Motion Capture in Live Theatre

Research Proposal Document

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Abstract

This proposal seeks to explore research into how motion capture technology can be best used within live theatre performances, with respect to its effects on production costs, health and safety for actors, and overall effects on revenue, alongside an inquiry into the limitations of the technology within the live performance industry. Researchers will work with theatres and animation studios under various production budgets to create multiple productions of Shakespeare's *Macbeth* that incorporate motion capture technology. Analysis of polled audience reactions, performer and crew responses, and changes to revenue across these productions will be conducted to determine how the inclusion of motion capture technology effects the quality of performance.

Keywords: motion capture, projection mapping, animation, theatre, Shakespeare

Motion Capture in Live Theatre

Live theatre is among some of the oldest artistic practices on the planet, dating back to its origins in Ancient Greece (Wiles, 2000), and the theatre has always been a place for innovation and creative expression. This research proposal hopes to expand on that great tradition by exploring how motion capture and projection mapping technology can be used to create new and exciting theatrical effects.

Project Vision

In 2016, The Royal Shakespeare Company in Stratford-on-Avon, England created a version of the classic Shakespeare play *The Tempest* that used 3D projections of motion capture artists for its magical characters and scenes (See Market Research). This project will attempt to create multiple productions of Shakespeare's *Macbeth* that uses the same technology and principles. The primary goal of this research is to determine if this technology is viable for various levels of production expertise and budget, while secondarily attempting to determine if the use of this technology is safer than alternatives that would normally be in place.

Technical Goals

The goals of this production require a number of niche pieces of technology.

Projection Mapping.

Projection mapping allows designers and animators to scan real world elements of a space and project images onto specific pieces of the space while still appearing coherent. This technology requires special software and a dedicated projector, which will need to be installed into the theatre and have dedicated technicians. This specific technology will likely be the biggest hurdle to overcome during development of the research project, as it represents the bridge between animation and theatre.

Complete Body Motion Capture.

A standard motion capture studio setup can be massively expensive, depending on how the motion capture is done. Certain studios have complex sensor and camera setups that require a large amount of space to perform in, even for a single person, while other methods can be more compact but possibly present problems with animation and budgeting.

Facial Motion Capture.

Given the most magical elements of *Macbeth* are the three witch characters, it makes sense to include facial animation for their actors as a separate need, as the animation process for speech can be overbearing without dedicated technology.

Visual Direction

While the consistent visual element of characters and effects being animated and projected onto the stage is the core of this project, it is suggested to leave the majority of visual creative decisions to the development team, as adjustments to budget considerations will greatly affect these concerns.

Premise and Narrative

Given that Shakespeare's *Macbeth* is not an original script, the majority of narrative decisions have been made already. The Folger's Shakespeare summaries the play adequately with the following:

"In depicting a man who murders to become king, Macbeth teases us with huge questions. Is Macbeth tempted by fate, or by his or his wife's ambition? Why does their success turn to ashes?"

From the Introduction, (Shakespeare, Macbeth, n.d.)

Audio Treatment

Alongside the overall visual direction of the project, it is suggested to leave the majority of audio creative and technical decisions to the development team. One notable exception is the acknowledgement that any animated characters will require some form of audio accompaniment, be it prerecorded or performed live.

Financial Information

As this research project is exploring financial feasibility of projection mapping and animation in theatre, three separate budgetary constraints are being enforced (see Controlling for Variables), representing a small volunteer community theatre, a large independently run organization, and a full Broadway level performance.

Costs and Financing.

The following is a breakdown of how the technology and software needs will affect financing across the three productions.

Technology Costs.

Given the various budgets the project will be working with as constraints, Table 1 [See Tables] details how the three major new technologies being introduced can be broken down into Amateur, Independent, and Professional level pricing.

Software Costs.

Consistent software use across the three tiers of budget will help development flow smoothly, therefore Table 2 [See Tables] lays out the pricing model for a complete animation suite alongside the necessary additional software.

Financing Models.

Each performance being conducted for this research will operate on budgets associated with similar quality productions in the community, volunteer, and professional theatre scene. See Table 3 for further information.

Revenue and Profit.

Given the different tiers of production each have different budgets, researchers can expect to see different revenue models from each performance. Table 4 [See Tables] has further information on how much revenue researchers can expect to earn from similar institutions. See Budgets for further information on how revenue will be used to determine success of the project.

