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Live visuals have become a pervasive component of our contemporary lives; either as visible interfaces that re-connect citizens and buildings overlaying new contextual meaning or as invisible ubiquitous narratives that are discovered through interactive actions and mediating screens. The contemporary re-design of the environment we live in is in terms of visuals and visualizations, software interfaces and new modes of engagement and consumption. This LEA volume presents a series of seminal papers in the field, offering the reader a new perspective on the future role of Live Visuals.



LIVE VISUALS

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LEONARDO ELECTRONIC ALMANAC, VOLUME 19 ISSUE 3

Live Visuals

VOLUME EDITORS

LANFRANCO ACETI, STEVE GIBSON & STEFAN MÜLLER ARISONA

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ÖZDEN ŞAHİN

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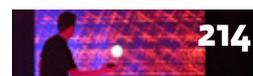


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When Moving Images Become Alive!

“Look! It's moving. It's alive. It's alive... It's alive, it's moving, it's alive, it's alive, it's alive, it's alive, IT'S ALIVE!”

Frankenstein (1931)

Those who still see – and there are many in this camp – visuals as simple ‘decorations’ are living in a late 19th century understanding of media, with no realization that an immense cultural shift has happened in the late 20th century when big data, sensors, algorithms and visuals merged in order to create 21st century constantly mediated social-visual culture.

Although the visuals are not actually alive, one cannot fail to grasp the fascination or evolution that visuals and visual data have embarked upon. It is no longer possible to see the relationship of the visual as limited to the space of the traditional screens in the film theater or at home in the living room with the TV. The mobility of contemporary visuals and contemporary screens has pushed boundaries – so much so that ‘embeddedness’ of visuals onto and into things is a daily practice. The viewers have acquired expectations that it is possible, or that it should be possible, to recall the image of an object and to be able to have that same object appear at home at will. The process of downloading should not be limited to ‘immaterial’ digital data, but should be transferred to 3D physical objects. ¹

Images are projected onto buildings – not as the traditional trompe l'oeil placed to disguise and trick the eye – but as an architectural element of the building itself; so much so that there are arguments, including mine, that we should substitute walls with projected information data, which should also have and be perceived as having material properties (see in this

volume “Architectural Projections” by Lukas Treyer, Stefan Müller Arisona & Gerhard Schmitt).

Images appear over the architecture of the buildings as another structural layer, one made of information data that relays more to the viewer either directly or through screens able to read augmented reality information. But live visuals relay more than images, they are also linked to sound and the analysis of this linkage provides us with the opportunity “to think about the different ways in which linkages between vision and audition can be established, and how audio-visual objects can be composed from the specific attributes of auditory and visual perception” (see “Back to the Cross-modal Object” by Atau Tanaka).

iPads and iPhones – followed by a generation of smarter and smarter devices – have brought a radical change in the way reality is experienced, captured, uploaded and shared. These processes allow reality to be experienced with multiple added layers, allowing viewers to re-capture, re-upload and re-share, creating yet further layers over the previous layers that were already placed upon the ‘original.’ This layering process, this thickening of meanings, adding of interpretations, references and even errors, may be considered as the physical process that leads to the manifestation of the ‘aura’ as a metaphysical concept. The materiality of the virtual, layered upon the ‘real,’ becomes an indication of the compositing of the aura, in Walter Benjamin's terms, as a metaphysical experience of the object/image but nevertheless an

experience that digital and live visuals are rendering increasingly visible.

“Everything I said on the subject [the nature of aura] was directed polemically against the theosophists, whose inexperience and ignorance I find highly repugnant. . . . First, genuine aura appears in all things, not just in certain kinds of things, as people imagine.” ²

The importance of digital media is undeniably evident. Within this media context of multiple screens and surfaces the digitized image, in a culture profoundly visual, has extended its dominion through ‘disruptive forms’ of sharing and ‘illegal’ consumption. The reproducibility of the image (or the live visuals) – pushed to its very limit – has an anarchistic and revolutionary element when considered from the neocapitalistic perspective imbued in corporative and hierarchical forms of the construction of values. On the contrary, the reproducibility of the image when analyzed from a Marxist point of view possesses a community and social component for egalitarian participation within the richness of contemporary and historical cultural forms.

The digital live visuals – with their continuous potential of integration within the blurring boundaries of public and private environments – will continue to be the conflicting territory of divergent interests and cultural assumptions that will shape the future of societal engagements. Reproducibility will increasingly become the territory of control generating conflicts between *original* and *copy*, and between the layering of *copy* and *copies*, in the attempt to contain ideal participatory models of democracy. The elitist interpretation of the aura will continue to be juxtaposed with models of Marxist participation and appropriation. ³

Live visuals projected on public buildings and private areas do not escape this conflict, but present interpretations and forms of engagements that are reflections

of social ideals. The conflict is, therefore, not solely in the elitist or participatory forms of consumption but also in the ideologies that surround the cultural behaviors of visual consumption.

Object in themselves, not just buildings, can and may soon carry live visuals. There is the expectation that one no longer has to read a label – but the object can and should project the label and its textured images to the viewer. People increasingly expect the object to engage with their needs by providing the necessary information that would convince them to look into it, play with it, engage with it, talk to it, like it and ultimately buy it.

Ultimately there will be no need to engage in this process but the environment will have objects that, by reading previous experiences of likes and dislikes, present a personalized visual texture of reality.

Live visuals will provide an environment within which purchasing does not mean to solely acquire an object but rather to ‘buy’ into an idea, a history, an ideology or a socio-political lifestyle. It is a process of increased visualization of large data (Big Data) that defines and re-defines one's experience of the real based on previously expressed likes and dislikes.

In this context of multiple object and environmental experiences it is also possible to forge multiple individualized experiences of the real; as much as there are multiple personalized experiences of the internet and social media through multiple avatar identities (see “Avatar Actors” by Elif Ayter). The ‘real’ will become a visual timeline of what the algorithm has decided should be offered based on individualized settings of likes and dislikes. This approach raises an infinite set of possibilities but of problems as well.

The life of our representation and of our visuals is our 'real' life – disjointed and increasingly distant from what we continue to perceive as the 'real real,' delusively hanging on to outdated but comfortable modes of perception.

