Stage Magic and Digital Installations in Museums

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Abstract

The word "magical" is often used to describe experiences that are wondrous, fantastic, or unbelievable. A "magical" experience is an experience we discuss, try to figure out, and which arouses our curiosity. In museum exhibition design we often design exhibitions that are meant to create similar sensations in the audience. Illusions are a design trick that adds a wondrous dimension to mundane artefacts, but at the same time communicate that it is only an illusion. The modern museum exhibition featuring reconstructions, scenarios, models etc. is designed to provide an immersive illusion—indeed a museum exhibition can be understood as an illusion. Our hypothesis is that modern museum exhibition relies on a set of illusions and that future exhibition design can be furthered by developing a theory of exhibition magic. Often illusions are understood as simply playing with the perspective or with mirrors, but we want to take this further and base our work on experts of illusions: the stage magicians. We argue that an exhibition can be understood as a stage or several stages, where principles of magic shows can be applied. From theories of stage magic we develop a theory of *exhibition magic* that can be used to analyse exhibitions and to design new exhibitions. In the contemporary museum the stage magician is exchanged with interactive digital installations, which by appropriate use may create some of the same sensations as a magic show. In this understanding working with magic installations in the museum becomes a means of communication which is targeted at evoking certain sensations within the audience. Based on this theory of exhibition magic we have devised an interactive audio installation for a museum. By observing how audience interact with the installation we argue that we created an experience that possess some "magical" features.

Introduction

"Magic" has, at least in the form of *stage magic,* positive connotations of wonder and amazement. We have all experienced the surprise, amazement and excitement, when we followed a magician performing a trick in front of an audience. Performing magic tricks or tricks of illusion is probably one of the oldest forms of performance art and is found in all cultures. Even specific tricks, like "cups and balls," where the balls magically move between three upturned cups are known to many cultures. Important to stage magic is the contact that the performer has with the audience. This extensive use of attracting and interacting with the audience is probably an explanation why stage magic has been a favourite of entertainment for centuries, and a performance form which continually is developed and which attracts new audiences through lavish stage shows, TV, and YouTube. A recent development has been home produced videos on YouTube, which reveal tricks performed by famous magicians. Professional magicians have also taken up this performance type through TV shows (e.g. "The Masked Magician" and "Penn and Teller"), where they deliberately show famous tricks and reveal their secrets, probably much to the chagrin of their colleagues, but they defend their shows by arguing that it inspires the development of new and more advanced tricks. Stage magic attracts audiences by producing entertainment in the form of wonder, amazement, surprise, and curiosity—affects that audiences of all ages and cultures share. Performing successful magic in front of an audience includes the ability to secure the audience' attention and awareness. Stage magicians consequently must have a deep intuitive understanding of how to work within the field of optical, visual and cognitive illusions. That is, magic either tricks our eye, our mind or both. The tricks are designed to attract curiosity and amazement, and can ultimately be seen as openings of learning, as the audience is left with problems that challenge their minds: How did the magician do it? At the same time no one is left with the impression that the

stage magician is able to do real magic. Indeed some magicians refrain from the title as "magician" and rather call themselves "illusionists" to underline the contract with the audience, that nothing supernatural takes place, and that stage magic is only meant for entertainment and enjoyment. Using natural and seemingly transparent techniques magicians create effects that seem to be impossible by the laws of nature.

In the modern museum digital installations have become naturalized (Parry 2007), but we are still exploring how to make them contribute to different kinds of learning (Parry et al 2006). Even though exhibition design have developed significantly over the past decades the benefits and challenges are still under discussion (Drotner 2011). Our hypothesis is that principles and aims of stage magic can inform the design of digital installations in museums. On the other hand using principles of stage magic could be seen as importing "tricks" into the exhibition and thus challenge the understanding of the museum as houses of learning. We argue that principles of stage magic can be used as an opening for learning and that most modern exhibitions already experiment with theatre like illusions, such as dramatic scenography, replicas, animated effects, interactive installations, simulations and so forth. Using stage magic as a frame, we argue, will enable the museums to gain a deeper understanding of how exhibitions can work in relation to the audience. Our research question is: how can principles of stage magic inform the design of digital installations in museums? We will answer this question by studying the theories of stage magic and within this frame develop a set of principles for designing "magical" digital installations. This in turn is evaluated by designing a digital installation in collaboration with a museum.

