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DEPARTMENT: ARTFUL MEDIA

Creating Performance-Oriented Multimedia Projects as Part of an Interdisciplinary Teaching Practice

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The authors describe four interdisciplinary performance-oriented multimedia projects developed at Bauhaus-Universität Weimar and reflect on the student participants' experience as well as lessons they learned as teachers and human–computer interaction researchers.

A significant part of teaching at Bauhaus-Universität Weimar (BUW) consists of semester-long, intensive projects, usually conducted by groups of students supervised by academic faculty. This gives teachers the freedom to pick novel topics and to experiment with ideas and approaches. They can furthermore direct the concept design and create interdisciplinary groups by offering places to students from other program areas outside of computing, or via collaborative projects across faculties.

In recent years, the Human–Computer Interaction (HCI) group at BUW has developed several performance projects or technology for artistic performances as an important and creative part of the university's teaching approach. These have ranged from a self-scripted theatre play using interactive technology, to interactive costumes custom-created for semiprofessional ballet dancers, to large-scale public installation-based performances. Some of our projects were completely developed in-house, whereas others had external clients and funding. In this article, we reflect on our experiences and consider the advantages and disadvantages of our teaching practice.

We present four of our most prominent projects via short profile descriptions. We characterize these works as live multimedia performances or public exhibition performances. The outcomes of such performances have to be of high quality in terms of aesthetics and artistic value, while the technology must function reliably in a real-time, live context. This requires a mix of disciplines, combining technology and arts/design competencies. There is furthermore pressure to perform since, without a public show, the projects are incomplete. In some cases the dates for shows are determined by the development team, whereas in others an external client and/or funder sets the performance date.

MEININGEN: AN INTERACTIVE FAÇADE MAPPING

- *Student team members*: 8 students of media informatics (BSc) and media architecture (MSc) plus 4 thesis students of media architecture responsible for the visual scenography of the projection
- *Other BUW participants*: a guest teacher with expertise in media architecture, two supervisors from media architecture for the four thesis students, and a music student responsible for creating the soundtrack
- *Collaborators*: staff from the city of Meiningen, technology sponsors, a choreographer, and schoolchildren
- *Project funding:* external client—city of Meiningen
- *Performance outcome*: 2 evenings with 3 shows each (about 30 minutes per show) in August 2014

In summer 2013, the city of Meiningen asked BUW to develop a façade mapping for the 2014 commemoration of Georg II, Duke of Saxe-Meiningen (1826–1914), who led and directed the Meiningen theatre and introduced the modern notion of theatre as *Gesamtkunstwerk* (all-embracing or total artwork). A group of media architecture students first developed a concept for the mapping visuals. Then, our team joined to generate a larger Gesamtkunstwerk including interactive elements. The resulting show ran three times per night on 22 and 23 August 2014 at Elisabethenburg Castle.[1,2]

Figure 1. Two views of the interactive façade mapping at Elisabethenburg Castle, Meiningen. (Top photo © Candy Welz, BUW)

The façade mapping illustrated Georg II's story and his 12 theatre principles. It was projected onto a 120-meter horseshoe-shaped curved façade inside the enclosed castle courtyard (see Figure 1). Like most good façade mappings, this was a site-specific project referencing local history in animated storytelling, but it also considered the entire site's layout and architectural setting.

The event was structured in four parts: (1) Visitors entered the courtyard via an archway with a re-active ceiling projection. Meanwhile, inside the courtyard, a countdown and other visuals were projected. (2) Next, a 13-minute façade mapping visualized the 12 theatre principles. (3) Dancing children brought in 12 illuminated spheres representing each of the principles, and used these to activate and illuminate the "theatre machine" in the courtyard center (see Figure 2). (4) The children demonstrated how to interact with this machine and invited the audience to control projected stage backgrounds. Similar to layered stage paintings, three layers of animated content from Georg II's original sketches could be moved independently in real time by pulling at ropes, an interaction paradigm inspired by the pulleys and ropes used to move theatre curtains and shift stage elements.

Figure 2. The theatre machine and its rope interface.

The theatre machine's design enabled group interaction, while also fitting the setting's architectural scale. Three large structures made of wooden frames were set around a fountain facing the façade. Within each frame, a rope was held or spun between wheels at each end, letting the rope be pulled along in an infinite loop. A long rope section provided access for several people and space for bystanders. Unlike other attempts at spectator interaction in this domain, the large interface made interaction visible and transparent, while also functioning as an architectural component of the entire spectacle.

