100 Stories

A CANON of Technical Theatre History

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Canon
THEATRE TECHNICAL HISTORY

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Introduction

The aim of the Erasmus+ strategic partnership project CANON is to create awareness about the history and heritage of technical theatre. It has developed a 'canon' of technical theatre history, supported by an interactive timeline, as well as tools and methodologies for teaching. Through the process, it has developed a network of like-minded people that support the goals of the project.

What is our knowledge of the history of technical theatre? And is this knowledge the same in all European countries, or do we think differently about past inventions, events and developments? How do we select, what do we select? How and what do we want to teach? We explored these questions with 20 teachers and 76 students from 9 universities and institutions from 7 different countries (Belgium, Czech Republic, Germany, Italy, Spain, Sweden, UK). This international cooperation meant that we could draw on different – regional – points of view, and the different background of the participants (architects, scenographers, technicians, theatre practitioners, theatre historians), to expand and enrich our view.

Linked to the other project outputs, including teaching methods and tools, but most of all the timeline and database (https://canonbase.eu), the CANON comprises 100 stories, each one an entry point into the bigger story of theatre design, technology and architecture across thousands of years of history and across the continent of Europe. We have selected some of the most significant concepts, achievements, practices, technologies, artefacts and buildings as well as supporting sources that together form a story about the many ways we have created theatre, performances and events, in different places and at different times.

The CANON is structured into 10 time periods (Antiquity, the Middle Ages...), and into 10 themes: stage mechanics and set construction, special effects and projection, lighting, sound, architecture, scenography, knowledge transfer, theatre management, health and safety – and a last category of the 'unexpected', in which we try to pay attention to curious, surprising or less well-known facets of our history.

A canon is the 'list of facts considered to be permanently established as being of the highest importance in a specific field'. It is the list that every knowledgeable person in a field is expected to know and understand. We can interpret this definition for our project as 'the hundred most important stories one needs to know about theatre technical history.' Of course, such a thing is impossible – we would need 200, 500, a thousand stories, and still it would not be enough. We have though tried to select 100 entry points, that together map the territory, and invite further exploration. Each one is perhaps a kind of corridor through time and disciplines, that opens onto various additional doors, leading to further immersion: to people, places, performances and innovations that reflect a turning point or essential part of our history.

Perhaps one day we will write another 100 stories, or perhaps you will, based on your own ideas of what is most important. However you respond to these stories, we hope you will find something surprising, exciting, and which stimulates you to dig deeper, and to learn more about the rich field that is the history of technical theatre.

Bri Newesely, Franziska Ritter and Nick Hunt

for the CANON team

If you have any feedback about the Canon stories, or any other aspect of the project, please contact us at info@canon-timeline.eu. We would love to hear from you!

The Stories

Using the Stories

The 100 Stories are written to be 'entry points' to an aspect of technical theatre in a particular time period. They assume some basic knowledge of theatre and how it is made, but otherwise they can be understood by those new to the particular topic. If you already know the field, they will help fill gaps, provide context, and locate the subject in the wider field of knowledge.

References

References in the stories use the Q-numbers in the CANON database, *Canonbase*. When you see a reference such as (Q466), go online to canonbase.eu, and search for 'Q466'. This will lead you to the entry for - in this case - Vitruvius's treatise on architecture, *De Architectura*.

Formats

The stories are available as a PDF, formatted for print, and online as part of the Canonbase - go to https://canonbase.eu/wiki/Item:Q29723. The online stories often have additional images.

Languages

The stories are written in English, the working language of the CANON project. The titles and subtitles have been translated into the 6 other languages of the project partners. If you need the stories in languages other than English, please use the web versions with online translation tools.

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B.10 Varje yta är en projektionsskärm: Projektioner och pixel mapping
C.10 En ljusemiterad värld: LED överallt
D.10 Ljudande objekt: Utvecklingen av ett rumsligt ljud
E.10 Guggenheimeffekten: Social och kulturell ingengörskonst genom konsten
F.10 Virtuella scener: Fascinerande teknik och hybridrum
G.10 Det som är vårt är ditt: CANON databasen och öppen källa
H.10 Allting är data: Digitala arbetsmetoder
I.10 Att dela med sig av säkra metoder: ETTEC - det internationella säkerhetspasset
J.10 Att lära sig säga nej: Katastrofen vid Love Parade och identiteten hos teknikerna

100 Canon Stories

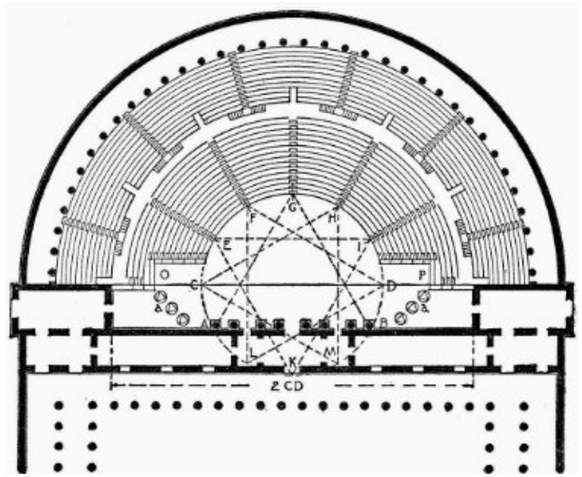
The First Mechanical Stage

Wagons, revolves and periaktoi

Machines were an essential part of the staging of Greek dramas, enabling changes of scene. Wagons and revolves were used to bring a dramatic tableau onto the stage, while the rotating periaktoi created rapid changes of location.

An *ekkyklêma* (from *ekkuklein*, to roll out, Q627) was a wheeled platform or wagon rolled out of the central door of the *skene* at the back of the stage, bringing a small scene or tableau into view. Some sources suggest there was a variation in which the wagon revolved, to turn the scene onto the stage. The *ekkyklêma* was used to bring interior scenes out into the view of the audience, for example onstage on an *ekkyklêma* to enhance the comic absurdity of the scene.

Compared with simply opening the doors or curtain in the *skene* to reveal the scene, the *ekkyklêma* offered an important benefit. The semi-circular auditorium of the Greek amphitheatre meant the view of the stage for some members of the audience was very much from the side, so the inner space behind the *skene* would not have been in view. By rolling or turning the *ekkyklêma*, it ensured all spectators could see it clearly, while the movement of the mechanism added to the sense of revelation. In Greek theatre there was a



Greek theatre, showing the periaktoi, from Vitruvius

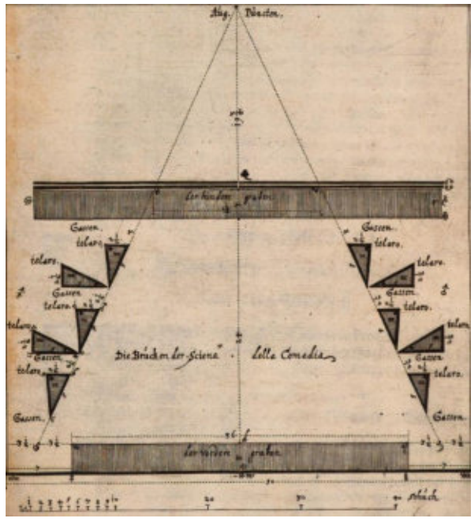
murder scenes, which were imagined in the form of living pictures. It was mainly used in tragedies for revealing dead bodies, such as Hippolytus' dying body in the final scene of Euripides' play of the same name, or the corpse of Eurydice draped over the household altar in Sophocles' Antigone. Other uses include the revelation in Sophocles' Ajax of Ajax surrounded by the sheep he killed whilst under the delusion they were Greeks. The *ekkyklêma* was also used in comedy to parody the tragic effect. An example of this is in Aristophanes' *Thesmophoriazusae*, when Agathon is wheeled

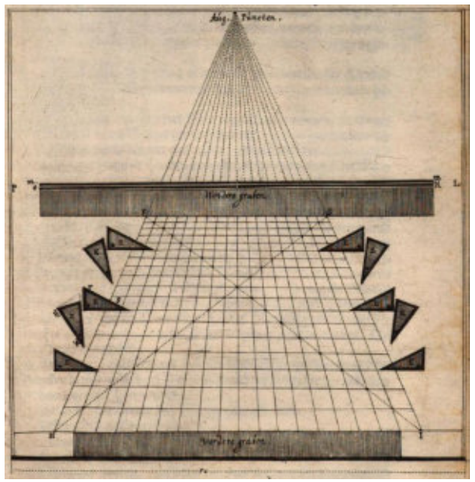
strict code forbidding violent deaths being acted out on stage, so the *ekkyklêma* also provided a permissible means to bring the result of a murder or death onto the stage, with much greater spectacle and dramatic impact than simply having another character report the events.

The Greek theatre did not provide a total, illusionistic stage environment. Locations were generic, and denoted by paintings mounted on the *skene* that were just one part of the overall stage picture. These pictures were called *pinakes* and could be changed between performances (F.01). A different technique was used to change the scene during the performance, if that was required: the *periaktoi* (from the Greek word meaning 'revolving' or 'rotating prisms' or 'angular frames', Q23827). *Periaktoi* were three-sided wooded frames covered with painted canvas – a different scene on each side. The frames were fixed to a central, vertical axis embedded in the stage floor, so they could be turned in order to change the location of the scene. This gave then opportunity of visualising different locations depending on the configurations of the *periaktoi*.

We don't have detailed records of the placements and mechanisms of the *periaktoi*, but some recreations of Greek theatres suggest at least two larger *periaktoi* used at the openings on top of the *logneion proskenion* on either side of the central opening of the *skene*. These *periaktoi* were housed within the *skene* and were probably turned by hand. Marcus Vitruvius Pollio mentioned the *periaktoi* in his ten volume *De Architectura* around 13 BCE (Q466). In the 5th book he focused on Greek and Roman theatre architecture, where he explained the triangular prisms. In Vitruvius' floor-plan for the Roman theatre, we can see a set of six *periaktoi* placed in a vee formation on top of the *proskenium* instead of within the building itself. However, whether these were turned by hand or by an interlocking mechanism made of gears and chains is unclear. The 2nd century Greek grammarian Julius Pollux describes the *periaktoi* in his dictionary The *Onomaticon* which was reprinted in 1502. This together with the first illustrated version of *De Architectura*, published in 1511, may be the reason why the *periaktoi* and many other theatre machines from Antiquity were revived during the Renaissance. Certainly, theatres of the Renaissance made use of *periaktoi*, interlocked with either ropes or chains to so they could be turned simultaneously, providing the sense of 'magical' transformation that was sought.

Rolling and turning mechanisms were used by the Greek theatres of Antiquity. The ingenuity of these devices and the flexibility they present to achieve quick changes of scene means they have been in use through much of the history of theatre staging since. The mechanical principle of the *periaktoi* can also be found in modern Trivision billboards, which allows for up to three different messages to be displayed: a modern application of an ancient device.





Renaissance theatre, showing the periaktoi, from Furttenbach's Architectura Recreationis

A.02

Deus Ex Machina

Cranes to fly people

In the Greek and Roman theatre of antiquity, cranes were used to raise and lower actors onto the stage, often to represent the arrival of the gods – an effect known as deus ex machina*, literally 'god out of the machine'.*

The Latin phrase *deus ex machina* is borrowed from the Greek (*apò mŕchanḗs theós*)and originally denotes the appearance of a deity with the help of stage machinery. It was a flying machine that began to be used in Greek theatre in the 5th century BCE. It was used to make quick and magical appearances and disappearances of certain characters.

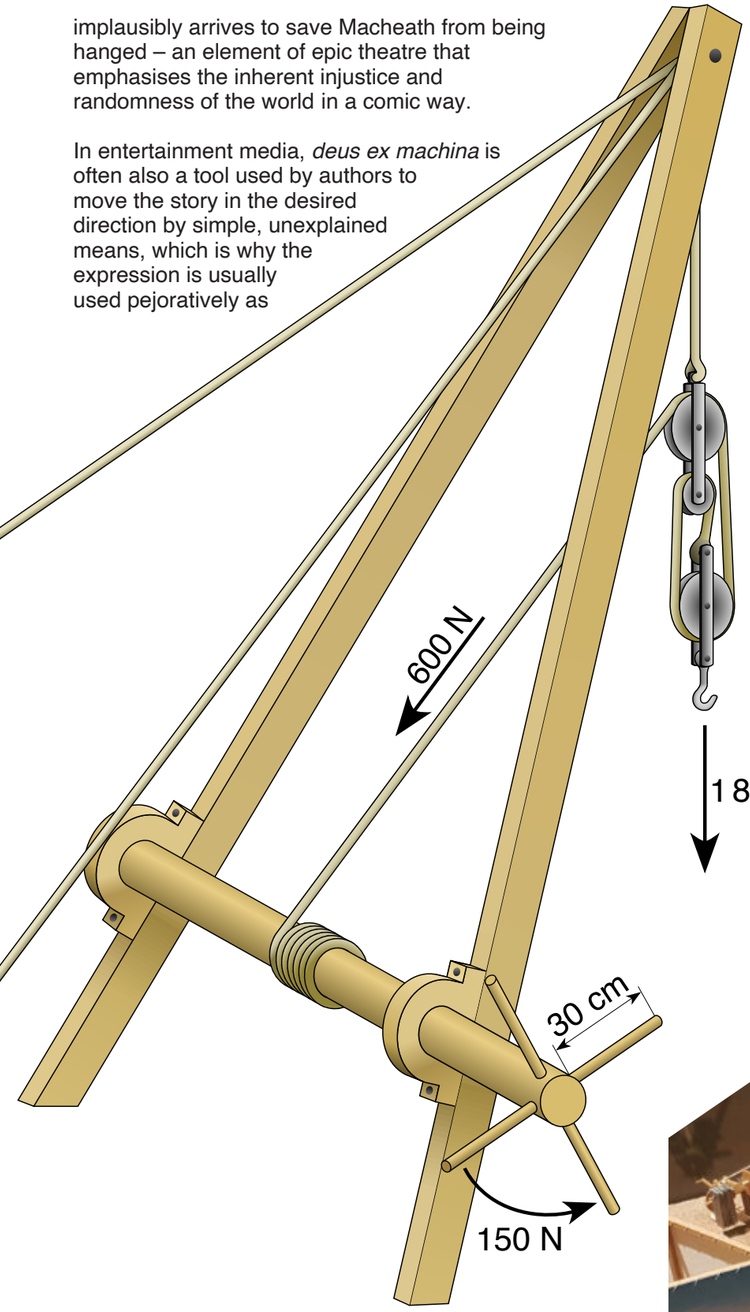
In Greek antiquity the effect was achieved with a crane, probably already used for the construction of buildings, which was adapted for use in the theatre as a flying machine. It consisted of an inclined shaft fitted with a pulley on which ropes and a hook ran, operated by a winch, although there are no precise references as to how exactly it worked. It seems likely that it was fixed to the top of the *skene* (*paraskenia*), behind the back wall, which concealed part of its function. It was able to raise and lower people vertically, although it is also possible that it could have been able to fly with a change of direction, as some references indicate that the crane could rotate on its base, so creating a panning action.

The end used to lift the performer from the ground took different forms, such as a celestial chariot or a griffin (a mythological animal), although some written testimonies of the period suggest that, on occasions, the figures were hung directly from a hook, or landed on the roof of the stage house. The effect was particularly suited to the appearance of the gods from the top of the *skene* and their descent to the stage, and their subsequent ascent and disappearance above the *skene* wall again. The simplest constructional version suggests that the machine consisted of a counterbalanced beam, operated by a rope, and in more complex versions, when the structure of the *skene* was larger, it seems possible that a winch was incorporated for its movement. Certainly Vitruvius (Q467) in the 1st century BCE described cranes and hoists, with windlasses and pulleys to allow heavy loads to be lifted with ease, although he does not relate these technologies with the theatre. At the Dionysos theatre (Q7829) there are two holes measuring 70x70cm and 125x70cm respectively which are possible anchoring foundations for a crane mast and winch, suggesting it was of a substantial size.

In ancient tragedy, there were tragic conflicts that could not always be resolved by human action. Their resolution or decision came 'from above' through the surprising intervention of a deity who gave the events their final turn. This was done to represent the power of the gods in the ancient imagination, and indeed their interventions in the stage action were often surprising. The earliest recorded use in a theatrical performance is in 431 BCE in Euripides' *Medea*, during the 87th Olympiad, where at the end of the play, the heroine Medea was lifted off the stage in the chariot of the god Helios by this device, leaving her dead children below. Many of Euripides' tragedies have as their denouement the appearance of a divinity from heaven, who resolves the plot. However, the playwright's intention emphasised the fact that humans are subject to the laws of the gods, who are in ultimate control of their existence.

In Greek and Roman theatre, the *deus ex machina* appeared as a surprise to the astonished audience. Today, the term is also used for a plot device whereby a seemingly unsolvable problem in a story is suddenly and abruptly resolved by an unexpected and unlikely occurrence. Its function is also to surprise the audience, to bring the tale to a happy ending, or act as a comic device. For example, in Brecht's *Threepenny Opera*, the 'King's messenger on horseback' implausibly arrives to save Macheath from being hanged – an element of epic theatre that emphasises the inherent injustice and randomness of the world in a comic way.

In entertainment media, *deus ex machina* is often also a tool used by authors to move the story in the desired direction by simple, unexplained means, which is why the expression is usually used pejoratively as a criticism of the authors' writing ability and denotes the inability to create a plot with continuous logical connections. One of the earliest known stage effects and mechanisms lives on as a term for a plot device that audiences find highly improbable, but thrilling and satisfying.



Greco-Roman trispastos *('Three-pulley-crane'), a simple crane type capable of a 150 kg load*

Model showing crane
Thessaloniki Technology Museum

B.02

Daylight

The ‘natural’ state and how to control it

Although the theatres of Antiquity were illuminated by daylight, the Greeks and Romans had various strategies for making the best use of the available light to support the performance.

The earliest known Greek theatre is the Theatre of Dionysus (Q7829), on the southern side of the Acropolis cliff in Athens, dating from around the 6th century BCE. At first, theatres were open spaces that allowed for dancing and rites. Over time, masonry seats were added in a semi-circle around the area for the chorus (the *orchestra*). The theatre was extended in several stages to eventually accommodate an audience of around 17,000 people. It was mainly used during the festival held at the end of March and April, initially to celebrate the year’s harvest and the end of winter, and later as a celebration of the god of wine, Dionysus. The festival lasted about a week and was a competition in which several plays by different playwrights were performed. The first day was devoted to processions, and on the next the playwrights announced the plays and judges were appointed. For the next four days, four to five dramas were performed each day, so it was necessary to start early in the morning and finish well into the evening. The changing light during the day was therefore a major part of the experience.

During the early morning hours, the dawn light allowed for some activity in the surrounding area. Greek theatres were built on hillsides outside the city, with the site chosen both to give the necessary shape to the bank of seating, but also for the view across the valley, which acted as a backdrop to the stage. There are examples of plays where the opening text talks about what is happening in a foreign country, so it was possible to light a large fire on this hillside to serve as a sign of activity in a foreign land. Later in the performance day it was necessary to use other signs, for example to show it was night-time in the play. One way was to have an actor come in with a lit torch, signifying night. Another way was to hang a black or dark drape in the doorway of the *skene* (the building at the back of the stage).

This served as a sign for night which would have been understood by the audience.

It is widely believed that the Greeks built theatres in such a way that the sun's migration across the sky could be exploited during the course of the day. It is true that many theatres were oriented so that the theatre building was oriented in an east-west direction. However, it is not so consistent as regards the audience seating, which was sometimes built on the southern slope of the mountain and sometimes on its northern slope. There have also been ideas that the Greeks used mirrors to throw light onto the *orchestra* and the *skene*. However, there are no definite sources to confirm this. A likely origin for this idea could be what is usually called ‘Archimedes’ mirrors’, a proposed weapon against warships which is attributed to Archimedes. According to this idea, many mirrors aimed at a warship could set it on fire if the reflection of the sun were concentrated in a small focal point. However, there are no sources to support that this could ever be done. The Greeks never made mirrors larger than hand mirrors, and these were a highly polished bronze surface, not the silvered glass of modern mirrors. In the theatre, on the other hand, mirrors could have been used to cast solar reflections – ‘sun cats’ – onto the stage as a one-off effect rather than to illuminate the stage and actors.

The Romans also sought to control the conditions that prevailed when performances were given outdoors in their theatres and amphitheatres. The major difference in construction between the Greek and Roman venues was that the Greek venues were located on the slope of a mountain or hill, while the Romans constructed buildings on flat ground in the centre of the city. The Greek theatre was open and therefore allowed the wind to easily blow through the venue and thus cool the audience. At the same time, it was very difficult to put up sunshades for the audience. In the Roman theatre and amphitheatre, the situation was the reverse. It was much more difficult for the wind to blow through the building, but the Romans were able to provide their theatre buildings and amphitheatres with sun protection sails (*Velarium*). These sunshades were supported by ropes stretched between masts along the perimeter wall of the building. These masts have long since disappeared, but their attachment points are still visible today, for example at the Colosseum in Rome (Q615).

Greek and Roman theatres did not seek to close themselves off from the outside environment: the audience was always aware of the natural light, temperature, wind and weather. Rather, they used various techniques to manage that environment, and to signal when the actual environment differed from that in the fictional world of the play.

C.02

Can You Hear Me at the Back

Acoustic amplification in early theatre

The Greek and Roman theatres were large, to accommodate many people on stage and in the audience. Physics and mathematics played a significant role in their design, to modify the acoustics so the actors' voices could be heard everywhere.

It is probable that Pythagoras (Q30510) was the first person to research sound and acoustics, in the 6th century BCE. He noticed that, unlike light, sound does not always travel in straight lines, and began to understand reflection and absorption. He observed that the sound of the chorus changed if the floor of the theatre was made of a soft mixture of sand, straw and chaff, rather than hard, flat sand.

In the 1st century BCE, Marcus Vitruvius Pollio (Q467) wrote his books *De Architectura* (Q466), including detailed instructions for building theatres with good acoustics. Crediting earlier Greek sources, he wrote,

> Therefore the ancient architects following nature's footsteps, traced the voice as it rose, and carried out the ascent of the theatre seats. By the rules of mathematics and the method of music, they sought to make the voices from the stage rise more clearly and sweetly to the spectators' ears. For just as organs which have bronze plates or horn sounding boards are brought to the clear sound of string instruments, so by the arrangement of theatres in accordance with the science of harmony, the ancients increased the power of the voice.

Greek tragedy mask, 4th-3rd century BCE

Vitruvius identified specific acoustic effects in theatres caused by reflections, both wanted and unwanted, including 'consonant places' where the voice 'falls on the ear with great distinctness of words. Hence, if due care be taken in the choice of the situation, the effect of the voice will be improved and the utility of the theatre increased'.

In antiquity, the design of the theatre significantly impacted how the sound was going to be received by the audience. Starting around 500 BC and usually set into the side of a hill, theatres had semi-circular tiered seating on the slope, curving around the stage – for example, the theatre in Epidaurus (Q7830), finalised in the late 4th Century BCE. The largest of the Greek and Roman theatres placed the furthest audience member around 50m from the performers, a much greater distance than more recent theatres and opera houses. Modern day studies suggest, however, that 40m is a maximum distance for words to be clearly understood, and that is if the audience is already familiar with the play.

Several techniques were used to help the audience follow the drama. Words were often repeated, and possibly directed to different parts of the auditorium. A wooden wall behind the stage began to be added – the *skene* – to reflect the sound towards the audience. This wall could be painted with a scene appropriate to the action, and developed into a more permanent architectural structure that could house dressing rooms.

It has been suggested that a way of amplifying the voice was through the use of the mask. These masks were conical in the shape of a mouth and fitted on the head like a helmet. The conical part may have allowed the voice to be amplified so the sound reached the audience at the back. Without this design the masks would limit and muffle the actors' voices. Other sources state that masks had no benefit for intelligibility, but were purely so actors could play multiple roles.

Theatre of Epidauros

Another possible means of amplifying the sound was the acoustic jar, also known by the Greek name *echea* (literally 'echoers'), or *sounding vases*, ceramic vessels set under the seats. They are believed to have been intended to improve the sound of singing, and were supposedly used to enhance the voices of performers, though no archaeological evidence has been found. The vessels mentioned by Vitruvius are made of bronze and designed specifically for each theatre. They used mathematical calculations to decide where they should be placed with a 'due regard to the laws and harmony of physics'. No original examples survive from the ancient world. Modern experiments have indicated that their effect would have been to absorb certain frequencies (acting as a Helmholtz resonator), rather than to amplify sound – an application found in many buildings since, and used today in recording studios to control unwanted resonances.

In modern times, in a city park in Syracuse, Italy, artist Michele Spanghero built the *Echea Aeolica* in 2015, a fibreglass and steel sound sculpture 'to create a connection to the ancient history of the land as if it leads an echo from afar'.

Sounding vessels found in churches in the Netherlands

APlace for Seeing, a Place for Thinking

The theatre at Epidaurus

The word 'theatre' comes from the Greek: theatron*, a place for contemplating, combining the sense of seeing and thinking. In classical Greece, a theatre was a place to contemplate the representation of a tragedy, comedy or satire during the festivals that suspended the life of the city.*

In Athens, the Great Dionysiacs were the focus of the life of the *polis* (city) for six days. These took place three times a year: the Great Dionysiacs in spring, the Leneas in January and the Peasant Dionysiacs in December. The festivals included a procession and performances of poetry, music and song as well as on the final three days performances of three tragedies in the morning and a comedy in the afternoon. The festival was highly organised: the plays were selected at the start of the event, and judges were elected to award the prizes. The city required the wealthy citizens to act as *choregos*, instructing the chorus. When the polis was wealthy, everyone had free admission to the theatre; when that could not be afforded, there was a subsidy for the poorer citizens. Prizes were awarded for the *choregos*, for the poet (writer) and for the protagonist. The festivals were not just entertainment; they were seen as a way to think and talk about moral and political questions, and also as a means to heal patients, since there was a belief that the observation of dramatic shows had positive effects on mental and physical health.

The theatre of Epidaurus (Q7830), built around 350 B.C., has been considered since antiquity the most beautiful theatre of classical Greece. Attributed to the architect Polykleitos (Q30025), the theatre follows the characteristic tripartite structure of classical Greek theatres: *theatron* (auditorium), *orchestra* (the playing area), and *skene* (a structure at the rear of the stage).

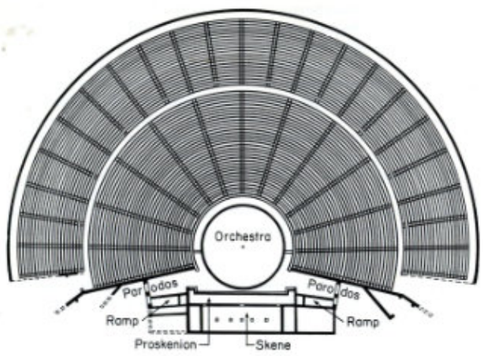
Set into the side of a hill, the auditorium is arranged in an arc, curving around the circular orchestra. The lower part of the auditorium is divided into 12 wedge-shaped sections, the upper into 22 sections. A walkway separates the upper and lower parts of the auditorium. The row nearest the orchestra was reserved for the seats of honour. The layout of the auditorium and orchestra was carefully designed to achieve optimal acoustics and sightlines, ensuring the 13,000 to 14,000 spectators could see and hear.

The orchestra, the space for the chorus, is a complete circle with a diameter of 20m. At its centre is a circular stone, probably the site of a small altar or *thymele*. Opposite the auditorium and behind the orchestra is the stage building of the theatre, the *skene*. The earliest *skene* was a temporary structure (the word *skene* derives from the Greek for tent) to provide a backdrop and hide the actors changing costume. The permanent *skene* at Epidaurus, built of stone, was constructed in two phases: the first at the end of the 4th century BCE and the second in the middle of the 2nd century BCE. The format of the *skene* from the later period consisted of a two-storey building and the proscenium – a raised acting area between the orchestra and the *skene*.There was a colonnade at the front of the proscenium, and on both sides of the *skene* the building projected forward, forming wings. Two small rectangular rooms either side provided space for the performers while not on stage. Two ramps lead to the roof of the proscenium, the *logeion*,wherethe actors could also perform.

The theatre of Epidaurus was the result of a gradual evolution in the design of performance space during Greek antiquity, over a period of several hundred years. During the 5th century BC, when the tragedies of Aeschylus were performed, the theatre building was simple, without the *skene*. Later, perhaps motivated by a public interest in spectacle as much as drama, the *skene* was built and later expanded. Some commentators have observed that it is precisely when the plays are mediocre that the building is perfected!

Today, the theatre of Epidaurus attracts a large number of Greek and foreign visitors and is used once again for the performance of plays. The first modern performance to take place at the theatre was Sophocles's tragedy *Electra* in 1938, and from 1955 there were annual performances of ancient drama. The Epidaurus Festival now continues each year during the summer months.

2,300 years ago, the people of the cities of ancient Greece invested substantial resources to build theatres and make performances, for all the citizens to attend. The format was developed and refined over several centuries, resulting in a space where thousands of people could hear, watch and think about the performance. The Greeks created the template for every Western theatre: a place for seeing and contemplation, where a society can see itself performed.



The theatre at Epidaurus

E.02

Setting the Stage

The first scenography

Villa wall painting, around 50-40 BCE

In the Greek theatre, the first scenery that was specific to the play comprised painted panels showing generic scenes, mounted on the skene *at the back of the stage, or on rotating* periaktoi.

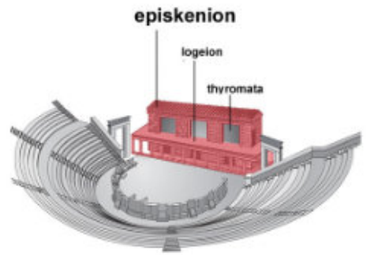
The term scenography comes from Greek word *skene*, meaning 'stage or scene building', and *grapho*, meaning 'to describe'. Aristotle wrote in his work *Poetics* about the appearance of *skenographia*, or painted scenes depicting the place where the action took place. Vitruvius (Q467) stated that Agatharchus (Q433) was the inventor of scenic painting and the first painter known to have used graphical perspective on a large scale. Significant advances in scene painting occurred between the date Sophocles wrote his first play (468 BC) and Aeschylus' death, twelve years later.

In the early days of Greek tragedy, scenography consisted of a large object placed in the orchestra. It could be an altar, a tower, or a tomb, as happens in Aeschylus' plays *The Suppliants*, *Seven against Thebes*, and *The Persians*. According to Aristotle, Aeschylus introduced the first painted scenography in the theatre of Dionysos (Q7829) in Athens around 505-456 BC.

Originally the *skene* consisted of a small temporary construction where the actor could change his mask and, occasionally, his costume. Its peripheral position and small size did not block the spectator's view of the surrounding landscape. Gradually the *skene* gained in size, and by the end of the 1st century BC it was built in stone. In the early, Hellenistic theatre the *episkenion* was the second floor of the Greek *skene*. Its facade was perforated by one or more openings called *thyromata*. These could be fitted with *pinakes*: painted scenic panels or flats that represented locations during performances and could be easily changed as required, but not during the show. *Periaktoi* (A.01) could also fit in these openings or just be placed on the stage. These were three-sided painted flats on a triangular base that could rotate in three different positions revealing three different places of action (clouds, mountains, the sea, a garden…) in front of the public. Changes of scenery in tragedies were exceptional, only in comedies were they more frequent and carried out in plain sight.

Euripides On Stage: Heracles' Madness

33 Greek tragedies have survived to the present day, 25 of them take place in front of a temple, palace, or tomb, 4 in front of an army chief's tent, hut or cave, 4 in an open landscape, 1 on a mountain and 2 in a landscape or sacred place. This means that at least two thirds of the places would correspond to an architectural background that could generically resemble a temple, palace or tomb, literally painted but also in a metaphorical way. The interaction of the different scenic elements with the other spectacular effects (machinery and sound) contributed to generate the illusion.



Many scholars believe ancient artists depicted certain visual phenomena using 'intuitive perspective', which means they had no clear system of perspective. However, according to Vitruvius (Q467), Apatorius of Alabanda (31-13 BCE), scene painter of the theatre at Tralles in Lydie, was chastened by the mathematician Licymnios for the incorrect rendering of roofs. He supposedly repainted the perspective to the mathematician's specifications. The Roman wall paintings at Boscoreale and Pompeii, which are believed to be copies of Greek works, show laws of perspective, because the bottom and top of the picture plane were curved, mimicking how two eyes view space.

