problems from another person's perspective and not just their own. This was noted by commentary in final reflections.

C. DEALING WITH AMBIGUITY AND FAILURE

Students are often given an exact problem to solve and specific criteria to solve that problem. As students enter the workforce, they need to recognize they are not going to be given all the criteria to solve the problem or even know what problem exists. It is their responsibility to find stakeholders who understand the challenge space so that they can identify the problems that need to be solved in that space. Within the themed entertainment industry employees may be given specific criteria (a specific storyline or IP) but for many it is on the organizational team to develop the concept. It is also valuable to listen to the needs of the client as the outside perspective or the guest (or the guests of the client).

It was found that students struggled with this ambiguity that was presented through the Jag Challenge curriculum. The underlying fear was that if students did not have constraints given to them that they would ultimately experience failure. Ambiguity and failure have been presented as a common struggle in other studies (Liu and Schonwetter, 2004). Students were not given specific examples for how to find a problem (other than suggested questions for interviews), or examples of solutions within each challenge space.

As students were moving throughout the Jag Challenge experience some developed solution prototypes that weren't exactly what they had initially planned. It was important for them to understand that failure is acceptable and inventible. One such example was a section where multiple teams struggled with developing innovative solutions. The instructor had them meet as teams' multiple times and pushed them to rethink their solutions to come up with something more unique to the proposed problem.

Mourtes (2010) found similar results as students who participated in a re-designed aerospace engineering course focused on problem-solving. Results from that study indicated that coaching, working in teams, and time management provided support for students and increased their confidence which led to a decrease in anxiety. This was found with the Jag Challenge as students went through the process. Students indicated increased confidence in solving problems in a safe environment where ambiguity and failure are accepted.

D. PROBLEM-BASED LEARNING

Jag Challenge has presented itself as a way of implementing problem-based learning (PBL) from the beginning of a students college career. Problem-based learning has been posited by the Accrediting Board for Engineering and Technology (ABET) as an approach with excellent potential for developing critical problem-solving skills and soft skills (such as communication and team skills). (Mourtes, 2010).

VI. FUTURE WORK

Much can be learned from the Jag Challenge 2019 and 2020 pilot but for future iterations of the Jag Challenge program but also for other innovation experience with interdisciplinary teams.

A. TRAINING AND DEVELOPMENT

In order to develop any type of problem-based learning experience where humans are at the center of the solution (i.e. themed entertainment design) faculty need to have a strong understanding of timing and methodology. The 2019 contained eight sections and thus was highly controlled. Nevertheless, one faculty member failed to follow the time restrictions and it caused issues for the students who felt their experience was poor. As the program grew the second year it was noted from the student reflections that a few sections had very thorough documents while others lacked substance. It is recognized that this is an issue of professional development. Like teaching students, instructors need presented materials in multiple modalities as well as exercises to walk them through the process of solving problems from a human perspective. Moving forward, the training will be refined for faculty to include a more hands-on approach to training so that faculty gain a clearer understanding of human-centered design. There also will be a greater emphasis for the faculty on student reflection at the completion of the Jag Challenge.

B. ADAPTABILITY

The pandemic played an impact on the 2020 pilot. It was noted there was higher levels of energy from the students within the 2019 pilot when they all met face-to-face for a five-day period instead of meeting either virtually or hybrid in a 10-week format. Students were unable to get together on the first day of the 2020 pilot due to differences in format between the classes and different days those classes were meeting. This was also noted by some of the faculty who participated in the Jag challenge from the first year to the second year. Nevertheless, the curriculum has proven adaptable and also repeatable through the use of Canvas modules that can be plugged into a course. As curriculum continues to be refined it will be implemented in a common module that can be implemented into multiple courses.

C. INTERDISCIPLINARY TEAM-BASED CURRICULUM

Moving forward, the principal researcher of this project will be engaging in an interdisciplinary team-based project where interviews will be conducted with team-members from various organizations (both with innovation and creative forms as well as in the themed entertainment industry) to understand how interdisciplinary teams work together, communicate and solve problems. This research will then be developed into curriculum for use in both the Jag Challenge as well as in the Themed Entertainment curriculum at IUPUI.