Research into stage magic

Scientific research into the mechanics of stage magic is sparse. The history of stage magic as a performance art however is well documented (Milbourne 1991) and lots of literature on how to do tricks is available (Nelms 2000). But how and why a trick amazes us is a relatively new field to researchers. As stage magicians must have a considerable knowledge of how to catch and divert attention, the field is of particular interest for psychologists and cognitive researchers. Here we will look at three approaches to the study of stage magic: a theoretical perspective based on psychology, an approach based on magic as visual illusions, and one as cognitive illusions. As the affect of *surprise* is important to any magic trick, we will also look at the research field of surprise.

Psychological research

The general theoretical study of stage magic as a study of the performance of deception has been done by Peter Lamont and Richard Wiseman – two psychologists who have also performed as magicians. In their book "Magic in Theory" (Lamont and Wiseman 1999) they categorize magic tricks into the following types:

appearance: An object appears where it was not.
vanish: An object disappears from where is was.
transposition: An object changes position in space.
transformation: An object changes form.
penetration: An object penetrates another object.
restoration: An object is damaged and restored.
extraordinary feats: Mental feats, physical feats.
telekinesis: The ability to control movements of objects without physical contact.
extra sensory perception: Clairvoyance, telepathy, precognition, mental control.

This classification relies both on the culture of magic tricks through the ages, and on the type of trick as experienced by the audience, but not on how they are performed. The principle means of magic is, according to Lamont and Wiseman (1999) the performance of *misdirection*, that is directing

the audience's attention or suspicion elsewhere while at the same time performing some hidden movement. Misdirection can be performed in several ways according to the wishes of the performer. Either it is performed to attract attention to a specific point or to reduce or divert attention from a specific point. Misdirection is an important part of any magic trick but always closely designed as an integral part of the trick to create the illusion of something supernatural happening. As attention and misdirection are central to any trick, stage magicians are experts in this art and have developed a range of methods to catch or divert attention, in ways that the audience's suspicions are not aroused. This refers to the psychology of deception (Mulholland 1963:324). Magic tricks are often deceptively simple. They may be based on elaborate and expensive equipment but are usually designed on the basis of a simple method ("how the trick works") to achieve the desired effect ("what the spectator perceives"). When the simple method is disguised by appropriate use of misdirection combined with elaborate props and performance skill, we have the basis for a working magic trick. Magic tricks are simple because misdirection have to be used carefully to divert the spectator from the method, but not from the effect. A dramatic misdirection may not only hide the method but also the outcome. Misdirection can be understood as to allow an effect by hiding how it is produced (Lamont and Wiseman:30).

Visual illusion research

Stage magic is a predominantly visual performance and consequently relies on tricks based on visual illusions or in combination with cognitive illusions. A stage trick is based on either visual illusions, optical illusions, cognitive illusions and may use special effects (fake gunshots, use of light and shadow, camera angles etc.) and secret devices specially built for the show (Macknik et al 2008). Visual illusions rely on how the perception of visual stimuli matches neural activity. Neuro scientists make use of visual illusions to dissociate how visual perception matches physical stimuli rather than subjective perception. Stage magicians use visual illusions to trick our visual perception basing them on the phenomenas called *dancing bar, retention-of-vision,* and the *trizonal space warp.* In the famous spoon-bending trick, a metal spoon looks as if it has become flexible, by shaking it gently. This is a result of the *dancing bar illusion,* where the neurons that respond to motion and corners of objects respond differently from other neurons thereby creating the effect that a solid object look flexible in the middle. The *retention-of-vision illusion* is based on what also may be called "after discharge". An image seems to persist in the visual system for a longer time than it is actually presented. Stage magicians may use this short period of time to hide something. In the famous trick where a woman's dress instantly changes from white to red is carried out as follows. First we see a woman wearing a white dress. Then red light is turned on making the dress look red. Then the red light is turned of and white light turned on to reveal the woman in red. In the short intermission between the two lights while the audience enjoys the after discharge, the woman quickly removes the white dress. It is also the same illusion that motion pictures rely on. The *trizonal space warp illusion* was already noticed by Aristotle when he looked at a fixed point on a waterfall for some time and then changed to look at the rocks on the bank. The rocks now seemed to be moving in the opposite direction. This is due to neural adaptation which decreases the responsiveness to a constant stimulus. These are the primary visual illusions which may be used for stage magic but there may be others (cf. Mackink et al. 2008).