Research Methodology

This paper proposes to be able to determine how effective projection mapping and animation technology within live theatre is at affecting costs, revenue, and overall health and safety. Key to this research is the fact that different theatres operate on different budget restrictions and with different skill levels of cast and crew. The following section lays out how to control for these variables, the development timeline, and under what criteria productions will be judged. This project will call for development of six different versions of the show: three versions without the projection technology at preset budgets to act as a control group, and three versions with the technology operating on the same budget.

Controlling for Variables

Given that live theatre is prone to a variety of contributing factors to success, this document lays out three key areas where stability and consistency in the production process will best allow for controlling for statistical anomalies and irrelevant data.

The Stage.

By using the same theatre for all versions of the performance, the theatrical development team saves on time, having only one lighting rig to set up, and allowing actors to use the same set regardless of which version of the production they are in.

A Consistent Team.

While Project Details lays out the plan for senior members of production, it is also suggested that all members of the casts, crews, and animation teams that will be producing these shows come from a limited list of possible candidates. Rather than having a separate cast for each show, each candidate shall set their own conditions for participatory compensation, and senior crew members will need to use this information to balance their budgets.

Budget Restraints.

In an attempt to recreate the different theatrical experiences this project proposes to research, three separate budgets will be set up. These individual budgets will be relative to research conducted into various levels of theatrical performance budgets. The goal for each performance is to spend less than 10% of the total budget on projection mapping and similar equipment, while also staying within the overall budget for the rest of the production.

Research Timeline

This research project will be done in phases, where each phase has a list of milestones that must be completed before the next phase can begin. The entire production plan for each version of the show should take approximately a year, assuming that teams are working simultaneously between productions.

Project Planning (approx. One Month).

During this phase, the separate teams (see <u>The Team and Responsibilities</u>) will be planning out exactly what is needed from each half of the team for each level of production. Key milestones include:

1. A complete budget for each team, based on the expected budgets shown in Table 3.

2. A finalized set design, at scale.

3. Acquisition of needed software.

4. Hiring of animation teams.

5. Acquisition of needed hardware.

The teams will have liberty to add to this list as needed.

Animation Production (approx. 8 Months).

This phase is dedicated to the core of the animation development of all digital assets. Key milestones include:

1. Completed models for all characters and props.

2. Completed textures for all characters and props.

3. Motion capture recording sessions with necessary cast completed. (Simultaneous with Theatrical Production Milestone 3)

4. Rendering of animation.

5. Setup of projection map, and rendering for projection.

The teams will have liberty to add to this list as needed.

Theatrical Pre-Production (approx. 3 Months).

This is the set rehearsal and preparation period for the theatrical team. Key milestones include:

1. A complete cast list for each level of production.

2. A complete rehearsal period for the cast, including training with special equipment.

3. Motion capture recording sessions with necessary cast completed. (Simultaneous with Animation Production Milestone 3)

4. Acquiring all necessary props and costumes.

5. A completed set construction.

6. A finalized lighting grid setup, including projection technology.

The teams will have liberty to add to this list as needed.

Theatrical Production.

This phase is simple – the team will be running the show and gathering data. Key milestones include:

1. Running at minimum three (3) shows of each production level.

2. Gathering audience feedback.

3. Gathering team feedback.

4. Gathering revenue information.

The teams will have liberty to add to this list as needed.

Final Analysis and Success Criteria

After all production phases are complete, and once the show has gathered enough relevant data as determined by the production team, the success of this project will be judged based on the following criteria. Meeting all success criteria for all productions will indicate that the inclusion of projection mapping and motion capture technology provides a statistically relevant improvement to the theatre experience.

Financial Success.

If profits see a statistically relevant increase associated with a projection mapping performance as compared to the standard performance of the same level, that performance will be considered to have been a financial success.

Audience Reaction.

If polls of audience reactions show a statistically relevant improvement between the projection mapping performance compared to the standard performance, this will be considered to have been a success for effectiveness of storytelling and popularity.

Health and Safety.

If crew and team responses show a statistically relevant decrease in evidence of risk behaviours like stunt performance injuries while also reporting standard levels of expected risks such as technology repairs on the lighting grid and eye strain, this will be considered a success for the technology as a safe alternative for more dangerous show elements.