Apollodorus Skiagraphos was an influential ancient Greek painter of the 5th century BC who worked as a mural painter and left a technique behind known as *skiagraphia*, which means he could gradate light and colour, to shade his paintings. That is why he is known as the inventor of chiaroscuro. This shading technique uses hatched areas to give the illusion of both shadow and volume. Pliny called him Apollodius from Athens, the 'first to give his figures the appearance of reality'.

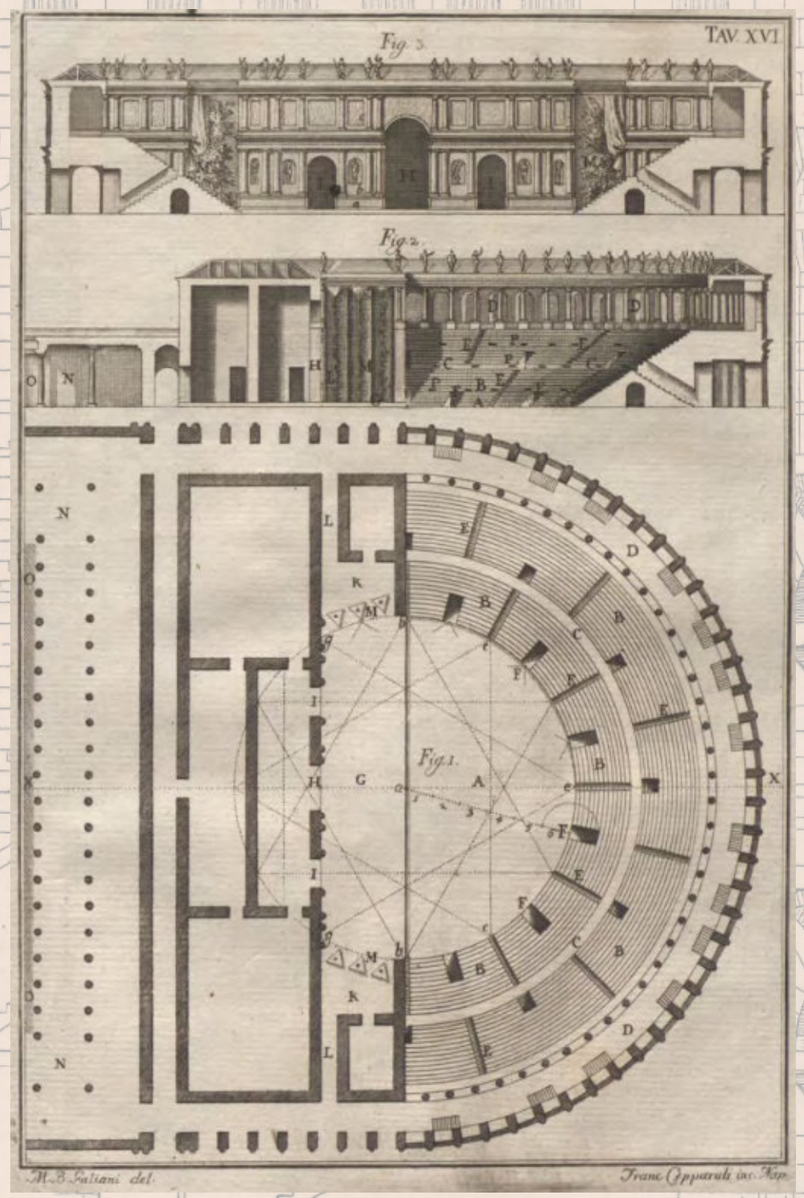
Other Greeks are known for their scenographies: Anaxagoras (500-428 BC) learned from Agatharchus, Clisthenes and his son Menedemus (450 BC), as well as Epiklytes (274 BC) from the Delos Theatre. Dioskurides (100 BCE) created two mosaic murals that may show *pinakes* of the Hellenistic stage.

The Greeks of Antiquity established a relationship between theatre and painting – embedded in the term 'scenography' – which has been a constant through much of the history of Western theatre. Today, while scenic painting is in a period of decline, the projected image fulfils a similar role – the scene within the scene.

F.02

Architecture Codified

The books of Vitruvius



In De Architectura*, Vitruvius codified Roman architecture, setting out principles and practical considerations for buildings and civil engineering of all kinds, including theatres. Revived in the Renaissance, its impact can be traced to the present.*

Marco Vitruvius Pollio was a Roman architect, writer, engineer and treatise writer from the 1st century BCE. He is the author of the oldest treatise on architecture that is preserved, and the only one from classical Antiquity. *De Architectura* (Q467) consists of ten books, probably written between the years 27 BCE and 23 BCE, and dedicated to the Emperor Augustus.

The ten books cover not only architectural design and the orders of architecture (the appropriate styles, proportions and functional requirements for various types of buildings), but also town planning, civil engineering, the qualifications required of an architect or the civil engineer, building materials, pavements, decorative plasterwork, water supplies and aqueducts. He also writes about the sciences influencing architecture – geometry, measurement, astronomy, the sundial – as well as the use and construction of machines, including Roman siege engines, water mills, drainage machines, hoisting, and pneumatics.

In book V, Vitruvius give a detailed account of the architecture and technical workings of Roman theatres of his time. He dedicates chapter III to the site, foundations and acoustics of the theatre, while chapters IV and V cover the theory of musical harmony, and the use of sounding vessels of the theatre as an acoustic treatment (D.01). In chapter VI, Vitruvius details the plan and proportions of the theatre, and in VII he compares the Roman theatre with earlier Greek theatres. Chapter VIII returns to the subject of acoustics, and IX describes the colonnades and walkways behind the stage.

Vitruvius asserts that the auditorium should be a semicircle (*emiciclus*) with rising tiers of steps that act as seats, and a colonnade surrounding the highest level. At the back of the stage is an architectural construction, with rows of columns *ex domorum imitatione*.

He writes about theatre acoustics and develops acoustic principles by explaining how sound waves spread out in space just as waves spread out in water. And as for the sounding vessels of the theatre he says that they have to be constructed in such a way that when they are touched they produce a sound from one to the other according to a sequence or harmonics.

Vitruvius does not give the measurements of the theatre but the proportions between the different elements that compose it, which start from a basic dimension: the diameter of the orchestra. It starts from the complete circumference of the orchestra on a flat area. The diameter of the circumference is chosen by the architect who defines the dimensions he wants for the theatre. The only fixed dimension is the height of the stage (no more than five feet) and the steps of the seats, which must be no less than 10 inches and no more than 18 inches, and their width must be between 2 and 2.5 feet.

As far as the setting is concerned, he mentions the *scenae frons* (Q23705) with its three doors and the three types of scene: tragic, comic, and satirical. He also describes the *periaktoi* (Q23827):

> The scene will have this arrangement: the middle gate will be magnificently adorned as a royal palace. Right and left are those of the guests: next to these doors are the spaces for decorations. The Greeks call them *periaktoi*, because in them the machines are placed on versatile triangles, and each one has three different decorations, which turn, and change as appropriate, when the fable begins, or when the coming of the Gods is feigned with sudden thunder, making a different scene and ornament appear. Next to the aforementioned spaces run the angles through which the scene is given transit, one for those who come from the forum, and the other for those from other parts. (Q467, book V, chapter VII)

De Architectura was not totally forgotten during the Middle Ages, but it was rediscovered in Saint Gall by Poggio Bracciolini in 1414. As a result, Alberti, in his *De re Aedificatoria* (Q30509), around 1450, was able to base his treatise on the theatre on Vitruvius. *De Architectura* was first printed in Rome in 1486, and the first illustrated edition in Venice in 1511. In the same years as the first edition of Alberti and the first edition of Vitruvius, efforts were made to rediscover the Roman models of architecture, as well as the rebirth of the works of the Roman playwrights, especially Plautus, Terence and Seneca.

Vitruvius's *De Architectura* is the oldest known systematic description of architecture and engineering, it not only gives an insight into Roman practices and technologies from the 1st century BCE, but its influence can also be traced, via the Renaissance, to modern day architecture and the design of theatres.

G.02

The Thespian Cart

Theatre on tour

Thespis lived in the 6th century BCE, and is said to be the originator of the idea of the actor, of dialogue as part of dramatic performance, and of touring theatre.

The actor Thespis of Icaria, described by Horace in the *Ars Poetica*, gave birth to the idea of a mass theatre, with a strong emotional impact and capable of conveying theatrical culture to forgotten segments of the population. He lived in the mid-6th century BCE, and had his own wandering company, called the Cart of Thespis, with which he gave dramatic performances in Icaria and other places in Attica. He also acted in Athens, when Pisistratus introduced the cult of Dionysus there and organised the Great Dionysias (festival of Dionysus) of 534 BCE. Thespis performed, for the first time, one of his dramas. He detached from the chorus a character who would 'answer' to the chorus and be a real actor: he invented or developed, the dialogic prologue.

Thespis brought other important innovations, involving the makeup of actors and especially the use of the mask. The followers of Dionysus, who was one of the most important deities of ancient Greece, had the custom of masking themselves, covering their heads with leaves and dyeing their faces black or red with soot or rust. Thespis transferred this custom to the scenes, added white to the two colours (for which he used white lead), and then made real cloth masks. Later masks were also made from cork and wood, more durable materials that remained in use throughout antiquity. Thespis thus also introduced into the theatre the suggestive element of fiction, that is, the distortion of reality.

Thespis, after a period of triumphant victories, left Athens to head elsewhere. He departed from the capital on a cart, with a group of actors like himself in tow. With his cart he reached villages, hamlets, inaccessible parts of the Greek countryside: and wherever he arrived he staged comedies and tragedies, written or improvised. And without knowing it, with that act of his, Thespis had given birth to that form of theatre which, for tens of centuries, would be an undisputed success throughout Europe: the wandering theatre – a theatre which does not wait to be reached by the public, but which goes to look for the public, in the most remote recesses of the province and rurality, in the name of an art that is – and must remain – by its very nature art for all and of all. Thespis is, in short, the ideal progenitor of all wandering actors, of all the homeless of stage art, of all those comedians who choose the difficult road of artistic and existential improvisation.

And it was precisely Thespis who would return as the inspirational model for those who, in the 16th century, gave birth to a form of theatre that was at times primordial and at times futuristic – a street theatre, devoid of theatrical buildings, scripts, and acting rules: the *Commedia dell'arte*, a typically Italian product, later successfully exported throughout Europe and endowed with truly exceptional longevity (H.02). *Commedia* is, first and foremost, a form of nomadic theatre, a theatre that goes looking for an audience there where it knows it will find one (in the squares, in the markets). The comedian of art, having arrived at

these meeting places, just like any other merchant, sets up his stall and, having climbed on it, improvises his art. He later migrates to other shores, seeking new audiences to beguile.

The Cart of Thespis and the Itinerant Theatre came back into vogue with Futurism and Fascism. Fascism made use of this model and the experience of the wandering theatre by constructing an open-air touring theatre project starting in 1929: four huge theatrical structures – three for prose and one for opera – transported on trucks that also took the name of Thespian Carts, conceived by set designer Antonio Valente and Giovacchino Forzano. They travelled throughout the Italian provinces on long tours, capable of involving hundreds of thousands of spectators. The Thespian Carts reached even the most remote localities, normally not involved in significant theatrical events. Here the workers would set up the vast seating banks, capable of holding five thousand spectators, and the large stage was topped by a Fortuny dome, on which many lighting effects could be realised (B.06).

The last of the Carts of Thespis in Italy was by the National Mobile Theatre Company, formed in 1960; it toured the country until 1973. In the summer of that year the company ceased to exist, and the pavilion was donated to those displaced by the 1972 Ancona earthquake. Elsewhere in Europe, other touring theatres, with the same motivation to reach the people where they were, built mobile stages. Against the odds, the spirit of the Cart of Thespis lives on.

Top: Chariot of Thespis, ceiling painting in the Burgtheater, Vienna, by Gustav Klimt

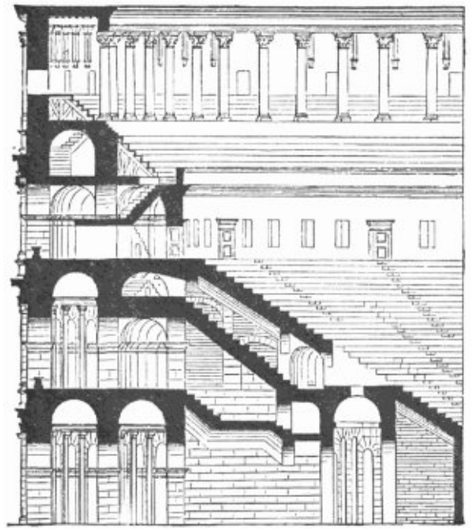
Above: Los Cómicos Ambulantes, by Francisco de Goya, 1793

H.02

Entrances and Exits

Crowd management in antiquity

Crowd management is a vital part of live events, and the larger the audience, the greater the care needed. The architectural principles for the flow of people in venues used today were established in the theatres and amphitheatres of Antiquity.



Section through the staircases and tunnels of a Roman amphitheatre

The theatres of ancient Greece were attended by all the citizens of the city. They therefore gathered large crowds. To enable everyone to attend, the Greek theatre used natural slopes on which to place wooden benches for the audience, with a circular platform called the *orchestra* for the chorus and a raised floor for the actors (E.01). Later, stone structures were built. The semi-circular seating area was divided into several overlapping sectors separated by aisles, and radial steps divided the auditorium into a series of wedges. The seats comprised an upper tier on which the spectators sat, and a lower one on which they placed their feet. There was, at the bottom, a row of seats of honour intended for priests and official figures. The auditorium was usually built by excavating or adapting the natural slope of the ground. At the sides were two entrances placed between the ends of the semi-circular seating area and the stage. The audience had to pass through the orchestra and then climb up to occupy the upper seats. The entire audience therefore had only two entrances and exits – shared, moreover, with the actors and the chorus. The entrance was therefore slower and had to be disciplined; only after entering could one disperse onto the auditorium.

The Greek theatres stood in sacred areas near temples and were built on slopes. The Roman theatres, on the other hand, were built in cities and were freestanding buildings, thanks to the Romans' knowledge of arch and vaulting, mortar and brick – methods unknown to the Greeks. The semi-circular tiers of seats in the auditorium now rested on brickwork arches and vaults, and connected to the stage with side galleries. This allowed the theatre building to be placed anywhere, and gave scope for an ornate and monumental external façade – in the imperial age – embellished with precious marbles. The spectators used several entrances, through various arches on the semicircle at ground level, and then walked along corridors, ascending to the upper levels through internal corridors and stairs, up to six storeys high, and then exiting to their assigned sector through the *vomitators*.The public therefore had independent entrances and exits, sheltered and enclosed spaces with many ways in and out of the auditorium at different levels. With this system of stairs and tunnels, the public could exit in just a few minutes and take their seats very comfortably and quickly, even in large theatres – the Roman theatre of Ostia Antica could hold 2500 people (Q30630).

The Roman amphitheatre was of a similar design, but elliptical in shape rather than semi-circular. The name 'amphitheatre' means 'spectator space running around the arena'. The centre of the amphitheatre consisted of a flat elliptical area covered with sand, called the arena. All around it was the auditorium, again with masonry tiers, where spectators took their seats. These tiers were usually divided into sectors, so that spectators of different social class and category would not be mixed.

The number of spectators in the amphitheatre compared to the theatre was much greater. The Colosseum in Rome (Q615) could accommodate up to 70,000 spectators. There were 76 entrances through the arches on the ground floor, each marked with a number. The spectators, from outside, could already tell, with ticket in hand, where it was best to enter. Once inside, they found themselves in a circular corridor (*ambulacrum*), which led them under the tiers of seats, which they accessed by climbing the stairs and passing through the *vomitorium* to the auditorium. Any doubts about which way to go were resolved by signs with directions.

Large sports stadiums today use the same principles for distributing the spectators through various entrances, and then using the interior spaces as a further subdivision of the flows of people. The Colosseum's capacity of 70,000 would put it in the top ten of the largest Olympic stadiums today. 2500 years ago, the Romans had mastered the principles of crowd safety. They even placed a separation between the crowd and the arena so there could be no equivalent of the modern day 'pitch invasion'.

This type of construction ensured disciplined entrance and exit movements that did not create traffic jams. Thanks to the very efficient system of stairs and galleries, the public was able to take their seats very comfortably and quickly, and after the show exit again in a very few minutes. The use of multiple entrances/exits, the use of internal spaces, created by arches and corridors, ensured that the quantity of people was always spread throughout the entire structure, so that unmanageable or dangerous crowds never formed.

Above: the Colosseum, Rome

Right: the Roman theatre in Catania, Italy, built within the city (Q19125)

I.02

Reconstructing the Past

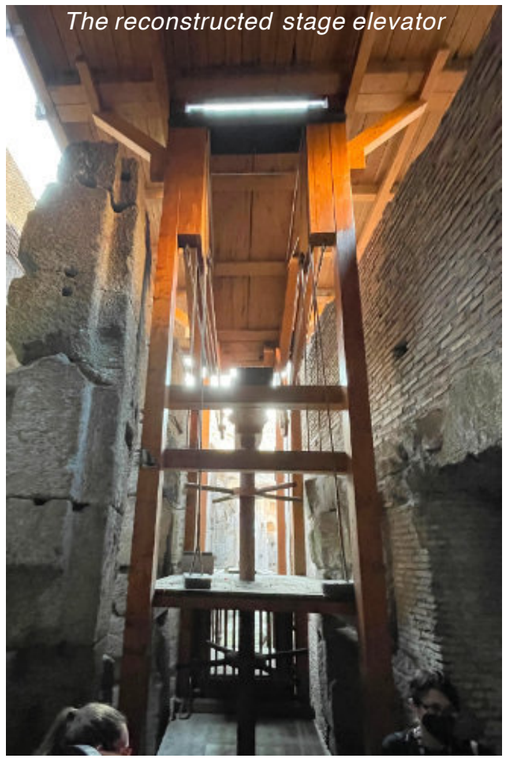
The stage machinery of the Colosseum

The Colosseum in Rome once had many stage lifts, able to bring people, scenery and animals up through the floor of the arena. In 2014, one of the lifts was reconstructed, demonstrating the skilful techniques used by the Romans nearly 2000 years ago.

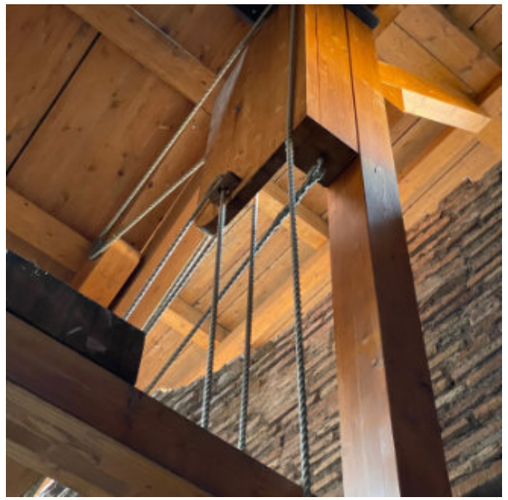
The Roman amphitheatres were elliptical buildings used for a variety of spectacles including gladiatorial games – fights between gladiators and between gladiators and animals. Perhaps the most famous amphitheatre is the Colosseum in Rome (Q615). At the centre of the amphitheatre is a flat elliptical area called the arena. All around it is the *cavea*, the brickwork tiers, where spectators took their seats. These buildings had foundations of *opus caementicium*,pebblesorrubblebound with lime mortar, and above that masonry, including stone and marble, reaching heights of around 50 metres. The outer perimeter of the amphitheatre, with arches, was adorned with columns and pilasters, with various decorations and statues, so as to give it a monumental appearance. The entire amphitheatre had a huge velarium – a canvas roof – for protection from the sun, stretched by ropes and driven by winches.

The games and fights took place on the arena's wooden deck, covered with sand. On the sides were openings with gratings for men and animals to enter. The fights were bloody and violent. The audience was constantly amazed by various tricks, scenic effects and spectacular gimmicks to thrill them. Dozens of beasts were raised simultaneously on the arena, lifted by hoists invisible to the public: leopards, bears, wolves, ostriches and deer were amongst the animals used, taken from all corners of the empire – the highlight of the spectacle.

The system of lifts installed in the Colosseum changed over time. The Colosseum first opened in 80 or 81CE, initially with 28 lifts around the perimeter, with another 20 inclined planes in the centre, that could bring large scenographic elements and people into the arena. After a disastrous fire in 217CE, the inclined planes for the scenery were reconstructed, while the hoists for the animals were increased to 60 and were placed in the corridors under the central part of the arena. The lifts were human-powered devices, so



The reconstructed stage elevator



The under-stage passages where the elevators were located

hundreds of people were required in the underground area of the Colosseum just to operate the hoists, as well as the gladiators and people to handle the animals.

There are no drawings or detailed records of the lifts. What little that is known about them comes from the careful examination of the surviving stonework of the walls in the under-stage – grooves and cut-outs in the masonry show where the wooden structures of the lifts fitted, while some of the metal sockets where the poles of winches ran are still present. To gain a greater understanding of the construction of the lifts, and to be able to demonstrate how they worked to the public, one of the 28 hoists has been reconstructed. The Project was a collaboration between the *Soprintendenza Special per il Colosseo, il Museo Nazionale Romano e l'Area Archeologica di Roma* (Special Superintendence for the Colosseum, the National Roman Museum and the Archaeological Area of Rome) and Providence Pictures, which in 2013 proposed the reconstruction of a lift for the making of the documentary *Colosseum: Roman Death Trap*.

The design for the reproduction lift was based on careful examination of the surviving stonework, to ensure the lift would fit in exactly the same way the originals did. The mechanism is not just a simple lift – as well as lifting a cage that can take a large wild animal, it also has to lower a section of the stage floor at an angle to make a ramp, and then open the cage door so that the animal's only way out is up the ramp and into the arena. Some of the design was worked out at the *Museo delle Navi Romane* (Museum of the Roman Ships) in Nemi, where historic techniques using ball bearings, pulleys, hemp ropes, winches and hoists can be seen, since these were the solutions to the problems of transmitting motion, lifting loads and reducing friction forces that the Romans had available. A 1:4 model of the lift was constructed, so that the planned mechanism could be checked and refined.

In May 2014, the full-size lift was carried over the walls of the Colosseum, lowered into the centre of the arena and placed in its position between the still-existing walls of the under-stage by a huge, modern crane. The cage measures 180cm by 140cm, with an internal height of one metre. The ascent, of about 7m, is achieved with 15 turns of a winch driven by 8 men working on two 160cm-high levels, 4 below and 4 above. Up to 300kg of cargo can be lifted. Testing demonstrated that everything worked as expected, and as a demonstration, a Czechoslovakian wolf-dog (a trained performance animal) was raised by the lift and emerged onto the arena floor – the first animal to do so in nearly 1500 years.

J.02

From the Heavens

Medieval stage machinery in churches

Annuciation Play, around 1500 - the first visual record of the heaven machinery

Religious theatre in the Middle Ages featured not only mortal beings, as in secular theatre, but also devils, angels, God, divine beings, ascensions, miracles. Machines were created to allow the required actions of the performance to be carried out.

In the Middle Ages, Christian churches became spaces for experimentation, investigating how to implement different types of stage machinery. The mechanisms used in the religious plays evolved over time and allowed for the constant improvement of the scenographic effects, such as flying characters or celestial spheres, required to present various scenes from the Bible.

For flying people or scenic elements, there were devices with ropes or cables, which have two ends fixed, one at a higher point and the other at a lower point or on the ground, thus allowing horizontal, inclined or even vertical movement. Examples are the star of the adoration of the Three Kings and the divine ray of the Holy Spirit, the dove of the Annunciation and the conception of the Virgin Mary, as well as the Ascension, the Baptism of Christ, and representations of the Pentecost.

Another category of mechanism is based on a device attached to a single point at the top, where a winch is located, which allows the figures or personages to be raised and lowered. This machinery allows purely vertical movement – the Mandorla. In Christian iconography, the *mandorla* (literally, almond) or *vesica de piscis* is the divine light that surrounds holy characters, including angels, when they appear on earth. It is often depicted as an almond shape, hence its name. It is also a machine used to raise and lower people from heaven. It has an iron arch in the centre of which is a circular wooden base where the central figure and the image of Mary are placed. The mandorla was moved up and down by means of a system of pulleys and ropes, while candles provided lighting. In the apparatus there are hidden tubes where the candles are placed to give the most impressive and unexpected effect of illumination – the tubes raised and lowered, so revealing or hiding the light as required. Cloth or wadding was used to create clouds, on or surrounding the mandorla, completing the effect.

These devices were further developed throughout the Middle Ages and into the Renaissance. In his book, *Lives of the Most Eminent Painters, Sculptors & Architects*, Giorgio Vasari describes Brunelleschi's representation of The Annunciation in the Church of San Felice (1435-1439), where a dome illuminated by candles held on cloud-like corbels represented the sky:

> [Brunelleschi] had suspended, between two of the beams that supported the roof of the church, the half of a globe in the shape of an empty bowl, or rather, a barber basin, with the rim downwards […]. At the foot of the inner edge it had certain wooden brackets […]; on each of these brackets there was placed […] boys, dressed like angels […]. From the aforesaid ring there issued a very stout bar of iron […]. The said stout bar of iron had eight arms, spreading out in an arc large enough to fill the space within the hollow half globe, and at the end of each arm there was a stand about the size of a trencher; on each stand was a boy about nine years old, well secured by an iron soldered on to the upper part of the arm, but loosely enough to allow him to turn in every direction.
>
> These eight angels, supported by the said iron, were lowered from the space within the half-globe […] In the midst of this cluster of eight angels – for so was it rightly called – was a mandorla of copper, hollow within, wherein were many holes showing certain little lamps fixed on iron bars in the form of tubes; which lamps, on the touching of a spring which could be pressed down, were all hidden within the mandorla of copper, whereas, when the spring was not pressed down, all the lamps could be seen alight through some holes therein.

The stage mechanics, lighting and scenic elements combined to create a remarkable effect. As the scene of the Annunciation played out,

> there was a God the Father on the outer edge of the globe, surrounded by angels similar to those named above and supported by irons, in such wise that the Heaven, the God the Father, the cluster, and the mandorla, with innumerable lights and very sweet music, truly represented Paradise.

Through the Middle Ages, stage machinery familiar to us today was used to bring to life the stories of the bible, creating divine beings, ascensions and miracles for the audience to marvel at, reinforcing the Christian faith.

Excerpt from The Assumption of the Virgin, *Francesco Botticini, around 1475*

Hellmouth

Theatre of fear and morality

The Hellmouth is the entrance to Hell imagined as the gaping mouth of an enormous monster, like a whale. Medieval theatre used props, mechanical devices and other effects to frighten the audience by vividly dramatising the entrance to Hell.

The Roman theatre of Antiquity declined under the Christian emperors of the late Roman Empire. For Christians of that era – and at various times and in various places since – entertainment was a sin. Theatre largely disappeared for hundreds of years, but its re-emergence came precisely from the Christians; those who erased it, restored it and used it to reinforce the Christian world-view. In Italy, Jacopone da Todi in 1236 wrote the *Laude Drammatiche*, and the practice of Liturgical Drama and Sacred Representation began to spread, dispersing throughout Europe as the Mysteries. These theatrical forms were realised by the Confraternities, performing only and exclusively sacred subjects from the Bible or the Gospels. The representations took place inside churches or in churchyards or town squares, with wooden, temporary structures. Performances only took place at Christmas, Easter or on Saints' days. The Catholic Church used theatre as a means of spreading Catholicism, but also as an instrument of fear and morality.

A common subject in northern Europe is the Hellmouth. In painting, in sculpture, in miniatures of manuscripts the image of the Gates of Hell was frequently depicted. The Hellmouth is most likely a reference to Leviathan, the monster-whale or sea-serpent (translated from the Hebrew, Job 41:1, 'garlanded animal'). The mouth of Hell is compared to the mouth of a whale – a mouth of a terrible and terrifying animal, taken from the narratives of the bible, which drags man, led by devils, into the belly, into the bowels of the whale-animal from where he can never return and must be damned all his life.

In sacred representations, such as that of Caedmon in the early 11th century, and later in the Mystery plays such as the Passion of Valenciennes (1547) and the Easter Drama of Lucerne (1583), the Gates of Hell were dramatically presented as a way to invoke fear, and to enforce morality. In these dramas, the Hellmouth was represented by scenic elements positioned on the 'playne' (plain) so that the devils emerging from Hell ran around the *plateas* (the main playing areas) before approaching Eve for temptation. In Valenciennes, the Mansions (F.02) were lined up in a row, on the left the gate of Paradise, and on the far right a prison and Hell. Behind the prison there is fire and a place of torture, while in front, there is the head of a terrible monster from which devils emerge.

From historical sources, it is clear that the medieval theatre-makers paid special attention and invested much labour to create the area of Hell. The monstrous head was *faicte en maniere d'une grande guele se cloant et ouvrant quant besoign este* ('made in the form of a large goblet that closes and opens when needed'). Sound effects were extensively used to create the infernal din of the devils in Hell, made by banging pots and pans together, hammering on anvils, and rolling stones in barrels or large metal bowls (D.02). Meanwhile, the jaws of Hell opened and closed, with fire and pyrotechnics to add to the effect. The records of the play put on by the Drapers' Guild in Coventry, England, in the 16th century show payments of 8 pence for 'the keeping of hell mouth' and 4 pence for 'the keeping of fire at hell mouth.' The Hellmouth in the 1437 Passion play in Metz, France was an automata, swallowing and vomiting out those condemned to Hell on its own. It also had eyes that glittered. The Hellmouth of the Corpus Christi play in Toledo, Spain in 1493 shot out fire, using rockets. Smell was also used, with the most noxious substances from around the town gathered to make Hell stink: excrement used for tanning leather, urine used in making dyes, blood and guts from the butcher. Perhaps unsurprisingly, at the 1510 Passion play in Châteaudun, France the price of a seat opposite Heaven was a great deal more than one near to Hell.

The Church, the civic authorities and the Guilds, using spectacular and visceral effects, created Hellmouth to invoke fear, maintain moral discipline and reinforce the beliefs of the Catholic faith.

Altarpiece in St George's Church, Haguenau, France

B.03

Theatre by Firelight

Candles and oil lamps

Candles and oil lamps were everyday light sources for the people of the Middle Ages, but used en masse, together with staging and other effects, their use in religious performances was highly spectacular and powerfully symbolic.

The use of open fires in the form of bonfires and torches goes back to human pre-history, both to light up the night outdoors for celebrations and rites, and to provide light indoors for more mundane activities. The use of candles is evidenced in archaeological findings from around 500 BCE, while oil lamps, fuelled by oils from seeds, nuts and animal fats, are far older, dating from at least as far back as 10,000 BCE. Oil lamps came in a variety of sizes and designs, but all consisted of a container for the oil, a handle for carrying the lamp and a mouth where the wick to be lit could be dipped into the oil. The brightness of oil lamps and candles is limited by the small size of the flame, so while a single light source is adequate for a small room, a large space must be lit by many. While an oil lamp normally has only one wick, even in ancient times there were oil lamps with several wicks. There are examples from Crete of oil lamps with forty wicks to provide a very strong light source to illuminate a large room.

The religious plays of the Middle Ages performed in churches were the first examples of stage lighting – the first indoor performances that needed to be lit by candles and oil lamps. Even at the beginning, such lighting was not only a practical matter of illumination so that the performance could be seen. Light was central to the metaphysics of the Christian faith: God created the light that is manifested in the angels, in the divine grace, and – finally – as optical light. The very matter of the world was ordered in its value according to its degree of luminosity, so the four elements were, in order of precedence, fire, air, water, earth. The colours too were ordered according to their luminosity.

Church services were similarly structured by symbolic light. In the *Tenebrae* ceremony at Easter, the candles of a candelabra with many branches were extinguished one by one, as a symbol of the death of Christ, all except the highest one which was left burning. Around 970, Bishop Aethelwold wrote in *Concordia Regularis* that when the symbol of the resurrection, the Vernicle, is shown to the congregation, the church is ablaze with light. Like the resurrection, the birth of Christ was understood as a victory of light over darkness. The star of Bethlehem was portrayed as moving overhead, along the gallery of the church, while the Virgin Mary carried a symbolic candle.

The Russian Bishop Abraham of Suzdal described performances of the Annunciation and the Ascension in churches in Florence in the 15th century (Q287), in which light played a central role. In the Annunciation, the figure of God sat on a raised platform at the West end of the nave. Seven concentric circles, the smallest 4 feet in diameter, surrounded the throne, supporting a total of 1000 burning oil lamps, representing the celestial orbits of creation. Opposite this representation of paradise, 175 feet away at the other end of the nave, sat Mary, also on a raised platform. When the moment of the annunciation reached, the Angel Gabriel flew on a ropeway from Paradise to Mary, over the heads of the audience. After the annunciation dialogue, Suzdal describes a ray of fire, filling the church with sparks, travelling out from God towards Mary and back again, which 'lights the candles in the church but without damaging the clothes of the spectators or causing any other harm'. Gabriel flies back to Paradise, the ray is extinguished, and the two platforms surrounded by curtains again, hiding God and Mary from view.