Cognitive illusion research

Whereas visual illusions build on the functions of the visual stimulus the cognitive effects build on higher level processing of the brain. Cognitive illusions manipulate our attention by employing the technique of misdirection. Misdirection can be used to draw the attention away from the 'method' (the secret behind the 'effect') or towards the effect (what the audience perceive). As humans our attention is directed towards salient objects. These are objects that are new to the surroundings, unusual, having high contrast to other objects, or are moving. These will receive more attention, and

will be within what is called our attentional spotlight. We will present what is called *inattentional blindness* and *change blindness*. Both can be performed covert or overt. Overt misdirection is when the audience's gaze is directed away from the method, while covert misdirection is the more subtle form, where only the audience's attentional spotlight is drawn away. This means that the audience is allowed to gaze at the method, but without perceiving it. When people's attention is drawn towards an object, we fail to notice even dramatic changes. A famous example is the video on selective attention where the spectator is asked to count the times a team is passing a basketball (Macknik et al 2008). What the spectator misses is the man in a gorilla costume that mixes with the players half-way through. An even better example is "the amazing card colour trick" as presented by Richard Wiseman (Wiseman n.d.). Here a simple card trick is performed while the spectator fails to notice that the shirts of performer and the assistant, the table cloth and even the backdrop change colour during the trick. A study by Kuhn & Land (Kuhn & Land 2006) of the vanishing balls trick show how the eye motor system and the brain are uncoordinated. The magician throws a ball and catches it again a few times. The last time the ball seems to vanish in mid air. A study of the eye movements show that the eyes do not follow the ball, when it is thrown the last time, but rests on the *eyes* of the magician. In other words, while the brain believes the ball to have vanished mid air, the eyes don't. This shows that our attention tends to follow other people's gaze. A video by "Eva Rawfruit" (Rawfruit n.d.) playing the violin show that a similar phenomenon may be observed when the spectator is asked to count downstrokes when a violinist is playing and we hear the music. As violin strokes and the music are not completely coordinated, it is an easy task when the sound is muted, but requires considerable attention when the sound is on. This tells us that the visual and auditive systems are competing for attention. *Change blindness* occurs when the people fail to notice that something is different from the way it was before. As with inattentional blindness dramatic changes may go unnoticed, but not because of fixed attention. Change blindness may occur during what is known as a transient interruption (blink, saccadic eye movement or a flicker of the scene). This requires the audience to compare post-changed with pre-changed state (Macknik et al 2008).

Insights on magic illusions and how they are perceived (cf. Kuhn & Land 2006)
- illusions may be either visual, auditive or cognitive – or a combination
- what we believe we see is heavily influence by where other people are looking
- magic is based on working with attention, awareness and expectation of the audience.

Surprise and Amazement

For a trick to work it has to create the sensation of amazement or wonderment. These are feelings that builds on being surprised – in magic surprise is normally obtained by giving the feeling that something is happening which is not possible by the laws of nature. This of course assumes that we are familiar with the laws of nature and that we step by step are introduced to the trick and gently led to a predetermined climax. This relies of the question of *priming*. Priming is the process of establishing a contrast to the magic trick. If the trick makes a watch vanish it is important to show the original position of the watch before the trick starts. This will frame the mind of the audience regardless of whether they gaze at the object or not. Priming is often a natural position on which the trick is made, and as such just as important as the trick. Priming can be done as a series of apparent repetitions before the unusual happens. Before the ball can vanish in mid air - in the vanishing ball trick - it is necessary to show how it is thrown and caught a number of times. This also underlines a trick as a somewhat unusual and novel experience in contrary to a normal experience. The "colour changing card trick" by Richard Wiseman, as discussed above, uses priming extensively. The trick is presented as a card trick and the focus is on the cards, although the trick is really about changing the colour of their shirts, the tablecloth and the backdrop. Because of the effective priming it is less plausible that we discover this.