D. EMPATHY AND HUMAN-CENTERED DESIGN

It is valuable for students to understand how to solve problems from the guest/patron perspective. This is true for students in the themed entertainment disciplines but also in many other fields. It is one thing for a student to come up with a themed land design on their own but if it is something that a guest would not value that it is not valuable putting time into. This is a difficult task for a student (to put themselves in another person's shoes). As students engage with others it is easy for them to include their own bias instead of finding the problems from another perspective. Further curriculum should be developed to look at the patron/guest experience and how these experiences can be used to co-design multiple experiences as well as develop new products and services.

Overall, the Jag Challenge has is considered to be a fun and creative experience for new students that they typically won't find at many universities. While much work needs to be done to further refine the experience it has proven to be a valuable way to begin a student's college career who may come into the institution with very little understanding of human-centered design.

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Poster Presentation

The Three-Year Capstone: A Progression of Learning in Purdue University's Theatre Engineering Program

Leigh Witek

Alumni – B.S.E. Multidisciplinary Engr. (Theatre Engineering Concentration.) and B.A. Theatre Design and Production

Controls Engineer – Wenger | J.R. Clancy

Purdue University

West Lafayette, IN, USA

leighwitek@yahoo.com

Abstract—**Purdue University's Theatre Engineering Program capstone combines the yearly production work of the College of Liberal Arts with the final senior design format used in the Colleges of Engineering. By starting their production work after gaining admission to the program, students work on progressively more involved projects throughout their time at Purdue. This poster presentation will examine the lessons learned and challenges faced by Leigh Witek, a recent Theatre Engineering graduate, as she completed each role in the program. She will share how each project informed her understanding of the design process and how a three-year immersion in production work benefitted her final project. The roles held by students as they progress through the program begins by working in the scenic shop. As carpenters, Deck Carpenters, Assistant Technical Directors, and Technical Designers, students grow from building the designs of peers to creating designs of their own.**

Experiencing the design process in stages leads to an understanding of the impacts of design and prepares Theatre Engineering students for the intensity of their final project. This format also encourages students of all years to interact with each other and provide a perspective from every role. The format of this process and program encourages a community within Theatre Engineering that fosters mentorship among the student cohort. This poster will present a student's perspective of the effectiveness of this process and provide insight for how learning objectives are received and interpreted.

Keywords—Student, production work, technical design, engineering, pedagogy, capstone, senior design.

I. BIOGRAPHY

Leigh Witek is a Controls Engineer at Wenger | J.R. Clancy. She graduated from Purdue University in December 2020 with a B.S.E. in Multidisciplinary Engineering (Concentration: Theatre Engineering) and a B.A. in Theatre Design and Production. As a student, she completed internships with PRG Scenic Technologies and Creative Conners. Her research with Purdue's College of Engineering Education investigated how institutional culture impacts pedagogical change in engineering colleges.

This will be Leigh's 3rd time at SEEE and she is excited to participate as an industry professional!

II. CAPSTONE COURSE CONTEXT

Purdue University's Theatre Engineering Program capstone combines the yearly production work of the College of Liberal Arts with the final senior design format familiar to the Colleges of Engineering. Production work begins immediately after gaining admission to the program and students work on progressively more intense projects throughout their time at Purdue. As a graduate of the program in December 2020, this informed my understanding of the design process through a three-year immersion in production work that benefitted my final project. The lessons learned as a scenic carpenter, Deck Carpenter, and Assistant Technical Designer exposed me to all aspects of design and supported me in my senior year as a Technical Designer for a main-stage production. Experiencing the design process in stages lead to an understanding of the impacts of design and prepares Theatre Engineering students for the intensity of our final project. This format also encouraged me to interact with my peers, acting as both a mentor and mentee. The format of this program encourages a community within Theatre Engineering that fosters community among the student cohort, ultimately creating connections that I have kept in my post-graduation career.