Suzdal also describes a performance of the Ascension. A platform was constructed the width of the church – 140 feet – with at one side a stone structure to represent Jerusalem, and on the other a cliff to represent the Mount of Olives. At a height of 56 feet above the mount, a large platform represented Paradise, painted like the sky, with a central opening covered by a cloth with sun, stars and moon on it. When the cloth was pulled aside, God was revealed, illuminated by many candles and looking down on Christ, Mary and the apostles below. For the ascension itself, a cloud and two angels were lowered from Paradise, and Jesus was lifted up until he ascended into the cloud. At that point, the cloud was lit up from within by many candles, and rose again, carrying Christ up to Heaven.

Light was central to the Christian understanding of the world in the Middle Ages, and was therefore central to the religious performances that took place in churches at that time. Candles and oil lamps were in everyday use, but they were expensive. The use of large quantities of light sources with pyrotechnic and luminous effects would have been a rare sight, both impressively spectacular and of deep symbolic meaning to the audiences of the time. We can consider these religious performances to be the first examples of lighting design, the massed flames of candles and oil lamps making an impact as great as any design since.

C.03

‘Imitating Heaven’s Thunder’

Sound effects in religious plays

The religious plays of the Middle Ages made extensive use of sound effects, especially to create Heaven and Hell. Drums, cannons and pyrotechnics, as well as musical instruments, created spectacular effects to support the storytelling.

Across Europe, the religious plays of the Middle Ages were performed in churches but also outdoors, with a series of scaffolds around an open stage, each representing a different location required in the play (F.02). Many plays involved spectacular effects, costing a great deal of money: elaborate scenery, lighting effects, flying people and objects, explosions, earthquakes and miracles. The depiction of Heaven and Hell was crucial, so the effects of thunder for when God spoke or when angels appeared, and the diabolical sounds of Hell, were important. Music, both instrumental and singing, was also extensively used.

Much of what we know about the sounds of theatre in the Middle Ages comes from descriptions of performances at the time, and the stage directions in scripts (G.02), as well as the detailed records of expenditure that were kept. These often indicate who was employed to do what, or what materials and devices were purchased or needed repair. Sometimes though these records are tantalisingly minimal. One of the oldest stage directions from the Middle Ages regarding sound is from a 13th century play called Adam, which for the depiction of Hell required ‘an infernal din’. But how was that sound to be created, and what did it consist of?

Other sources give a little more detail. In 14th century France, thunder was required, to be produced by ‘stones rolled around in a tub’. The same method was described for a play called Doomsday, in York, England, when an earthquake was needed. With the arrival in Europe of gunpowder in the 13th century, explosions were added to the range of possible effects. In the early 15th century in Florence, a performance inside a church used ‘a volley of shots imitating Heaven’s thunder’ – one can imagine the effect of this inside the church’s resonant acoustics. Around the same period, for the Prades Assumption in Catalonia, explosions marked the return of an angel to Paradise, while the instructions for the same performance state ‘Lucifer and the other devils are to take an anvil and hammers to make a loud noise when the time comes’.

In the 16th century, contracts issued to those making the effects are revealing, setting out what is to be provided:

> The cannons and flaming fireworks necessary for the devil-scene.
>
> They shall make a great blaze of fire and noise every time the devils take some dead to Hell, every day.
>
> They shall fire cannons and bombards when Gog and Magog greet Antichrist.
>
> They shall supply the large cannon and falconets [small cannons] with necessary petards [small bombs] to make earthquakes.

A falconet (small cannon), 1476-1525

The number of people involved also gives a sense of the scale of the performances, and of the effects created: 2 x Thunderers, 4 x Musketeers, 4 x Hornblowers and an unspecified number of smoke makers.

Records also indicate the equipment used:

> ITEM: For a new thunder barrel and for renovating the barrel of the old thunder barrel
>
> ITEM: For 12lbs of powder for the guns and the thunder

The 1501 Passion Play in Mons had people operating a thunder machine, involving ‘two large flat bronze basins’, which seem to have been mounted on a frame, face-to-face with rocks inside, in such a way that the whole construction could be rotated, as if on a spit. The rocks inside would have rolled around, producing the sound of thunder. This effect was supplemented by two wooden barrels covered with vellum skins, and a cauldron with a skin of parchment, to make drums that would create different types of sound. The same play also made use of a ‘thunder sheet’ (Q142), a large sheet of metal hung up and shaken to create the sound of thunder. This is the oldest record of the use of a thunder sheet, which continued in use in theatres until the middle of the 20th century, when recorded sound largely took over from live acoustic effects. The records of the play in Mons state:

> To Pierart Viscave, tinker, for the installation of two big sheets of bronze for the aforesaid mystery, place in Hell to make thunder, has been paid: 32 shillings.

Many performances took place outdoors, with singers, musicians and effects people placed around the outside of the performance space so they could be heard. In some cases, musicians were placed below the stage, and sounds of thunder would come from overhead if the source could be placed in an attic of a house. But theatre in the Middle Ages did not operate within a convention of illusion or naturalism, as found later in theatre’s history. As with all aspects of the performance, effects were there to represent the thing they referred to, with no need necessarily to hide or disguise how the effect was produced.

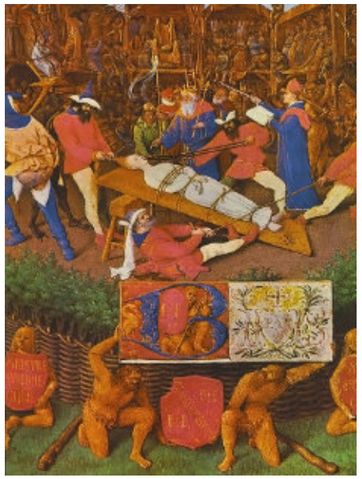
Sound in the religious plays of the Middle Ages played an important role, and was produced by a variety of means, making use of the skills and available resources of the craftsmen and tradespeople in the community. These people were not full-time theatre-makers, but knowledge of the required techniques was passed on through the play scripts themselves, resulting in spectacular and impressive effects.

Hellmouth. Detail from Scene from the Mystery of the Passion of Valenciennes *by Hubert Cailleau*

D.03

For the People

Theatre in the marketplace



The Martyrdom of St Apollonia by Jean Fouquet, around 1445

In the Middle Ages, as with the churches, theatre performance was located in urban space: in squares and streets. Here, mystery plays were performed, such as in Lucerne and the one that is supposed to have taken place in the square in front of the Palais d'Arshot in Valenciennes in 1547.

An illustration by Hubert Cailleau shows the stage design for *The Passion and Resurrection of the Saviour*. This dramatic performance representing Christ's Passion from the Last Supper to the Crucifixion took place in 1547 and lasted 25 days. Although from the Renaissance period, the painting shows it to be one of the best examples of the theatrical place of the Middle Ages.

The text of the Passion of Valenciennes has fifty thousand verses and narrates two cycles: the Annunciation-Incarnation-Nativity and the Passion-Death-Resurrection, superimposing different stories with diverse places: Paradise, Hell, Nazareth, Capernaum, Lake Tiberias, Egypt, Rome, the kingdoms of the Three Kings and the sea. These places are housed in mansions, little stages, which represent them figuratively. They are able to change and look like a pavilion or palace, with a colonnaded portico standing on a raised podium. At either end there are two fixed mansions. On the left, the paradise, a small temple with God contemplating on a throne surrounded by a choir of angels. On the right is the hellmouth (Q30601), represented by a flaming castle in which human figures are enclosed and suffer atrocious tortures and burn, consumed by eternal fire, surrounded by dragons and demons. Mechanisms were created so that characters, such as angels, could fly; clouds and sky cloths concealed the pulley system. Trap doors were used for quick appearances and exits, also red paint as blood and other special effects.

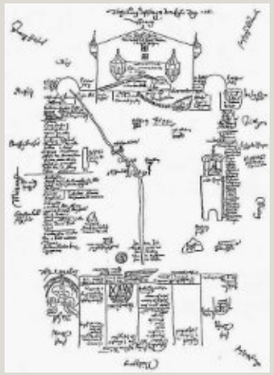
The text presents the whole world and the afterlife in one space. In a way, Valenciennes' podium is a continuation of the *skene* of classical Greek theatre, but the unity of the stage front has been broken down. Even so, during the play, the audience had to move from one mansion to another and saw the performance from three sides of the stage.

The German-language Mystery play of Lucerne, Switzerland took place from the early 15th century into the late 17th century in intervals of twenty years. Many documents survive, like the stage layout with about seventy places, an actor's contract, an account of receipts and costs, the names and roles of most participants, and the script. Strict rules required actors to:

- accept the roles assigned, and provide their own costumes unless they differed from their ordinary clothing. The majority were merchants and the working class, mostly men and boys.
- agree not to meddle in the affairs of the supervisory committee and not to grumble against decisions. There was a schedule of fines, if they were late, drunk, or missed lines, and a list of missing rehearsals (the only excuse allowed was illness)
- contribute to the finances. The amount varied based on the importance of the role. The council paid for a lot of the expenses, such as banquets after performances, but actors were asked to chip in.

A painting by Jean Fouquet, *The Martyrdom of Saint Apollonia* from the mid-15th century, has allows us to understand more aspects of medieval staging. The action of The Mystery of Saint Apollonia takes place in Alexandria, and the painting shows: Apollonia the virgin, a judge, an old man, the director of the performance with the conducting scroll (G.02), the script and a jester. We can see the mansions: The paradise, the orchestra, the empty throne, two spectator boxes and the Hell. Unlike the Valenciennes painting, one value of Fouquet's painting is that it situates the spectators, who are spread out everywhere. Here, too, the place of the action is symbolically represented by scenes separated from one another. Although most of the mansions are intended to be performance spaces, some, placed in no clear order, are reserved for musicians or privileged spectators. The painting shows how medieval staging uses the spaces between the mansions, known as the stalls, for the purposes of the action. If an actor leaves his mansion and performs in the stalls, the stalls become, by convention, another part of his house. If he has to travel from one mansion to another, the ground on which he walks represents the space separating the two places. The stalls are anywhere and can be occupied by both the audience and the actors, who are mixed together.

In the Middle Ages, theatre took place not in dedicated buildings, but in the everyday environment of the streets, squares and marketplaces: theatre for the people.



Plan for the Lucerne Passion Play, 1583

Frontispiece by Hubert Cailleau showing the stage design for a mystery play, The Passion and Resurrection of the Saviour, performed in Valenciennes, 1547

E.03

Many Mansions

The simultaneous and the Terence stage

In the Middle Ages and the Renaissance, multiple locations were denoted by 'mansions' on stage. The simultaneous stage and the Terence stage were superficially similar, but represent different ideas of performance space.

The simultaneous stage was a stage form of the religious plays of the late Middle Ages and remained the predominant stage form outdoors or indoors such as in the church until the Renaissance. On the simultaneous stage, all the settings were next to each other, often simultaneously.

Before around 1200, performances took place mainly within churches, generally as part of the church services. Performances took place in two main areas: small scenic structures called mansions, each indicating a location, and the *platea*, a general acting area adjacent to the mansion. Various places within the church were used for the mansions, so the choir loft would be used for heaven, and the alter could represent the tomb of Christ. Effects, including lighting and flying, could be spectacular (A.02).

Later, performances began to take place outdoors, with the same concept of multiple simultaneous stages – the mansions and the platea – either set up as fixed scaffolds, or on mobile wagons (E.02). The audience would gather around each stage as the story unfolded, and in the case of moving stages (known as the wagon stage, or the pageant stage), the scene would be played multiple times as the wagon moved through the town. The locations represented would be determined by the story to be enacted, but it was common for Heaven and Hell to be included, with hell on the left, heaven on the right, and the earthly realm in the centre. The use of the space had a significance that is unfamiliar to a 21st century audience; the medieval simultaneous stage, like simultaneous representations in the visual arts of the time, expressed a pre-modern understanding of space and time. Simultaneous actions are not parallel because they take place at the same time, but because they have a comparable significance.

The Ommegang in Brussels on 31 May 1615: The Triumph of Archduchess Isabella, by Denys van Alsloot

Superficially similar, the Terence stage also divided the scenic space into multiple mansions. The Terence stage is the name given to settings of the plays of Roman dramatist Publius Terentius Aphro, known as Terence, when they were revived in the Renaissance period. Because of its similarity to bathing cabins, the Terence stage is therefore also called the bathing cell stage. As in the theatre of Greek and Roman antiquity, it was intended to show the unity of the place of action, not several settings like the medieval simultaneous stage, though it also had many mansions. The Terence stage took up the stage structure of classical antiquity, which was considered idealised, following the example of the comedy poet Terence. For this purpose, it consisted of a flat podium, on the back wall of which house facades were indicated, whose construction of columns with curtains hung between them symbolised the entrances to the houses; these curtains were partly provided with inscriptions and could also reveal a view of a second scene inside the house behind them.

Publius Terentius Aphro was an author of comedies during the Roman Republic, first performed between 170 and 160 B.C. During his lifetime he wrote only six plays, all of which have survived. The genre that Terence wrote was the so-called *palliate fabule*,the *palliata* comedy, a genre inspired by Greek comedy, but with typically Roman elements: customs, costumes, laws, buildings, historical allusions, and the names of the gods.

Some of Terence's publications in Italy and France were illustrated. The first printed edition of Terence's comedies dates from 1470 in Strasbourg. The engravings that accompanied the editions of Terence's dramatic works represented how the people of the Renaissance imagined ancient theatre. In the Trechsel edition of 1493 appears the idea of the theatre as a centralised building representing the symbol of moral construction. In the lower part of the engraving, vice is represented compared to virtue, reached through a staircase that leads to the theatre itself. Above, the audience and the stage are shown – the proscenium is labelled, and the mansions with their doorways and curtains are depicted.

Illustration of the theatre for the comedies of Terence in the edition of Jean Trechsel, 1493

Publius Terentius Aphro - 'Terence'

The underlying concepts and world-view are different, but in the simultaneous stage and the Terence stage, scenic space is organised and codified in a way that would have been highly meaningful to the audience.

In Writing

Documenting stage action and techniques

The play text is a vital means to communicate how a play is to be performed, containing the lines to be spoken by the actors, but also information about the staging of the performance. However, the play text of today was unknown in the Middle Ages.

Medieval theatre was very different to that of today. Plays were performed in improvised spaces, often outdoors. The religious plays, representing episodes from the bible, were performed not by theatre professionals in the modern sense, but by ordinary people under the control of church, civic or guild authorities. In any one place, there might be many years between performances. Plays were documented through scripts, both as a set of instructions for future performance, and as a record of what had taken place for future reference.

The conducting scroll was a director's script used in late medieval theatre. Unlike most writings of the time, it was designed as a scroll. The Regens or Magister Ludi (Latin for 'play director') used it to direct the performance of the drama. Unlike most modern scripts, it contained not only the words to be spoken and stage instructions but also precise instructions on stage construction and scenery, costumes and make-up, as well as practical performance notes, including a list of persons and the keywords for the actors.

Some of the best-known conducting scrolls are the records of the Frankfurt Passion Play from the early 14th century, the Alsfeld Passion Play, the Friedberg Procession Play (1465) and the so-called Sterzinger Szenar, a version of the Neidhartspiel (a play by the 13th century poet Neidhart).

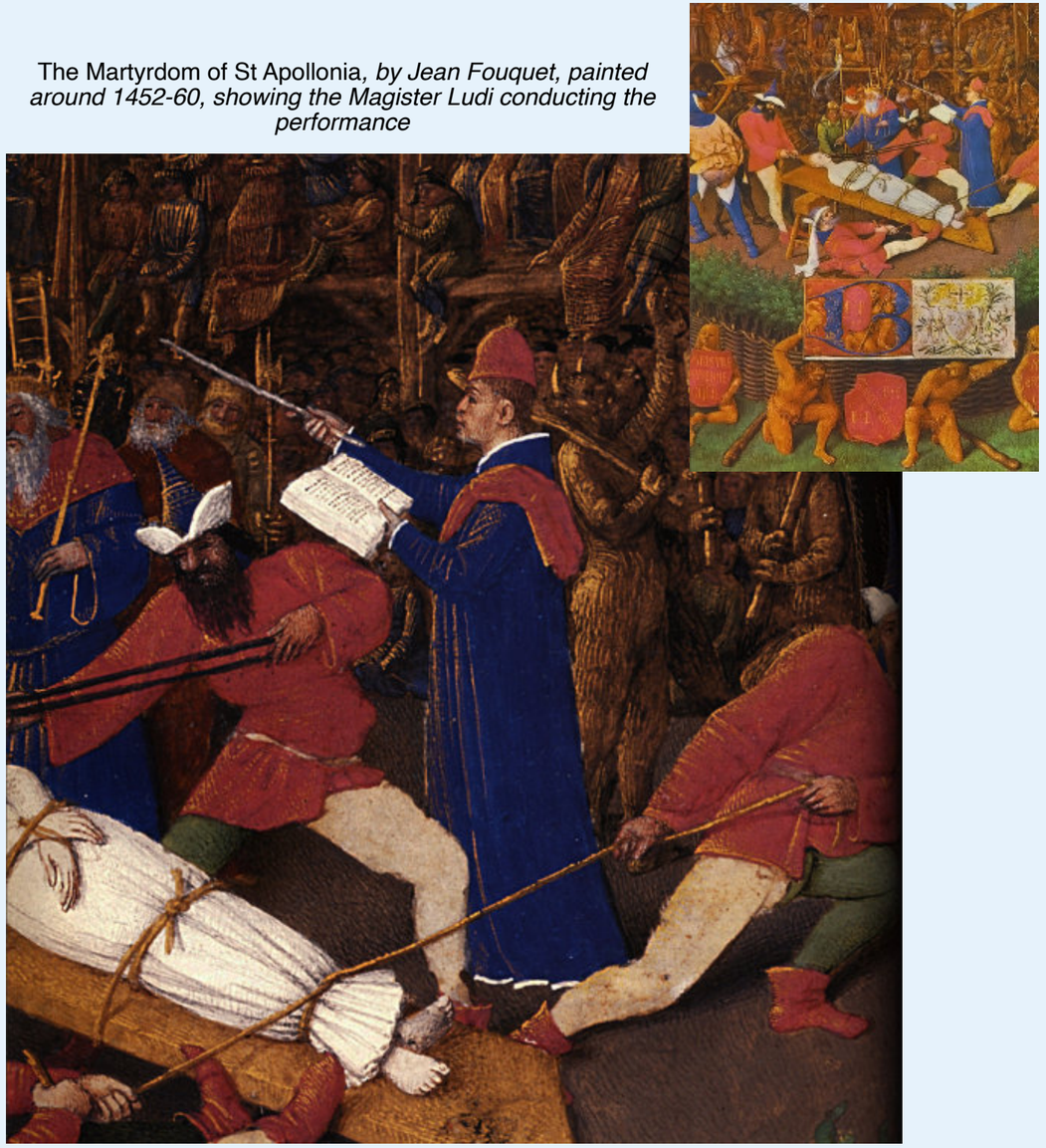
The Frankfurt Conducting Scroll describes the oldest Passion play of several days' duration and is the oldest known record of a director's book. The scroll is over four metres long, and has the title Incipit ordo siue registrum de passione domini ('here begins the order or register of the Lord's Passion') and the end note ludo fiat finis ('let the play end'). It consists of eight strips of parchment glued together to form a roll. The scroll has continuous writing without interruptions. The scroll uses red and black ink to distinguish the rubric (instructions) from the text, a method then common in liturgical manuscripts, just as a modern day stage manager might mark up the prompt copy in different colours to make it easier to find the needed information in a hurry. The scroll has numerous changes and additions in the margins – both to the spoken text and the instructions – testify to the changes in the performance practice of the play during the first half of the 14th century. The changes, only slightly newer than the basic text, were at least partly made by the original writer.

English theatre in the Middle Ages also used a master text, containing stage directions as well as the spoken words. These were more commonly bound as a book, rather than a scroll, but the principle is the same, with again the use of red and black ink. All plays had a master version of the text, from which the parts could be copied. Parts consisted of just the lines for one actor, with a word or short phrase of the preceding line to act as a cue. Actors therefore did not read the whole play, but learned just their own lines and the cue which they should respond to. Actors were only given their part written out, while the master copy of the play was held by the civic authorities as a record of the authorised text that was allowed to be performed. Any copies had to be checked against the master version.

The stage directions were generally written in after the performance – they were therefore a retrospective record of what had taken place during the performance, and perhaps instructions for future performers. Stage directions could include practical information on how to create stage effects, including violent acts such as murders and hangings, or miracles such as making water spring from the ground. The late 12th century play Le Mystère D'Adam describes how to safely enact the murder of Abel by Cain:

> Then shall Abel genuflect towards the east. And he shall have a pot hidden in his clothes, which Cain shall strike as if he were really killing Abel. Abel, moreover, shall lie prostrate, as if dead.

The Martyrdom of St Apollonia*, by Jean Fouquet, painted around 1452-60, showing the Magister Ludi conducting the performance*



Or this example from the Lucern Passion Play, where Mosses must strike the earth to create a spring of water:

> Now the water comes with full force. They all run to drink, pressing forward in a throng. Note: the rock is to be made artificially, namely a container which will take a good amount of water under a cover, arranged and made so that it looks like a rock with at three or four places glass or brazen bungs sticking out which Moses strikes out when the water is to flow.

In a context where plays were performed intermittently, by people who were not full-time theatre makers, the play text had a vital role. It both recorded and passed on not only the words to be spoken, but also the other actions, and – crucially – the staging methods and techniques by which they could be carried out to give the desired effect.

Finding a Formula

The business model of Commedia dell'arte

Actors from the Commedia dell'Arte on a Wagon in a Town Square, by Jan Miel (1640)

Commedia dell'arte *was a type of theatre performed outdoors in temporary venues by professional actors who were costumed and masked. Establishing themselves as companies, they created a successful business model, touring from town to town.*

Commedia dell'arte (literally the 'comedy of professional artists' Q23336, Q23582) was an early form of professional theatre that may have been an evolution of carnival and the rustic street *guillare* (itinerant satirical storytelling jesters). The roots of many of the characters and plots are much older, going back to the Roman comedies of Antiquity. What probably began as an informal entertainment organised through trade guilds, Commedia developed into the first professional touring companies, popular throughout Europe between the 16th and 18th centuries. Several features made Commedia a successful format, such that the members of the company could made a full-time living.

The performances were characterised by improvisation, but each actor knew by heart a lot of witty speeches, conceits, jokes and double entendres, which he kept ready for every suitable occasion. The scenarios of the comedies, which were based on plot outlines sketched out before the performances and used by the typecast professional actors, were full of folly and marked by crude, erotic and implausible incidents, and concluded with a happy ending. As a result, the company could adapt to the local situation, adjusting the content according to the audience, and dealing with any interruptions as they performed in public areas.

Commedia dell'arte was an actor and ensemble theatre, it did not serve an author or a text like other forms of theatre. The most important thing was the commercial success of the troupe; the actors themselves determined the parts of the play and its form and no longer subordinated themselves to the ideas of an author. The basis was the craft, the profession, therefore each actor could improvise from his professional experience, which is why commedia dell'arte is also called improvisational or impromptu theatre.

The characters of the *Commedia* usually represent fixed social types and stock characters, and the play consisted of gags, effects, stage action and movement on stage. These recurring elements made it possible for the play to be agreed upon more quickly, and frequently used passages of text that were already memorised. This type of performance was designed to connect quickly to an audience and have a wide appeal.

Beginning in Italy, the companies spread across much of Europe. They moved from town to town, to find new, paying audiences, often timing their arrival to taking advantage of fairs and celebrations, maximising the potential earnings. Wealthy patrons might summon the company to perform, but they were not always welcomed by the authorities, as the performances were often considered indecent, and there was a fear that travelling people spread disease. Companies were also careful not to outstay their welcome, preferring to leave while the public wanted more, to ensure they would be asked to return. The price of the performance would depend on the local situation, with higher prices in wealthier towns, or if the visit was shorter. Some civic authorities regulated the prices of dramatic performances.

The companies generally consisted of ten performers, to cover all the standard roles in *Commedia*. There would also be a 'production team', with carpenters, props masters, servants, nurses, and prompters, all travelling with the company. To move everything the company needed to perform and to live whilst on tour, the companies used large carts. Each company each had its *impresse* (like a coat of arms) reflecting something particular about the company – an early form of branding.

Commedia was a highly influential form of theatre, elements of which have been adopted by theatre-makers ever since. The idea of a fixed set of familiar, stereotypical characters, which the audience can see over and over again in slightly different – but ultimately the same – situations, is familiar today in sit-coms. But *Commedia* was also the template for professional, commercial touring theatre companies: a complete team of cast and crew (in modern terminology), travelling with everything they required to perform, and using a variety of strategies to gain an audience and ensure an income. This template is still familiar today.

Commedia dell arte Szene, by Peeter van Bredael (1629-1719)

H.03

Look After Yourself

The unregulated work environment of the Middle Ages

Excerpt 'Hell' from The Garden of Earthly Delights, painted around 1490-1510, by Hieronymus Bosch

I.03

Seeking Attention

Making a stage without a theatre

In the Middle Ages, performances took place without the aid of dedicated theatre buildings. The players used speech and action to create a performance space, and to guide the audience where and when to give their attention.

Theatre buildings don't just provide a warm, dry space for the performance, and the technical infrastructure required to stage it. They also help manage the audience, guiding them to behave in the right way so the performance can take place as intended. Entrances to the building, and the foyer spaces, direct people into the auditorium – itself a defined space that determines the audience's behaviour. Seats are arranged so that each spectator has a good view of the playing area, which is often raised up both to give better sightlines, and to demarcate the stage from the auditorium. This separation ensures the audience cannot get in the way of, or interfere with, the dramatic action. Wing space at the side of the stage provides room for the actors when they are not in a scene, and where various technical functions can be carried out, such as costume changes, the storage and preparation of scenery and props, and so on. The curtain signals the start and end of each part of the performance when it is raised and lowered; alternatively, the dimming and raising of the houselights in the auditorium has the same function. Theatre buildings, as we know them today, support some of the fundamental features of theatre: that some people perform, while others watch; that those watching can tell what is part of the performance, and what is not; that they can tell when the performance has started and when it has finished.

A contemporary street performance in India

In the Middle Ages, theatrical performances did not take place in theatre buildings. Religious performances took place in churches, or in public spaces such as market squares, sometimes using a series of temporary stages constructed for the purpose, and sometimes mobile stages known as pageant wagons (E.02, F.02). In the same period, small nomadic bands of actors travelled around Europe, performing wherever they could find an audience in the marketplaces and squares, sometimes on wooden stages with a scrap of fabric as a backstage area, and sometimes just on the open ground.

In the absence of a theatre building, theatre-makers need other means to define the space of the performance, to tell the audience when the show starts and ends, and to indicate who is part of the action. Texts recording the performances of plays in the Middle Ages (G.02) show that the theatre-makers of that time had a specific set of strategies to achieve these things. Where temporary stages were used, the playing space was defined by the area of the platform. However, in the case of the 'simultaneous stage' system common for the large-scale religious plays, the performance moved between platforms, and smaller shows had no platform at all. At the start of each scene, an actor would enter the crowd, calling out for space to be made for the players – in John Palsgrave's *Lescarcissement De La Langue Francoyse* (1530), an entry reads, 'Make romme maysters here cometh a player' (make room, masters, here comes a player). Similarly, John Baret, in his *Aluearie* (1574), records: 'I haue not Roome enough Cause the people to auoyde, or giue place, or make roome' (I have not room enough. Cause the people to avoid, or give place, or make room). For one processional performance moving through the streets in Norwich, England in 1590-91, a person known as the 'whiffler' rode 'before to laye ope the waye' (before to lay open the way).

As well as making space for the action, it was necessary to silence the audience – in one play, the Imperator opens the performance with 'Be styll, beshers, I command yow/ That no man speke a word here now/ Bot I alon' (be still, I command you, that no man speak a word here, but I alone). Opening lines were sometimes in the form of a command, a greeting, a thanksgiving or prayer, an announcement, or a complaint. All had the effect of calling the audience to be silent and pay attention.

Individual actor's entrances also needed to be marked, since there was no wing or physical entrance space from which they could appear, and they could be mistaken for a member of the audience. In the anonymously authored play, *A newe merry and wittie Comedie or Enterlude, newely imprinted, treating upon the Historie of Jacob and Esau* (1568), a stage direction states, 'Here Esau appereth in sight, and bloweth his Horne, ere he enter' (here Esau appears in sight, and blows his horn before he enters). In the same play another character is described as coming in 'clapping his hands and laughing'. Both these stage directions show a clear understanding of the need for the actor to draw attention to themselves when they enter, using action and sound, in a crowded market-place, with no stage lighting, scenery or defined stage to direct the audience's attention to the action.

In the Middle Ages, there were no dedicated theatre buildings. Without the devices we now expect as part of theatre – an auditorium with seats, a stage, scenery, lighting, and so on – the essential requirements of theatre performances were still needed: a defined space and period of time, clearly communicated to the audience. This was achieved through the actions and words of the players, serving as master of ceremonies, narrator, actor and stage manager, all in one.

Christ Is Born as Man's Redeemer (Episode from the Story of the Redemption of Man), tapestry based on a mystery or morality play, 1500–1520

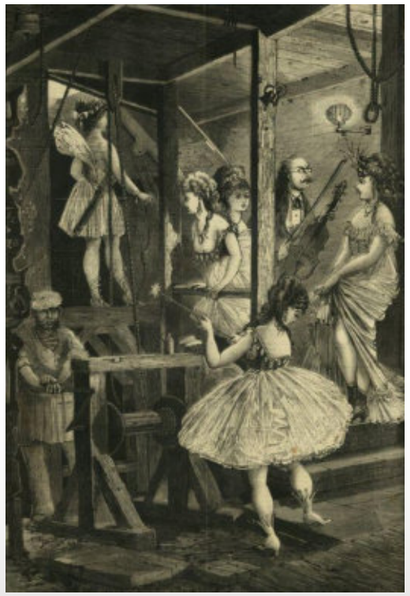
AWorld Below

Lifts, traps and Hell beneath the stage

As well as its practical functions, in Renaissance theatre the space beneath the stage – accessed by traps and lifts – could represent Hell, the world of the dead, and the supernatural, as part of a cosmological conception of the theatre space.

Theatrical machinery has been in use since at least the 5th century BCE. In the Colosseum in Rome, animals and objects were raised by elevators onto the stage, as well as gladiators. The medieval mystery plays used stage machinery, including a trapdoor, for the emergence of devils. In the conventions that have lasted from Middle Ages, the mechanised lower stage represented Hell, from which the hellish forms could emerge to spread fear and terror. The stage itself was the earth, and above the heavens (A.02).

The Globe, London (Q7846) was built in 1599, possibly in time for the opening production of *Henry V* and its famous reference to the performance crammed within a 'wooden O'. At same time the *corrales* were developing in the Spanish Empire (E.03, H.03, Q13175). Both types of theatre buildings had simple sub-stage machinery with trapdoors and lifts: Around the stage and surrounding it on three sides, in the Elizabethan as well as in the Spanish Golden Age Theatres there was an area called the 'yard' (Spanish: *corral*), the name deriving from the old inn-yards. In London, for a penny, people (the 'groundlings') would stand on the rush-strewn earthen floor to watch the performance. At the Globe, a raised rectangular stage platform, also known as an apron stage, thrust out into the middle of the open-air yard.



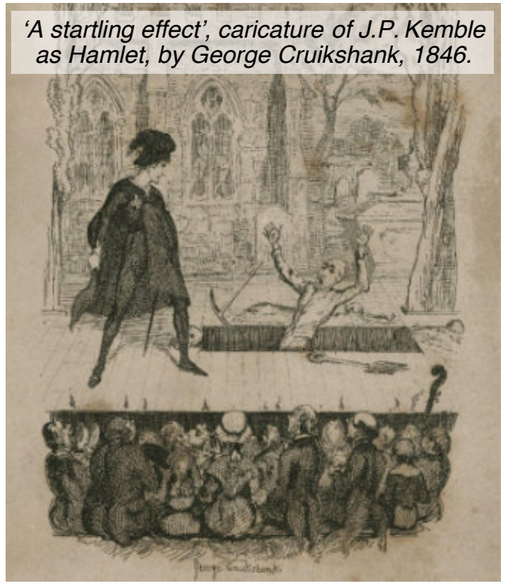
19th century newspaper illustration of below the stage: 'angels in the lowers depths preparing to ascend'

The height of the stage was 1.5 m, so the area beneath the stage was easily big enough to hold actors. Trap doors were built into the stage allowing dramatic entrances from the 'cellarage' area during the performances of plays. This area underneath the stage was given the title 'Hell'. This was taken from the term 'hellmouth' which was used to refer to any trapdoor in the floor of a stage. Actors would hide in 'Hell' waiting to make their entrance or to create other special effects. In the Globe theatre, the Hell below the stage was mirrored by the Heavens above in a literal sense, as the underside of the floor of the tiring house, which formed a ceiling over the inner stage, was painted with stars and the signs of the zodiac. Thus, the theatre became, in miniature, an entire cosmology, in accordance with the religious and philosophical beliefs of its time.