For a trick to excite it must always create an experience which is out of the ordinary. This

positions stage magic as always being able to surprise, because it works on a backdrop of the ordinary to create excitement. Therefore the stage magician uses common or at least ordinary looking props, like cards, boxes, chairs, cloth, and seemingly dangerous appliances as electric saws, knives, and chains. Excitement and amazement relies on the experience of surprise, which has been subject to research. The cognitive evaluation of surprise is assumed to include four subprocesses: (a) the verification of the schema discrepancy; (b) the analysis of the causes of the unexpected event; (c) the evaluation of the unexpected event's significance for well-being; and (d) the assessment of its relevance for ongoing action (Reisenzein et al. 1996). The first (a) acknowledges that the event is contrary to the expected. This is the climax of the trick. The second (b) is an analysis of the trick, that is how did the magician do it.

Magic as a tool for learning

It has for some time been known to psychologists that if we experience a novel situation within a familiar framing, this will attract our attention and eventually more easily store this in our memory. Recently studies of the brain have been able to explain and beginning to understand how this process happens. It seems that novelty, that is new material in contrast to the familiar, promote memory processing. This will suggest new ways of teaching (Fenker et al 2008) As stage magic relies on creating surprise and amazement it should follow that it can be used as a means of creating an opening for learning. We believe that a magic trick opens for two kinds of learning: one of surprise ("how did he do that?") and one of action ("what did he do?"). In stage magic performances the former will be most prominent, but in other forms of learning environments, like in a museum, it may be the other way round. We propose a design concept of exhibition magic where the surprise will fuel the opening for museum learning creating a sense of learning and wonderment. We find similar approaches in the museological history in the form of the *Wunderkammer* or *Cabinet of Curiosities*. A modern counterpart has been developed in some educational departments of museums and schools, notably at Samworth Academy at Nottingham University, where they keep a "Wonder Room" with a collection of mysterious and wonderful objects, curated by Matthew McFall acting as an "Agent of Wonder" (McFall n.d.). The object is by the use of special objects, puzzles, books, tricks, mysteries to spark thoughts which lead to lots of questions, which in turn leads to learning. The important thing is the direct contact with the objects. "Wonderment" emerge when people have an actual encounter with the special objects, according to Mathew McFall.

What can museums learn from Stage Magic?

First it is important to acknowledge that even though it is called a "trick", when the magician performs his art, the contract between the magician and the audience is based on *trust*, just as the contract between the museum and its audience (cf Parry 2013). The magician does not do real "magic", and the illusions are part of the contract in order to amaze and entertain within the frames of performance. As magicians do illusions, museums do illusions. It is an illusion when a burial is reconstructed in an exhibition or when the ship Great Eastern is placed in a dry dock with a thin layer of water covering a glass construction giving the illusion of the sea. As spectators we know that part of it may be real, while other parts may be made to look real, and many exhibitions are designed this way without compromising the contract with the visitor. The important difference is that stage magic has its focus solely on amazement, the museum has its on learning in some form or other. What stage magic fails to do is to make *use* of the surprise, the trick has just created. The shows by the "Masked Magician" (Masked Magician n.d.) where he deliberately performs a trick just to tell the secret is an exception, just as the Penn & Teller show where they perform a trick, tell the secret, and then perform it in their own extended version, this time without telling the secret (Penn & Teller 1990). These performance types blend magic with learning and show that it is possible to combine entertainment and learning in a performance, that otherwise only is known for its entertainment value.