III. STARTING STRONG IN THE SHOP

The first exposure every Theatre Engineering student gets to Purdue's production environment is as a carpenter in the scenic shop. Students learn fabrication skills for carpentry, steel work, and CNC, ensuring a strong foundation in existing practices. During my time at Purdue, I worked on 8 productions after coming into the program with no construction experience. My time in the shop helped me learn what construction techniques and materials are available. I didn't know we were limited to 4'x8' sheets of plywood and wasn't familiar with common rigging practices. This made my design tasks much easier down the line because I had a good understanding of our shop's capabilities. This also applied to load-in and strike, understanding workflow of a high-intensity environment. I experienced how design decisions impact the shops work. Issues with access to bolts or fabrics that are too thin to staple became cautionary tales for my designs down the line. Sometimes these difficulties were for good reasons. I learned why decisions were made not only from my faculty, but also from my peers that were in years ahead of me. Their knowledge helped me learn why we use certain manufacturing techniques.

The Deck Carpenter position brings students from the shop into the rehearsal and performance space. Once the set is finished and tech rehearsal starts, the set is handed to the Deck Carpenter for maintenance and training the cast and crew. My production, She Kills Monsters, was a show that combine realism and fantasy using large puppets and moving set pieces. I got to see the full life cycle of a set and understood the wear it experiences during tech and for each performance. There were multiple adjustments to the set asked for during rehearsal by the designers and I understood the reasons behind any changes from an artistic perspective. The show also included large puppets resting on the shoulders of actors. I received feedback about the comfort of these puppets and how the engineer's design impacted the performance. Overall, the experience shed light on who the end users are for a technical designer's choices and seeing how quickly design decisions can be made during the rehearsal process.

IV. BEYOND THE BUILD-LEARNING FROM EACH OTEHR

Once students are assigned to productions, they begin attending THTR 597: Production and Design Seminar. This is where all the technical design-focused students share work with peers and our faculty mentor. Receiving feedback allows for judgements to be made and defended before bringing work to the production's design team. Younger students are giving feedback to older students and vice- versa. Younger students also benefit from seeing the thinking process of students in roles that they will take into the future. This class was important to me because it mentally prepared me for my future roles. It gave me a space to practice defending my design decisions and speaking coherently about complex engineering challenges. This was also an excellent environment where I was never afraid to fail or be incorrect, because my peers and I understood that we were there to question everyone's design process.

V. THEATRE CLIENT-CENTERED ENGINEERING DESIGN EXPERIENCE

Junior year, I was an Assistant Technical Director for These Shining Lives. At Purdue, Assistant Technical Directors support cost estimation, material acquisition, are given a "mini" design project, help plan load in and strike, and lead a team for strike. I was responsible for the design of custom gear- shaped platforms, one of which needed a fire curtain pocket driven by pneumatics. For me, this was a great practice for my capstone. You work through every part of the coming project with the guidance of the technical director. I saw it as a practice round that built my comfort level with design and piqued my interest in designing a mechanical effect and control system for my senior design. You also start going to design meetings before the set is finalized. This helped me understand the priorities of the designers and the process leading up to the technical design. The gear-shaped platforms in this show were exponentially more difficult to design than a 4'x4' triscuit, but the shape had thematic importance to the show.

VI. PULLING IT ALL TOGETHER- SENIOR CAPSTONE DESIGN EXPERIENCE

My capstone project was the culmination of all these experiences. I developed, designed, estimated, and built a roll drop for Nell Gwynn. This was controlled by an Arduino. For my capstone, I could choose if I wanted to make this more of a mechanical or controls-based challenge. I decided keep the mechanics simple and put most of my time into the controls system because I did not do many controls-based practical projects in my time at Purdue. My capstone allowed me to explore a discipline that I was interested in and felt I needed more practice with before I graduated. My gradual exposure to the design process in my previous roles allowed me to practice all parts of the design process before this project. What I wasn't prepared for was the isolation of working as an individual. Being an older student, I was acting as a mentor much more than a mentee. I had to find a new way to seek out resources and help from students who had graduated, from other schools, business owners that I have connected with over the years. Since younger students and most faculty couldn't help me on the more challenging aspects of my design, I had to learn to find these other resources and go out of my comfort zone to ask for help from sources outside of the Theatre Department. Since my senior design was designed and built during COVID, I graduated before the load in, run, and strike of my show. I had to leave documents that could be easily followed by those left responsible for my design.