Our event was unique on several levels compared to typical façade mapping shows: it conceptually integrated the overall architecture of the compound; it utilized a very long curved surface; it had a multi-part (and mixed media) choreography; and audience interaction was a central element, with audience members using a large architectural-scaled interface instead of, for example, mobile phones.[1]

A particular challenge of this project, in addition to the diversity of technologies and media elements, was the number of stakeholders and participants, which required extensive negotiation and coordination. The production included a choreographer and dancing children, a soundtrack composer, technology companies sponsoring and managing the high-end projectors, city officials, and castle staff. Moreover, the live elements of the show needed a failsafe approach in case of technical failure or interference. For example, running out of time to detect placement of illuminated spheres via sensors, the fallback plan had a student manually press buttons on his phone to control the machine's illumination.

To evaluate the audience reaction, we had 6 volunteers hand out 3-page questionnaires (80 returned from about 1,500 visitors). However, the results were hampered by overly diverse research questions and the inability to compare data with other events (when evaluating interactive art, uniqueness of performance is an issue). While much was learned from this project, we did not have the opportunity to draw deep or generalizable findings from our experience and approach.

DUSK: A PLAY WITH INTERACTIVE TECHNOLOGY

- *Student team members*: 11 students of computer science/HCI (MSc), media informatics (BSc), media architecture (MSc), product design, and media design/arts
- *Collaborators*: 3 semiprofessional actors and a drama educator/theatre pedagogue practitioner
- *Project funding*: self-generated, in-house project
- *Performance outcome*: two 20-minute shows in March 2015

This interdisciplinary student project explored interactive technologies in theatre performance.[3,4] With our students, we developed an interactive play based on the short story "Dusk" by British author Hector Hugh Munro a.k.a. Saki (1870–1916). A drama educator mentored our team in developing the script and also directed the staging process. We further collaborated with 3 semiprofessional actors who performed the play. Our production timeline of 18 weeks involved ideation and script preparation, building and testing interactive components, rehearsals, and stage setup. Most of the time was spent designing and developing the interactive components, with one intensive week of rehearsals.

The play was performed twice, for around 100 visitors in total. We wanted to explore how interactive elements can enhance a play, both in how director and actors adapt and with regard to audience perception. Our research combined a research-through design approach with analysis and reflection of video documenting the rehearsals, interviewing, and audience questionnaires.

In the story, the main character Gortsby sits on a bench in the park at dusk, thinking about modern society and people's prejudices. He is joined on the bench by an old shabby man whom he avoids, and a young well-dressed man who asks for help as he cannot find his way back to his hotel after going out to buy soap, and now has spent all he had in his pocket. Gortsby doubts the story, as the young man cannot show him the soap, claiming that he lost it. The young man leaves. When Gortsby finds the soap, he searches for him, feeling guilty, and offers him money. Upon returning to the bench, he finds the old man searching for a piece of soap.

We matched input and output technologies to story themes and symbolic objects, and developed concepts for interactive components: (1) A background projection wall, controlled by a Kinect sensor, evokes the city's light-shadow atmosphere of danger and adventure. The projected graphics show the dark evening silhouettes of buildings and lights. In two scenes, Gortsby interacts with the graphics, first switching lights in the houses on and off by walking along the wall and back, and later, wiping out fog with his hands to reveal the city lights again. (2) An illuminated bench represents a contradictory place of equality and encounter. The three-part bench has tilt plates under each seat, and reacts with different lights depending on the scene and the sitters shifting weight (see the left photo in Figure 3). (3) Abstract projections on the foreground wall are manipulated by the actors' voice and heartbeat, representing inner thoughts and prejudices. (3) A symbolic prop for the soap, symbol of class society (only rich people could afford it), is activated by a proximity sensor. The prop is large enough to be visible to the audience and, when found, reacts by blowing bubbles (from a toy bubble gun).

Students worked in small interdisciplinary teams to build the interactive components. Working with the director, they were responsible for everything behind the scenes including stage lighting, sound, and video projection. While the software for each single component and scene was simple, ensuring that background graphics were only interactive for correct scenes required careful orchestration and additional code to move between phases. Students were responsible for hiring/borrowing equipment, setting up the lighting system, building the stage, and transforming a lecture hall into a theatre, with the lecture podium serving as control center (see the right photo in Figure 3). They also engaged in marketing and advertising, and in finding sponsors.

Figure 3. Creating the interactive theatre play *Dusk*: (left) interactive projections and the tilt-light-up bench, and (right) the control center where everything was orchestrated

Focusing our analysis on how the actors and director reacted to, approached, and appropriated the technology, as well as having audience questionnaires on the technology elements in the play, enabled us to gain valuable research insights. While the diversity of interactive components involved makes it hard to compare and generalize, we hope to detect patterns consistent with our other stage-oriented projects.