The cinematic visions of live visuals from the 19th century have become true and have re-designed society unexpectedly, altering dramatically the social structures and speeding up the pace of our physical existence that constantly tries to catch up and play up to the visual virtual realities that we spend time constructing.

If we still hold to this dualistic and dichotomist approach of real versus virtual (although the virtual has been real for some time and has become one of the multiple facets of the 'real' experience), then the real is increasingly slowing down while the virtual representation of visuals is accelerating the creation of a world of instantaneous connectivity, desires and aspirations. A visuality of hyper-mediated images that, as pollution, pervades and conditions our vision without giving the option of switching off increasingly 'alive' live visuals. 

The lack of 'real' in Jean Baudrillard's understanding is speeding up the disappearance of the 'real' self in favor of multiple personal existential narratives that are embedded in a series of multiple possible worlds. It is not just the map that is disappearing in the precession of simulacra – but the body as well – as the body is conceived in terms of visual representation: as a map. These multiple worlds of representations contribute to create reality as the 'fantasy' we really wish to experience, reshaping in turn the 'real' identity that continuously attempts to live up to its 'virtual and fantastic' expectations. Stephen Gibson presents the reader with a description of one of these worlds with live audio-visual simulations that create a synesthetic

experience (see "Simulating Synesthesia in Spatially-Based Real-time Audio-Visual Performance" by Stephen Gibson).

If this fantasy of the images of society is considered an illusion – or the reality of the simulacrum, which is a textual oxymoron at prima facie – it will be determined through the experience of the *live visuals becoming alive*.

Nevertheless, stating that people have illusory perceptions of themselves in relation to a 'real' self and to the 'real' perception of them that others have only reinforces the idea that Live Visuals will allow people to manifest their multiple perceptions, as simulated and/or real will no longer matter. These multiple perceptions will create multiple ever-changing personae that will be further layered through the engagements with the multiple visual environments and the people/avatars that populate those environments, both real and virtual.

In the end, these fantasies of identities and of worlds, manifested through illusory identities and worlds within virtual contexts, are part of the reality with which people engage. Although fantastic and illusory, these worlds are a reflection of a partial reality of the identity of the creators and users. It is impossible for these worlds and identities to exist outside of the 'real.' This concept of real is made of negotiated and negotiable frameworks of engagement that are in a constant process of evolution and change.

The end of post-modernity and relativism may lead to the virtuality of truism: the representation of ourselves in as many multiple versions – already we have multiple and concurrent digital lives – within the world/s – ideological or corporate – that we will decide or be forced to 'buy into.'

It is this control of the environment around us and us within that environment that will increasingly define the role that live visuals will play in negotiating real and virtual experiences. The conflict will arise from the blurred lines of the definition of self and other; whether the 'other' will be another individual or a corporation.

The potential problems of this state of the live visuals within a real/virtual conflict will be discovered as time moves on. In the end this is a giant behavioral experiment, where media and their influences are not analyzed for their social impact *ex ante facto*; this is something that happens *ex post facto*.

Nevertheless, in this *ex post facto* society there are some scholars that try to understand and eviscerate the problems related to the process of visuals becoming alive. This issue collects the analyses of some of these scholars and embeds them in a larger societal debate, hinting at future developments and problems that society and images will have to face as the live visuals become more and more alive.

The contemporary concerns and practices of live visuals are crystallized in this volume, providing an insight into current developments and practices in the field of live visuals.

This issue features a new logo on its cover, that of New York University, Steinhardt School of Culture, Education, and Human Development.

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Özden Şahin has, as always, continued to provide valuable editorial support to ensure that LEA could achieve another landmark.

Lanfranco Aceti

Editor in Chief, *Leonardo Electronic Almanac*
Director, *Kasa Gallery*



1. 3D printing the new phenomenon will soon collide with a new extreme perception of consumer culture where the object seen can be bought and automatically printed at home or in the office. Matt Ratto and Robert Ree, "Materializing Information: 3D Printing and Social Change," *First Monday* 17, no. 7 (July 2, 2012), <http://firstmonday.org/ojs/index.php/fm/article/view/3968/3273> (accessed October 20, 2013).
2. Walter Benjamin, "Protocols of Drug Experiments," in On Hashish, ed. Howard Eiland (Cambridge, MA: Harvard University Press, 2006), 58.
3. "The point here is not to issue a verdict in the debate between Adorno and Benjamin, but rather to understand the debate between them as representing two sides of an ongoing dialectical contradiction." Ryan Moore, "Digital Reproducibility and the Culture Industry: Popular Music and the Adorno-Benjamin Debate," *Fast Capitalism* 9, no. 1 (2012), http://www.uta.edu/huma/agger/fastcapitalism/9_1/mooreg_1.html (accessed October 30, 2013).
4. Paul Virilio, *Open Sky*, trans. Julie Rose (London: Verso, 1997), 97.

Architectural Projections

Changing the Perception of Architecture with Light

by

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1 INTRODUCTION

Throughout the past ten years, public space became increasingly used for projections of art installations, performances, and as large-scale communication surface. Evolving from a stage design approach, projections in public space gained in popularity because powerful projectors became more affordable and at the same time the computer made it much easier to map a projection onto its canvas. The idea to take a building as a canvas to stun an audience with visual effects equally fascinated artists and marketing professionals. While there are projections focusing mostly on mapping visual content on a building, more often these projections go hand in hand with a music performance, with the projection being an accompanying visualization for a concert or the music supporting the visualization. In addition, some works also make use of interaction with its spectators.