Unusual special effects could be made from 'Hell' including sounds using different musical instruments such as the trumpet, or drums. Actors' skilled in imitating the baying of hounds and crowing of roosters or the wailing of ghostly sounds would also be waiting in 'Hell'. Here there were also other technical devices such as a lifting machine, with which, for example, the witches in *Macbeth* were raised through a trap door onto the stage. But the lift also served for the 'magical' appearance of set pieces and could take on the meaning of an opening not to Hell, but in the earthly realm, such as a pool of water or a grave.

The Globe theatre stage is believed to have had two trap doors on the outer stage and one trap door on the inner stage (below the tiring house) called the 'grave trap'. This trap was named for its most famous use, as an open grave in the graveyard scene from *Hamlet*. Many theatres built since 1600 have also featured grave traps as a permanent part of the stage machinery; they are typically a large, rectangular opening, with the long axis running across the stage, usually positioned downstage centre.

The association of the space below the stage with Hell, the world of the dead and the supernatural continued in the 19th century. The Vampire Trap (Q30596) was invented for James Planché's 1820 adaption of Polidori's *The Vampyr*. It involved two spring leaves that parted under pressure and immediately reclosed. Placed in the floor or stage wall, it could give the impression a figure was passing through solid matter. The Corsican Trap



'A startling effect', caricature of J.P. Kemble as Hamlet, by George Cruikshank, 1846.

(Q30026), made for Dion Boucicault's 1852 adaption of Alexandre Dumas' *The Corsican Brothers*, involved an ascending track, on which a wheeled cart could be run, rising up out of the stage through a 'bristle' trap – a trapdoor covered with bristles painted to match the scenery. Once on the stage and in view, the track was covered by a sliding arrangement similar to a roll-top desk; thus, nothing was seen except the ghost rising up through the floor and gliding across the stage.

The space under the stage often serves a variety of practical purposes, facilitating the performance in various ways. However, it has a long history of being associated with Hell, the world of the dead, and the supernatural – stage mechanisms such as lifts and traps provide passage between the earthly realm and the worlds below.

Model of the Theatre Royal, Drury Lane, London, showing various traps in the stage, made around 1911

Playing with Fire

Theatre and pyrotechnics

Fireworks on the River Thames, 1749

Fire is humankind's oldest form of illumination, representing warmth and safety, but also danger, the diabolical and the supernatural. In the Renaissance theatre, pyrotechnics created spectacular effects, and brought the diabolical on stage.

The term pyrotechnics comes from the Greek words *pyr* ('fire') and *tekhnikos* ('made by art'). Explosions, flashes, flames and other pyrotechnic effects have been used in the theatre since before the Renaissance. It is believed that fireworks originated in China around the 9th century, although they were also used in ancient India. In the Middle Ages, fireworks had begun to be manufactured in Italy. In the 14th century, fireworks were used for religious events, celebrations and public festivals. Increasingly complex displays were created by 'fire masters', trained in newly established pyrotechnic schools across Europe.

The first written description of fireworks displays in Europe are from 1379, describing a performance in front of the bishop's palace in the city of Vicenza, which had a great impact on the audience:

> There was a flash and a loud thunder-clap, and straight away there descended down this rope the image of a shining dove. Almost all fell to the ground in terror and amazement, beseeching God in hymns and chants that the holy spirit should descend upon them according to the prophesies.

Perhaps the most popular type of pyrotechnic in the Renaissance period was the squib – also known as a serpent, rocket, or fizgig. A small tube of paper was filled with gunpowder, with a fuse running the length of the tube. When lit, squibs produced a bright, short burst of flame, and a powerful and unpleasant smell. If not held onto, they shot around erratically. The squib was one of many types of pyrotechnic devices used as part of theatre performances, creating a multi-sensory experience for the audience, involving light, sound, fire, smoke, heat and smell.

In 1611, Sebastio Serlio (Q568) described a pyrotechnic lightning effect in his First Book of Architecture:

> Lightning must be made in this manner, there must be a man placed behind the Scene or Scaffold in a high place with a boxe in his hand, the cover whereof must be full with holes, and in the middle of that place there shall be a burning candle placed, the boxe must be filled with powder of vernis [i.e., varnish, resin] or sulphire, and casting his hand with the boxe upwards the powder flying in the candle, will shew as if it were lightning. But touching the beames of the lightning, you must draw a piece of wyre over the Scene, which must hang downewards, whereon you must put a squib covered over with pure gold or shining lattin [sheet tin] which you will: and while the Bullet is rouling, you must shoote of some piece of Ordinance, and with the same giving fire to the squibs, it will worke the effect which is desired.

Squibs were not only used to create natural effects such as lightning, they also created the supernatural, being especially associated with the devil. Often, pyrotechnics were shown in the orifices of devils on stage, as they emerged from smoke and fumes. In the play *The Tragical History of the Life and Death of Doctor Faustus* by Christopher Marlowe (Q30567), pyrotechnics are associated with Mephistophilis and his devils. In an eyewitness account of a performance by John Melton, devils are described rushing about the stage 'with squibs in their mouthes.' At another point in the play, Mephistophilis enters, and 'sets squibs at their backs', and when Faustus signs his

The Devil and Dr. Faustus Meet, around 1825

contract with the Devil, Mephistophilis holds 'a Chafer of Fire.' Mephistophilis also enters 'with fire-workes'.

Later in the play, Faustus himself controls fire, for example when attacking the friars with fireworks. He casts a spell that invokes the appearance of a dragon on stage – a pyrotechnic effect well-established since the Middle Ages. Later, an 'ever-burning' chair descends onto the stage. Finally, at the end of the play, Hell is discovered and a flaming 'Hellmouth' appears. Pyrotechnics were central to the late 16th century staging of *Dr Faustus*, not only for their ability to create spectacular effects that would impress and excite an audience, but also for their symbolic value, to conjure the idea of diabolical forces at work.

As well as pyrotechnics made with gunpower, saltpetre, sulphur and such materials, theatre-makers in the Renaissance period had another technique to make flames on stage. Lycopodium powder (Q30584) consists of the dry spores of clubmoss plants. When it is mixed with air, the spores are highly flammable and are used to create dust explosions, as the spores have a large surface area per unit of volume and a high fat content. The principal use of the powder is to create flashes or flames that are large and impressive but relatively easy to manage safely in magic acts and theatrical special effects.

Pyrotechnics have been used in performances since the 14th century, whenever spectacular effects are required, for events such as festivals and celebrations. Their dramatic power also continues to be used when there is a need to invoke the menacing, dangerous, unearthly, or supernatural.

B.04

Light as Spectacle

Illuminating, decorative and mobile

The Candle Snuffer, published in The Illustrated Sporting and Dramatic News, 1876

In the Italian Renaissance courts, light was central. Feasts and festivals were illuminated with torches, candles, and displays of fireworks. The temporary indoor theatres too were lit, not just for visibility, but for the pleasure of light.

In the 16th century princely courts of Italy, light embodied the joy of living, and represented the triumph of life over death. Light displays were a feature not only of theatre performances but also of processions, dances, illuminations, and all kinds of celebratory events. Candles, torches and fireworks were used as visible sources of light, reflecting and sparkling off the shining material of costumes and decorations, as well as the clothing and jewels of those present.

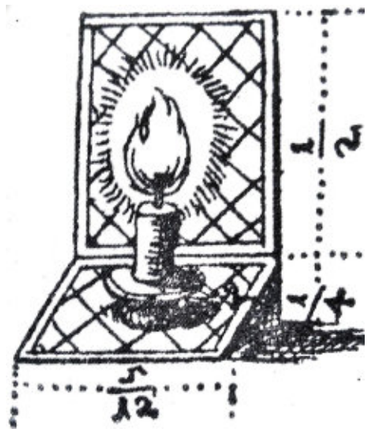
In the court theatres – stages and seating built especially for the occasion – the lighting of the auditorium had the character of a festival hall, blazing with light. One description of a feast in Florence dating from 1568 describes how, when the candles in the auditorium were lit, the stage curtains were drawn aside to reveal the scene – the auditorium and the stage worked together to create the sensation of festive bliss and beauty, fused by light. Multiple cut glass and crystal chandeliers illuminated the space, and glass vessels filled with water, called *bozze* (Q30608), were used to concentrate the light of candles or torches. The bozze could also be filled with coloured water, giving further variation to the light.

Sebastiano Serlio, in his 1545 treatise *Architettura* (Q30278), describes how to light the stage. His plans show a semi-circular auditorium – like the amphitheatres of Antiquity – and a stage with a shallow, wide flat floor at the front, and a raked section behind with the perspective scene constructed on it. There was no proscenium arch.

In describing his scenes for comedy, tragedy and satire, Serlio refers to the buildings 'adorned with innumerable lights, great, middle sized and small' placed so as to look like brilliant precious stones – diamonds, rubies, sapphires and emeralds. He also describes the sun rising, traversing the sky, and setting, and planets going through the air. Serlio categorises three kinds of light: general stage light, decorative light, and mobile light.

The general lighting of the scene and acting space is achieved with torches, suspended in front of the stage, together with chandeliers with large candles. Above these are glass vessels filled with water and a piece of burning camphor, acting as reflectors to increase the intensity of light on the stage. It is notable that Serlio does not attempt to align the stage lighting with that of the scenery – he says the painted shadows should indicate light coming from one side, but the actual light is from above. Serlio notes this issue, but pragmatically says the light will be brightest if placed over the centre of the stage. 350 years later, Adolphe Appia (Q249) returned to this question and addressed it in his theorisation of stage lighting.

Serlio goes on to describe in detail the decorative light and how it should be arranged. Small openings in the scenery have lights behind, and these apertures have small pieces of coloured glass, colouring and diffusing the light. Most importantly, glass vessels filled with coloured water are placed between the light source and the opening. If a brighter light is required, a torch can



Candle light fitting with reflector

Bozze, also known as cobblers' balls

be used instead of a candle, with a polished metal basin as a reflector. Thus Serlio anticipates the fundamentals of the modern spotlight: source, reflector and lens.

The third type of light in Serlio's schema is for the firmament – the sun, moon and planets. He does not give details of these, but they are known from earlier accounts of Italian festivities. According to Vasari's Life of the Artist Aristotele di San Gallo (Q30602), he had made a lantern containing two torches, which could be moved mechanically along an arch. In front of the torches was a large crystal ball, 58cm in diameter, filled with water, focusing the light. During the course of the play, the sun rose, traversed the sky, and set again at the end of the comedy – so mimicking the theatre of Antiquity, that timed its performances according to the sun.

Later, De' Sommi in his dialogues (Q708) describes a technique in which the auditorium lights are placed not between the assembled people and the stage, but behind them, so reducing glare and giving a clearer view of the stage. In this account, De' Sommi points to a model of stage lighting that begins to move away from the festival hall of the Renaissance, and towards the picture-box of the Baroque court theatres; the joyous atmosphere is retained, but the stage is now the primary focus.

C.04

Sounds and Sweet Airs

Music in Shakespeare's theatre

In Elizabethan theatre, music, and the sounds made by musical instruments, were used in a highly codified way as part of the story-telling, taking advantage of the audience's familiarity with the richly aural culture of the time.

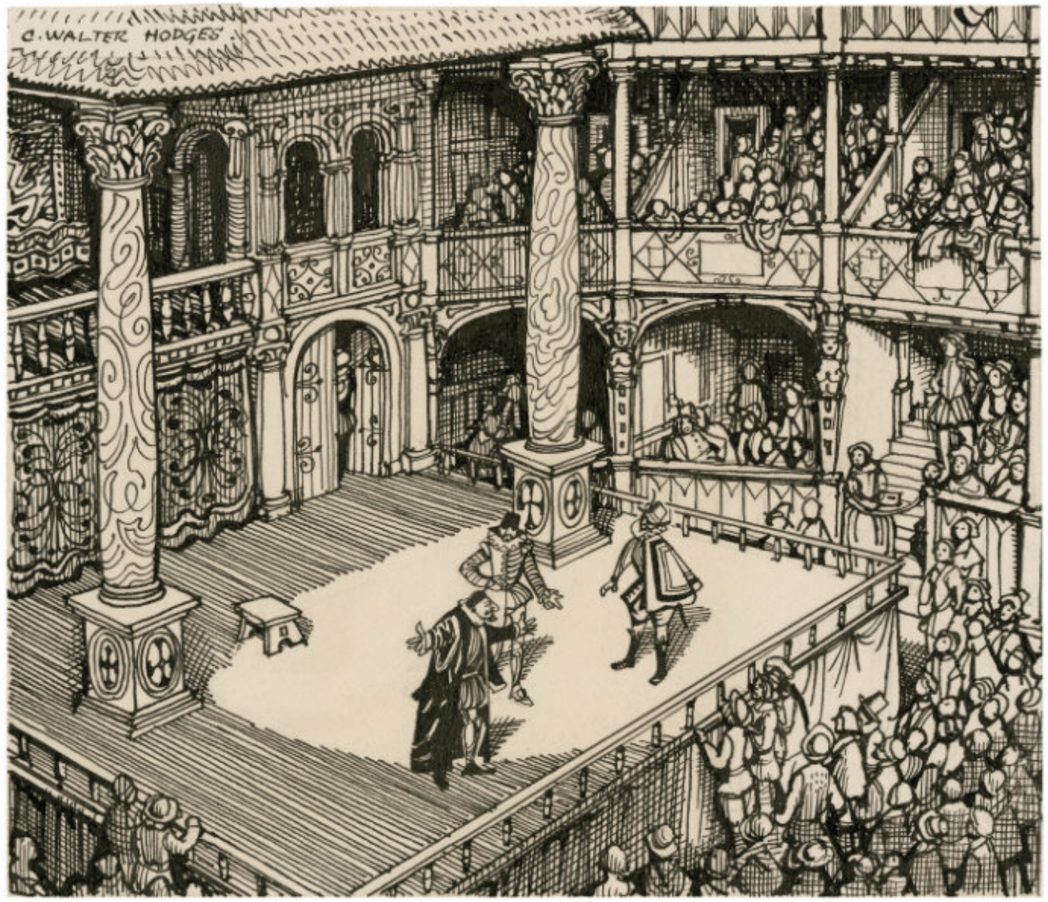
In the late 16th and early 17th centuries, at the Globe theatre in London (Q7846), performance days were indicated visually, by flying a flag on the roof to draw audience members across the river Thames to the theatre. However, unlike the modern visual cue of lowering the houselights, the start of the performance itself was signalled aurally, by a trumpeter placed high in the tiring tower, over the stage. To the Elizabethan listener, the sound of a trumpet fanfare was more than a simple alert. It was associated with Royal proclamations, coronations, and similar events – a sign that something momentous and authoritative was about to happen.

After that opening fanfare, music and the sounds of musical instruments were a frequent element of the performance. In Shakespeare's history plays, the action often starts with fanfares or drums, signalling the entrance of the main, usually Royal, characters. The comedies rarely begin with sound. This sonic 'scene setting' continued: bells signalled either the time (representing a clock bell), or alarm or ceremony (as with a public bell such as that in a church). The sounding of horns indicated hunting, while thunder would be created symbolically with drums, or more representationally with a cannon ball rolled around the wooden floor of the tiring house. The underside of the floor of the tiring house, which formed a ceiling over the stage, was painted with the signs of the zodiac to signify the firmament. The thunder therefore came literally and symbolically from the heavens.

Modern-day archaeologists have found a 'bird whistle' at the site of London's Curtain Theatre, one of Shakespeare's least-historically documented playhouses (Q9336). The remains of the Curtain, which opened in 1577, were found as part of regeneration works in 2011. The Curtain was home to Shakespeare's Company, the Lord Chamberlain's Men, from 1597 until the Globe opened two years later. In *Romeo and Juliet*, first staged at the Curtain Theatre, there are numerous references to bird song such as 'That birds would sing and think it were not night', so although bird whistles were children's toys, they may have been used for sound effects in theatrical performances.

In addition to the use of musical instruments for effects and punctuating sounds, the plays incorporated music and songs. Composers were commissioned to write specifically to accompany the plays. The composer Robert Johnson (Q30565) wrote music for productions by the King's Men theatrical company between 1610 and 1617 for plays by Shakespeare and other playwrights such as Ben Jonson, Francis Beaumont and John Fletcher. Johnson composed 'Full Fathom Five' and 'Where the Bee Sucks' for the first performance of Shakespeare's *The Tempest*. For winter performances at the indoors Blackfriars theatre, Johnson composed musical

A 'bird whistle', discovered at the site of the Curtain Theatre, which may have been used for sound effects in performances of Romeo and Juliet



interludes to be played between the acts, while the candles were being replaced. Elizabethan performances generally ran continuously, without breaks, but the requirement for music to fill an interlude while a technical requirement (changing candles, setting scenery) is completed has continued until today. Modern productions of Shakespeare's plays now sometimes commission well-known music artists to create new music or settings of the original songs.

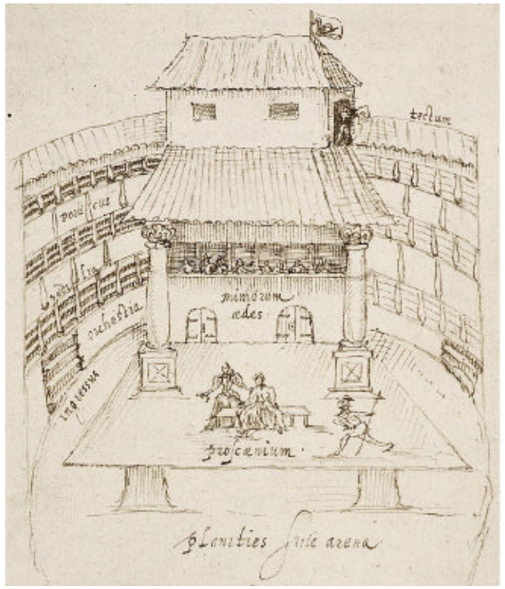
Music was a well-established part of Elizabethan life, and people would have been familiar with music in churches (including the singing of minstrels) and at the royal court. Actors were often also trained musicians. The use of specific instruments was highly coded: percussive sounds represented war and elemental chaos, such as storms, waves and earthquakes. Brass instruments were associated with human intervention, while stringed lyrical instruments signified a peaceful idyll, the resolution of a problem or conflict, or the sweet release of death. Audiences would therefore have understood the significance of the choice of instrument, creating the opportunity to make use of the 'wrong' instrument for ironic or comedic effect.

In Elizabethan theatre, sound effects and music were written into the play texts as stage directions, indicating music, songs, flourishes of trumpets, and effects. A description of sound effects is provided in *A Dictionary of Stage Directions in English Drama 1580-1642 (Q30566)*, which includes everything from simple effects to specific needs for battle scenes. These sounds were used to create atmosphere, to reproduce pistols, clocks, horses, fanfares, or alarms, but sound was also being used for symbolic effect of the supernatural and to help create drama. To the audience of the time, these sounds and music would have been highly meaningful, drawing as they did on the rich aural culture of the period.

Room for Everyone

The first commercial theatres

The Renaissance period is often associated with court theatres, but in the late 16th century commercial theatres made for large audiences were being built for the first time in London and Madrid, responding to the strong public desire to see plays.



The Swan Playhouse in London, as sketched by Dutch scholar Johannes de Witt in 1596

The late renaissance period saw a flourishing of dramatic literature in Spain and Britain; the work of writers such as Sor Juana Inés de la Cruz, Miguel de Cervantes, Lope de Vega, William Shakespeare, Christopher Marlowe and Ben Jonson was immensely popular, and theatres were needed to meet that demand.

The first permanent venue in London designed specifically for theatrical productions was called simply The Theatre, built in 1576 (Q10092). It was followed by the Rose (1587, Q12550) and Swan (1596, Q8428) theatres, and then the Globe theatre in 1599 (Q7846). These three theatres were built in an area called Bankside, on the south bank of the river Thames. Bankside was outside the jurisdiction of the City of London's civic authorities, so it became a place with less social regulation, where people would go for entertainment and relaxation.

The Globe was a circular building of 45m across, with an inner courtyard 30m in diameter. There were three floors for the public, which allowed a capacity of about 3,300 spectators (the reconstruction of 1997 only allows 1500 people, due to modern audience expectations and safety requirements). On one side, the rectangular stage, 13m x 18m, projected into the central space.

The three-storey structure established an audience hierarchy, although everyone entered through the same main entrance. The cheapest tickets, one penny, were the ones for the pit, representing more than half the capacity of the theatre, where spectators gathered standing next to each other. Here, the audience was without shelter, while the stage and wealthier spectators in the surrounding galleries were covered by thatch roofs.

The stage had three main parts: a front, unenclosed space thrusting out into the audience; a rear stage, separated from the front by a curtain; and a balcony or upper stage. The rear stage could be set with different props for different scenes and revealed by the curtain. The upper stage introduced the possibility to use height as part of the performance, as in the iconic balcony scene in Romeo and Juliet.

In Spain, the first public theatres were the Corral de Comedias – theatres built in the form of courtyards. The first of these was the Corral de la Cruz, Madrid, built in 1579 (Q13175), followed by the Corral del Príncipe in Madrid in 1583 (Q13175). The Corral de Comedias de Alcalá (Q8570) was built in 1601-02 by Francisco Sánchez, who bought a house and fenced off the back yard.

These theatres were arranged with the stage at one end of the courtyard and the audience around. Men of the common public watched the spectacle standing in the centre, while at the sides the balconies housed rooms for the nobility. Opposite the stage was another balcony: the upper floor for the clergy and the city's notables. Below this was the women's *cazuela*. A canopy across the courtyard provided shelter from the sun.

At the rear of the stage, the balconies were divided into niches that could be used for different stage effects. Their railings were removable to install elements such as city walls, stairs or towers. Each of these spaces was covered with curtains behind which small scenes could be prepared. As at the Globe, simple props worked with the so-called 'spoken decoration' in the play text and the audience's imagination to create the scene.

Above the stage and the upper corridor, hidden by the canopy, was the attic where the stage machinery was housed. From here, elements such as clouds could be lowered. This attic also had a wooden floor with hatches, directly above the lower hatches in the galleries, to make room for the ropes from which the counterweights of the stage sets hung. The hatches both in the stage and in the niches of the galleries were usually connected with a lifting mechanism based on pulleys.

The only corral that has been completely preserved is the one in Almagro (Q9440), where the International Festival of Classical Theatre is held annually.

The circular public theatres of London, and the courtyard Corrales in Spain, were amongst the first permanent, commercial theatres, and built on a tradition of performances on temporary stages in inn yards, dating back to the Middle Ages. They shared common features: they organised the audience in accordance with a social hierarchy, and they wrapped the audience around the stage to maximise audience capacity and so revenue. Both represented a radical shift from the court theatres. No longer was the building designed around the view of a single monarch looking at a perspectival, picture-frame stage – rather, the building was planned to accommodate the largest possible numbers of people from all parts of society.

The preserved Corral de Comedias de Almagro

AWorld On Stage

The illusion of perspective

The invention of perspective as a way of drawing that made a picture look visually like reality had a huge impact on scenic design. Perspective scenography dominated the court theatres of Renaissance Italy, and spread across Europe.

Around 1425 Filippo Brunelleschi (Q667) invented a technique for drawing that was consistent with visual experience through an exact geometric construction – perspective.

reduced, not like in paintings or drawings, in which there is no third dimension. Sebastiano Serlio was the first to illustrate the three scenes of the theatre of antiquity (comedy, tragedy and satire), and the first to propose a method for designing scenes in perspective (G.03). In both his tragic and comic scenes, as well as in the theatre with which he illustrates his perspective method for designing theatrical scenes, what is shown is 'the city' and this is what Palladio and Scamozzi also show forty

to the front of the stage and the one seen in depth, at an angle and foreshortened), examples of which are the houses on the central street of the Teatro Olimpico in Vicenza, or those of the later Sabbioneta theatre (Q653). In the 17th century, the two façades are represented in a single plane, located parallel to the front of the stage, the pictorial surface of the frame. The perspective effect is achieved by placing a series of flats along the depth of the stage in positions whose interval decreases towards the rear of the stage, and with their inner edge increasingly close to the centre line. In addition, the flats decrease in height and the floor of the stage rises in a rake. This can be seen in the Farnese Theatre of Parma, opened in 1618.

At first, only flats parallel to the front of the stage

stage. The axes of the space represented in the scene, running at an angle to the centre line of the stage, were oriented differently to those of the real space of the room, so there was no sense of continuity between both spaces: the stage and auditorium were visually and conceptually separated. The angled scene therefore makes the represented space more distant and reinforces the idea of illusion, since what was seen on the stage was presented as a portion of reality for the spectator to contemplate, and in this sense create the illusion of it being reality.

Below: excerpt from The Ideal City of Berlin, *Francesco di Giorgio Martini, around 1477*

Bottom: constructing two-point perspective scenery, Ferdinando Galli Bibiena, 1732

This 'correct' construction was later published by Leon Battista Alberti in 1436 with a dedication to Brunelleschi. It can be defined conceptually as a flat intersection of the 'visual pyramid'.

This perspective, this *perspicere* 'to see through something', went on to be used in the design of sets by the architect-engineers, or architect-scenographers, Antonio da Sangallo the Elder, Bastiano 'Aristotile' da Sangallo (his nephew), Sebastiano Serlio (Q568), Giorgio Vasari, Bernardo Buontalenti, Giulio Parigi and, during the first half of the 17th century, by Inigo Jones (Q20471), Cosimo Lotti (Q21026) and Joseph Furttenbach (Q60).

Scenic perspective differs from normal perspective in that it includes the third dimension, albeit

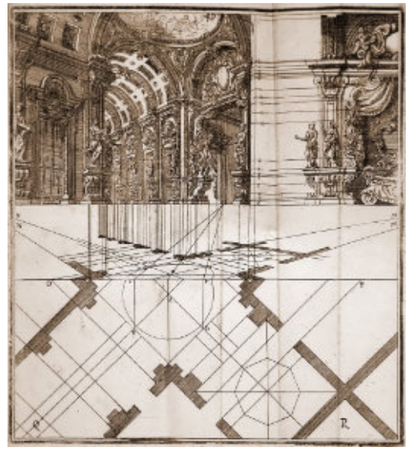
years later in the stage of the Teatro Olimpico in Vicenza (Q650).

In the theatre, perspective visually conveys the city as a stage. The trio of city-perspective-theatre, building on the ideas of antiquity, is possibly the most representative scheme of the Renaissance. Theatrical scenery evolved alternating between treatises on perspective and the practice on stage. It was not until 1600, when Guidobatdo del Monte converted perspective definitively into a science by proposing, precisely through his study of theatrical scenes, the geometric concept of the vanishing point as a limit point.

The scene in perspective evolved from the first houses in relief represented on stage, built in the two planes visible to the public (the facade parallel

were used, but later, in order to improve the view for the spectators at the sides of the auditorium, flats were also used in angled positions. One of the first occasions in which oblique wings appear is in the plan of the Theatre of Saints John and Paul in Venice, which dates from 1639. Andrea Pozzo extensively developed the layout of these wings in his treatise.

In the perspective illusionism of the Baroque theatre, the only person who could correctly see the scenic perspective was the monarch, since he was the one who occupied the point of view. The spread of angled scenes – with the vanishing point off to one side, and sometimes two-point perspective – by Ferdinando Galli Bibiena (F.04) at the beginning of the 17th century meant a change in the conception of the space of the



F.04

Scenography Codified

Serlio's scenes for comedy, tragedy and satire

The 16th century painter and architect Sebastiano Serlio was the first to codify and publish drawings of the three types of classical set designs: comedy, tragedy and satire. These designs had a great influence on stage design across Europe.

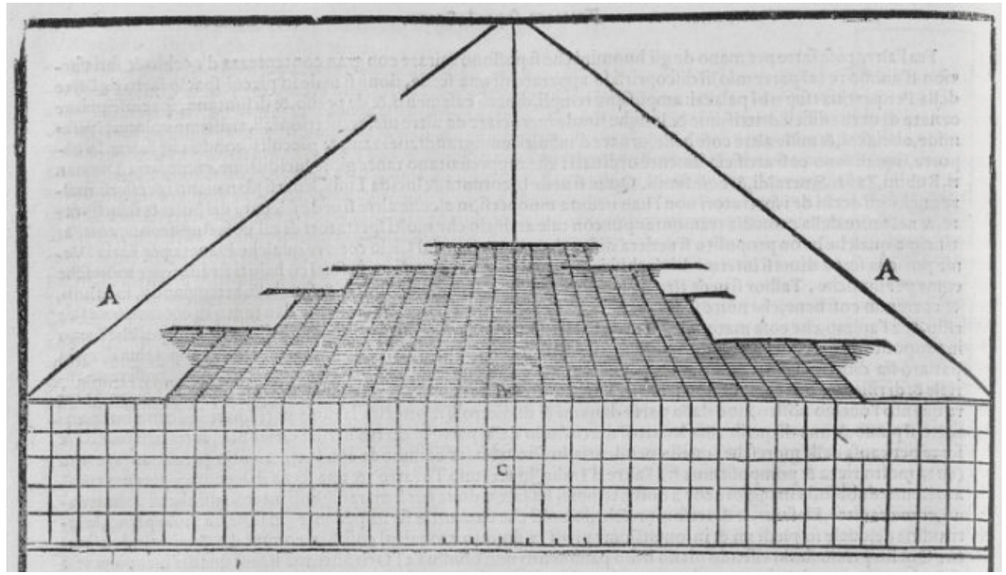
Sebastiano Serlio (Q568) was an Italian painter and architect, who gave a systematic description of classical architecture in his influential treatise *Seven Books of Architecture* (Q30606, 56). He pioneered the use of high-quality illustrations to supplement the text, and his treatise, both practical and theoretical, catered explicitly to the needs of architects, builders, and craftsmen.

The books, published between 1537 and 1551, cover geometry, perspective, Roman antiquity, the orders of architecture and church design as well as antique principles of symmetry and proportion. Significantly, the last few pages of the second book, 'On Perspective', contain drawings of three theatrical scenes (comic, tragic, and satiric) and a stage plan and cross section which were highly influential in Renaissance theatre. For the theatrical space Serlio proposes a semi-circular auditorium, surely similar to the one he had built in Ca Porto, in Vicenza. He recommends placing the stage at eye level and with a flat proscenium area and the rest sloped 1 in 9. This area of slope he grids in exaggerated perspective, to create the so-called houses in relief and the illusion of greater depth.

For the tragic scene with its majestic palaces, he explains that it must represent the architectural nobility according to the social elevation of the characters, with a look towards classical antiquity and creating the sensation of the ideal city for whoever appears on the scene.

The comic scene with a decoration of ordinary town houses must show the daily life of the different characters. There must be variation of materials and proportions in the buildings. We can add that the aesthetics used in the buildings has a correlation with what is found in his home town, Bologna.

In the satirical scene with its landscape of trees, hills and huts, the entire space is full of natural elements, in addition to showing primitive constructions to represent the Arcadian paradise as Vitruvius proposes.



Serlio dedicates his second book to perspective representation and theatre and published it in 1545, when he moved to France. This second book, understood by its author as a manual, deals with general perspective, relief perspective, stages, theatres and scenic apparatus. The set of books was inspired by those of Vitruvius (Q467). Furthermore, he is considered one of the first decorative mannerists because of his innovative view of theatrical appearance.