Exhibition Magic

The insights of the scientific study of magic can inform the design of exhibitions both to make them more amazing, but also to make the illusions work as openings for learning. Stage magic can be used in several ways in the museum. In this study we focus on the design of digital installation and not on stage performances in the museum, e.g. science shows or other theatre-like performances. One of the differences between stage magic and museum exhibitions is the relation between the performance and the audience. In most exhibitions the audience is moving around, while the exhibition is fixed, while in most stage shows it is the other way round. However when using digital installations we may almost reverse this relation, by attracting and securing the attention of the visitor by a dynamic interface. This does not have to be interactive, as videos shown in exhibitions have proved. Figure 1 shows the relationship between the audience and the exhibition. A typical museum visit would be a combination of several performance styles. The scope for magic performances would be within the dynamic exhibition styles.

Audience performance / Exhibition styles	*Static exhibition (displays)*	*Dynamic exhibition (non-interactive)*	*Dynamic exhibition (interactive)*
Audience is static (seated/standing)	Examining details of an exhibit	Watching movie / Watching working models	Manipulating digital installation / Using audio guide
Audience is dynamic (moving about)	Audience walking in exhibition	Experiencing animated effects / Art installation	Digital installation based on motion

Figure 1

The task of exhibition magic is to build up a suspense, reach a climax where the visitor becomes surprised and then offer openings for learning (Figure 2)

The magical experience
1. Priming. Establishing the frame, often using repetition.
2. Climax: the surprise.
3. Amazement: the Wow!
4. Learning: the How? and What?

Figure 2

For it to be magical and not just a surprise, it is important that the surprise at least for a short time appears to be inexplicable by the laws of nature or that it creates amazement by being fantastic or wondrous. Techniques of misdirection can be used to enhance the feeling of wonder and to conceal the secret.

Magic effects (Lamont & Wiseman)	**Stage magic example (Lamont & Wiseman)**	**Exhibition design**	**Exhibition design example**
Production: an object appears	Pulling a rabbit out of	Showing emergence (new / evocation /	Showing the emergence of a new bronze age technology by

	a hat	emergence)	making the artefact emerge.
Vanishing: an object disappears	Vanishing of a coin	Attracting focus to an object by vanishing others (selection, deletion)	Showing how indigenous people are disappearing by making them vanish in the exhibition.
Transposition: an object changes position in space from position A to position B	Two people change places	Showing change in time (change from one position into another)	Showing how trade between two countries work by showing goods magically move from harbour to harbour.
Restoration: an object is destroyed and then restored to its original condition	Cutting and restoring a robe; sawing an assistant in half	Showing complete/incomplete (showing an artefact as complete vs the parts)	Showing how a heap of shards can be restored to a vase.
Penetration: a hard object moves through another hard object	Chinese linking rings	Showing force/vulnerability or quality of materials	Showing how an arrow can penetrate a body.
Transformation: an object is transformed into another object	A silk handkerchief changes colour	Making objects look like they did when then were discovered (reconstruction)	Showing how antique marble statues looked when they were coloured.
Escapement: the magician is restrained and has to escape	Magician is handcuffed and put into a watertank. Has to escape before certain death	?	
Levitation: a object is made to fly	A silver ball is made to float on a handkerchief	Suspended or flying objects.	Showing how a boomerang is thrown and how it flies.
Prediction: The magician predicts the choice of a spectator	A spectator chooses a card. The magician shuffels the deck and shows the card	Prediction	Creating a quiz-like interactive installation, where the visitor asks the question.

Extraordinary feats (including mental and physical feats)	Extraordinary memory	Extraordinary feats: large contrasts... enormous/ microscopical loud/silent impossible: flying	Walking under water. Having X-ray sight that allows the visitor to see the inside of the artefacts. Becoming very small or very large compared to the exhibits.
Telekinesis	Spoon bending; levitation	?	
Extrasensory perception	Clairvoyance	Prediction	Predict the future and watch the consequences.

Figure 3 (based on Lamont and Wiseman 1999)

Figure 3 shows an overview of categories of magic tricks and traditional examples. In addition we have provided examples of how they could be used in exhibitions.