In the 'projection community' the term 'architectural projections' is now commonly accepted for such large-scale building projections. However, the content being expressed with these new means of visual communication merely uses architecture as a canvas without deep reflection on the underlying architectural con-

ABSTRACT

In the recent years, using buildings and building façades as projection surfaces has become a widespread practice of the live visuals community. However, while projections on a building are typically called 'architectural,' they often ignore the interaction of the projection with the architecture and use the building surface merely as a projection screen. In this paper, we reflect on the potential of using projections within the architectural context, and we will discuss early or famous architectural projections as a starting point. Among architectural education aspects, the urban and sociological impacts of projections are examined as well as the use of knowledge about computer animation and simulation for architectural design. The relation of a positive perception of architecture and ephemeral activities like festivals is implicitly being shown with many examples. The paper is complemented with a case study, a large-scale architectural projection at a city festival, realized by architecture students. Based on the study, we provide insights in the technical setup and show how the architectural education aspects can be included in practical work.

cepts. Therefore, the goals of this paper are to go beyond using architecture as a blank surface. We analyze the architectural potential of 'architectural projections,' show its relations to traditional illumination of buildings and discuss the potential to enhance architecture curriculums. Thereby we build on the work carried out at the Chair of Information Architecture of ETH Zurich, both in terms of graduate courses taught ¹² as well as research carried out to establish foundational concepts and techniques, ³ mainly inheriting from spatial augmented reality ⁴⁵ and traditional 'linear perspective' as employed since the Renaissance.

The remainder of this paper is organized as follows: We will first give an overview on the history of projections (Section 2), and then provide in-depth considerations from the architectural viewpoint in Section 3. In Section 4, we will present how the techniques were applied in a concrete case study, both from conceptual

as well as technical viewpoints. We will conclude with final remarks in Section 5.

2 THE EMERGENCE OF PROJECTIONS ONTO FAÇADES IN ART AND ADVERTISING

The projection of light has been of great interest to humans since the ancient world. Whether it was Plato's cave allegory or the stones of Stonehenge, the projection of light and shadow was used as a metaphor for knowledge. In the ancient Greek theatre, which might be seen as a 'simulation platform' of that time, the stage designers attempted to create spatial illusions on flat stage elements. This need forced them to conduct research on perspective and projecting light. In the 15th century these ideas were re-discovered with the linear perspective by Filippo Brunelleschi and the *camera obscura*, followed by the

invention of the ‘magic lantern’ in late 16th century,⁶ which was mainly used by magicians to animate usually inanimate objects or to create the belief in bringing the dead back to life. The similarities between the magic lantern and the magic of architectural projections are evident, despite the differences in technology, scale and perception. While the magic lantern was prohibited because people were too frightened of ghosts at the time, today’s audience is generally conditioned for an increased intensity of large-scale visual and audio content, such as at music festivals and concerts. However, also today architectural projections can draw negative attention, for example when there is too much visual communication (i.e., advertisement) in public space.⁷

In the early 20th century, Bauhaus artists like László Moholy-Nagy extensively explored the possibilities of artificial light in photography, for light sculptures, and for stage design. Moholy-Nagy documents a light sculpture he created for ‘Persil’ laundry detergent in his book. To achieve this stunning visual effect – obviously used for advertisement – he used anti-aircraft searchlights. In Mischa Kuball’s book *Bauhaus-Block*, Wulf Herzogenrath⁸ mentions not only the tradition of synaesthetic approaches at the Bauhaus, but also takes a note of the affinity of northern artists to artificial light due to climatological reasons. While some of the experiments at the Bauhaus may be considered as the prototypes for stage projections performed at concerts later in the 20th century (e.g., Karajan’s Berlin Philharmonic Orchestra, Pink Floyd) the fascination for artificial light in areas where there is seasonally only little sunlight is a possible explanation for the popularity of today’s architectural projections. Cultures that originate from the woods, mostly in northern Europe, have a long tradition of light brought into cold dark winter nights. Examples are lit Christmas trees, or Scandinavia’s St. Lucy’s Day. Nonetheless most cultures developed their own symbolic meaning

for light and shadow, sun and fire. Therefore the affinity of artists towards the light may vary, and it might as well be based on Chinese and South-East Asian shadow plays, or other metaphors.

Today’s audience has many different associations with artificial light in public space, Christmas lights being only one possibility. Neon lights, best known from the famous strip in Las Vegas, are another association. The city itself becomes a huge light sculpture at night and fascinates us when viewed from the street level, from the top of a hill, or from an airplane. People got used to the fact that buildings, especially in urban areas, are illuminated at night most of the time. They do not get excited anymore about an illuminated church. However, they do get excited of illuminations beyond the norm, such as impressively shown by lighting artists like James Turrell⁹ creating stunning combinations between artificial and natural lighting.

In that respect Paul Houdin-Robert’s concept ‘son et lumière,’ for the first time conducted in 1952 at *Château de Chambord* in France, must be seen as one of the early initiators for large scale projections on architecture.¹⁰ The project was concerned with the combination of sound and light to tell the history of a location with the support of a magical atmosphere. The projections were shown mainly in France, with additional ones in Rome and India in the 1950s and 1960s. They were an inspiration for many concert stage designs as well as for early projection artists in the 1990s such as the Paris-London based *The Projection Studio*.

Throughout the last 20 years the capabilities of digital technology, in particular of computer graphics, dramatically improved, and the availability of digital projection hardware and interaction techniques changed the way artists started exploring relationships of space, time, architecture, and culture. An important work is

Jeffrey Shaw’s *The Legible City*,¹¹ which premiered in 1988. The work allowed the audience use a stationary bicycle to navigate through a virtual 3D world, in which the streets are based on a real city (Manhattan, Amsterdam, Karlsruhe). These streets are represented by 3D letters and words that let the user pursue narrative threads. Another seminal work is *Displaced Emperors* by Rafael Lozano-Hemmer, presented at Ars Electronica 1997 in Linz. Through wireless 3D sensors, the installation enabled the visitors to interactively reveal the interiors of the Habsburg residence in Mexico City, Castillo de Chapultepec. These were projected on the façade of the Linz Habsburg castle. With its historical references, it thereby “departs from the supposition that cultural property is cultural poverty. As an architectural mise-en-abîme, the project supports the idea of perpetration of culture instead of calls for its vampiric preservation.”¹²

In 1998, Raskar et al. coined the term ‘Spatially Augmented Reality’^{4,5}, which made use of computer graphics, geometric mapping and projectors to create a kind of augmented reality that did not require virtual reality helmets. Pablo Valbuena conducted one of the first applications in art in 2007 with his *Augmented Sculpture v1.2*,¹³ also shown at Ars Electronica. Since then, spatial augmented reality techniques became more widespread, with notable artists labels such as the French-British ANTIVJ,^{14,15} Germany’s URBAN-SCREEN,¹⁶ or Australia’s The Electric Canvas.¹⁷ At the same time, the techniques were quickly exploited for marketing purposes, as PLAYMIND’s projection for Microsoft¹⁸ exemplified. Others were exploring the possibilities of mobile projectors, such as Blue-BlastMedia’s *Target Velocity Projections*¹⁹ that did not map content onto building façades, but rather let animated symbols ‘run’ on buildings.