MERMAIDS: INTERACTIVE BALLET COSTUMES

- *Student team members*: 6 students of computer science/HCI (MSc), media informatics (BSc), product design, and media arts/design created the costumes; 2 students of HCI (MSc) supported staging the costumes
- *Project funding*: external client—children and youth ballet of Gera/Altenburg
- *Performance outcome*: 3 shows of the ballet so far, with more planned for fall 2018

Building on prior collaborations with our group, a local children and youth ballet asked us to develop interactive costumes for performances of *The Little Mermaid*. The resulting student project developed costumes for two supporting underwater characters in the birthday party scene, Jellyfish and Seahorse (see Figure 4), who were on stage for 17 minutes of the 90-minute show. Both costumes are sensitive to dancers' movements and translate these to on-body light concepts that support dancers' expressivity, while respecting the show's overall appearance.[5]

The artistic intention was to present a colorful and fantastic picture of the underwater world at the glamorous birthday party. To support this vision, we carefully selected fabrics, materials, aesthetics, and colors to fit with the entire production. The costumes needed to resemble sea creatures without hindering the dancers' movements. The seahorse dancer wore a hooded bodysuit containing all electronics with a bright illuminated exoskeleton with 180 LEDs over a black leotard. The LEDs reacted to upper arm movements. The Jellyfish dancer wore a balloon dress (representing the jellyfish umbrella) with oral arms, integrating 110 addressable LEDs that also reacted to arm as well as spinning movements.

Our students attended rehearsals during the ballet's preproduction process, tested ideas with the dancers and choreographer, and iterated the final design for robustness and wearability. The overall production posed various constraints, including a given timeline, the challenges of designing for specific (and still growing) bodies, and the need to harmonize with the overall stage aesthetics and lighting. Unlike other projects, here we were not responsible for the actual performance but were part of the background mechanics of a stage production. This made it easier to handle, though we nevertheless felt pressure for our costumes to "perform" correctly and enhance the show. After the costumes were finished, the academic term ended and the official production period started—the costumes were supported by two new students who also helped evaluate this process.

Figure 4. Seahorse (left) and Jellyfish (right) costumes during rehearsals of *The Little Mermaid*.

Our collaboration with the ballet troupe benefited from earlier experiences working on interactive costumes in theatre[6] and the *Dusk* project, as well as prior exploratory work with this same troupe.[7] We built on our earlier experiences and knowledge regarding best practices for integrating our work with the theatre production process, as well as how to work with theatre staff (for example, dressers) and how to give actors/dancers appropriate opportunities to familiarize themselves with the technology.

As part of her PhD project,[8] one of the authors collaborated with the theatre's costume designer and wardrobe mistress to create a third dance costume, resulting in a contrasting case study with respect to the design process. This is part of our emerging research strategy of analyzing across case studies.

DIE ERMITTLER: A PUBLIC DIALOGUE WITH REFUGEES

- *Student team members*: 10 students of computer science/HCI (MSc), media informatics (BSc), media architecture (MSc), and visual communication.
- *Collaborators*: established artist as artistic director, 2 additional production organizers/teachers, and interviewed refugees
- *Project funding*: various technology sponsors, external clients—Kunstfest Weimar and Kreativfond BUW
- *Performance outcome*: 2 evening performances in August 2016

A project exploring the use of real-time projection mapping in a participatory context resulted in a performance/event (9 pm–12 pm) presented during 2 nights of Kunstfest Weimar, central Germany's leading annual arts festival. *Die Ermittler: Ein Dialog über Flucht, Fremdsein, und Heimat* ("The Investigators: A Dialogue about Flight, Displacement, and Home") was originally inspired by the avant-garde work and progressive ideas of writer, artist, and political activist Peter Weiss (1916–1982). In light of the emerging refugee crisis in Germany, the project's goal was to foster dialogue between refugees and the citizens of Weimar by enabling refugees to share their experiences and perspectives with the audience.[9,10] We chose the Goethe–Schiller Monument on Weimar's Theatre Square, which embodies German national cultural heritage, as the performance location. Together with Krzysztof Wodiczko, a pioneer of projection art in public spaces, our team created an interactive projection mapping that enabled ordinary citizens and refugees to lend their voices and faces to the statue while also enabling audience members to ask questions to whomever was currently "being the statue."