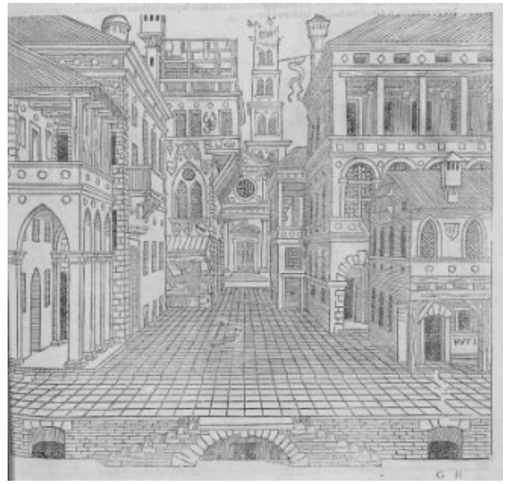
Serlio also describes how he and probably other set designers made and painted their sets. Thus, we know that the sets combined the painted perspective with certain three-dimensional elements. The flats nearest the front were on the flat floor, arranged at an angle to simulate the corners of houses. These nearer houses had cornices and architectural decorations, which were not present on those at the back of the stage. There, painted shading created appearance of the overhangs. The bottom edges of the flats were angled to fit the slope of the raked stage, and the top edges were also angled, to make the perspective as complete as possible. Serlio intended to generate in the spectator the sensation of an infinite space in which the theatrical action is located.

Serlio also provided a great deal of information on how to imitate thunder, lightning, how to move mechanical figures of men, animals or planets by means of invisible wires and on the lighting of the scene. In addition, he evaluated everything related to the scene in terms of invoking the desired emotions in the viewer, according to the type of stage action.

Serlio's volumes were highly influential as a conveyor of the Italian Renaissance style, and quickly became available in a variety of languages like Flemish, German, French, Dutch, English and Spanish, with the same illustrations as the original Italian editions. Sebastiano Serlio greatly helped the consolidation of perspective as a compositional instrument within set design carried out throughout the Renaissance.

Left: Serlio's plan of the stage, showing the perspective scenery, and the raked stage narrowing towards the vanishing point

Right, from top to bottom: Serlio's scenes for comedy, tragedy and satire



G.04

The Price of Entry

Commercialising theatre

The late 16th and early 17th century saw a great growth in the public demand for theatre in Spain and England. New venues were needed, and new methods to run theatres as commercial enterprises, without the support of a monarch or wealthy patron.

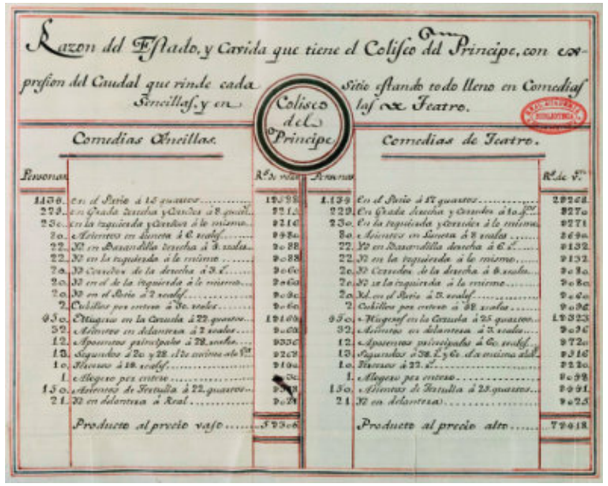
The Golden Age is the name given to a period in which Spanish literature flourished, from the end of the 15th century to the late 17th century. Inseparable from the development of dramatic literature were the physical conditions that made the existence of theatre possible: the venues and ensembles, the organisation of audiences and the infrastructure as a whole. However, before the mid 16th century the concept of a building dedicated to the performance of theatre did not exist in Spain. The first public theatres were the *Corral de Comedias*–theatresbuiltintheformof courtyards. The first of these was the Corral de la Cruz, Madrid, built in 1579 (Q13175), then the Corral del Príncipe in Madrid in 1583 (Q13175). Others followed.

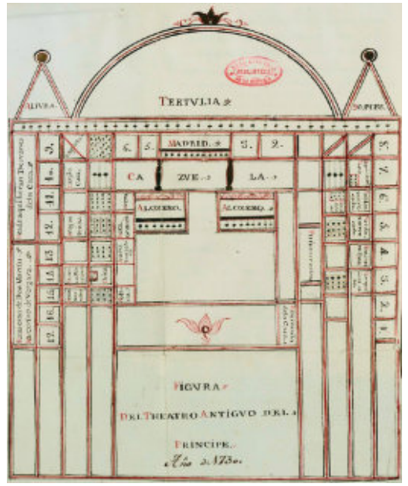
A decree by King Philip II in 1565 established brotherhoods (like guilds) to build and run the corrals in Madrid, as a way to regulate the immoral content of the theatre. Profits from entrance fees, introduced in a structured way for the first time, were used to fund hospitals. As demand grew, the brotherhoods created new corrals.

Over time, the income was found insufficient to support the hospitals. In 1623 reforms were made, and the role of the brotherhoods changed; they became responsible for protecting the comedias (meaning all types of theatre: comedy, tragedy and satire) and for operating a system of censorship. Income from entry fees was still central, however; by 1630 the Corral del Príncipe had increased its seating capacity from 1000 to 2000 spectators since the first opening.

In the corrals, the audience was divided by social class and gender: the men of the common public watched the spectacle standing in the centre of the courtyard, while the side balconies had rooms for the nobility. Opposite the stage the upper floor housed the clergy and the city's notables. Below was the women's *cazuela*, immediately adjacent to the entrance. A spectator who wanted to reserve a seat had to pay a triple ticket: for the company of actors, for the landlord of the corral and for the seat reservation.

The Red Lion (Q30603) was an Elizabethan playhouse located in Whitechapel, London. It was built in 1567 for John Brayne, and is the first known purpose-built playhouse in London since Roman times. It was designed to serve the many touring theatre companies that played in the courtyards of inns. Its existence was short-lived, however, as the theatre seems not to have survived after the summer season of 1567. The Red Lion was outside the City of London, in open farmland, and unattractive to travel to in the winter.





Brayne and his brother-in-law, the actor-manager James Burbage, went on to build a theatre known simply as The Theatre (Q10092). Unlike the Red Lion, The Theatre accepted long-term residencies, with theatre companies being based there: a radically new form of theatrical engagement. It was expensive to build, and as well as borrowing money, Brayne and Burbage put on performances while the theatre was still under construction to fund it. Once open, it was commercially successful; spectators could pay one penny to stand in the open area in front of the stage, or two pence to stand in the raised and covered galleries. For three pence, they could have a stool to sit on. Wealthier patrons could pay for a private compartment in the galleries.

Brayne and Burbage did not own the site of The Theatre, and when the lease expired they decided to reuse the timber to build a bigger theatre with more capacity – the Globe (1599, Q7846). The cost of construction and lease was divided between the previous founders Cuthberd and Richard Burbage, and William Shakespeare. By this time the Rose (1587, Q12550) and Swan (1596, Q8428) theatres had also opened.

The Globe was larger than the earlier theatres, with a capacity of about 3,000 spectators. Following the multi-level model of The Theatre again allowed the division of the audience by wealth and social status. Nevertheless, all the audience came in through a single entrance, ensuring no-one could enter without paying.

In Madrid and in London, the popular demand for theatre in the late 16th and early 17th centuries led to the creation of new venues, and new organisational structures. Money was raised by borrowing, with lenders gaining a share in future profits. State control continued in various ways, but entrance fees were the source of revenue – maximised by offering the wealthier audience members better facilities for a higher price, while segregating them from other parts of society. This model of commercial operation, with elements of state intervention and regulation, has continued to the present day.

Left: ticket sales and seating plan for the Corral del Príncipe, Armona, 1785

Right: Shakespeare's Globe, a reconstruction of the original Globe, showing the seating levels and crowded pit

Fire, Disease and Violence

The hazards of the Elizabethan Pit

The theatre scene in Europe during the late 1500s can be defined as the period when all members of society were drawn to the theatre. There was a thirst for entertainment, but no infrastructure for the health and safety of actors and public.

Before the late 16th century, theatre had been generally reserved for members of the upper classes and royalty, often with actors being summoned to courts and estates to perform. But during the 1500s Europe developed a vibrant, commercial theatre scene that appealed to everyone. New theatres were built to meet this demand. Their ground-plan - like that of the Roman amphitheatres – wrapped the audience around a central stage, trying to fit in as many people as possible and optimising the viewpoint from many different angles. Buying a ticket didn't have to cost a fortune. People of the lower classes could buy cheap tickets in the pit, an open standing space around the stage. People who could spend a little extra could buy a more comfortable seat on a bench in the gallery. In some cases, rich nobles and members of the upper class could pay to sit on a chair on the stage itself to observe the actors up close.

In London, public theatres weren't allowed to be built in the city itself, as it was considered a possible health hazard where the plague and other diseases could manifest and spread. Large gatherings of people also attracted unseemly, vulgar behaviour, prostitution, and violence, which wasn't wanted in the city centre. An entertainment district therefore developed south of the river Thames, beyond the control of the city authorities. The theatre district wasn't a sanitary place: with no toilet facilities, people relieved themselves where they saw fit. Sewage was disposed in the river or buried. In the case of the Globe theatre, water from the

nearby river Thames regularly flooded the lowest part of the building, creating a further hazard for the groundlings in the pit. This lack of hygiene is believed to have contributed to the spreading of the plague.

In the commercial theatres of the time, spectators' bodies were pressed tightly together: at the Globe theatre there were 3,000 spectators in a space 45m in diameter. The replica of the Globe built in London in the late 1990s only welcomes 1570 people, with 700 standing in the pit – little more than half the capacity it had in the Renaissance era. Even allowing that people were smaller then than now, in the Elizabethan theatres they stood very closely together, leaving little room for movement, let alone enough room to prevent accidents in case of an emergency or tumult. The audiences in these public theatres weren't always well behaved, by modern standards. People arrived late, left early, cheered and booed the actors and often tried to interact with them during the performance. Food or drink would be thrown on stage to express discontent. The 16th century theatre pit was the equivalent of the mosh pit in a modern-day music venue.

Disease and unruly behaviour were not the only hazards at the Globe theatre. When first built in 1599 the timber building was roofed with thatch, which in 1613 caught fire when a stage cannon set light to it. The theatre was destroyed, but it was rapidly rebuilt, reopening a year later - this time with a tiled roof. Sir Henry Wotton, an eyewitness of the fire, recorded the event in a letter dated July 2, 1613:

> Now King Henry making a Masque at the Cardinal Wolsey's house, and certain cannons being shot off at his entry, some of the paper or other stuff, wherewith one of them was stopped, did light on the thatch, where being thought at first but idle smoak, and their eyes more attentive to the show, it kindled inwardly, and ran round like a train, consuming within less than an hour the whole house to the very ground. This was the fatal period of that virtuous fabrick, wherein yet nothing did perish but wood and straw, and a few forsaken cloaks; only one man had his breeches set on fire, that would perhaps have broyled him, if he had not by the benefit of a provident wit, put it out with a bottle of ale.

Another eyewitness, Mr. John Chamberaine, wrote in a letter of July 8, 1613 that the fire, 'burn'd [the theatre] down to the ground in less than two hours, with a dwelling-house adjoyning; and it was a great marvaile and a fair grace of God that the people had so little harm, having but two narrow doors to get out.' From these accounts we know that the initial smoke of the fire was ignored, as people believed it was from the canon, and that the theatre only had two exit doors to evacuate the audience of up to 3000. It is indeed remarkable that the injuries were not greater.

In the unregulated theatres of the Renaissance, fire, disease and violence were routine hazards, just as they were in the daily lives of the theatre-goers of the time.

Left: the fire at the Globe theatre, 1613

Below: View of London during the Great Fire*, Pieter Hendricksz Schut and Nikolaus Visscher, 17th century. The fire destroyed much on London in 1666, showing the fear of fire was well justified.*

Vanishing point

Making room for infinity in the Teatro Olimpico

The Teatro Olimpico is the oldest of only three surviving Renaissance theatres. The innovative scenery was the first use of false perspective in a Renaissance theatre; to accommodate it, an extension to the rear of the theatre had to be built.

The Teatro Olimpico in Vicenza (Q650) was commissioned by the Olympic Academy and designed by Andrea Palladio (Q651). Palladio, a founder of the Academy, had already designed temporary theatre structures at various locations in the city, and drawn plans for theatres following the patterns of Roman and Greek architecture through the writings of Vitruvius (Q467). In 1579, the Academy obtained the rights to build a permanent theatre in an old fortress, the Castello del Territorio. Despite the awkward shape of the old fortress, Palladio decided to use the space to create a reconstruction of the Roman theatres that he had so closely studied, including the full Roman-style *scenae frons* back screen across the stage. This however was to be made from wood and stucco, imitating the Roman marble.

The central street of the Teatro Olimpico

Construction of the Teatro Olimpico began in February 1580, but in August of the same year Palladio died, with the works well advanced. Vicenzo Scamozzi, another important architect in Vicenza, took over the project, making some additions to and changes to Palladio's designs. For the opening performance, *Oedipus Rex* by Sophocles was chosen, and Scamozzi designed the scenery. Representing the play's location in the city of Thebes, and following the precepts of Peruzzi and Serlio (Q568), Scamozzi's innovative designs created seven streets built in exaggerated perspective, each starting from one of the five openings of the *scenae frons*, and running away from the stage. The streets were so arranged that from every seat in the auditorium, at least one street could be viewed, while the remarkable trompe-l'oeil painting gave life and dimension to the scene. Scamozzi not only designed the sets, but also put considerable effort into designing the lighting that permitted the houses of the stage scenery to be lit from within, completing the illusion that these were real streets. The lighting for *Oedipus Rex* is one of the first times that artificial lighting in theatre by cobbler ball lenses (Q30518) with coloured liquids is documented.

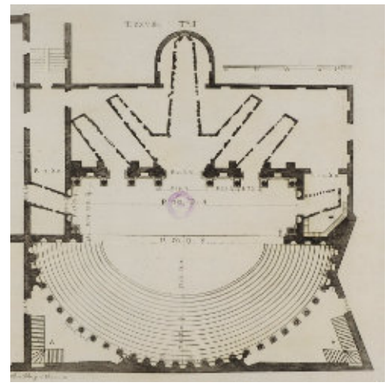
The realisation of Scamozzi's designs faced one, rather unusual, obstacle, however. Even with the compression of the false perspective, the streets could not be fitted within the original stage space or indeed the theatre building – an extension would be required. Furthermore, the Academy did not own the land on which the scenery was to be built. This land was acquired in 1582, after Scamozzi had taken charge of the project. This made it possible to extend the building (including a special apse-shaped projection to accommodate the longest and most elaborate of the seven street views). The Academy's petition to the city government for the additional land anticipated that if acquired, the space would be used to create perspective scenery; it explained that the extra land would be used to build a theatre 'along the lines laid out by our colleague Palladio, who has designed it to permit perspective views.' The land was obtained, the theatre extended, and Scamozzi's perspective streets, disappearing apparently to infinity, were installed.

The Scenae Frons and Streets of the Teatro Olimpico

The Teatro Olimpico was little used for performances after *Oedipus Rex*, and has survived largely intact, together with Scamozzi's setting – the oldest surviving stage scenery. It is still used for plays and musical performances, but audience sizes are limited to 400, for conservation reasons. Over the centuries, the Teatro Olimpico has had many admirers, lots of influence, but relatively few imitators. The first theatre to draw inspiration from the Teatro Olimpico, and the one in which its influence is the most obvious, is the Teatro all'Antica, Sabbioneta, Italy (Q653), also designed by Vincenzo Scamozzi. The English architect Inigo Jones (Q20471) visited the Teatro Olimpico shortly after its completion, and took careful notes, in which he expressed particular admiration for the perspective views.

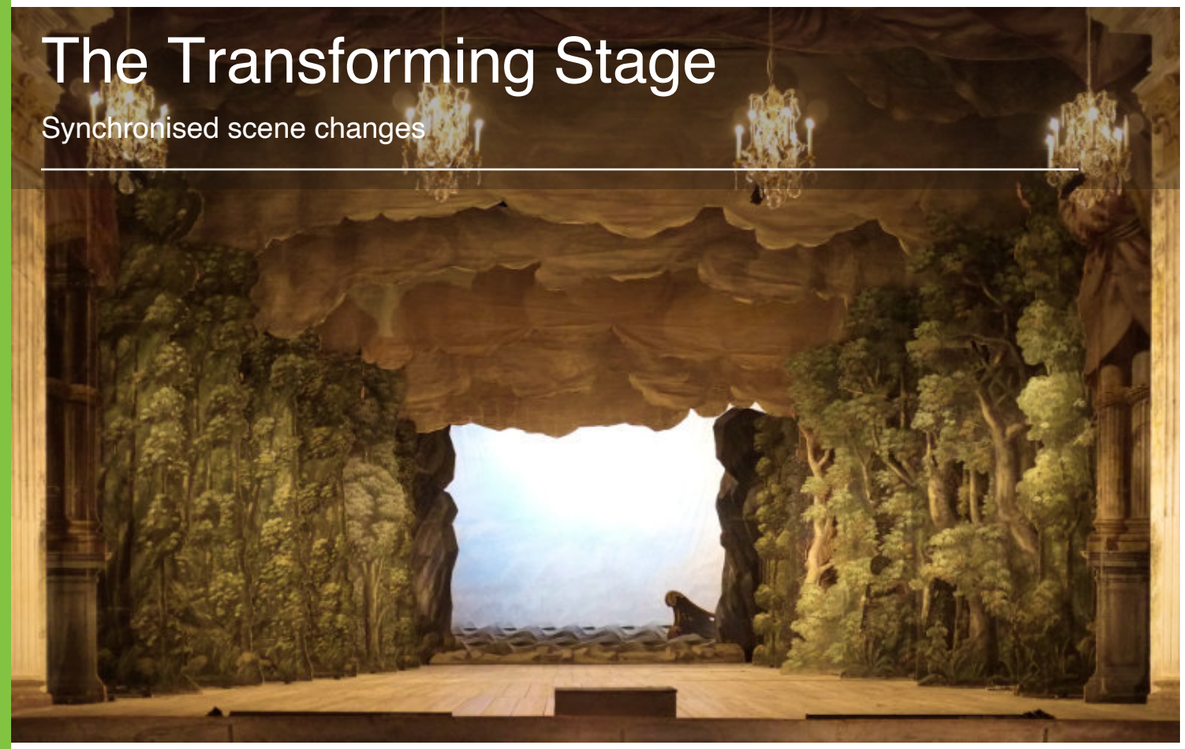
Scenic designers must usually fit their designs into the available space of the theatre. However, there have been times when theatres have been modified to accommodate the scenography, such as knocking a hole in the back wall of the stage to give a greater throw for back projection. The Teatro Olimpico is the first and perhaps greatest example of the theatre building being fitted to the stage design.

Plans of the Teatro Olimpico, Antonio Mugnoni, 1788



The Transforming Stage

Synchronised scene changes



Baroque court theatres used elaborate, hidden machinery under and above the stage to create scene changes to be marvelled at. In moments, one painted perspective scene would be replaced by another, apparently without human intervention.

From the early 18th century, court theatres began to appear in Europe. They had in common wooden machinery that enabled synchronised scene changes of both the painted scenic flats at the side of the stage (the 'wing flats') and those overhead ('headers'). The flats depicting one scene moved off the stage, and – simultaneously – another set of flats depicting a second scene moved onto the stage. The technical solution varied from one theatre to another, but all of them were able to operate these scene changes from only one or two places in the stage cellar, using ropes and pulleys to connect the moving scenery to one or more capstan shafts driven by a group of stagehands under the stage.

The Drottningholm Court Theatre outside Stockholm in Sweden (Q34) still has its fully functional stage machinery, where the wing flats on each side of the stage, as well as the headers over the stage, can be moved in the same operation. The scenography of the court theatres was based entirely on a central perspective, organised to give the ideal view to the prince or monarch, with wing flats and headers placed parallel to the front of the stage, forming a series of portals diminishing in size towards the rear of the stage, so creating the perspective effect (F.03).

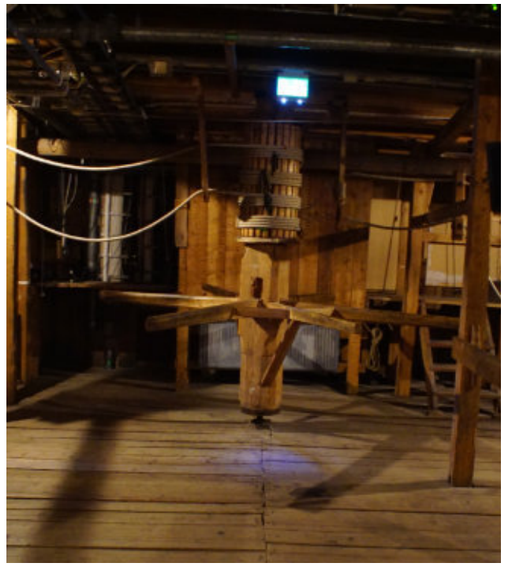
The painted wing flats were attached to frames on either side of the stage. These frames in turn extended through slits in the floor, down to the stage cellar where they attached to the 'chariots', which could roll from side to side on a wooden track (Q19398). The movement of the frames was such that when they were on the off-stage position, furthest from the centre of the stage, the attached wing flat was hidden, but when the frame was moved on-stage, into the centre, the wing flat appeared in view. The frames with their chariots were in groups, and between these groups there were larger gaps to allow for entrances for the actors. At the front of the stage there could be up to four frames directly behind one another, while at the back of the stage there were only two frames grouped together.

Typically, the under-stage machinery was in the form of a centrally mounted shaft extending from the front of the stage cellar to the back. To this central shaft were attached ropes, directly or indirectly via pulleys, to each of the chariots. When the shaft was turned, the ropes began to be wound up onto the shaft, moving the attached chariots with their frames and scenic flats. Chariots attached directly to the shaft were pulled in towards the centre of the stage, so appearing into view, while those whose rope was attached via a pulley at the side of the cellar space were pulled in the opposite direction, away from the stage centre and so out of view.

Similarly, the scenic headers, arranged in pairs, were suspended on ropes so they could be lowered and raised into and out of view. In the loft over the stage there was a shaft that ran from the front of the stage to the back. The ropes that supported the headers were attached to the shaft so that when it rotated, one of the pair was lowered while the other was raised. Both the machinery in the cellar and in the loft were moved by capstans, hand-powered by up to six people per capstan. In some theatres, including Drottningholm, the ropes operating the chariots were diverted via pulleys to the capstan, rather than running them directly between the shaft and the chariot. In this way, both a large and centrally located trapdoor, as well as two smaller ones further back on the stage could be accommodated, without being blocked by a drive shaft.

The final part of the stage picture was the backdrop, closing off the view upstage. In some theatres, there was enough height above the stage for the cloths to be raised out of view with a counterweight system. Where there was less height, the cloth would be raised in two parts, lifted first from the top of the cloth, and then from a point two-thirds of the way down, so the cloth folded as it rose and occupied a space only one third of its actual height.

When all the machinery was operated together, one complete scene comprising painted wing flats, headers and backdrop was replaced by another: the location moved from palace interior to garden, to forest, to seascape in a few moments, with the mechanism entirely concealed. The idea of transformation was central to the performances of the Baroque court theatres. As well as offering the audience delight and amazement, it – like the geometric gardens outside the palace – demonstrated an orderly world, operated by clockwork-like mechanisms, all under the benign eye of the powerful yet benevolent monarch.



Drottningholm Theatre: (left) forest scene with sea; (right, from top to bottom) capstan for the wing flats; chariots and tracks for the wing flats; slots in the floor for the frames.

Nature on Stage

Seas, skies and storms

Audiences of the Baroque era delighted in the depiction of nature, such as seascapes and storms, created by a combination of elaborate effects. De Loutherbourg's Eidophusikon *took such spectacle to its limit: a miniature theatre without actors.*

In the Baroque period, theatres developed elaborate facilities to create illusionistic stage settings, representing a wide variety of locations, both imaginary and real. Theatres had a repertoire of stock scenes and effects, which could be used in different combinations, according to the needs of the play, opera, dance or spectacle being presented. In addition to various interiors and street scenes, garden, forest and sea scenes were common, as well as depictions of clouds through which heaven could be seen, or from which gods and angels descended. Machinery above, below and to the sides of the stage made it a highly dynamic environment, so that scenery and lighting could be changed, and actors and scenic elements could rise up, descend or roll onto the stage from the wings. The actual mechanics of these effects was always either hidden by the proscenium arch or the painted scenery, or disguised by additional scenic elements.

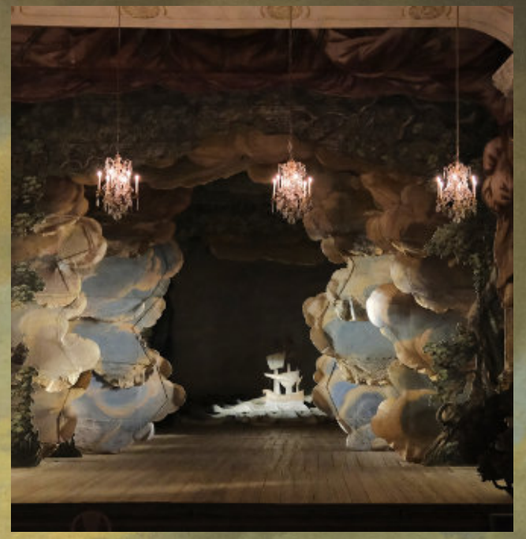
At the Drottningholm Court Theatre in Sweden (Q34), in addition to the machinery for mechanised scene changes (A.04), further machinery enabled people and objects to be lowered from above, and raised up through the floor. Two of the flying machines raised and lowered vertically, while the third machine the movement was diagonal, as the platform could be raised or lowered while also moving sideways across the stage. To hide the ropes that supported the lifting platforms, it was also possible to lower clouds from the roof. The lines from these clouds were attached to drums of different diameters on a common drive shaft, so the clouds lowered at different rates. In this way, the clouds lowered in a simultaneous movement, apparently expanding to fill the sky, and surrounding the descending performers.

Under the stage floor, lifting platforms allowed the actor to enter the stage from below. To use this lift, it was first necessary to open a trap in the stage floor. A common design was to slide a section of the floor the same size as the lifting platform to the side, just below the stage floor. The rising platform then filled the space left by the sliding trap. As well as actors, scenic elements could be raised up through the floor, to surprise and delight the audience.

Methods were also developed to create the impression of sea waves, where ships sailed and sometimes even sank. At Drottningholm, five horizontal, screw-shaped cylinders with a diameter of about 40cm were located at the back of the stage, with a crank handle at the end. When the cylinders were rotated, they gave the illusion of rolling waves when viewed from the auditorium. Between the cylinders, it was possible to place a rail on which a model of a ship could be pulled sideways amongst the waves. Another technique to create the illusion of undulating waves was to use a rotating axle covered along its entire length with a strip of canvas painted as foaming waves. Ribs attached perpendicularly to the rotating axis pushed on the canvas from below, creating an undulating movement in the painted canvas. For a storm scene, the lowering clouds, the rolling waves, and the moving ship were supplemented with dimmed lighting (C.04) and a soundscape of wind, rain and thunder (D.04) to create a dramatic *tableau vivant*.

Towards the end of the 18th century, tastes were moving away from mythological and allegorical subjects, and towards the representation of scenes from life. In the 1780s the painter and scenic designer, Jacques-Philippe de Loutherbourg (Q30769) and the English actor, David Garrick (Q30768) created a large-scale miniature theatre in London called the *Eidophusikon* (Q30544). Presented on a stage around 2m wide and 2.5m deep, the *Eidophusikon* attempted the creation of a perfect illusion of natural reality: city- and landscapes at different times of day, and the drama of storms and volcanoes. Lighting, music, sound and staging effects animated the scenes, which unfolded over time, with the miniature stage making possible effects that were difficult or impossible at full size.

When the *Eidophusikon* was first presented, the programme included a dawn scene over London, noon in the port of Tangier, a scene of Naples, and moonlight over the Mediterranean. The final scene was a 'Storm at Sea and Shipwreck'. In the *Eidophusikon*, scenography and stage effects were no longer in service to the drama, they *were* the drama; it was a stage without human actors, where light, sound, scenery and mechanics performed on their own terms. For audiences of the Baroque period, the recreation of nature on stage, its romantic beauty and drama, was central to the idea of theatre.



The Drottningholm Court Theatre. Left: ship at sea, with clouds. Right: the wave effect

Philippe Jacques de Loutherbourg, A Shipwreck Off a Rocky Coast, *1760s*

B.05

Light and Transformation

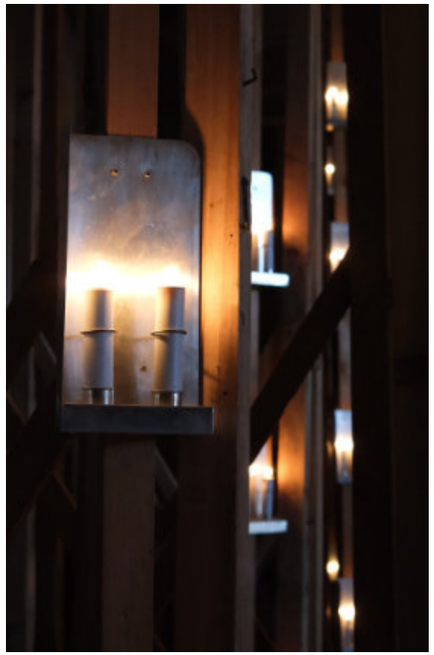
The dynamic stage

Light was vital to the scenic illusion of the Baroque court theatres, distributed around the stage illuminating the scenery as much as the performers. Moving the sources enabled them to be brightened and dimmed in a dynamic stage transformation.

In the Baroque period, the royal court theatres of Europe established an approach to staging that prioritised the perspective illusion: an illuminated 'magic box' viewed through the frame of the proscenium arch. During this period, the main light in the auditorium as well as on stage came from oil lamps and candles located on chandeliers over the front of the stage, in sconces around the auditorium, between the scenic wing flats, over the stage between the scenic headers, along the front of the stage (footlights) and at the back of the stage at floor level. The lights in all chandeliers and sconces in the auditorium were lit before the start of the performance and then remained on throughout the performance. The burning time of a wax candle rarely exceeded one hour, and if the performance lasted longer than that, it was necessary to change the candles one or more times during the evening, and to refill the oil lamps. Furthermore, before the 19th century, the wick used in candles was made from a round cotton thread, not braided as they are now, which meant that when the burning wick was too long it was necessary to cut it off to prevent excessive smoke being produced. There are records of complaints by audience members when the candle snuffer entered in the middle of an aria to use scissors to snip the candle from the dangerously long burning wick.

The chandeliers could be lowered to the floor so that new candles could be inserted or the wicks trimmed without needing a ladder. Onstage, the sconces holding the candles were mounted one above the other on poles placed behind each of the scenic flats on either side of the stage. A reflector behind each candle directed the light onto the stage, maximised the brightness. To install new candles in the sconces positioned high up, they were hung on chains so the whole group of sconces could be lowered to the floor.