The emergence of artists and art collectives, many of them using a do-it-yourself approach, realizing pro-

jections in public urban space also indicates a close relationship to the many forms of urban art and street art, as often some ‘guerilla activities’ were involved. However, while sprayed graffiti and tags mainly fulfill the purpose to visually communicate with other sub-cultural groups,²⁰ public projections immediately attracted a larger audience, most likely due to the larger scale they were operating at. In 2007, the Graffiti Research Lab established with L.A.S.E.R. Tag^{21,22} an explicit link between tagging and projections by combining projectors and laser pointers to tag buildings at large scale. At the same time, in the commercial area, companies started to exploit the technical possibilities to push the scale of projections: in 2008, projector manufacturer Christie used 27 projectors on a building in Quebec to create an oversized screen 600 meters wide and 30 meters high.²³

3 THE ARCHITECTURE VIEWPOINT: FROM FAÇADE DESIGN TO ARCHITECTURAL PROJECTIONS

As shown in the previous section, today there exists a broad range of activities and possibilities creating projections in public space. However, there is very little work dealing with explicitly taking the underlying canvas (i.e., the architecture) into account. In this section, we examine the potential to do so in terms of architectural communication and education, and of creating media-augmented responsive architecture.

3.1 Architectural communication

Similar to street art, art performances or even Christmas lighting, urban projections are part of the public space. They combine the flexibility and relatively low cost of lighting with the precision of a drawing or a façade design respectively. Apart from its evidently public character and the possibilities to include the neighborhood in local planning more interactively, urban projections offer another interesting potential.

Usually, if architects want to test the visual perception of a façade (or a part of it) at 1:1 scale, building a model at this scale is beyond cost and time constraints. Therefore, projections constitute a valuable and flexible alternative to explore new façade designs at 1:1 scale.

The important aspect about 1:1 scale for architecture is that façades are perceived differently at different scales: Typically, architects draw elevations of all the façades in a street if they are planning a new building in order to get an overview of the neighborhood. Usually this totally neglects the fact that on the other side of the street there are buildings too, which means that in reality viewers of a façade never really see a whole street at once but put together the image of a façade or a whole street in their minds. This obviously leads to stronger focus on façade details than its overall design. This effect was observed in one of our case studies, when the projection surface was larger than the spectators' visual field. Our students could experience the different perception of a projection in scale 1:10 and scale 1:1. While in the model they could still step back to get an overview, in the real scale projection there was not enough space to step back far enough. This situation is evident in many urban settings. Thus, the simulation of façades in 1:1 scale forces architects to consider scale and realistic perspectives. Projections therefore can be seen as a powerful communication medium for architects. The following list presents typical architectural concepts that we regard as well-suited to be visualized using projections:

- » **Illumination.** Testing of different illumination and lighting variants can be carried out with a single projection setup.
- » **Design.** References to design decisions (such as proportions or ornaments) of a given façade can be highlighted directly.
- » **Construction.** Details such as construction principles, the force model, insulation, or air convection (e.g., heat exchange) can be visualized directly on the façade.
- » **Operation.** Projections can highlight factors relevant for facility management, such as user circulation. In addition, projections may take an active role, for example by guiding people through crowded spaces.
- » **Historical context.** Relevant historical information of the building, the site or its surrounding can be displayed.
- » **Spatial context.** Projections can highlight relations to neighboring buildings, streets or squares.
- » **Architecture theory.** Projections in 1:1 scale can be applied for educational purposes to explore theoretical issues, such as the use of perspective in Renaissance façades, or the concept of transparency by Rowe and Slutzky.²⁴
- » **Architecture history.** Façades of different styles from different epochs can be projected, analyzed and compared.

When shown in public space, the projections are a useful medium to communicate with many people at once and hence can support collaborative urban development processes as well. In this regard a project can be explained much more immersive and thus potentially more convincing or at least more plausible. Architects can review and communicate their design decisions, and for example explain why they replaced some popular parts with something better. Competition juries can explain their arguments to a broader public and other stakeholders can be involved in decision-making.

Compared to media façades (i.e., façades with integrated active visualization elements such as LEDs), projections do not physically affect the real façade behind it, which leaves the possibility for a façade that can be perceived as a normal façade during daytime. One limitation for testing different façades obviously

is that they are visible only at night. Another limitation is the relief of the existing façade, which would need to be visually neutralized first when projecting a new façade on top of it. To solve this pragmatically, a building or façade could be disguised in order to visualize a new project or a renovation on top of it.

In a broader context, the ongoing advancement in augmented reality will most likely allow augmenting a person's visual field directly using glasses with heads up displays to achieve similar possibilities to projectors. The implications of augmented reality for architectural communication are manifold.

3.2 Teaching selected architectural façade theories with projections

Given the excellent communication capabilities of projections described in the previous section calls for their application in architectural education. As shown in our previous works, it is valuable for students to experience the difference in perception when preparing the projection on a small model or even in 3D on the screen and compare it to the visual impression they get from the 1:1 scale projection.^{1 2} Students also gain knowledge by studying theories about façade design and exercising it directly in the process of creating projections.

In addition, architecture students learn how to handle dynamic media and animated content, and how to integrate them in architectural communication. Out of 14 students 11 answered that learning 3D modeling

and animation software was a contributing factor to choose the course. Not only have projections developed vastly over the last five years, increasingly, clients also expect architects to deliver quality imagery of their projects, if possible in the form of movies or in an interactive way (such as websites or games). This demands more advanced content creation techniques as opposed to the presently used Photoshop collages.