Project Details

As this project is developed, the following considerations have been made for development team composition and market analysis.

The Team and Responsibilities

The development of the proposed research project will require a diverse set of expertise. In order to control for some of the many variables at play, senior roles within the team will remain consistent, and be divided up as follows. While these will remain some of the most important roles throughout project development, the need for additional roles may become apparent as development progresses.

Theatrical Leads.

This portion of the team will be dedicated to the live performance half of the production, and is composed of standard roles within theatre.

Creative Direction.

This subsection of the team is made up of the *Director*, *Costume Designer*, and *Set Designer.* Other creatively leaning roles may be added to this list at a later time. The common element between these roles is that they make creative decisions on the style and aesthetics of the show.

Director.

The Director, similar to directors in film or creative directors in games, is the person responsible for maintaining a consistent vision across the performance. Their duties include casting actors, running rehearsals, and working with the creative direction team of the Animation Leads to bring coherence to the two halves of the project.

Costume Designer.

The Costume Designer's role is a relatively simple one – they are responsible for clothing the actors on stage. Certain special considerations may need to be made to accommodate for the technical needs of the projection mapping system.

Set Designer.

Similar to the Costume Designer, the Set Designer is in charge of designing props and the physical space the actors will be working with on stage. This role will need to be highly connected to the Animation Leads, as set decisions will vastly impact the projection mapping software.

Stage Management.

This subsection of the core team is made up of the *Stage Manager*, *Props Manager*, and *Technical Director*. Other technical leaning roles may be added to this list at a later time. The common element between these roles is their responsibility to creation and implementation of the technical elements of the show.

Stage Manager.

The Stage Manager is the person responsible for all of the activity of the personnel of the theatrical team, including recruitment of stage hands and technicians, scheduling rehearsals, and running the final production of the show. Their role is primarily focused on ensuring the production happens as planned, rather than on creative input.

Props Manager.

The Props Manager is in charge of collecting, organizing, maintaining, and repairing any moving set pieces or handheld props for the show. They may also work with other roles like the Costume Designer or the Set Designer in order to best accompany the props with other stage elements.

Technical Director.

The Technical Director is in charge of setup and maintenance of all permanent fixtures of the set and theatre technology, including construction of set pieces, setup of the lighting grid, and any audio-visual technology considerations.

Animation Leads.

This portion of the team will be dedicated to the animated half of the production, and is composed of standard roles within animation.

Creative Direction.

This subsection of the team is made up of the *Creative Director*, *Lead Artist*, and *Lead Animator.* Other creatively leaning roles may be added to this list at a later time. The common element between these roles is that they make creative decisions on the style and aesthetics for the animation assets.

Creative Director.

The Creative Director is the equivalent of the industry standard for that title – they will be the head of the animation project's development, giving final approval on design decisions.

Lead Artist.

The Lead Artist will be primarily directing the efforts of the modelers and texture artists preparing assets for animation. They work as a middle manager between the Creative Director and the art team as a whole.

Lead Animator.

Similar to the Lead Artist, the Lead Animator is in charge of the efforts of the animation team, taking the work done by the art team and using the animation rigs provided by the technical art team to bring their creations to life.

Technical Direction.

This subsection of the team is made up of the *Technical Director*, *Director of Photography*, and *Lead Technical Artist.* Other technical leaning roles may be added to this list at a later time. The common element between these roles is their responsibility to creation and implementation of the technical elements of the animation.

Technical Director.

The Technical Director operates hand in hand with the Creative Director, making decisions on technical restrictions and considerations such as asset resolution, and directing the technical team as a whole.

Director of Photography.

The Director of Photography plays a special role in motion capture considerations, as they will be the person in charge of the motion capture set and working with the actors to produce the data needed to produce the final animations.

Lead Technical Artist.

The Lead Technical Artist operates as the manager of the technical design team, monitoring the work of riggers and artists working on shaders and special effects. They will be working closely with the creative team and technical director to ensure their needs are met.

Market Research

Several theatrical projects have used similar technology to the motion capture and projection setup researchers will be exploring during this project. Here are some examples of excellent shows that are using digital media elements in their productions.

Royal Shakespeare Company's Performance of *The Tempest*, 2016.