The Castle Theatre, Český Krumlov, Czech Republic: modern electric lighting recreates the effect of the original candle and oil



The Castle Theatre, Český Krumlov, Czech Republic
Left: modern electric version of the original wing lights
Right: foot and wing lights

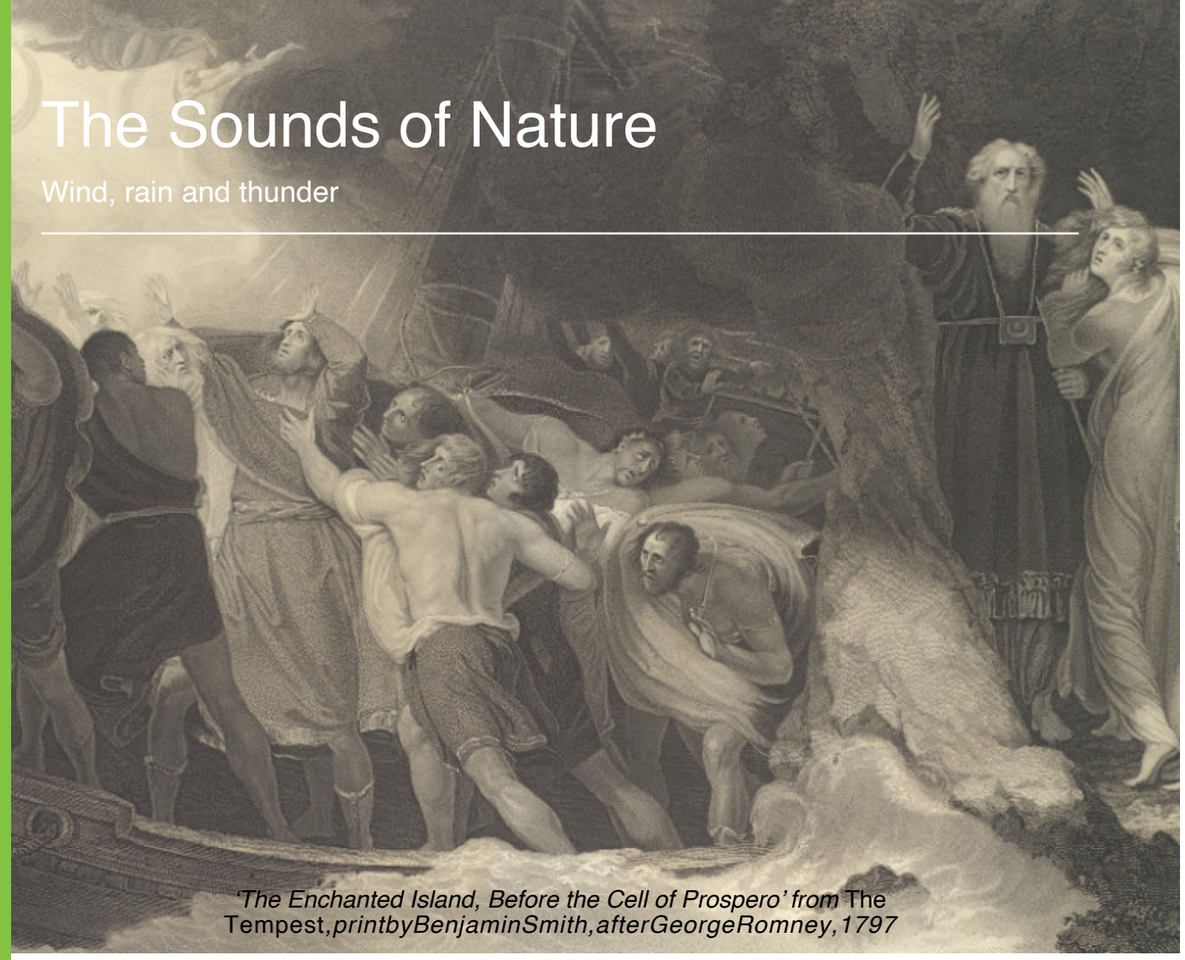
In some theatres the poles with their sconces could be turned, so when they were directed towards the stage, the light on the stage increased, but if they were turned away from the stage, the stage became darker. With the operation of these lighting columns in each wing linked by a system of ropes, pulleys and capstans below the stage, it was possible to synchronise this lighting control in a simultaneous movement so that the lighting either dimmed or brightened depending on the direction of the lighting columns. Similarly, the footlights at the front of the stage – known as 'floats' because of the common method of burning wicks floating in a bath of oil – could be raised and lowered through a slot in the stage floor, so controlling the brightness. In addition to darkening the stage when the footlights were lowered, it was also possible to change the burnt-out candles, or refill oil lamps, while they were out of sight of the audience.

Because the lights in the wings and overhead were close to the painted wing flats and borders, those scenic elements were relatively brightly lit, as were the backcloths when lit by sources set into the floor at the back of the stage. The centre of the stage, by comparison, was dim, being the furthest from any light source. Performers at the front of the stage benefited from the chandeliers overhead, and especially from the footlights – the closest light source for an actor at the front of the stage. The main acting area was therefore the front, with the centre and upstage areas occupied by less important or contextual action, and of course serving as a scenic space – a three-dimensional stage picture with its artificial perspective and illusion of infinite depth.

Although they were an important method of lighting actors, because they could be close and so illuminate brightly, the footlights were disliked by some: Sabbatini (Q13) complained they cast shadows on the scenery, made the actors look pale, and sent fumes into the audience. The footlights would finally be abolished with the advent of electric spotlighting (C.07), except when used as an effect to signal a certain kind of 'theatricality'. Nevertheless, the Baroque court theatres were able for the first time to control the distribution of light on the whole of the stage, increasing and decreasing its brightness dynamically for each scene. Light had begun to be a means for stage *transformation*,a use that would continue to develop until the present day.

The Sounds of Nature

Wind, rain and thunder



'The Enchanted Island, Before the Cell of Prospero' from The Tempest, *print by Benjamin Smith, after George Romney, 1797*

Sound was an important part of the theatre of the Baroque courts. Various ingenious techniques were used to reproduce the sounds of nature, staging storms to thrill and delight the audience.

In the court theatres of the Baroque period, audiences found great pleasure in illusion and surprise. Stage settings could be transformed from one scene to the next in moments, animated by unseen backstage workers (A.04), and lighting, scenery and sound were used together to create a sense of wonder and delight. Effects were used not only to tell the story, but as an entertainment in themselves, in *intermezzi* – shorter performances such as dances and spectacles between the acts of a play or opera. Representations of nature were popular, such as a scene of a ship at sea in a storm, and a range of techniques were developed to create the sounds of weather: wind, rain and thunder.

The sound of rain could be produced in a variety of ways. Perhaps the simplest was the rain tray – a wooden tray, held with two hands and moved back and forth, filled with dried peas, small shot or even pieces of marble. Sometimes, nails were hammered into the tray so the peas or shot bounced off them as they rolled. Each variation in the technique gave a slightly different quality to the sound. A more complex alternative to the rain tray was the rain box, which comprised a hollow wooden structure containing shot or small peas, mounted on a pivot. Tilting it backwards and forwards made the contents roll from one end to the other, producing the sound of rain. To slow down the movement of the contents, wooden strips or other obstacles were attached to the interior of the box, which functioned in the same way as the nails in the rain tray. A third method was the rain drum (Q126) consisting of a sealed wooden drum containing small shot, lentils, rice or dried peas. The drum was mounted on a rotating axle with a handle to allow the drum to be rotated. When the drum was turned, the contents produced the sound of rain. As before, depending on the desired effect, the drum could be filled with different contents.

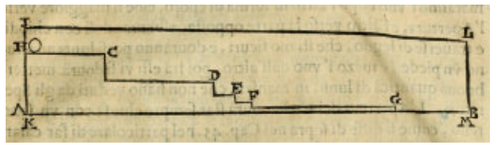
Nicola Sabbatini described a method to make the sound of thunder in *Practica de Fabricar Scene e Machine ne' Theatri* in 1638 (Q24), in which stones or metal balls were rolled down a slightly inclined wooden trough with steps in it at random intervals, to break up the sound. At the Castle Theatre in Český Krumlov (Q688), the trough is built into the structure of the building at the left-hand side of the proscenium arch, and later theatres had permanent 'thunder runs' in the loft space over the auditorium, so the sound of thunder would rumble overhead. To make a 'crash' of thunder, rather than a rumble, a large sheet of metal known as a 'thunder sheet' or 'thunder plate' was suspended, so it could be shaken or hit when the sound was required (Q142).

The sound of wind could be made with a wind machine comprising a rotating drum, similar to the rain drum, but instead of peas inside, it had a strip of fabric such as canvas stretched over its outside (Q160). The drum, rubbing on the fabric, made the noise of a howling wind, rising and falling in tone as the operator increased and decreased the speed of rotation. The example in the City Theatre, Kortrijk (Q644) has what appear to be rope guides on the side of the drum. Their purpose is unclear, but they may have been used to operate the rain drum from a distance, for example when the machine was placed over the stage but controlled from stage level. Another possibility is that two drums were connected together to be worked by a single operator – the rain drum in the same theatre also has rope guides.

The sound of wind could also be made by attaching the ends of thin strips of wood to a cord and whirling it rapidly around in the air. Joseph Furttenbach (Q60) gave details of the technique:

> Several thin rulers or pieces of veneer two feet long, three inches wide and no thicker than a knife blade have a small hole the size of a quill at one end where a cord one and three quarters feet long is tied. Someone takes the cord in his hand and swings the ruler with all his might. When many rulers are whirling, they roar like a hurricane.

Furttenbach proposed a remarkable enhancement to the effect, using the audience's sense of touch as well as hearing: 'At the same time great bellows may send a wind out through hidden bored holes so that a strong wind actually blows on the audience. This whistling wind with the thunder and lightning, especially if the lights are darkened, will seem like a natural storm.' The Baroque court theatres used various techniques to create complex soundscapes, which, combined with the elaborate scenery and lighting methods, created scenes of nature to delight and amaze their audiences – a theatre of sensation.



Top: Wind machine at the Ravensburg Konzerthaus, Germany

Middle: Rain machine, Christiansborg Palace Theatre, Copenhagen

Bottom: Sabbatini's drawing of a thunder run

Fit for a King

Baroque Court Theatres

The Baroque style of the 17th and 18th centuries used ornament, movement, exuberant detail and surprise to achieve a sense of awe. The Drottningholm Palace Theatre is one of the few Baroque theatres still in use, with its original stage machinery.

The Drottningholms Slottstheater (Q34) is located on the island of Lövon about ten kilometres from Stockholm, Sweden. It is part of the former summer residence of the Swedish royals, now the Royal Palace.


Drottningholms Slottsteater, 2016

The first theatre intended to serve the court opened its doors in 1754 and was built by the architect Nicodemus Tessin the Elder and his son Nicodemus Tessin the Younger (Q30563). It passed directly into the hands of the Queen Regent Hedvig Eleonora. A terrible fire burnt down the theatre during a performance in 1762. Its reconstruction was commissioned to the architect Carl Frederik Adelcrantz (Q46) in 1764 to open its doors in 1766. The new theatre, known as the 'opera house', boasted magnificent stage machinery by Donato Stopani.

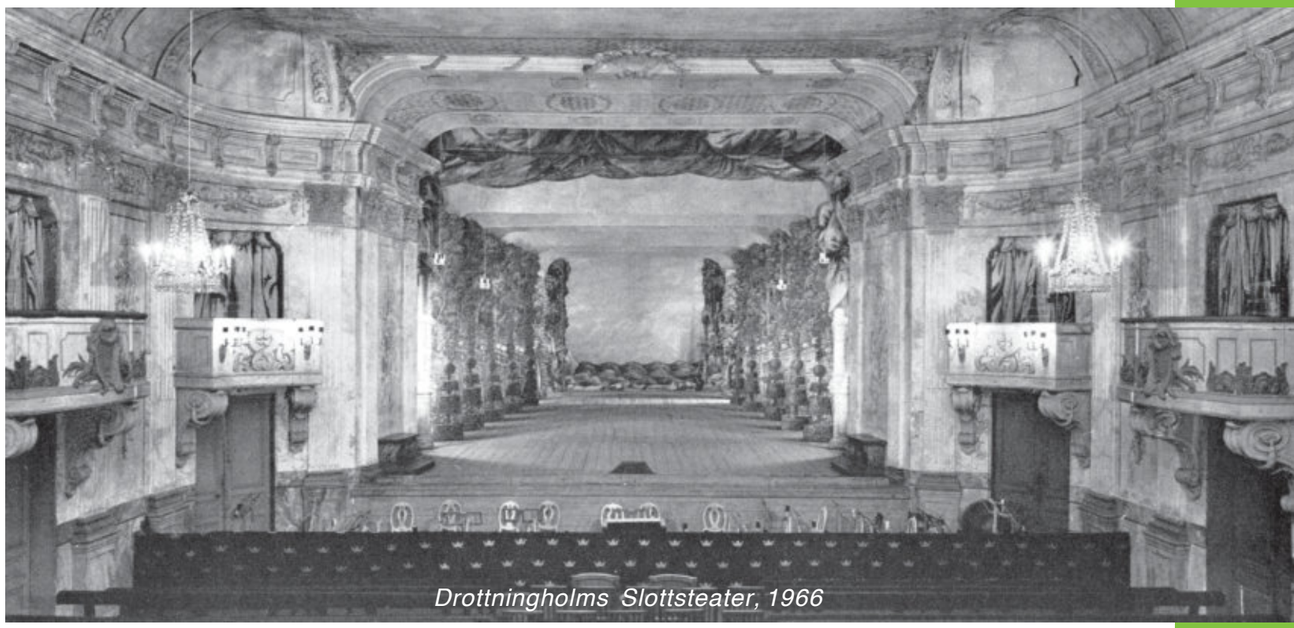
After the death of King Adolf Fredrik in 1772, Queen Lovisa Ulrika remained in charge of the theatre until 1778, when she handed it over to her son Gustav III, the new King of Sweden, known as the 'Theatre King'. The end of the Gustavian Period came with his assassination by gunfire in 1792 during a masquerade at the Stockholm Opera House and the subsequent closure of the theatre 20 years later.

After more than a century in which the theatre was closed and almost forgotten, Agne Beijer (Q89), an assistant at the National Library of Sweden, rediscovered it in 1921. He directed the restoration of the theatre and created the Drottningholm Theatre Museum, of which he was the director from 1925. On 19 August 1922 the theatre was reopened and the first performance was held. During the 1940s, its role as a museum still dominated, and the performances were intended to generate income for the museum and provide a space for experimentation. From the 1950s onwards, operas and ballets began to be produced on a more regular basis. Today the Drottningholms Slottstheater hosts the annual summer festival of classical opera. Since 1992 it has been a World Heritage Site.

The building has a classical French-style façade, with its front entrance facing a small square that connects it to the palace. In plan, the theatre is aligned to an axis of symmetry coinciding with its entrance and connection to the Royal Palace. A second transversal axis that passes through the side doors of the auditorium divides the stage space from the audience, becoming almost an axis of symmetry accentuated by the opposing inclinations of the stage and the auditorium. This second axis and the relationship between the building and the garden were emphasised by Gustav III's extension. This involved the construction of a new space attached to the theatre called the Déjeuner-Salon, designed by the set designer Louis Jean Desprez in 1791 (Q30564).

The theatre has a 400-seat auditorium. Although the entire group of spectators have a good view of the stage, the ideal point from which to best experience the perspective of the stage was where the King's seats were located in the front row. The sightlines are good, as the rows of seats are parallel to each other and the hall is sufficiently inclined to allow all the spectators to see. There was a break in the rectangle of the hall with a central Baroque oval linking actor and spectator. Later, it was removed, and benches were placed around it. A peculiarity of this theatre is that a curtain can be lowered between the widest main part of the auditorium and the last eleven rows of benches. In Gustav III's time it was used to separate the high nobility and royalty from the bourgeoisie and lower nobility during intermissions and at the end of performances. The auditorium does not have balconies, but has six boxes in the middle, three on each side. They were used to seat musicians who could not fit in the orchestra pit and for kings on official occasions.

As in all Baroque theatres, the most striking effect of this theatre is the *changement à vue* – that is, the change of scene in full view of the audience. To achieve this effect, the theatre has a fully functional mechanism for changing wings and backdrops; this mechanism is operated from offstage and out of the audience's view, so the stage appears to change 'magically' from one scene to the next, with perfect synchronisation.


Drottningholms Slottsteater, 1966

The dynamics of the stage are not limited to the horizontal plane, but also include a system of clouds and flying machines capable of lowering characters from the attic and a system of trap doors and lifting platforms to make the actors appear and disappear into the substage. All of this is linked to sound effects such as thunder and wind, and lighting effects such as the dimming system that turns candles or oil lamps towards or away from the stage. The theatre is designed to create wonder, delight and awe, displaying the King's cultural prestige to his guests and courtiers.


Drottningholms Slottsteater, 2016

E.05

The Architectural Scene

The work of the Galli Bibiena family

In the Baroque period, architecture, painting, and scenic design were not such separate disciplines as today. Four generations of the Galli-Bibiena family moved freely between them, bringing a rich visual creativity to the courts of Europe.

The Galli-Bibiena family (Q21769) was a family of Italian artists of the 17th and 18th centuries. Using the highly ornate style of late baroque sculpture and architecture, the members produced as painters, architects and designers a series of theatrical and other designs that are exceptional for their intricate splendour and spacious proportions achieved by detailed perspective.

From about 1690 to 1787, working for many of the courts of Europe, eight Bibienas designed and painted intricate settings for operas, weddings and funerals. In four generations they developed and spread their knowledge regarding theatrical development in the family:

- father, Giovanni Maria Galli da Bibiena (1625–1665)
- daughter Maria Oriana Galli Bibiena (1656–1749), painter
- son Ferdinando Galli Bibiena (1656–1743), architect/designer
- son Francesco Galli Bibiena (1659–1739), architect
- grandson, Alessandro Galli Bibiena (1686–1748), architect/painter
- grandson, Giuseppe Galli Bibiena (1696–1757), designer
- grandson, Antonio Galli Bibiena (1697–1774), architect
- grandson, Giovanni Carlo Galli-Bibiena (1717–1760), architect/designer
- great-grandson, Carlo Galli Bibiena (1728–1787), designer, son of Giuseppe Galli Bibiena.

The Galli-Bibiena worked for the main European courts, from Lisbon to Saint Petersburg, where they achieved fame and international recognition. They were originally from the Tuscan city of Bibbiena, having settled in Bologna in 1628. The Galli Bibiena generated through the different generations a particular common style. The collective output was very large, and with an undoubted family resemblance: the drawings of some of them are so similar that it is not easy to determine their author.

The creator of the inheritance is Giovanni Maria, but it was his children who established the artistic reputation of the family. His older brother Francesco Galli Bibiena (Q20592) stands out for stage design and, thanks to his knowledge of architecture, for the design of several theatres. Among them are the Vienna Hofburg (Q8389) that influenced theatre design in Germany and Austria at the time, and the Teatro Filarmonico at Verona (Q8347).

The other brother, Ferdinando Galli Bibiena (Q565), was also an architect, designer and painter. Together with Francesco, he carried out, among other works, the reform of the Ducal Theatre of Parma. Ferdinando was the one who obtained the most reputation in relation to scenic decoration thanks to his innovative designs, becoming one of the greatest Italian scene painters. Ferdinando worked in Parma, Modena, Genova, Torino, Venezia, Rome and Milan, and later for Philip V of Spain in Napoli. He left behind two published treatises, and a huge number of projects and sketches.

His greatest innovation was the introduction of two-point perspective into the set designs he was making for the theatre and festivities at the court of Vienna, where he had been the Emperor's architect since 1717. Two-point perspective uses two vanishing points, and is generally employed to give a diagonal view of a building or rectilinear space. It had been a well-established architectural drawing technique since the early 16th century, and Sabbatini had illustrated its use for stage designs in his 1638 treatise, *Pratica di fabricar scene e machine ne' teatri* (Q24). Ferdinando's great innovation was not a new way of seeing or drawing, but in the practical application of the principle of two-point perspective to scenic design.

This innovation, called *scena per angolo*, provided a way of creating, using two-dimensional scenic elements placed parallel with the proscenium, the sense of a three-dimensional architectural environment, with the illusion of an infinite continuation beyond what can be seen on stage.

The Galli–Bibiena are known as one of the most important families of architects and set designers of the 18th century. Their decorative works for court functions were necessarily temporary, and their theatrical scenery was not executed in durable material, so few of their creations have survived. However, the richness and splendour of their works can be judged from drawings made at the time, which have been preserved in great numbers and are found in many collections all over the world.

Above: 'Studio of fantastic architecture', Giuseppe Galli da Bibiena

Background: Teatro Filarmonico, Verona, Italy: Section and Ceiling, 1715-1720

F.05

How to build a Theatre

The books of Sabbatini and Furttenbach

Nicola Sabbatini and Josef Furttenbach documented theatre architecture and machinery during the Renaissance and Baroque periods. Their writings helped preserve and spread knowledge of theatre architecture and technology.

Sabbatini (Q13) was extremely influential for his pioneering and inventive designs of theatres, stage sets, lighting and stage machinery. Working in the court of the Dukes of Urbino, he was among the first designers of sophisticated machines which created realistic visual and sound effects such as the sea (the column wave machine), storms, thunder, lightnings, fire, Hell, flying gods and clouds, and so on.

But the work Sabbatini is known for today is his treatise *Pratica di fabricar scene e machine ne teatri* (Q24), the first book of which was published in 1637. In the same year, Nicola Sabbatini took part in the project of the Teatro del Sole: Situated in former stables next to a palace, like the Florentine halls or the Teatro Farnese in Parma, or in a public barn, like the Teatro degli Intrepidi in Ferrara, the Teatro del Sole remodelled existing architecture for stage use.


PRATICA
DI FABRICAR SCENE.
E MACHINE NE'TEATRI
DI NICOLA SABBATTINI
DA PESARO
Già Architetto del Serenissimo Duca Francesco Maria Feltrio della Rouere
Vltimo Signore di Pesaro.
Ristampata di nouo coll'Aggiunta del
Secondo Libro.
All'Illustriss. e Reuerendiss. Sig. Monsig.
HONORATO VISCONTI
Arciuescouo di Larissa della Prouincia di Romagna,
& Essarcato di Rauenna Presidente.
CON PRIVILEGIO.
IN RAVENNA, Per Pietro de' Paoli, e Gio. Battista Giouannelli
Stampatori Camerali 1638. Con licenza de' Superiori.

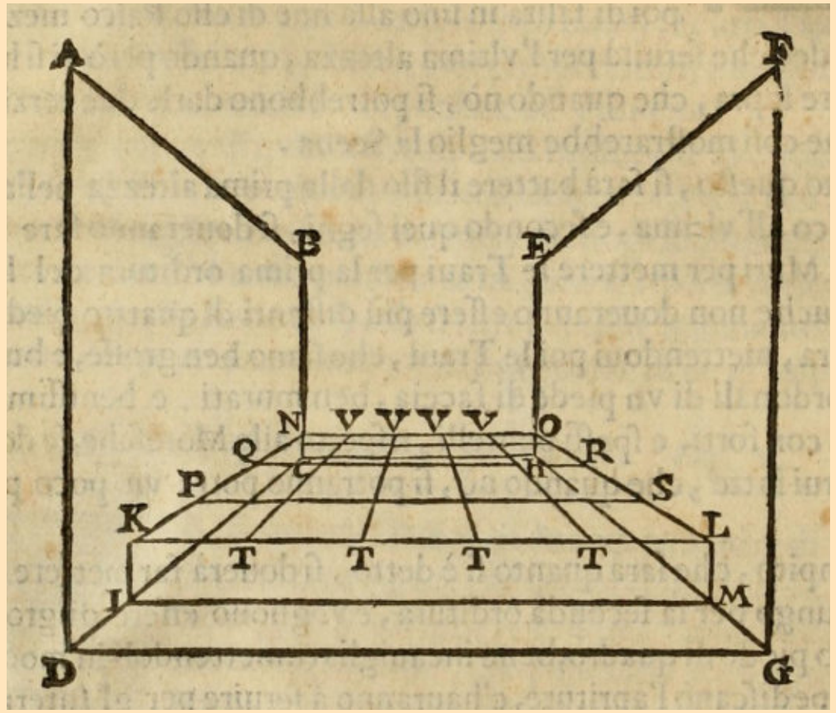
Sabbatini's 'Pratica'

The treatise writes down and illustrates the scenographic practice of its time, giving clear guidelines on the construction of scenographic artefacts. Chapter by chapter the Pratica's discourse is devoted to the architectural elements of the theatre's interior: hall, stage, tiers, orchestra, and the scenographies painted in perspective.

The first chapters focus on the construction of the stage, with a prior warning to check the structural stability of the existing building. It is important to point out that for Sabbatini the theatre is not built on a specifically created site, but reuses existing spaces. The stage is to be elevated, inclined with a gentle slope to facilitate performances with dancing. It is entirely built with wooden beams with enough space between the beams to allow for entrances. And it leaves the lower part open to accommodate the different stage mechanisms.

With the stage and sky in place, Sabbatini proceeds to position the point of view and the first wings. These not only completely organise the stage, but also the room, since the Prince's viewpoint must coincide with the optimum point of the perspective, at the same height as the established horizon line, and in a central and forward position with respect to the room. Once the Prince's point of view and the horizon line have been established, the urban scenes can be constructed in perspective using wooden frames with painted fabrics, and scene changes can be deployed to achieve the spectacle and illusion sought in the theatrical representation.

The audience is positioned in the room according to pre-established rules. A wooden railing nailed to the floor delimits the seats for the Prince's court and his guard, who must be placed in the surrounding area. In the space immediately in front of the Prince, seated on chairs or benches, are the young women and immediately behind are the older women, followed by the men. Sabbatini does not concern himself with the chairs or benches, preferring to indicate how and in what order the spectators should sit. A self-supporting wooden tier is built around all the walls of the hall to accommodate the rest of the audience. Finally, the musicians can be located inside the hall, on a raised wooden balcony, decorated and hidden



A diagram from Sabbatini's 'Pratica', showing the stage, and reference points for its construction

behind a lattice, or on a balcony inside the stage. Thus, the rules for building a theatre in an existing architectural space are set out.

Joseph Furttenbach the Elder (1591-1667, Q60) was a German architect, mathematician, engineer and diarist. From 1607 to 1620 he stayed in Italy, where he did an apprenticeship as a merchant under the supervision of his uncles. Moreover, he studied engineering, military architecture and grew an interest in theatre and stage design while abroad as well as festivals, processions, pyro technics and dramatic performances. Back in Germany, he had a successful career as an architect, universal engineer and writer. He designed a hospital, a waterworks system, a theatre, and houses. His cabinet of curiosities including models of scenic machinery was one of the most famous in Germany. A pious Lutheran, Furttenbach was at the same time an important cultural broker between Baroque Italy and Southern Germany. In three of his books, *Architectura navalis* 1629, *Architectura universalis* 1635 and *Architectura recreationis* 1640 (Q61) he gathered the architectonical and technical knowledge of his time and wrote expositions on scenery and lighting for the theatre.

The development of theatre architecture and technology has always been dependent on the sharing of knowledge and innovations, and in an age before telecommunications, the writings of Sabbatini and Furttenbach were critical to the advancement of theatre practice in their own time and since.

Joseph Furttenbach

G.05

How Big is Too Big?

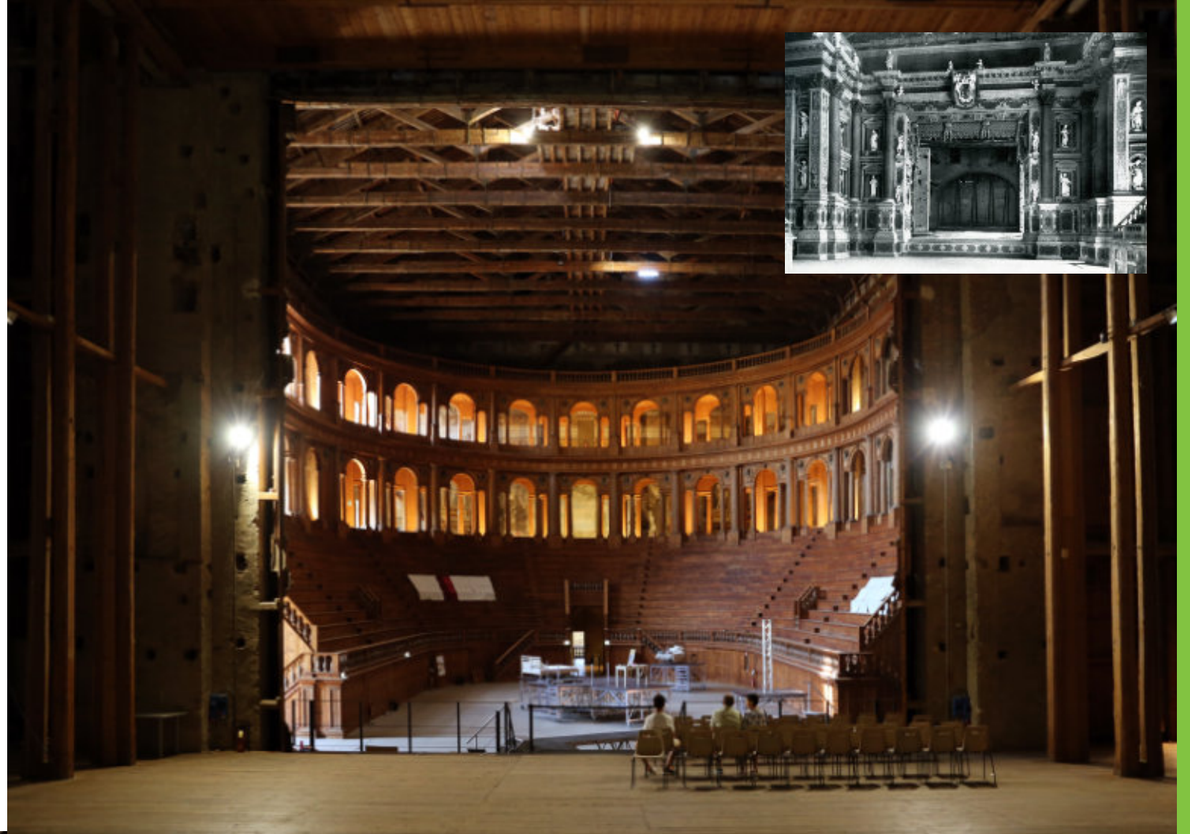
The Teatro Farnese

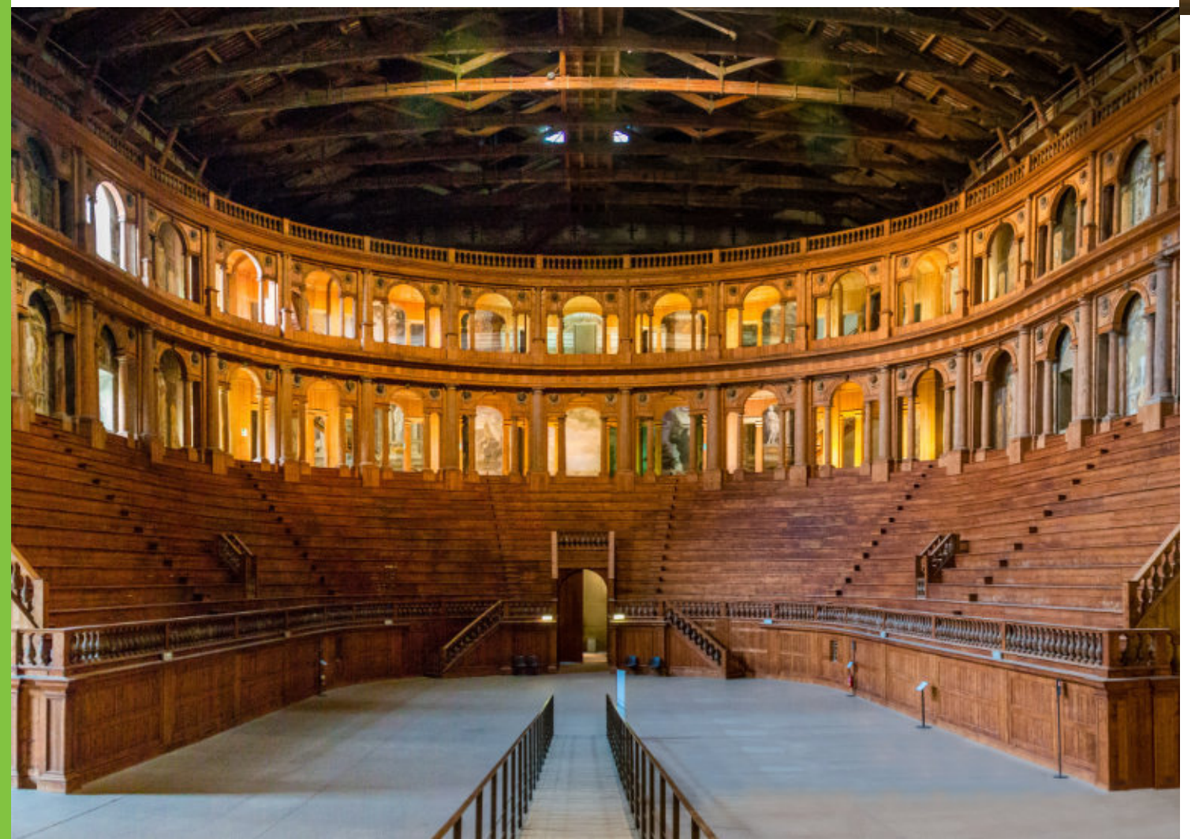
The Teatro Farnese is vast. Designed to impress, and built by order of Ranuccio I inside the unfinished Palazzo della Pilotta, the theatre is on the same gigantic scale as the palace, more medieval castle than harmonious Renaissance palace.

Ranuccio, the son of warriors, turned his palace into an immense mass that would frighten the nobility of Parma, who were in conflict with his power. The idea of building a theatre occurred to Ranuccio after visiting Florence in 1604 at the invitation of the Grand Duke Cosimo II. It was then that he attended a performance of great scenographic effect, with which the Medici wanted to surprise and impress their guests, asserting their greatness. Ranuccio returned to Parma wishing to surpass them. The origin of the theatre was therefore political. The aim was to show the Medici that the dukes of Parma were worthy enough in wealth and culture to be related to them.

In November 1617, in a hurry, Ranuccio called a large group of artists and craftsmen from neighbouring Ferrara, led by Giovanni Battista Aleotti, who had designed the Teatro degli Intrepidi, to rapidly build a theatre to put on a great show for the Grand Duke. The result was the gargantuan Teatro Farnese: 87 metres long, 32 metres wide and 22 metres high (Q7847). At the same time, Alfonso Pozzo wrote *La Difesa della Bellezza*, assisted by Antonio Goretti for the music; six intermissions were interspersed between the acts. The work was fanciful, full of mythological references that were the pretext for an extensive display of scenographic tricks, including the flooding of the stalls.