To provide an overview of the possibilities of using architectural projections in education, we highlight typical theories and exercises that were explored in our courses.

Semper's principle of cladding

Among the theories that fit very well, an exploration with the means of projections is the idea of change of material, part of Semper's *principle of cladding*. Looking at buildings such as Greek temples, Semper claims that shapes derived from a wooden construction are transformed to a construction with stone. Therefore a similar form is being 'disguised' with a different material. Despite the haptic of a material cannot be simulated with projections, visual implications of a construction with a different material can be shown. For example, in the seminar week of October 2012, students attempted to turn a concrete wall into a brick construction, as shown in Figure 1. The realized projections made evident that a brick building would not only completely change the architectural expression of the building itself, but also changes the impression one would get of the street and the surroundings where the building is located at.

Figure 1. Architectural projection by ETH Zurich students, October 2012. "Change of material" simulated with a projection on a concrete façade by Mario Campi at ETH Zurich, Science City Campus. Image © Lukas Treyer, 2012. Used with permission.



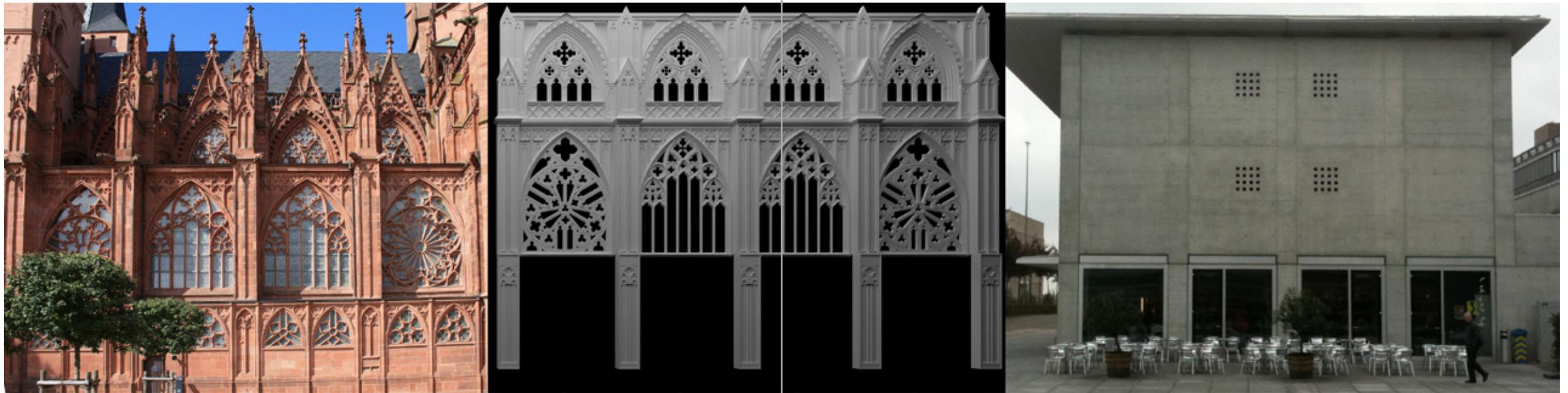


Figure 2. From left to right: St. Katharinen Kirche, Oppenheim 1315. The façade was then transformed (middle) to fit the canvas façade by Mario Campi located at ETH Zurich, Science City Campus (right). Images: cc Patrick-Emil Zörner (left) and © Lukas Treyer, 2012, (middle, right). Used with permission.

Proportion

The rules of proportion constitute another domain of architectural knowledge that can be well studied and explained with projections. Many façades from the Renaissance until the 20th century are clearly structured, i.e., they follow specific rules. Even though uneducated viewers may spot the regularity of a façade, they most likely are not aware of the rules behind it. Since priorities in façade design have changed in the last century, most students only know these theories from the books. To research these by realizing a projection has several consequences: the students need to practice façade design and to understand the underlying structure, similarly as they would have to by redrawing classical façades. In addition, they are forced to present their work to the public, as if they would 'publish' a façade. For most of the students this leads to increased motivation, because the work is being exposed publicly. Last but not least the proportions can be experienced in 1:1 scale. Students get to know the differences of proportions at different scales.

Visual overlay of different epochs

Another interesting approach is to use a building as a canvas, and overlay virtual façades onto the physi-

cal one. This is how different styles and epochs can be related to each other in a very direct way. Figure 2 shows an example of a gothic façade of the St. Katharinen Kirche in Oppenheim, Germany, built in 1315 and its adaption to the proportions of the concrete façade of a building by Mario Campi at ETH Zurich's Science City Campus. The façade of the church in Oppenheim was chosen because of its similarities in proportion with the canvas façade. In this adaption we intended to preserve as much details as possible, however other works might examine which rules about proportion of a given epoch should be considered when adapting a façade to a new shape.

Perspective

With the development of perspective drawings in the early 15th century in Florence by Brunelleschi,²⁵ the architects of that time were given a planning tool by which architects were able to create façades with perspective effects. Even more they were able to rationalize space, to understand the impression of space in a more objective manner. According to Argan and Robb²⁶ Brunelleschi's interest in the development of the linear perspective is closely interlinked with his

architectural interests. The perspective for him and his followers was a tool to plan façades more accurately. The Tempietto del Bramante in the San Pietro in Montorio church in Rome²⁷ for instance continues the lines of the top circle on the inner walls with reliefs in such a way that one could think there are no inner walls.

A similar trick is used by Michelangelo on his Palazzo Senatorio in Rome²⁸ where the two staircases are arranged symmetrically so that their railings form the outline of one single imaginary large staircase. Renaissance architects gained the skills to do so from their spatial illusive paintings and frescos, where single viewpoint spaces and structures seemed to be visually augmented. The play with the perspective, e.g., through different viewpoints, is still a subject in today's street art. Artists like Julian Beever,²⁹ Edgar Mueller³⁰ and Axel Peemöller,³¹ to name just a few, successfully incorporate perspective distortion in their work.

Similar viewpoint considerations had to be addressed when we developed the 'shifted lens' method³ for the

projections in our courses. In order to provide an easy process to simulate visual depth for a dynamic viewpoint in a projection we had to apply simple rules of optical physics, namely use the proportional relation between real world and its image created by a lens.