VII. EXPERIENCE VALUE FOR INDUSTRY

I have found this type of capstone best applies to students seeking roles as Technical Directors in theatres; being a "technical expert" on an artistic team. In my post-graduation role as a Controls Engineer, I find that I am more surrounded by resources that can quickly give me help and more time is put into the design and troubleshooting processes. I find myself doing more technical work and less direct interaction with end users. Overall, it moves slower than a production setting. The biggest lessons I took from the four-year capstone into my career is to never hesitate to ask for help from my plethora of resources and that I better understand the mindset of end users.

This progressive method of exposing students to the design process brilliantly prepared me for Purdue's Theatre Engineering capstone project. An increase in responsibility in each role helped me learn to tackle complicated challenges without throwing me into the deep end. Working in the shop gave me a solid foundation for construction techniques and experiencing the impacts of design. My time as a Deck Carpenter helped me understand the mindset of end users. I experienced the design process with a helping hand as an Assistant Technical Director.

The capstone combined these experiences into a project that complimented my interests and challenged my resourcefulness as a designer. Notably, the cycle of mentorship among the student cohort created a sense of community where I felt comfortable to seek and eventually give guidance. I left Purdue and have taken my growing network of Purdue Theatre Engineers with me. A group of students that has closely worked and grew together through this program and will be a source of mentorship for life.

VIII. ACKNOWLEDGMENTS

I wish to thank Prof. Richard Dionne and Prof. Mary Pilotte for creating a home where analytical brains with a passion for the arts can thrive. Irene Byrne Ohl and her hard work through piVot2, who has been instrumental in pushing students to speak early and often in their careers. My Theatre Engineering cohort, the Theatre Techs of Tomorrow, and the Purdue M.F.A. Technical Director mentors, my peers who that are ever a source of inspiration. Industry mentors Toni Zobrist, Sylvia Bagaglio, Harmony Water, Bonnie Howland, Nicholas Freely, and many more for trusting an intern to touch their stuff. Most importantly, to my loving family for cheering me on through this entire journey.

Symposium Workbook

Undoubtedly, most everyone here has attended other conferences, and find them to be a source of inspiration and re-invigoration. It is our sincere hope that this event will have the same effect for you as well. It is also our experience—and a swath of education research on learning supports this—that active and goal centered participation in your individual learning aids in "stickier" retention and improves personal achievement more so than passively receiving information or "hoping" you will get something out of your invested time.

Our lives are very full these days, and our brain's ability to keep all of the important "bits" of information—even the most important ones—can suffer recall problems. To that end, we would like to offer the following reflective prompts and organizational pages as a first step toward encouraging you to actively engage with the symposium and its participants and presentations. The following pages were designed to help you manage your newly formed connections, jot down ideas and concepts, or make note of items you want to take action on or investigate more fully.

We have shamelessly borrowed elements of this concept from other workshops and conferences, including the Lilly Conferences on Evidence-Based Teaching and Learning held across the country each year. We encourage you to consider attending a Lilly Conference, as they can be exceptional experiences.

Intentional Symposium Goal

In a brief sentence, set one personal goal for your attendance at this symposium:

____

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What ***one word*** captures the essence of this goal? ____________________

Networking

Of all the people I met at the symposium, when I return home **I just have to send a follow up email to**: ____________________

Name	Institution/Email	Notes/Reason for Follow-up

WORKBOOK

Paper 1, “Timing, Latency and Live Performance”: Points of Interest

Paper 1, “Timing, Latency...”: Follow-up Action Items

Paper 2, “Catenate...”: Points of Interest

Paper 2, “Catenate...”: Follow-up Action Items

Paper 3, "Studio D Institute...": Points of Interest

Paper 3, "Studio D Institute...": Follow-up Action Items

WORKBOOK

Paper 4, "Developing Soft Skills...": Points of Interest

WORKBOOK

Paper 4, "Developing Soft Skills...": Follow-up Action Items

Poster, “Three-Year Capstone...”: Points of Interest

Poster, “Three-Year Capstone...”: Follow-up Action Items

Post-Symposium Follow Through

Of all the possible follow-up action items, **the one I will act upon in the next 10 days is**:

Of all the points of interest in the symposium, **one that I want to share with a colleague** at my home school/work/professional group is:

Notes and Reflections

Notes and Reflections

Notes and Reflections

Notes and Reflections

WORKBOOK