Designing a digital installation based on the principles

In collaboration with Museum Lolland-Falster (Denmark) we decided to try out the principles of exhibition magic on an exhibition problem. The manor house Pederstrup is home to a collection showing the stately home c.1800 of the prime minister Reventlow, with some of his furniture, paintings etc. The exhibition is meant to create the atmosphere of a home and not a museum, which means that signs etc. are avoided when possible. Within the collection is a unique musical instrument (the only extant harpsichord made in Denmark, dated 1770), which is exhibited in the hall in the middle of the house. As the museum is not a musical instruments collection, the visitors coming here can not be assumed to be familiar with the harpsichord. The museum wanted an audio installation, so the visitor could hear samples of music played on the instrument. A typical way of would be to design a stand with a digital installation, where the visitor may press a button and hear samples of music recorded on the instrument. The stand with buttons would typically be placed near the instrument to create identification between stand and instrument. Following the principles of magic above we devised a digital installation based on surprise and amazement. We started by analysing the routes of the visitors through the rooms. It turned out that they always approached the room where the instrument was exhibited through a door close to the instrument. This meant that they were not able to see the instrument as they went into the room. As magic is "design for surprise", we designed the surprise as the illusion that the visitor's movements controlled the harpsichord. As the harpsichord would be behind the visitor when he/she entered the room, the music will be more surprising as it emanates from behind.

The MOSHACK harpsichord digital audio installation
Priming: stately rooms which fit with the music they will hear.
Surprise: chords, cadenzas, short pieces, longer pieces according to the visitor's position in the room.
Amazement: Where does the sound come from? Why did it start? Why did it stop? Is is me who controls it? How do I start the music again?
Opening for learning
What is going on?
- identification of sound source with the harpsichord
- learn more about the instrument by inviting visitors closer to the instrument

How is it done?
- what is the secret?

Setup
A professional harpsichordist recorded a series of sounds and pieces on the instrument. There were short clips of a few seconds (chords or cadenzas) which were played when the visitor was at the other end of the room and acting as an invitation to explore and come nearer the instrument. Nearer the instrument arpeggios and longer cadenzas were heard and close to the instrument proper pieces by Scarlatti, Rameau, and Palschau could be heard. In total 51 audio clips (including the sound of tuning) were played randomly within their group to make the experience of the audio installation individual and unique. This should also ensure that the "trick" is never performed in exactly the same way more than once.

Secret
A camera focusing on the room is placed above the door. A computer tracks the visitor's movements and plays audio in speakers mounted under the instrument. The software was also programmed to at times stay silent, to make the audio installation non-deterministic.

Misdirection
The camera is not placed near the source of the sound, where we assume the visitors will direct their gaze.

Limitations
The design can not handled more than one (moving) visitor in the room at the same time. If two or more visitors are moving they will not be able to recognize that their movements are connected with the audio experience. With this particular museum it was not thought to be a problem, as there are relatively few visitors visiting the museum and seldom more than a couple at the same time.

Expectations
If the visitor is amazed we will assume that he or she will move about in the room, hearing different sounds and also come nearer to the instrument to study what it looks like. As for learning the visitors would learn that this kind of instrument can play the sound they hear. By their movements we expect to see them perform an identification of the instrument with the sound by moving nearer to the instrument. Visitors who are interested in denouncing the trick could be expected to point at the camera or at the speakers.

Evaluation
It is difficult to ascertain whether the audience experienced the audio installation as "magical". We could have conducted a qualitative study, but chose not to, because we felt that it would be difficult to ask for a reliable opinion of the visitor whether the experience was "magical" or not. Instead we did a quantitative study along with some observations of the room. The quantitative data was elicited from the log of the audio installation, as the software monitored the room it was designed to log the movements of the visitors and details on the music played. The audio installation was installed and worked during most of the opening period of the museum in 2013 from May 1. to Sep. 30, that is 61 days of approx. 5 hours. In total it played 8500 audio clips, of which most were due to people moving in the adjacent rooms (the entrance) and because it was programmed to make a noise now and then. As the installation was out of order for some days (the speakers did not work) we have log data of the visitor movements when no sound was heard. It turned out that several groups or visitors in pairs visited the museum. As the visitor is not able to identify the connection between their movements and the sounds, these were not counted. The software was also only designed to track one person at a time.