Teaching with new media

Recent work by Angela di Serio et al.³² documents the positive effect augmented reality has had on the motivation of students. This supports our claim that certain architectural theories can be communicated in a more plausible way with projections and that students are more attentive when being presented a projection on a building instead of slides on a canvas in a lecture hall. However, the question whether or not media have an influence on learning performance is part of an on-going controversy in education research^{33 34 35} and requires further research to be validated through additional, systematic studies.

3.3 The reaction of architecture

Today, concert halls, clubs, bars, and similar, are increasingly outfitted with projection canvases by design, i.e., the canvas is becoming an implicit part of the



Figure 3. The Velvet Underground dance room at Zouk Club Singapore, designed by Phillips Connor. The LED ceiling can be controlled directly through a DVI output for VJ performances (Laptop in front, in this case). Additional projection-mapped surfaces are at the far end on the wall (illuminated tetrahedral structures and artwork). © Stefan Müller Arisona, 2011. Used with permission.

overall space. Notable examples are the Pitch Club in Porto, designed and illuminated in 2012,³⁶ the Velvet Underground at Zouk Club in Singapore (Figure 3), renovated in 2011,³⁷ or the Nuits Sonores, a concert installation in Lyon, realized in 2009.³⁸

The inclusion of canvases as a design element contributes to the holistic experience of a space and its program, and the symbiosis between the projection, the canvas and the architecture fascinates visitors. While most of these installations are rather fixed and serve a specific purpose, one could think about more generic canvas reliefs that would allow for lots of different projections. It is very likely that this kind of symbiosis between architecture and projection will be adapted for advertisement as well. For architecture this would imply including advertising in façade or interior design more strongly. Why not, if some kind of advertisement is mounted to the architecture anyway? Obviously, projections might re-trigger an old discussion about architecture and advertising.

As previously pointed out, during the Renaissance, the introduction of perspective techniques allowed for much more precise planning of architecture. In particular, the final outcome could be presented to citizens in a much clearer way ahead of creating the building. In addition, the ability to create perspective drawings influenced architecture: Architects arranged elements

of a façade to integrate perspective effects and to take into account different appearances of the same object at different distances. Visualization techniques developed in the past centuries, such as perspective drawing, photography, film or computer graphics, had an impact on architecture and influenced the design itself. In turn, new types of architecture, such as planetariums, cinemas, or newsrooms, supported them. First person perspectives generated in real-time for augmented reality applications³⁹ have the potential to simulate the human perception of architecture even more precisely. Using projections as a spatial augmented reality tool, potentially influences architectural design because architects can simulate human perception more precisely and thereby compose visual effects like rhythm, contrast, color, more adequately. Even more, similarly as renaissance architects did with several perspective tricks, they might incorporate hints into their architecture, pointing at the new possibilities of augmented reality.

4 CASE STUDY "STADTFEST BADEN"

A group of ten architecture students of ETH Zurich took the opportunity to create architectural projections as an art installation for the Stadtfest Baden 2012, a festival in the town of Baden, Switzerland. Together with the art director and organizers of the festival we realized projections that were not supported by music but explored the artistic possibilities of architectural projections on a temporary building structure built specifically for the festival – performed alongside concerts and theatrical productions.

4.1 Architectural concepts and theories

While the students were free to choose their design approach, we encouraged them to focus on exploring different methods of 2D illumination as an initial direction (Figure 4). The main reason for this direction was obviously reduced complexity as opposed to correctly mapping 3D geometry. Also, the exploration of 2D illumination techniques constituted the basis for applying other techniques, and allowed for easy experimentation with physical boundary conditions, such as projector limitations in terms of distortion, color, or brightness – the latter two which were also influenced by material properties of the canvas.

Similar to Frescos known from the Renaissance, the next step was the attempt to create the illusion of depth on the façade. To speed up the content creation process, the students were given a template where most of the perspective settings were already predefined. Therefore they did not have to deal with optical settings of the virtual camera of the 3D software. The resulting projections were of a very geometric character, demonstrating the students' ability to create and project a three dimensional illusion (Figure 5).

The template to simulate the illusion of depth was used by other students to overlay a different façade on top of the wooden structure. Examples were Moorish and Gothic facades that not only made use of perspective illusion but also created the illusion of stone facades from a different epoch (Figure 6). Probably due to the wooden façade, in this case the 'change of style' attracted more attention than the 'change of material,' the latter which was more evident in the ETH Science City example previously shown in Figure 1.



Figure 4. Different lighting situations visualized with projections. Stadtfest Baden, 2012. © Lukas Treyer, 2012. Used with permission.



Figure 5. Examples of projections playing with geometry and perspective. Stadtfest Baden, 2012. © Lukas Treyer, 2012. Used with permission.

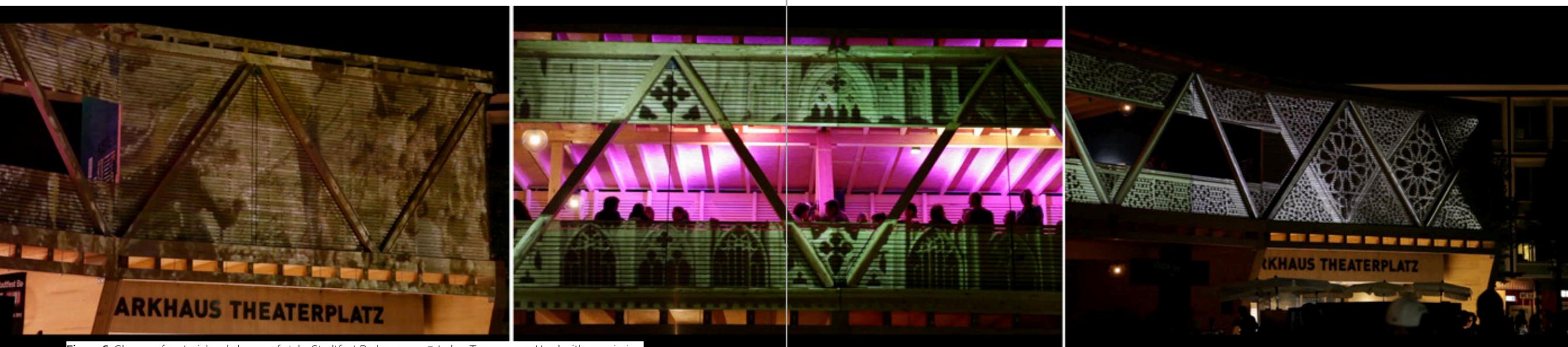


Figure 6. Change of material and change of style. Stadtfest Baden, 2012. © Lukas Treyer, 2012. Used with permission.