The RSC performance of *The Tempest* is the project that inspired this research. Working with The Imaginarium Studios, The Royal Shakespeare Company created a world of mysticism and wonder by projecting animated characters and advanced animations onto the set and actors costumes (The Tempest - Youtube Playlist, 2016).

Stratford Festival's Performance of *Macbeth*, 2016.

The Stratford Festival in Stratford, Ontario sets the bar for production quality for the independent tier of production. Their version of *Macbeth* that was recorded in 2016 is available for streaming online via their website (Shakespeare, Macbeth, 2016).

Berkeley Repertory Theatre's Performance of *Macbeth*, 2016.

Berkeley also performed a version of *Macbeth* in 2016 (Ambroff-Tahan, 2016), but relied heavily on video editing and projection to create some spectacular imagery on set. This production is definitely a source of inspiration for researchers to follow and compare their shows against.

Forecasting

As this document proposes a research project focused on determining the audience reactions to animation technology in theatre, the hope is that development of this project proves an increase in audience demand exists for this type of theatrical content, beyond that of a standard theatre experience.

Target Audience.

As this project is based around Shakespeare, developers can expect to focus on a standard theatrical audience. For Shakespeare especially, this often involves high school students – as such, ethical standards for underage participants must be met. The hope is that the inclusion of animation technology will result in a larger target audience than usual.

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Tables

Table 1

Pricing for Needed Hardware

Technology Need	Expense Tier	Product Name	Price per Unit ($)	Number Needed (Estimated)	Subtotal ($)
Projection Mapping	Amateur	Standard Projector	150 (approx.)	3	450
	Independent	Lightform LFC & Projector	1,000 (approx.)	3	3,000
	Professional	LUMITRIX T2 Series Projector Kit	20,000 (approx.)	3	60,000
Full Body Motion Capture	Amateur	Microsoft Kinect	100 (approx.)	3	300
	Independent	Perception Neuron Studio	6,500	3	19,500
	Professional	OptiTrack PrimeX 13 Setup	60,000	1	60,000
Facial Motion Capture	Amateur	Logitech C920 HD Pro	100	3	300
	Independent	Go Pro Hero 7 Black	300	3	900
	Professional	FaceWare Mark IV Wireless Headcam System	24,995	3	74,985

Note: These prices reflect a limited range of current products, and alternatives may exist at different prices. This budget also proposes that these tools be purchased outright, where rental or company consults may be cheaper.

Table 2

Pricing for Needed Software

Software Need	Price per Seat ($)	Number of Seats (Estimated)	Subtotal ($)
Autodesk Maya (Modelling, Motion Capture, and Animation)	265/month	5	1,325/month
Adobe Creative Suite (Sound and Textures)	105/month	5	525/month
MadMapper (projection mapping)	399	3	1,197
FaceWare (Facial Animation Capture)	195/month	3	585/month

Note: Alternative software may exist for different prices, and the number of needed seats is to be

determined by the animation team based off of available budgets.

Table 3

Budget Models for Amateur, Independent, and Professional Theatres

Theatre Tier	Example Theatre	Example Show	Production Budget ($)
Amateur	Kitchener Waterloo Little Theatre	Unknown	Unknown
Independent	Stratford Festival	2019 Season (12 shows per season)	3,000,000
Professional	Princess of Wales Theatre	Lord of the Rings	28,000,000

Note: Example Amateur budget to be requested from the Kitchener Waterloo Little Theatre.

Example Independent budget gathered from Stratford Festival via Charity Intelligence Canada

(Stratford Festival, n.d.). Example Professional budget sampled from the Princess of Wales

Theatre production of Lord of the Rings (Portman, 2006)

Table 4

Revenue Models for Amateur, Independent, and Professional Theatres

Theatre Tier	Example Theatre	Example Show	Production Budget ($)
Amateur	Kitchener Waterloo Little Theatre	Unknown	Unknown
Independent	Stratford Festival	2019 Season (12 shows per season)	2,500,000
Professional	Princess of Wales Theatre	Lord of the Rings	Unknown

Note: Example Amateur revenue to be requested from the Kitchener Waterloo Little Theatre.

Example Independent revenue gathered from Stratford Festival via Charity Intelligence Canada

(Stratford Festival, n.d.). Example Professional revenue unknown as the Lord of the Rings ended

early due to poor reviews (Knelman, 2006).