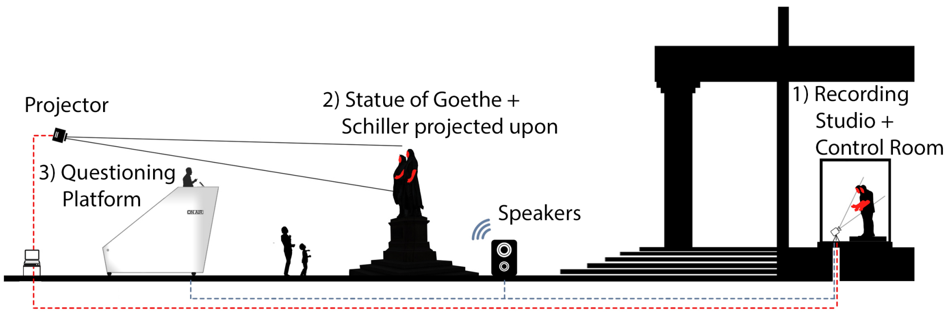

Figure 5. *Die Ermittler* setup. (1) The recording studio and control room were located inside the German National Theatre foyer. (2) A video feed was projected onto the Goethe–Schiller statue on Weimar's Theatre Square. (3) The Questioning Platform faced the statue and enabled audience members to enter a dialogue with those currently in the recording studio. (Graphic © Hala Ghatasheh)

There were four parts to this installation (see Figures 5, 6 and 7). Two were located inside the German National Theater foyer. Here, in the control center, the stage direction team controlled the projection content, adjusted the projection, and switched between different content sources (live and prerecorded video). The foyer also housed a recording studio for capturing live content. Two people could converse while standing on a positioning rig, which held them in a posture similar to that of the statue. Their heads and lower arms were projected onto the statue. More visible to the public was the statue that the video was projected onto, and the Questioning Platform (stairs facing the statue, leading up to a microphone) that enabled the audience to directly speak to the statues, while the current participants in the recording studio would be able to hear and see the interlocutor and answer.

Figure 6. Audience members using the Questioning Platform to interact with the statue. (Photos © Krzysztof Wodiczko)

Figure 7. Recording studio view.

Over several months, the physical installation design was ideated and developed, the performance concept refined, the software developed and tested, and the overall process trialed and prepared. Contact with local refugee organizations was established and interviews were recorded on the positioning rig (used later during breaks and to start the performance). This prephase was important to establish contact with the refugee community, as the event crucially depended on their participation.

Given the significance of participating in a prestigious art festival and examining a complex topic, the team's priority was getting everything to work correctly and smoothly managing the event. The latter was a huge effort—the team needed to orchestrate the technology and content;

enlist participants (for the recording studio and the questioning platform) on the spot, help them make their mind up about what to say, and make them feel at ease; and coordinate between the recording studio, control center, and outside square. Even with our large team, this left no resources for planning an evaluation. Moreover, the setup had little in common with our earlier projection projects, making it difficult to build on our previous questionnaire design.

LESSONS LEARNED

Reflecting on these four projects, here we draw attention to key components that we believe will be useful to developing multimedia performance projects. In teaching, it is important to consider student motivation and experience, and the overall learning effect. We also examine the impact of these projects on the entire research group in terms of the projects' potential to contribute to our research and to individuals' careers, as well as to create a successful performance outcome for our clients.

Students' Perspective and Learning

Publicly exhibiting a work or performing for an audience tends to be a huge motivation and source of satisfaction for students, who generally put in tremendous effort and want to do their best. Working on large, richly mediated projects can bolster student portfolios and resumes, as media documentation of the performance—videos, photos, audio, and so on—is both accessible to diverse audiences and impressive in itself.

The inherent interdisciplinary nature of our projects provides both opportunities and on occasion potential drawbacks.

On the positive side, all students are exposed to different styles of thinking and working, and can see how their own contribution fits in and supports an overall project that depends on both technical and artistic mastery. The live performance aspect of these projects provides our computer science students with a unique and challenging production environment that helps them learn project management skills on a broader range of topics than in traditional software projects. Running a live event includes dealing with live time-keeping and synchronization between multiple components and live activity, scheduling and setting up team rosters, and engaging in social engineering (e.g. activating audience members to participate). One clear outcome is learning the skill of improvisation and always having a Plan B, or even a Plan C. Moreover, several of our students subsequently achieved research-level theses work blending creativity, craft or design work, and organizational skills, resulting in publications. For computing students with less technical knowledge, the projects provide an opportunity to work within a technical environment in a way that supports their skillset, helps them build confidence, and ultimately directs them toward other classes and potential careers on the fringes of computing. On the other hand, we need to acknowledge that they might not be forced to learn as much about technological aspects as in traditional computing-based projects.