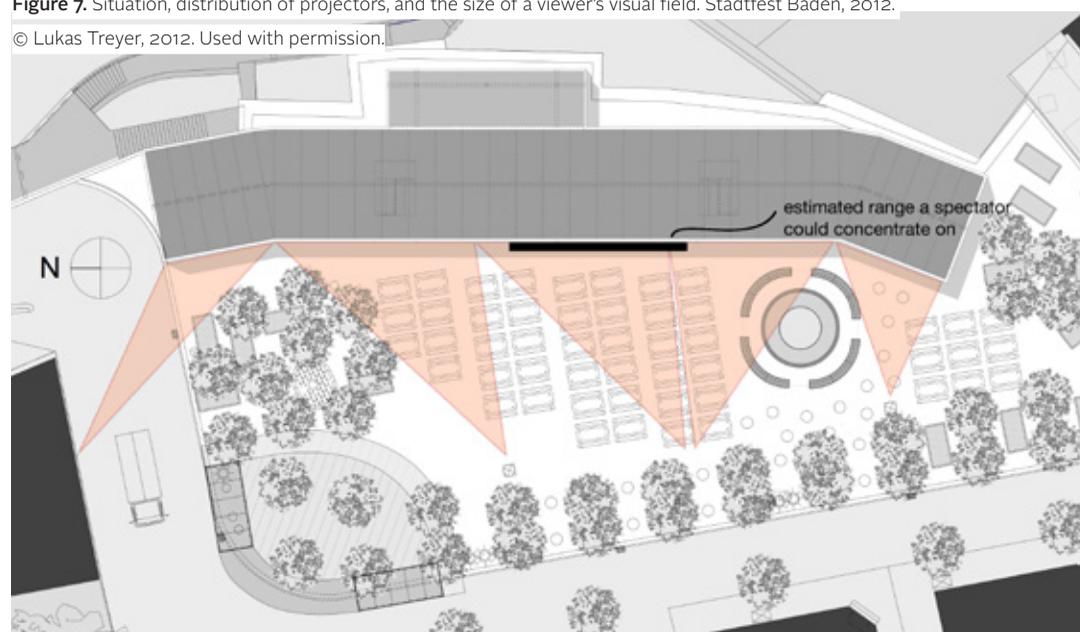
4.2 Technical setup

The building in Baden was a wooden structure designed as a temporary building for the festival. The façade had a width of 60 meters and a height of 8 meters and was covered by five projectors. As shown in Figure 7 the building is angled towards the ends. The workflow consisted of a content creation phase that lasted several months, and a content mapping phase, lasting a few days.

For the mapping phase, 3D content was rendered to rectangular images and movies. The students were provided a template to ensure that the same reference points were used of all content. With the help of the Mesh Warp Server ⁴⁰ the resulting imagery was cut into segments according to the different levels of depth of the façade shown in Figure 8.

Figure 7. Situation, distribution of projectors, and the size of a viewer's visual field. Stadtfest Baden, 2012.

© Lukas Treyer, 2012. Used with permission.



In a second step, the Mesh Warp Server was used to edit the shape of these segments directly in the image that was projected onto the buildings. In this way, we were able to map the segments precisely to the corresponding segments of the real façade. In the same way as in famous Renaissance paintings and frescos, the illusion of depth only works for one single viewpoint. From other angles the geometry appears to be distorted. Thus we implemented the shifted lens method ⁵ within our template, so the distortion can be adjusted in order to match different viewpoints over time. Consequently by applying this method we were able to create movies with fixed reference points, while at the same time being able to animate the viewpoint.

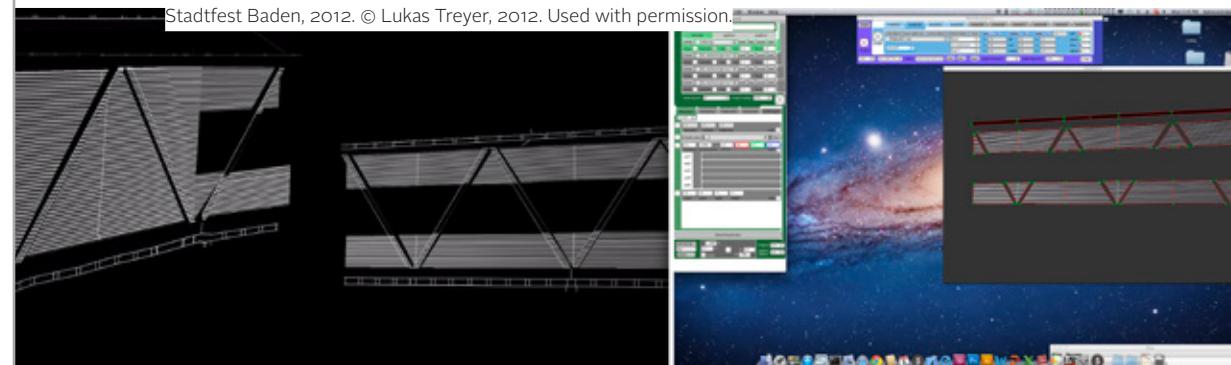
4.3 Lessons learned

The projection setup for the Baden festival was larger in scale and more complex as compared to earlier setups explored at ETH Zurich's Science City campus. Both the increased scale and complexity contributed to a number of issues to be resolved, which are discussed in this section.