But the rush was to no avail. The Grand Duke, seriously ill in Florence, never came, and Ranuccio died in 1622 without seeing the theatre inaugurated. It was finally opened on 21 December 1628 for the wedding of Odoardo Farnese to





Cosimo II's daughter, Margerida de' Medici. Ten years later than planned, the theatre served its intended purpose, able to host 3000 people.

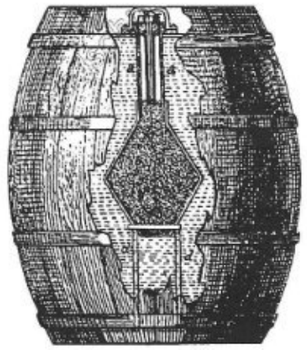
The inaugural performance was worthy of the space built: no effort was spared. Thus, Claudio Monteverdi, the greatest composer of the time, was called upon to put music and song to the Torneo Regale Mercurio e Marte. When the curtain rose 'the Aurora appeared, sitting on a triumphant chariot pulled by a fierce horse', and four quadrilles of knights performed. The spectacle ended with the appearance of Neptune in his chariot, accompanied by the sound of the water flowing from both sides of the proscenium. Aleotti's old idea for the show in honour of Cosimo II had finally been realised: a *naumachia* –a staged naval battle - closed the performance. Because of the high cost of this type of courtly production, the theatre was only performed in a total of nine times until 1732. The theatre was almost destroyed by an Allied air raid during World War II (1944). It was rebuilt and reopened in 1962 not only as a venue but also as an extraordinary entrance hall to the National Gallery of Parma.

The Teatro Farnese is not only larger than earlier Renaissance theatres (such as the Olympic Theatre of Vicenza, (Q650) and the Teatro all'Antica of Sabbioneta, (Q653)), but it is also more suitable for hosting various types of shows. Versatility is necessary to satisfy the varied tastes of the public, in which the charm of the Italian theatre coexists with the violence of medieval tournaments. Different shows require different scenic spaces: one is secluded, enclosed in a box equipped with machinery capable of creating any world; the other, expansive, occupying the entire hall.

At the beginning of the 17th century, Italian-style theatre was in conflict with two types of spectacle: classical and medieval theatre. The stage opening recalls the classical *scenae frons* of Roman theatres, and between it and the tiered seating there are traces of Roman *versurae* and Greek *parodos*. At the same time, as the first performance showed, it is not free from medieval tradition either. Some claim the Teatro Farnese as the first permanent theatre with a proscenium arch, and the proscenium arch underlines the division between the two types of spectacle. The unity of the classical theatre, organised around the circle, has been lost. The stage space, though, is no longer a bas-relief background, but has become a magic box.

Keeping Control

The fire extinguisher



The first fire extinguisher, by Zacharias Greyl, 1715

In the history of fire extinguishers, there have been some curious and important inventions. Developed as a response to many devastating fires, modern extinguishers have come a long way since their invention in 1715.

The first fire extinguisher (Q3612) was invented in 1715 by the German Zacharias Greyl. The device consisted of a wooden barrel filled with 20 litres of water and ignited with the help of black powder and a fuse. In case of fire, the fuse was lit, the device was thrown into the fire and the fire was extinguished with it.

About 100 years later, in 1816, the English captain George Manby invented what was perhaps the first fire extinguisher as we know it today. It contained 13 litres of potassium carbonate, a chemical that has been used in firefighting since the 18th century. The liquid was released by opening a tap, which was previously pressurised with compressed air.

The Fire Annihilator was patented by William Henry Phillips in 1844. The design was quite complicated, but basically chemicals were mixed inside the device, which ignited and caused a strong heat that turned the water inside into steam. This was released through nozzles on top of the fire extinguisher. The creator, however, could not convince anyone that it was a working device, as many demonstrations failed, and his factory was destroyed by a fault in the device.

In 1850 there was another 'chemical' fire extinguisher produced in Germany, by Heinrich Gottlieb Kühn: a small box filled with sulphur, saltpetre, coal and a small charge of gunpowder. It was to be ignited, thrown into fires and 'extinguishing vapours' created. These were then supposed to extinguish or smother the fire. In Chicago, an extinguishing grenade was invented in 1871. This was essentially just a glass container filled with a salt-water solution, to be thrown into the fire. Although the extinguishing effect was minimal, this grenade was produced throughout Europe until 1950.

In the meantime, Mr Schwartz of Bocholt developed the 'patent hand fire extinguisher' in 1884. It was filled with extinguishing powder (probably sodium bicarbonate). The contents had to be thrown into the fire by force. In 1902, the Graaff brothers developed the spray bag in Germany, which used pressure to force water out of the extinguisher. This was achieved with the help of a bottle of sulphuric acid which broke inside the device and reacted with the soda water.

The 'Silesia' fire extinguisher

In France, the Frenchman Alexandre Laurent developed the first foam-based fire extinguisher in 1906. In the event of a fire, two liquids were mixed in the extinguisher, which produced an extinguishing foam and then smothered the fire.

A few years later, the first carbon dioxide (CO_2) extinguisher was invented in Germany. With the help of CO_2 and a water-resistant powder, the fire was then extinguished.

Modern fire extinguishers have come a long way since their invention in 1715. Most are now manufactured as powder extinguishers with stored pressure or with CO_2 cartridges. This design is essentially unchanged since the 1950s, but of course all components have been improved and reliability increased. Modern extinguishing powders are also rated according to specific fire classes and performance. There are five main types of fire, each of which must be handled and extinguished differently:

A for solids (wood, paper, textiles, etc.)

B for flammable liquids

C for flammable gases

D for flammable metals

F for cooking oils and fats

Fires can involve electrical equipment, which also determines the correct type of extinguisher to use.

It is dangerous to use the incorrect type of extinguisher: water on liquids can cause a fire to spread, water on metals can cause a violent explosive reaction and water on grease can cause a grease explosion. However, the most common fire extinguishers are generally those with an ABC powder that is effective against most small fires.

Many of the first fire extinguishers were not only unsuitable and had too little effect, but were actually very dangerous. Today, experts state that 90% of fires can be extinguished with a fire extinguisher if discovered in time.

Chemical fire extinguisher, by Heinrich Gottlieb Kühn, 1850

Framing the picture

The proscenium arch and professional invisibility

In the model of theatre space of the Italian Baroque, the proscenium arch limits the audience's view, framing the stage as a picture. It not only hides the technical apparatus of the stage – it makes invisible all backstage labour.

The spatial model of the Baroque court theatre had a central axis, with the audience looking along it one way, and the performers the other, framed by the proscenium. The arch itself was a rectangular structure that separated the auditorium from the stage – a frame through which the audience observed the event. It produced a sense of depth and allowed the perspective scenery to create a three-dimensional illusion of a fictional space, within which the action of the play could take place. This concept derived from the perspectival method drawing that developed in the Renaissance period. The first documented appearance of the arch was 1585 in Vicenza, Italy, in the Teatro Olimpico (J.03, Q650). The oldest intact arch still in use is in Parma in the Teatro Farnese (H.04, Q7847).

The later concept of the invisible fourth wall of the theatre stage can be considered as a social and conceptual construct which divides the actors and their stage-world from the audience which has come to witness it. But since the curtain usually comes down just behind the proscenium, it also has a physical reality when the curtain falls, hiding the stage from view.

While the sides and top of the proscenium frame became an important feature of European theatres through the 18th and 19th centuries, often becoming very large and elaborate, the proscenium front below the stage – the bottom edge of the picture frame – became plainer. The introduction of an orchestra pit for musicians during the Baroque era devalued the proscenium frame, bringing its bottom edge forward to the front of the pit, where a barrier, typically in wood, screened the musicians. The result was the framing proscenium arch – sides and top only.

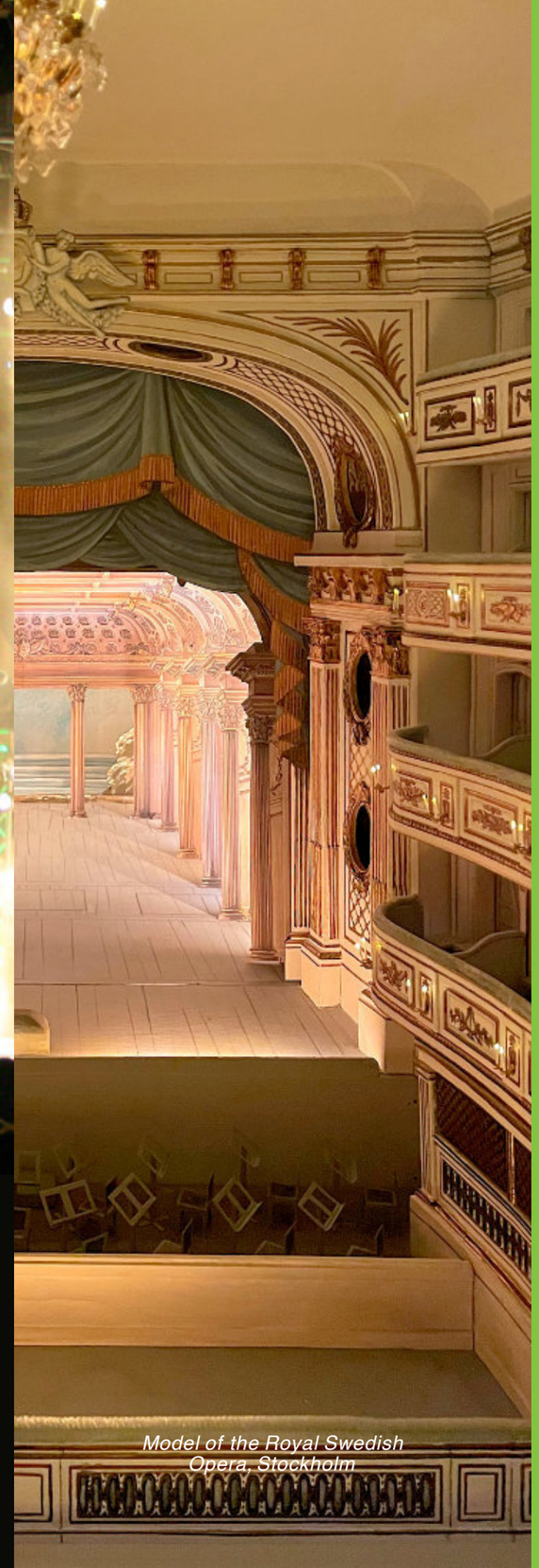
The proscenium arch frames the fictional world of the performance, making it clear to the audience what is in that world and what is not. The proscenium therefore also masks the wings, overhead and substage mechanics that provide for scene changes, lighting, and so on. In his 1640 book Recreational Architecture (Q61), Josef Furttenbach writes about how to light the stage, saying oils lamps can be placed 'within the scene, above between the clouds, at both sides, and in the front and rear pits, all of course completely concealed.' The phrase 'of course' here is telling – Furttenbach knows his readers will understand the imperative to hide the lamps. The light must be visible, but its source must not – that is the fundamental conceit of the illusionistic stage, which dominated Western ideas of theatre from the Renaissance until the early 20th century, and is still influential today.

The conventions related to the proscenium arch have been increasingly challenged since the start of the 20th century. The Festspielhaus, Hellerau (E.06, Q63) radically reimagined performance space, with no proscenium, and no pretence of a fictional world, with audience and performers sharing a single room. Mainstream theatre underwent a more gradual change: the 1960 premier of the musical *Oliver!* is believed to be the first production in London's West End to expose the overhead lighting rig, with no masking. To meet his political aims, Bertolt Brecht's actors would 'break the fourth wall', addressing the audience directly as part of the dramatic action.

The staging of rock and pop concerts has gone a step further – the technical apparatus of lighting, sound, video and rigging has *become* the scenography. Speaker stacks, once carefully hidden in theatres, are now proudly displayed, while truss rigs are artfully designed, part of a mobile architecture of space and light (A.09). This aesthetic has sometimes found its way back into theatre, in particular in rock musicals but even occasionally in opera. The proscenium arch is often no longer a frame to the dramatic picture, but an important signifier – something built specifically as part of the scenography of the individual production, not as part of the building's architecture. Here, the proscenium tells us that what we are looking at is not just theatre, it is deliberately and overtly *theatrical*.

Within this rich variety of ways of staging, one legacy of the proscenium concept remains: the expectation that the backstage staff in the theatre should be out of view. With only very occasional and carefully controlled exceptions, technicians, stage managers, dressers and others must not be seen. The result is a lack of recognition – a kind of *professional invisibility* – in which backstage labour can be undervalued and disregarded not only by audiences, critics and scholars, but also by other theatre workers and employers.

Basil Wolfrhine & The Claymore Highlander in concert



Model of the Royal Swedish Opera, Stockholm

The Steel Stage

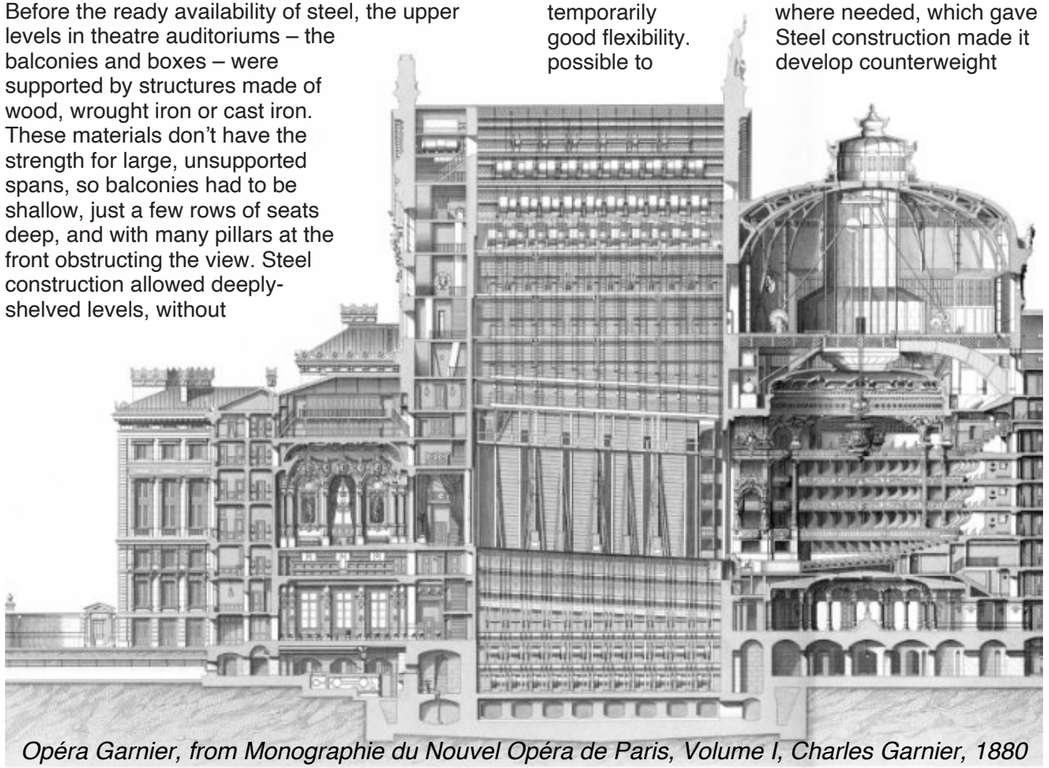
Metal machinery and flying

The advent of cheap and easily available steel in the second half of the 19th century transformed the construction of theatre buildings, stages and machinery.

Steel has been known as a material since antiquity, but until the 19th century its production was expensive. In 1855 Henry Bessemer introduced a new process that could make steel much more cheaply and in large quantities. This innovation had a substantial effect on theatre buildings and the technology used in them: steel, held together with rivets, could build wider spans and stronger constructions in less space. The Opéra Garnier (Q365), designed in 1861 by Charles Garnier and opened in 1875, has a steel frame for the structure of the building that make it possible to have slender pillars, creating more interior space.

Before the ready availability of steel, the upper levels in theatre auditoriums – the balconies and boxes – were supported by structures made of wood, wrought iron or cast iron. These materials don't have the strength for large, unsupported spans, so balconies had to be shallow, just a few rows of seats deep, and with many pillars at the front obstructing the view. Steel construction allowed deeply-shelved levels, without pillars. Cheap steel coincided with and enabled a change in auditorium design, away from the horseshoe shape, where spectators in the balconies could look at each other as much as they could see the stage, towards more rectangular spaces, without seats on the side walls, where everyone faced forwards, towards the stage. Theatre became less about a shared, communal experience in which an audience watches the stage action together, and more about an individual, immersive experience of the fictional world of the drama (D.05).

The introduction of steel also impacted the construction of the stage and its machinery. Before the Industrial Age the upper machinery was mostly build as a hemp system (named after the type of rope used, Q678), manually powered by wooden shafts and drums, and supported by free hanging counterweights. The battens were placed temporarily where needed, which gave good flexibility. Steel construction made it possible to develop counterweight systems (Q15920) where the weights were guided and balanced. The fly bars were hung permanently and parallel to each other at pre-defined distances. These systems were less flexible, but improved the working conditions and the efficiency greatly, as well as allowing much larger and heavier scenery.



Opéra Garnier, from Monographie du Nouvel Opéra de Paris, Volume I, Charles Garnier, 1880

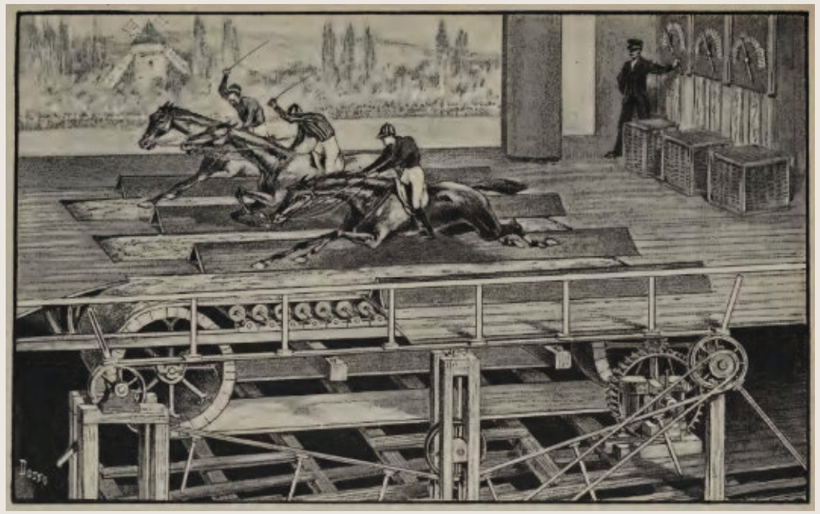
On stage, wagons (also known as trucks, Q4298) could be used, guided by rails in the floor; the steel construction meant their height could be kept low, minimising the visual impact. New, spectacular effects were developed. The revolving stage (Q3536) was already used in Japanese theatre in the latter half of the Edo Period in Kabuki theatre where they were called *mawaributai* (Q30618), and in 1617 at the Palais du Louvre a first experiment with a turntable (Q30619) took place. Karl Lautenslager (Q418) developed the revolve further at the Residenztheater (Q13019) in Munich 1896. In 1954 a 'drum revolve' (Q30620) with built in elevators was developed by Sepp Nordegg, and a similar concept was installed in the 1970s in the Olivier space at London's National Theatre (Q9343) – all these later developments were only possible with steel construction.

The first steel under-stages were built as a copy of the earlier wooden type, but with the use of steel, the chariots (Q19399) for moving the scenery could be much smaller, creating space for other uses. Larger elevators could be integrated, powered by hydraulic and later electrical motors (A.05). In a second phase, the chariots disappeared, giving more freedom to organise the under stage.

Steel was not only used in permanent machinery. For the staging of *Ben Hur*, a device was developed for the race (Q30617) consisting of two movable treadmills for the chariots and the live horses. The background was created by a moving panorama (Q23451). Other ideas from this innovative period didn't catch on. The Grand-Théâtre de Lyon, for example, had a unique revolving double stage (Q512): the rotating under-stage was a traditional chariot stage, and the grid also turned, suspended from a massive central pivot. Hanging scenery and lights turned with the standing sets.

Another idea that didn't make it was the elevator stage. The first elevator stage was built for the Madison Square Theatre in New York (Q30616) designed by Steele MacKaye. The construction consisted of two stages, each with a grid, that were built on top of each other and that could move up and down as a whole, so that either one stage or the other could be seen through the proscenium opening, making quick changeovers possible between the two scenes.

The introduction of steel in theatre machinery marks the turning point between manually operated wooden equipment and motorised steel equipment, and was the start for further development and changing working methods. The timing of these changes, however, depends on the type and size of theatre, the type of productions and on regional differences. Germany was an early adaptor, but in other countries the change was only seen in major opera houses or large city theatres. In some countries like the UK and Italy the tradition of 'hemp houses' still exists in smaller venues.



Horse race on treadmills, from Trucs et décors; explication raisonnée de tous les moyens employés pour produire les illusions théatrales, *Georges Moynet, 1893*

A.06

Phantasmagoria

Pepper's ghost and the magic lantern

Interpretation of Robertson's Phantasmagoria, from F. Marion L'Optique, 1867

In the late 18th and 19th centuries, there was a great fascination with horror shows and the supernatural. The magic lantern and the technique of Pepper's Ghost were used to create eerie effects to thrill the audience.

In 1792 in Paris, Paul Philidor (Q30597) presented his show, *Phantasmagorie*, during which a small audience witnessed, in a darkened room lit only by the embers of the fire, mysterious ghosts and apparitions. This was not the first such showing of Philidor's, but it was probably the first under the title of *Phantasmagorie*–fromtheGreekfor 'ghost' and 'gathering'. Previously, Philidor had raised his ghosts in Berlin, but he was accused of being a fraud and was expelled from Prussia. He spent the rest of his life travelling around Europe startling and delighting audiences with his showings, which expanded to include a variety of 'mechanical and optical arts', such as a peacock automaton, which ate and drank as if it were real. In October 1801 a phantasmagoria production by Paul de Philipsthal – most likely the same person as Philidor – opened in London's Lyceum Theatre in the Strand, where it was hugely successful. The show subsequently went on tour around Britain, and its success inspired other showmen to create similar, and more elaborate spectacles.

Philidor's Phantasmagorie was created using a *Laterna Magica* (magic lantern) – a simple slide projector that displayed an image made with translucent paint on glass (Q306). The principle of the projector had been known for many years – a 1420 illustration by Giovanni da Fontana shows a lantern projecting the image of a winged devil. The oldest known magic lantern was made in about 1720 by the Dutch instrument maker Jan van Musschenbroek. It used an oil lamp as a light source, greatly limiting the brightness of the image. It is likely that Philidor used the recently invented Argand lamp (Q588) for his projections, but even so it would have been necessary for the room to be in almost total darkness.

The Belgian inventor Étienne-Gaspard 'Robertson' Robert (Q30598) developed Philidor's Phantasmagoria further, adding new elements to the show. By moving the magic lantern near and further from the surface it was projecting onto, he could make the ghostly figure grow and shrink in size. He ensured the auditorium was in complete darkness, to allow the audience's eyes to adapt to low light levels, locking the doors of the theatre so there could be no disruptions once the performance started. He also made use of sound effects to add to the frightening atmosphere, such as bells, thunder, and ghostly calls. By moving the slides through the projector, he created movement, and smoke blurred the image, heightening the mysterious and enigmatic effect, while multiple projectors were used to make a complete scenography of ghostly images.

The magic lantern as Philidor and Robert used it was too dim to use on stage unless in a complete blackout, however. Brighter projectors using limelight (Q176) as a source appeared, but it was not until projectors using carbon arc lamps (Q232) became readily available that projected images could become a regular part of the scenography of theatre shows. Nevertheless, in 1862 the English scientist John Henry Pepper demonstrated a new way to bring a supernatural apparition onto the stage, with the effect named after him: Pepper's Ghost (Q305). The effect is created by a large sheet of glass placed at an angle on the stage. Out of direct view of the audience in a pit at the front of the stage, a brightly lit actor plays the ghost. The audience sees the ghost's reflection in the glass, but of course can also see the other actors and stage set – the image of the ghost and the view of the stage are overlayed. By carefully arranging the position of the performers on stage and the lighting, the glass and the ghost-actor, the ghost can seem to walk, hover, and pass through solid objects and people.

Like the phantasmagoria shows, the Pepper's Ghost effect fulfilled the 19th century public's appetite for the supernatural, as did other stage effects such as the vampire trap (Q30596) and the Corsican trap (Q30026). Today, equivalents to Pepper's Ghost still exist: the effect now is generally done with video projection onto a special, semi-transparent screen. Hologauze is a fine-weave gauze or scrim, that has a silvered finish to maximise light reflection, while still being fine enough to see through when it is not lit (Q30547). Musion offer a tough but thin transparent plastic 'foil'. Both can be stretched across the stage, serving the same function as the sheet of glass in the 19th century version; the technology is different, but the ability to place a semi-transparent image into the performance space is the same. Just as they did over 150 years ago, audiences today still thrill at the sight of a mysterious image, floating ghostlike in the 'magic box' of the stage.

Pepper's Ghost, Le Monde Illustré, 1862

B.06

In the Limelight

Focusing and controlling the light

La Muette de Portici, Paris Opéra, 1863

The industrial age brought two lighting innovations: gas light, which made the brightness more controllable; and the lime and arc lights, that could create a high intensity 'point source', making it possible to focus the light into a beam.

For centuries, lighting was made only by flame based sources, mainly candles or organic oil lamps, with a limited intensity that was hardly controllable. The light sources were evenly spread over the stage area, organised in floor lights, wing lights and some chandeliers. Top light was impossible because the sources could not burn upside down. Control was only possible by covering the lights or turning them away from the stage. The light could not be focused and directed as a beam. By the end of the 19th century, all that had changed.

The first use of gas light (Q256) in a theatre is contested, but was around 1816-17. The first gas lighting burners were rather rudimentary, producing a large round ('rats tail') or flat ('bat wing', 'fish tail') open flame that generated a lot of risks for the actors as well as the building. The accident in Philadelphia's Continental Theater in 1861 (Q315) where the ballerinas caught fire is just one example of many. The later adaptation of the Argand burner (Q30615) for gaslight provided a glass chimney, ensuring a better combustion and producing more light with less danger. The burners were connected to the gas system with iron pipes for fixed positions or flexible leather tubes for movable equipment.

An advantage of gas lighting is that the flame can burn upside down. For the first time, border lights, lighting the stage from the top, could be used. Together with wing lights, footlights, and 'all sorts of special form and size to suit particular pieces of built scenery', they formed the basis of the lighting plot. In the auditorium, the main chandelier was replaced by a 'sun burner' and the lights on the sides with smaller burners. These could also be controlled along with the stage lighting, which made it possible for the first time to darken the auditorium.

Control was done with a simple gas table, a set of valves with a master valve. By controlling the amount of gas, the intensity could be adjusted. A valve would control one, two or three rows of burners. Later, small pipes were added to ensure a pilot flame would stay lit if the burners were extinguished, so allowing complete blackouts during the performance. Bram Stoker (Q258) states in his essay on Irving and lighting (Q259) that darkness was 'found to be, when under control, as important a factor in effects as light'. Changeover could, from this moment on, be done in darkness, without closing the curtain. The stagehands were therefore given 'dark clothes and silent shoes'.

Gas Control at the Normansfield Theatre

Carbon Arc Floodlight

Limelight men operating in the fly-gallery (The Graphic, 1874)

The arrival of lime light (Q176) in the 1830s changed the way lighting was used on stage. For the first time, a high power point source was available, so it was possible to make full use of optical systems, focus the light in a specific direction, put an actor 'in the spotlight' or reveal the dimensionality of an object. Shadows became sharp, defined and visible, and the full range of colours became readily discernible. Effects such as Pepper's Ghost (B.05, Q305) could be achieved. Projections on stage became powerful enough to be combined with stage lighting.

The luminous source of a lime light is a block of lime heated at a point by an oxygen-hydrogen burner, creating an intense white light. This point source can be placed in the focal point of a concave mirror to create a powerful beam (open lime), or the light can be concentrated and directed using a lens. In both cases a beam is created that can't be created with flame based light sources. The lime light needed the constant attention of an operator to control the gas pressure and the burner, and turn the lime block, so the lime light was used more like a modern-day follow spot than like a spotlight. Lime lights were expensive to run, and could only be placed where a human operator could reach them, so the general lighting of the stage continued to be gas light, with limes for effects.

The carbon arc lamp (Q232) was the first electric light used on stage, creating an intense blue-white light from the discharge between two carbon rods fed from a DC power supply. As the use of electricity for other applications grew, and electricity supplies became more readily available, carbon arc lamps replaced lime lights as a focused source of light from the 1880s, with all the same benefits as limes.

The 19th century brought great change to stage lighting, with the move to gas for general lighting and the introduction of lime and arc lamps for directional, focused light for the first time. The fundamentals of today's stage lighting were in place – focused and controllable light – ready to be developed and refined with the complete electrification of lighting that followed.

C.06

The Mystic Gulf

The invisible orchestra

View from the orchestra at Bayreuther Festspielhaus

Wagner termed the space between the 1st and 2nd proscenium in the Bayreuth Festival Theatre the 'mystic gulf'. The sound cover hides the orchestra, making it invisible to reinforce the stage illusion by removing a visual distraction.

The wooden sound cover consists of two parts: a horizontal sound screen attached to the front of the stage and almost completely covering the orchestra pit from behind, and a shell-shaped screen between the orchestra pit and the auditorium, which reflects the sound rising from the orchestra pit towards the stage and prevents direct sound from reaching the auditorium.

Bayreuth's orchestra pit, which is unique in the world, descends in terraces on six steps to the back of the stage and is completely invisible to the audience. The result of this exclusively indirect sound distribution in the auditorium is a mixed sound that makes it virtually impossible to locate not only individual instruments but the entire orchestra. Instead, an orchestral sound is achieved that spreads ubiquitously throughout the room.

> In a perfect theatre building, it is the demands of art that give, even in the smallest details, the standard and the measure (...) The stage has, in the first place, the task of fulfilling all the conditions required by the dramatic action (Richard Wagner, Q30604).

The new operatic form, Wagner's conception for the Work of Art of the Future, was to lead to a new architecture and new theatre techniques. In 1871, after an unsuccessful attempt to build his theatre in Munich with the architect Gottfried Semper, Richard Wagner identified the city that was to house it: Bayreuth, halfway between Berlin and Munich, the two great German cities (Q5086).

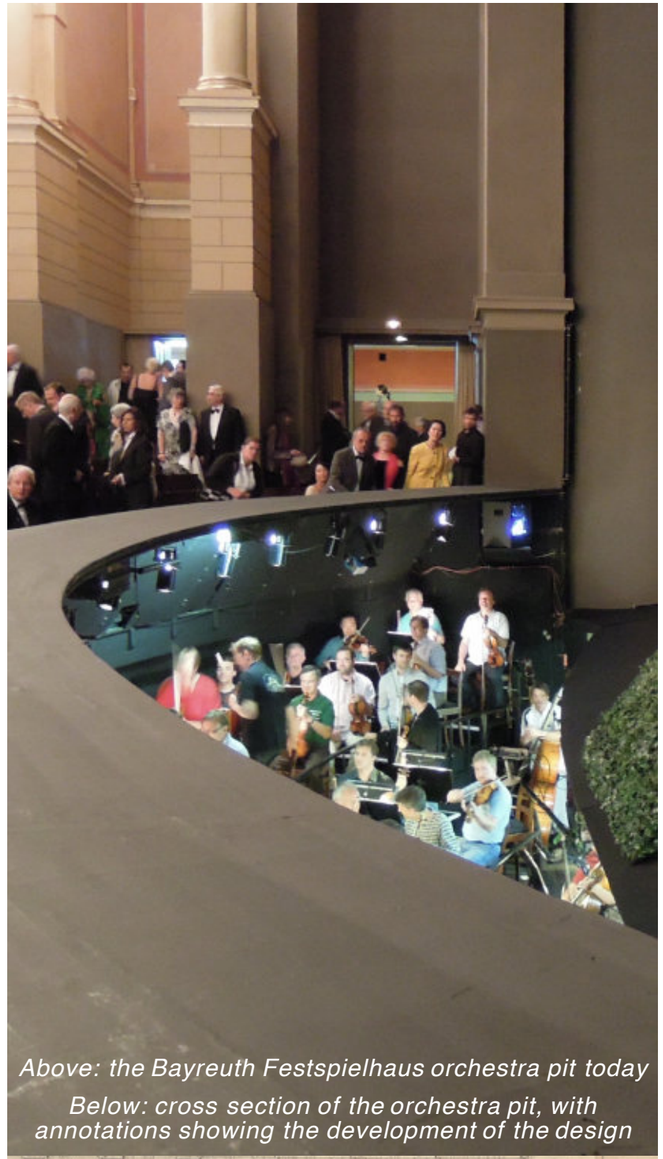
The poverty of the materials used in the construction and the absence of ornamentation are the two points Wagner emphasises in his description of the new building, which aims to establish a relationship with the spectator very different from that of the great bourgeois opera houses of the period such as Charles Garnier's Paris Opera (Q365), opened only a year before. But it is not only these aspects that distinguish Bayreuth from the great opera houses of the 19th century. Other innovations differentiate the space.