There are also downsides in that as time pressures grow in such projects, decisions must be made about what to cut or sacrifice. This can mean having to do quick hacks here and there—for example, Wizard of Oz'ing a component when it cannot be programmed in time. It can also be frustrating for computer science students who might not get the chance to delve as deeply into technical issues as they would like to. Moreover, there is rarely time left for code documentation or re-engineering, which would be important for prolonging the legibility of their work.

It is also important to acknowledge that interdisciplinary projects can take a long time to develop or can evolve and change quite drastically past the midway point, meaning that technical work might need to be discarded or redone. However, we have learned over the years how to best mitigate these issues by giving students technical experimentation and learning tasks early on that remain useful, anticipating future demands, and making technical exploration an integral part of the project learning outcomes.

Our Perspective as Teachers and Researchers

Developing large-scale projects enables all team members, including the faculty, to achieve much more than could be done through a typical individual thesis project or small faculty pilot initiative. The constraint of our semester structure focuses and productively directs our endeavors over a 4- to 5-month period, helping to create a clear endpoint that mitigates procrastination. The projects themselves also constitute a unique form of dissemination, demonstrating that computing can be both beautiful and accessible. They serve to increase our visibility to the public and extend our network of collaborators. In addition, the professional execution of these projects enables us to approach potential partners with a portfolio of prior works, in addition to continuing collaborations with early sponsors of our work. Moreover, as mentioned above, we educate future theses students who are already used to working in an interdisciplinary way, and outside their comfort zone.

> The projects constitute a unique form of dissemination, demonstrating that computing can be both beautiful and accessible.

There are, however, several caveats to be mindful of when engaging in these kinds of projects, which can be very resource-intensive and have complicated logistics both during preparation and at the actual event. Deep in-the-moment involvement by the full team limits our ability to carefully evaluate our approach, which in turn makes it harder to publish our work in standard research papers. We often lack the resources to devise and pilot evaluation instruments, let alone implement such instruments during the performance. The one-off nature of the projects also makes testing an evaluation instrument difficult. Traditional evaluation methods, such as alternating designs for a comparative evaluation (A/B testing), would create too much additional work for the event to run smoothly, and might even compromise the aesthetic and conceptual design. Although we have published descriptions of several projects in short papers, case studies, or art track contributions, full studies require costly and time-intensive meta-analysis across several projects. The effort needed to produce enough material to “contribute” to the field is higher than in standard research.

These types of projects also can involve considerable risk. As public events and shows, they must be flawlessly executed and performed in real time. The presence of an external partner/funder raises the stakes even higher in that the event’s timing often cannot be negotiated. Further risks to achieving a quality outcome include having a budget usually well below that of comparable professional projects and starting each project with a new and inexperienced team, which necessitates decidedly more supervision than other projects which are “allowed to fail.”

It is thus extremely important to assess what is feasible within the given constraints and resources. However, this raises a chicken-and-egg question in that doing so requires experience gained only from doing such projects. Based on our own experiences, key feasibility metrics include the budget, the potential disparity in skillsets within unknown student teams, and faculty members’ ability to intervene and invest effort.

CONCLUSION

An important lesson we have learned from these performance-oriented multimedia projects is that the technology must be so seamless within the performance that it effectively becomes invisible. This invisibility is rather unusual in a computer science context, where we usually aim to foreground the capabilities of our systems. Yet in the context of performance and interactive installation work, the core requirement is simply for the technology to work, and to work reliably. It is normal and indeed necessary to develop workarounds and backup plans, including hard coding aspects of the piece or simulating interactivity entirely. But making the technology invisible to the audience makes it harder to evaluate from a research perspective. Something that is invisible is hard to ask about, and mentioning it directly could create bias. Moreover, we often end up having less technology than anticipated or not exploiting options that would be interesting from a research perspective, either due to lack of development time or because these would not add to or might even detract from the performance.

It was our experience that the more external collaborations we had, the more resources we gained access to. However, bigger collaborations usually also mean higher expectations and greater pressure to perform well, with increased risk of failure or embarrassment.

For those interested in working on performance-oriented multimedia projects, we recommend starting small to gain experience, unless there is external management to assist with risk-management or the risk of failure is small. When there are external collaborators, openly discuss the nature of the risk involved with them and create a fallback plan (or several) so that the project can be scaled back, postponed, or even cancelled with minimal legal or professional repercussions. Working at a smaller scale, your team can consequently build up a set of related case studies that have the space and resources for in-situ evaluation and process reflection, making your project outcomes fruitful for research.

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