The first issue deals with the application of the shifted lens method in conjunction with other animated content. As indicated, we were applying the shifted lens method during the first 1:1 scale field tests for the Baden projection setup. It showed that one of the main issues was that viewers were unable to distinguish the moving viewpoint from other moving elements in the projection. Therefore, when applying

Figure 8. Mesh Warp Server setup. Projection output (left), control and editor windows (right).

Stadtfest Baden, 2012. © Lukas Treyer, 2012. Used with permission.



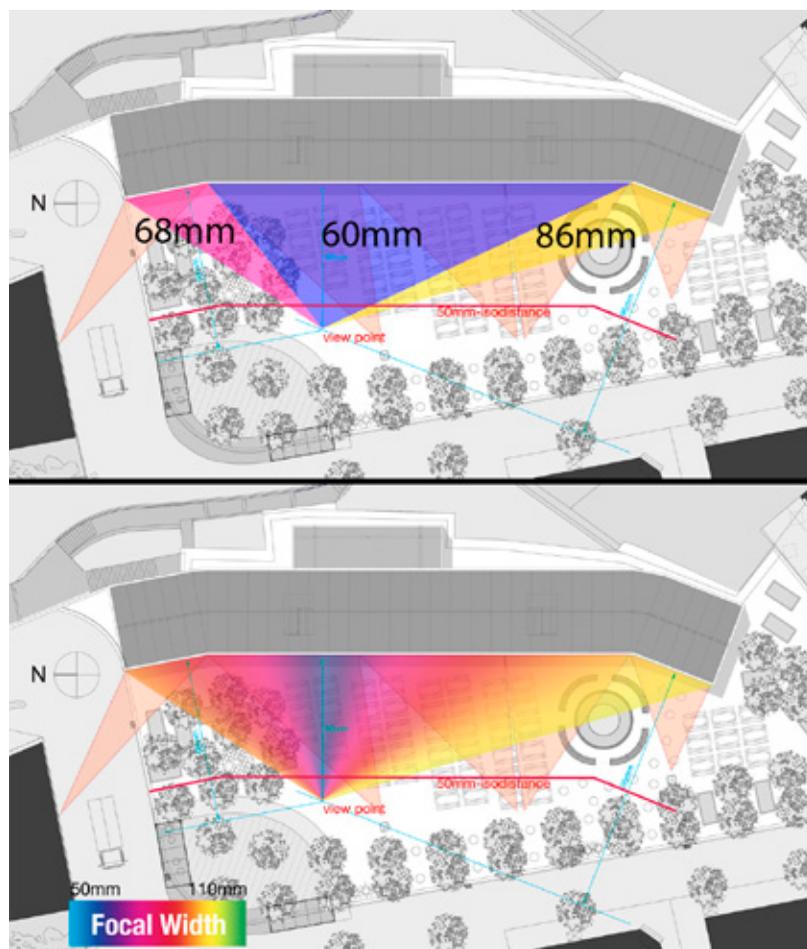


Figure 9. Different focal widths for the three separate surfaces. With the help of distorted lenses we might achieve a continuous variation of the focal width without the clearly visible abrupt changes between the individual flat surfaces (bottom). Stadtfest Baden, 2012. © Lukas Treyer, 2012. Used with permission.

a continuously moving shifted lens, we recommend stopping all animations during viewpoint movement.

The second issue deals with the earlier noted perception of scale: As most of the content was prepared using a 1:50 model, it was hard to predict the final impression of the work at 1:1 scale. In particular, the large building width of 60m and the relatively small space in front of the building made impossible for the audience to step back far enough to obtain a field of view of the whole façade at once. The typical range a visitor was able to focus on is indicated in Figure 7. In retrospective, the lesson learned is that this situation needs to be considered in-depth during the early design phase. If possible, preliminary tests at 1:1 scale should be run (even if on a different façade) in order to adjust individual levels-of-detail of the content. Ideally, on-site adjustments would be most effective, but currently still impose a limitation, as much of the content is pre-rendered. Moving towards real-time rendered content

that can be adjusted quickly will certainly be of great help to deal with scale issues.

The third issue relates to the angled building shape and projection setup requiring considerations regarding focal width and distortion. Figure 9 shows the discrepancy between the strict difference of the focal widths implied by the given projection and virtual camera setup (top) and the fluent variation of human visual attention (bottom). The main problems with this setup were a) the abrupt changes of focal width at the angled transitions (68mm – 60mm – 95mm), and b) the perspective distortion caused by the extreme width and aspect ratio of the middle façade part. To deal with the situation, we chose a compromise based on the observation that it is much harder to tell the difference between 50mm and 100mm photographs than between 50mm and 15mm just by judging how distorted the geometry appears: The focal width of the middle projection was slightly increased, resulting

in an ‘over-orthogonal’ but less distorted image in the middle façade element. In addition, the focal width of the right projection was decreased in order to reduce the abrupt and well noticeable jump of focal width. While this compromise resulted in a visually acceptable solution, in the long run, further research will be required to increase the visual accuracy. One possibility would be to use virtual lenses that adapt focal width towards the edge of a picture and especially at geometrical transitions. This would allow for a more continuous variation of focal width between three surfaces, as indicated in Figure 9 (bottom).

5 CONCLUSIONS

This paper elaborated architectural projections, a technique that uses computers and projectors to cast imagery in existing façades. While this technique is growing in popularity in a broad range of applications, only little work actually investigates the use of architectural projections for architecture. Based on selected architectural areas of interest, we have highlighted the potential of applying projections for architectural communication and education. At ETH Zurich, we have offered graduate courses and seminar weeks with great success since 2008, and we will continue to investigate in the topic. One of the main directions will be to further study the potential of architectural projections and to systematically analyze and validate their value, so a future integration into the architecture curriculum could be considered. Therefore, from a conceptual viewpoint, we plan to further apply projections to study and validate architectural theories. In terms of technology, the main obstacles are currently the large diversity of software tools that often do not work together as expected and need further integration. Here our focus will be to develop optimized workflows that allow students and architects to focus on content rather than tweaking software. In addition,

the previously mentioned need of increasing visual accuracy, especially for non-planar surfaces, constitutes an important area of investigation. Finally, from an artistic viewpoint, we plan to further realize architectural projections that can be brought to public space as artworks. ■

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