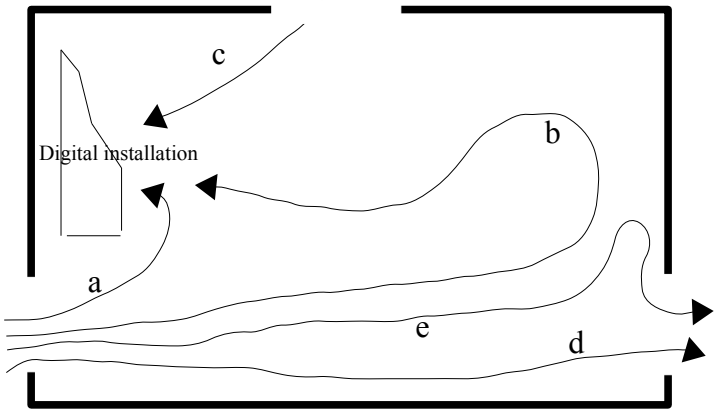

Figure 4. Typical routes for the visitors through the exhibition room

The object of the installation was to let the visitor magically explore that the sounds of the instrument were connected to their movements, and that it they would show their interest by moving nearer to hear longer pieces. By examining the log we extracted the following data.

Affect/No. of clips	1	2	3	4	5	6	7 or more	Totals
Amazed	0	77	68	41	29	14	28	267 persons
Indifferent	4	39	9	20	11	11	11	105 persons

Figure 5. Number of visitors per number of audio clips heard in the room

Figure 5 shows the number of audio clips played and how it affected the performance of the visitor. 77 visitors performed "amazed", that is went nearer to the audio installation, while hearing 2 sound clips. 39 heard to sound clips while they were in the room without showing interest for the audio installation. The table shows that significantly more visitors were amazed by the audio installation than visitors who did not show interest.

The typical performances were as follows. Route a) were visitors who was immediately attracted and went straight to the instrument. They heard 2 or 3 audio clips. Route b) were visitors who explored the digital installation by walking round the room and listening to several (6 or more) audio clips. Route c) were visitors who was attracted by the sound and took a different route compared to visits where the installation was not working. They heard 2 or 3 audio clips. Route d) were visitors who went straight through the room hearing 2, 3 or 4 sound clips. Route e) were visitors who went around the room but without showing a direct interest for the installation. They heard 5 or more clips.

Our results show that the installation created amazement for the majority of the visitors. We also observed that the staff (which was not counted) behaved differently from the visitors, by skipping quickly through the room. When the installation was working it diverted the normal routes of the visitors as the sound could be heard in the entrance hall. Quite a few visitors followed the routes and clearly positioned themselves in different places of the room ending by approaching the instrument, and showing that they had grasped the intentions of the installation. Comparing the installation when working with the times it was not working we found that the interest for the instrument was

much less.

Conclusion

Digital installations are an integral part of modern museum exhibitions today (Parry 2007). The question is: how do we secure that they support learning? We have proposed that theories of stage magic may inform the design of digital installations. The magicians are experts at creating sensations of wonder and surprise, which leads to openings for learning. In this paper we have developed a set of principles for the design of digital installation using ideas from stage magic. The principles are based on priming the audience through repetition, create a climax through surprise, and support learning through relevant information. Along with the principles the technique of misdirection is explained as a means of attracting attention to enhance the surprise. Above all, a digital installation should be wondrous, that is amazing and out of the ordinary, as a magic trick is. To support our ideas, we have designed and developed a digital audio installation for a musical instrument at a museum and evaluated its performance through data collection and observation studies. The evaluation suggests that the installation in many situations created special interest and that many visitors were surprised. Studying the typical routes of the visitors we saw patterns emerge which showed that the majority of the visitors were amazed by the installation and interacted with it. Comparing the same installation running without sound, but with the same data logging, we observed that it did not attract the same amount of attention. Future work should work with the magic principles to enhance them and work with the notion of *amazement.*

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