The first of these is the darkening of the auditorium during the performance. The spectator was to concentrate on the reception of the work of art; nothing was to be a distraction. The value of the theatre as a social meeting place was irrelevant for Wagner. In the auditorium one is not there to see and be seen, to whisper between aria and aria, one is there to contemplate, to listen devoutly to the Wagnerian *Gesamkunstwerk* (Total Work of Art).

The second innovation is the arrangement of the audience in an amphitheatre, in the manner, though not exactly in the manner, of the Greek theatre. Here, too, the Festspielhaus stands as a landmark against the *teatro alla italiana*: the classical amphitheatre versus the horseshoe; the unitary image of the people, of the nation, *das Volk*, attending, united with the work of art, as opposed to the compartmentalisation in boxes, as in theatres such as La Scala in Milan (Q2610), with its fragmented ownership.

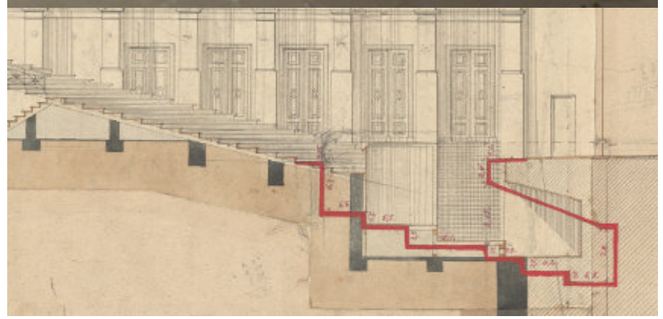
The final innovation consists in hiding the orchestra in a pit, concealing the 'technical apparatus of music', the musicians playing their instruments, so reinforcing the spirituality of the music, which was to envelop the hall without being visible where it came from. Walter Benjamin contrasted this operation with Bertolt Brecht's epic theatre. For Benjamin, the ideal epic theatre space should be raised on a platform like a boxing ring, unlike that of Wagnerian opera, in which the unfathomable, mystical abyss separates the dead from the living, the stage from the hall, the ideal from the real.

The separation of the world of the stage from that of the audience is strengthened by the pilasters that run through the hall, as if they were a sequence of proscenium arches, producing an optical effect that adds depth to the scene, mysteriously distancing it from the expectant community. Everything in this theatre is designed to accentuate the mystical abyss between the auditorium and the stage: the life of Art. The new operatic form, *The Work of Art of the Future*, was to lead to a new architecture, while the orchestra – the very essence of opera – was to become invisible, and music was to be detached from the living, breathing means of its creation. The invisible orchestra, and the invisible – or at least intangible – stage was later to find its fullest realisation, as Susan Sontag pointed out (Q30607, 157), in that immaterial stage, the cinema screen.



Above: the Bayreuth Festspielhaus orchestra pit today

Below: cross section of the orchestra pit, with annotations showing the development of the design

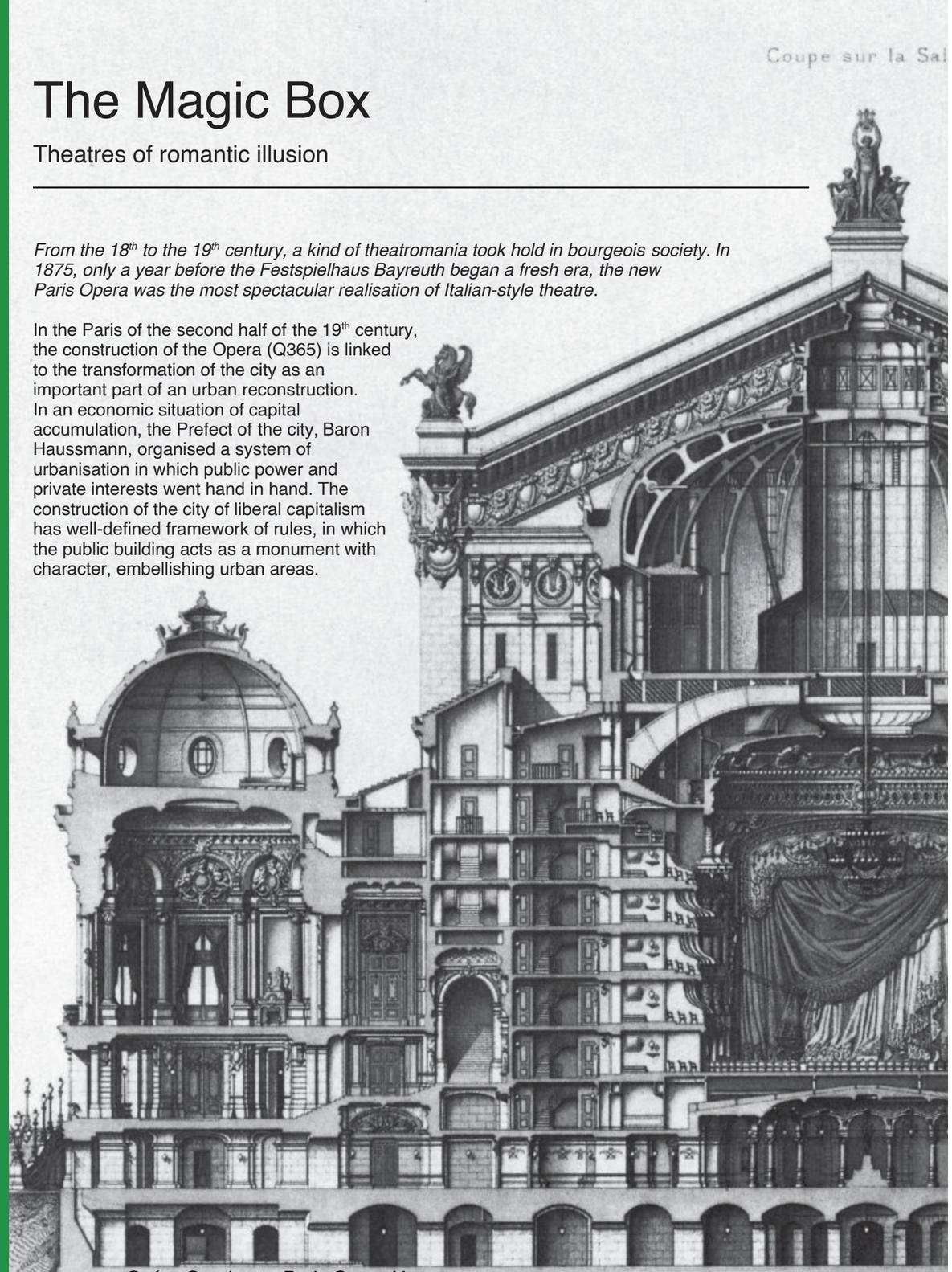


The Magic Box

Theatres of romantic illusion

From the 18th to the 19th century, a kind of theatromania took hold in bourgeois society. In 1875, only a year before the Festspielhaus Bayreuth began a fresh era, the new Paris Opera was the most spectacular realisation of Italian-style theatre.

In the Paris of the second half of the 19th century, the construction of the Opera (Q365) is linked to the transformation of the city as an important part of an urban reconstruction. In an economic situation of capital accumulation, the Prefect of the city, Baron Haussmann, organised a system of urbanisation in which public power and private interests went hand in hand. The construction of the city of liberal capitalism has well-defined framework of rules, in which the public building acts as a monument with character, embellishing urban areas.



Opéra Garnier, or Paris Opera House.

The work of Charles Garnier (Q531), a synthesis of the École des Beaux Arts and the empiricist movement, is a blend of rationalism and picturesque style. The interior and exterior of the building are related: the play of the various volumes of the building reveals the different parts of the Opera House. Garnier articulates the masses according to a sequence which can be perceived from afar thanks to the differentiation in planes established by the play of the roofs. The volume of the stage tower acts as a pictorial background to the composition, in which the top of the gabled roof outlines a silhouette which, despite the differences, is similar to that of classical temples. The dome of the auditorium emerges in the intermediate plane. And in the foreground is the colonnade of the foyer.

Inside, the Paris Opera displays in all their splendour the emblems which had characterised the Italian-style theatre. For a long time, the stairs had been limited to providing access to the different floors of the building. In Giuseppe Piermarini's Teatro alla Scala in Milan (Q2610), inaugurated in 1778, the magnificence of the hall contrasts with the meagre size of the foyer. For the Paris Opera, Garnier did not use the model of the Burgtheater Vienna (Q7817) by Gottfried Semper, inaugurated in 1888, where the spectator enters the auditorium with almost no preliminary space, ascending a staircase with a certain authoritarian air that expresses well the power of the emperor and the aristocracy's desire for ostentation, but which does not make the access theatrical, playful. In Paris, Garnier multiplies the opportunities to contemplate the arrival of the spectators like a stage director. The ascent takes on a less abrupt, more fluid movement. An architectural promenade in which the foyers provide an opportunity for rest, for conversation before entering the auditorium or during intermission.

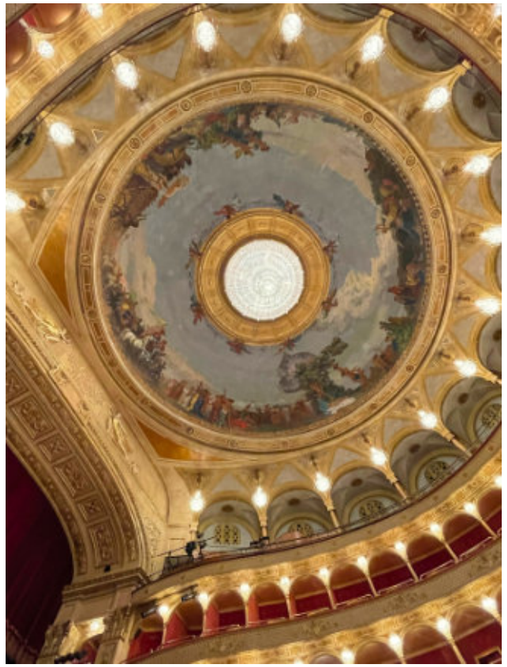
The audience boxes are described by Marcel Proust in *A La Recherche du Temps Perdu* as 'small hanging rooms with one of their partitions removed', in words almost identical to André Antoine's definition of the theatre stage: a room with one wall removed - the fourth wall. The boxes thus serve as a stage as well as a tableau. Their occupants must be experts in the art of balancing the act of seeing and the act of showing. They must know how to appear and disappear.

However, the boxes had to fight against the amphitheatrical layout of the auditorium, preferred by the spirit of the enlightenment for both ethical and aesthetic reasons. For the enlightenment, the sad repetition of the boxes broke the unity of the hall and prevented the celebration of a collective, communal spectacle. It is for this reason, and because of its classical reference, that Richard Wagner adopted the amphitheatre as opposed to the boxes in the Festspielhaus in Bayreuth (Q7857).

In bourgeois opera houses, the boxes win the contest. Among them, the royal box, when it is there, acquires a singular presence. The royal box is an eye, that of the King set up as a superior divinity. Because of its size, the royal box makes the monarch present in the hall even when he is absent. The French arrangement places the monarch on the proscenium, the king ceases to see the scene to offer himself to the admiration of the hall.

The chandelier and the ceiling of the auditorium are further emblems of opera houses. The sun and the sky cover the auditorium and offer yet another opportunity for the artists and craftsmen whose work gives the building its splendour. And finally, completing this ensemble and marking the boundary between the world of reality and that of fiction, the curtain of the mouth unfolds, another opportunity to load the universe of the architecture of bourgeois operas with symbols and allegories.

Auditorium of the Teatro dell'Opera di Roma, Rome (Q8407)



Production and Reproduction

The mass production of scenes and scenery

In the later part of the 19th century, changing ideas about how theatre should be made created a demand for more realistic staging – a demand met on an industrial scale by workshops that sold scenery and other staging requirements from a catalogue.

The second half of the 19th century was a period of great change, brought about by the industrial revolution, advances in science and new ideas on religion, government, and culture. The theatre responded by seeking to project new visions: romanticism and classicism gave way to naturalism and realism. Interest in historical accuracy grew like never before. Archaeological precision was expected in the architecture represented on stages, in the furniture, curtains and in all the ornamental details that appeared on stage, and in the costumes in action, style and form. This new trend toward historical accuracy was costly, because instead of using the same sets and costumes repeatedly, sets had to be designed and built to be the visual embodiment of the action in a specific time and place.

The number of theatres increased and theatre workshops and set decoration studios grew. Catalogues were printed so that the theatres could place their orders directly with the studios, and the painted scenes were made according to the stage measurements.

The historical rigour was already notable in the productions made between 1850 and 1859 by the director Charles Kean (Q30559). His repertoire was composed almost entirely of poetic drama (especially Shakespeare) and melodramas in which he introduced his 'improvements'. The sets featured impressive painted panoramas and multiple machine effects. Kean's productions became known and admired throughout Europe, especially in Germany. For example, Friedrich Haase (Q30560) had seen productions by Charles Kean in London, and declared himself indebted to them. Haase became famous for his productions at the court in Saxe-Coburg-Gotha from 1866 to 1868 and in Leipzig from 1870 to 1876. These productions were designed by the brothers Max and Gotthold Brückner (Q30561, Q30562). The Brückners would later be employed by the two most influential director-managers of the last quarter of the 19th century.

For four decades (1870-1913), Max Brückner ran one of Germany's leading scenic art studios in Coburg in northern Bavaria with his younger brother Gotthold. Max Brückner was a great theatre painter and landscape painter born in Coburg. His father, Heinrich Brückner was also a painter at the Hoftheater in Coburg and his first teacher.

In 1863 Max Bückner began working at the Stadttheater Köln (Q17047). He was on good terms with Ernest II, Duke of Saxe-Coburg and Gotha (Prince Albert's older brother, who would become consort of Queen Victoria of England). The Duke for example paid for Brückner's study trip to London, where he became acquainted with the burgeoning naturalistic-historical set design and the latest achievements in theatrical machinery. Then in 1865 the Duke appointed Brückner life theatre painter at the Hoftheater in Coburg (Q8050), with express permission to accept foreign commissions.

Max Brückner then founded a studio in the family home in Coburg in 1870, and two years later his younger brother Gotthold joined him. The 'Gebrüder Brückner - Atelier für szenische Bühnenbilder' (The Brückner Brothers – Scenic Workshop) produced set designs for all major theatres in Germany for the next 40 years. In 1874, through the mediation of Carl Brandt (Q414), the best-known theatre engineer of the time, he came into contact with Richard Wagner, for whom he initially created the sets for the *Ring des Nibelungen*, between 1882 and 1911 sets for all of Wagner's major operas were created in the Brückner workshop. They also designed sets for King Ludwig II of Bavaria and regularly did work abroad, for example Darmstadt, Mannheim, Wiesbaden, Hamburg, Cologne, Zurich, Petersburg and New York.

The Brückner brothers' stage sets were known for their historically accurate depiction and strong yet subtle colouring, and achieved world fame over decades. They made various efforts to combine painted scenery with sculptural set design, experimented with shifting and cyclorama horizons, and with the use of lighting as a means of scenic design.

As Max Brückner had no children, he appointed his pupil Max Kürschner as his successor; from 1913 the company was called 'Max Brückner Nachfolger Max Kürschner - Atelier für szenische Bühnenbilder'. He went blind in 1914 and donated his estate to the art collections of the Veste Coburg. Parts of his archive is in the Theatre Studies Collection of the University of Cologne, including catalogues for painted sets in different sizes. Some of Brückner's scenery can be seen in the Meiningen Theatre Museum (Q9287).

At a time of great demand for theatre, and for theatre presented in a detailed and realistic style, the Brückner Brothers developed a model of scenic design, construction and painting that followed the industrial and commercial model of the age.

Designs by Max Bückner for the operas of Wagner.

Left: reproduction of the design by Brückner for the final scene from *Götterdämmerung*, showing Valhalla on fire

Above: design for Valhalla, 1896

Below: design for *Die Walküre*,1896

The Brandt Dynasty

Intra-family knowledge transfer over generations

In the 19th and early 20th centuries, the Brandt family significantly shaped stagecraft practice at Germany's major court theatres. Their influence was largely based on traditions of practical knowledge, transferred between members of the family.

In the absence of textbooks, training standards or legal requirements for the profession of stage technician, the professional practice in the 19th century was determined by the personal transmission of knowledge, and the social position at court.

Favoured by courtly privileges, the Brandt family (Q4822) passed on practical knowledge from father to son, from master to pupil. Theoretical-systematic foundations hardly existed; stagecraft found its conventionalised methods of work dictated by the theatre architecture. The stage-technical practice and the technical set-up of new theatre buildings were characterised by tried and tested procedures, technical solutions for staging problems and a few prominent stage reform ideas from professional authorities. Through a circle of students that steadily expanded beyond the family, the Brandt family built an effective professional identity. In 1929, Friedrich Kranich's influential Bühnentechnik der Gegenwart (Q264) concisely portrayed the family as the bearers of practical stage knowledge.

Probably the most defining figure of the stage technician family – not the only one, but the largest and most influential – was Carl Brandt (Q414), one of the four sons of the upholsterer and machinist Elias Friedrich Brandt (Q413). All the brothers had varying degrees of success as stage technicians. In addition to Carl's engagements at the Munich Court Theatre and, after a brief period around 1848 at the Königstädtisches Theater Berlin, as head of machinery at the Darmstadt Court Theatre, he distinguished himself as the machinist for the first Bayreuth Festival in 1876. Not only did he realise Wagner's 'Ring of the Nibelung' for the first time, but he was already involved in the planning and construction of the theatre itself.

Carl Brandt was supported by his younger brother Fritz Brandt (Q415) and his son, also Fritz Brandt (Q4821), who both studied under him. While Carl's brother successfully directed the technical side of the Königliche Schauspiele in Berlin for more than four decades, the Brandt family's renown was strongly linked to the Bayreuth Festival. The Brandt's reputation benefitted from their meeting Wagner's technical requirements, which were considered almost unsolvable.

The family's practical expertise, in contrast to a later educational and professional practice based on abstract standards, can be placed in the more general development of art, technology and science. The Brandt family is an example of a master-pupil relationship that was common in traditional trades, but in this case privileged by the court. The socially differentiated technical professions only became more accessible when the technical universities shaped abstract, theoretical knowledge cultures. Here, even those who were not born into the profession could now acquire and apply professional knowledge. Theoretical training started to push back against a technical professional practice, which was shaped by genealogy and ideas of honour – but without completely abandoning these virtues of practical knowledge. Friedrich Kranich's *Handbuch Bühnentechnikder Gegenwart*,writteninthe 1920s, is a paradigmatic example of theorising stage technology based on genealogical tradition.

Georg Brandt (Q4824), the son of Carl's brother Fritz and himself a stage technician trained in the family circle, donated his father's collection of stagecraft related material to Friedrich Kranich, who was then technical director of the Bayreuth Festival. Fritz Brandt's estate, which was used as a basis for Kranich's handbook and which documents the stage-technical practice of the Brandt family in the 19th and early 20th centuries in a wealth of material, has been digitised by the Theatre History Collections of Freie Universität and made available in a database (Q4826). Today, experience and expertise are spread through training, education and standards as well as learning on-the-job, but in the 19th century, personal and social links were critical to the transmission of stagecraft and the building of the technical stage profession.

Abb. 10. Karl Brandt-Darmstadt

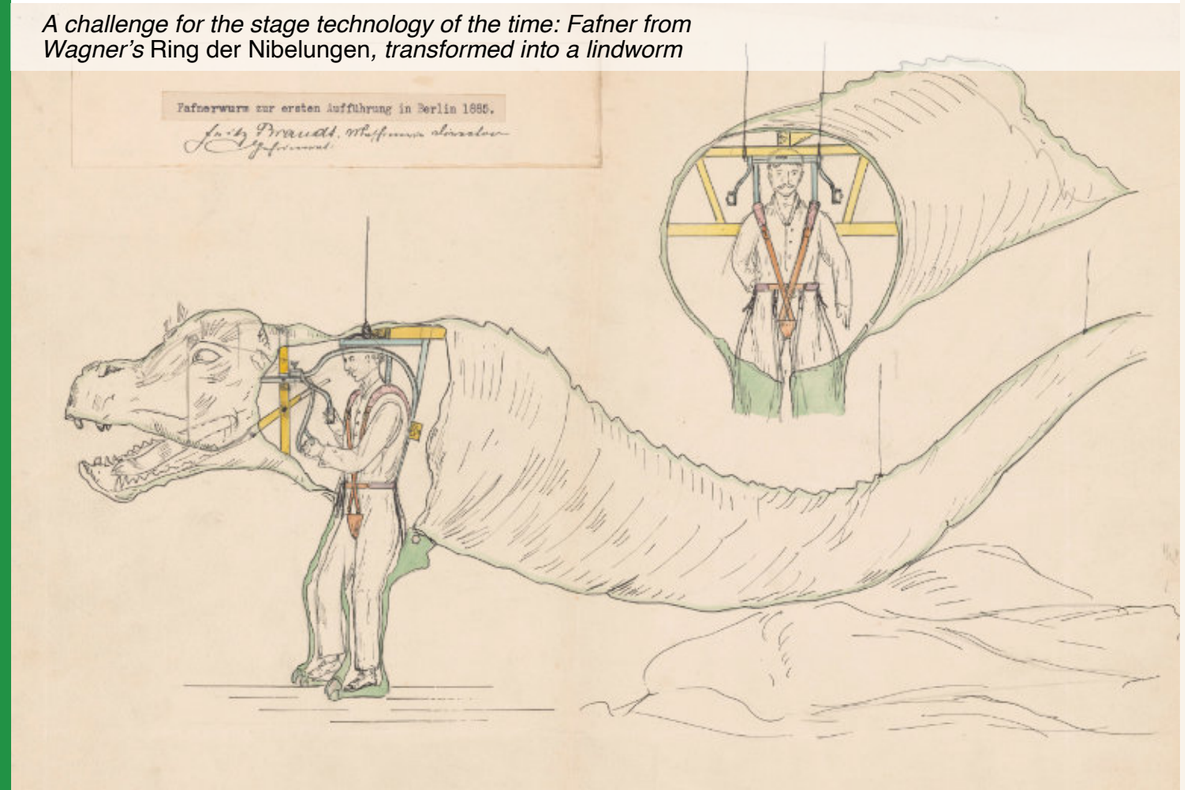
Abb. 13. Fritz Brandt-Berlin

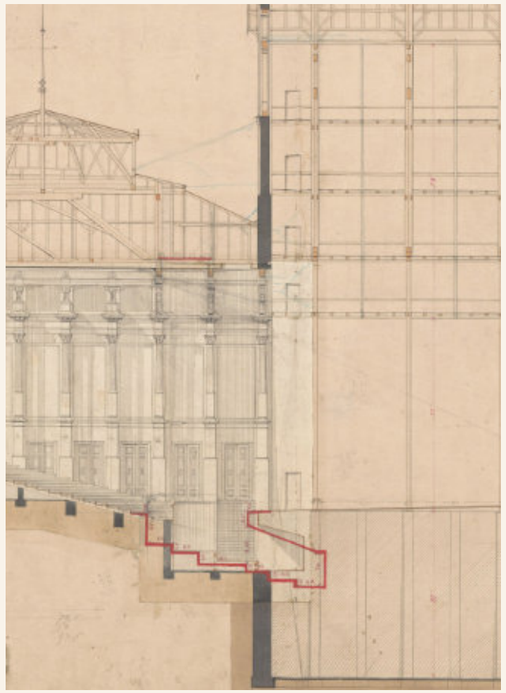
Abb. 11. Karl Brandts technischer Stab, Bayreuth 1876

Abb. 12. Georg Brandt d. Ältere-Kassel

Abb. 14. Fritz Brandt-Weimar

A challenge for the stage technology of the time: Fafner from Wagner's Ring der Nibelungen*, transformed into a lindworm*





Bayreuth Festival Theatre, cross section, with the orchestra pit (D.05) marked in red

Industrial Revolution

Reorganising theatre for an industrial society

Underlying the theatrical changes of the 19th century were the social upheavals following the French Revolution. Across Europe the middle class took over or built new theatres, effecting changes to repertoire, style and design, as well as machinery.

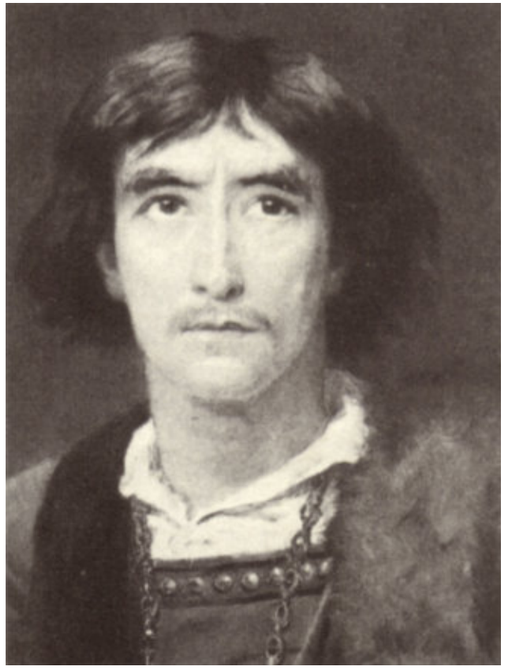
Throughout the 19th century, cities exploded in size, as industrial centres attracted labour to their factories and mills. The working-class suburbs of cities and the industrial towns created their own demand for entertainment, which led to the construction of large theatres. The pattern of theatre was disrupted: in England, for example, productions were mounted in London and sent on tour, facilitated by the growth of the railways, which could rapidly and cheaply transport not only a company of actors, but an entire production with scenery, costumes and props. The railway companies even built special trucks to transport scenery. The old provincial stock companies folded and theatres became touring venues rather than producing houses. The change in status from enterprise to industry gave rise to the commercial theatre systems and the exchange of productions further extended the possibilities of profitable exploitation. Touring companies were led by actor-managers, such as Henry Irving (Q257), who formed their own companies and controlled the actors, the production, and the financing, as well as staring in the productions. The most successful of these were enormously popular, gathering huge audiences.

National theatres were founded to give expression to the views and values of the middle class. In western Europe a different pattern of development emerged, varying considerably in each country but having the unified features of a demand for 'realism' on the stage, which meant a faithful reflection of the life-style and domestic surroundings of the rising class in both its tragic and its comic aspects. Those in revolt founded so-called independent theatres to present a more critical or scientific view of the workings of society or so-called art theatres to rise above vulgar materialism with the establishment of aesthetic standards. Independent theatres took the Meiningen Ensemble as their model, sometimes only to a closed membership, to avoid censorship. The art theatres looked to Wagner for inspiration.

The new theatre demanded 'truthfulness' not only in the writing but also in the acting and stage setting. The actors were expected to ignore the audience and to behave and speak as though they were at home; from this style of acting arose the concept of the 'fourth wall' separating the stage from the audience. Behind this 'wall' – invisible to the audience, opaque to the actors – the environment portrayed was to be as authentic as possible. If an attack on the audience were to be mounted effectively, however, the separation of stage and auditorium had to be diminished. Attempts were later made either to contain stage and auditorium in a single unified spatial area or to adapt existing spaces in order to break through the barrier imposed by the proscenium arch.

With both ideological aims and theatrical tastes in mind, members of the German middle-class theatre audience formed an organisation called the Free Volksbühne in 1890 for the purpose of buying blocks of tickets and commissioning performances and even productions for its membership, which included a large working-class element. During the 1890s in France, a similar program of democratisation was attempted by *Le Théâtre du Peuple*, inspiring similar movements in other countries. In England the works of Ibsen aroused great interest and attracted the attention of the censors, as with the work of George Bernard Shaw.

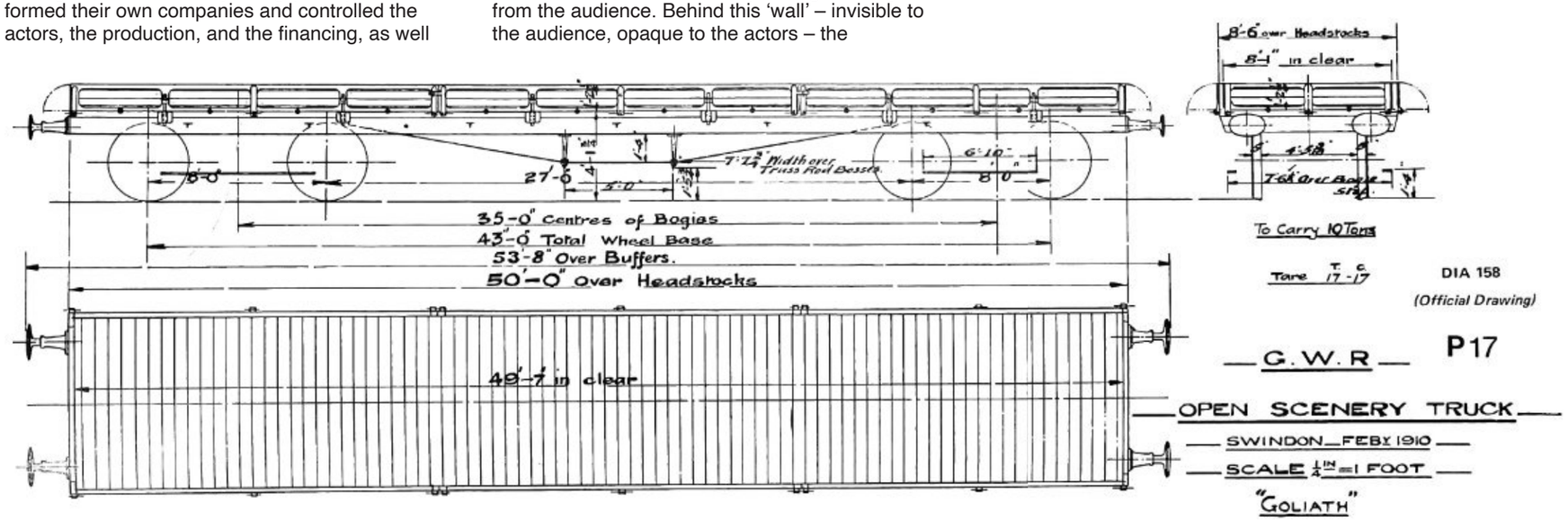
Beyond the development of stage lighting and techniques, from the 1880s electricity provided the solution to many of the problems that were arising with respect to scene changing (c.06). The demand for rapid changes of cumbersome naturalistic sets coincided with demands for a dematerialised stage that could flow smoothly from one symbolic vision to another. In addition, those seeking to 'retheatricalise the theatre' wanted an open stage on which scene changes could be accomplished simply and rapidly. New inventions and instrumentation made practical many of the theoretician's ideas, and these were adapted by designers, directors, and stage engineers on both sides of the Atlantic, with the greatest centre of innovation being Germany.



Henry Irving as Hamlet*, 1888*

In 1896 Karl Lautenschläger introduced a revolving stage at the Residenz Theater in Munich (Q13019). Elevator stages permitted new settings to be assembled below stage and then lifted to the height of the stage as the existing setting was withdrawn to the rear and dropped to below-stage level. Slip stages allowed large trucks to be stored in the wings or rear stage and then slid into view. New systems for flying were developed. Hydraulic stages made it possible to raise sections of the stage, tilt them or even rock them to simulate, for example, the motion of a ship. All of these mechanisms required larger backstage facilities, higher flying towers, greater depth and width of stages, and increased under-stage space.

The 19th century was the peak of the industrial revolution, radically changing not only technologies, but the whole of society across Europe. The theatre took on new roles, used new methods to produce work, organised itself in new ways, and made performances that were innovative in content and form.



‘For Thine Especial Safety’

The fire safety curtain

The safety curtain is a fire safety device used in large proscenium theatres. It can be lowered to separate the stage house from the auditorium in order to ensure a safe escape of the audience, in the event of fire.

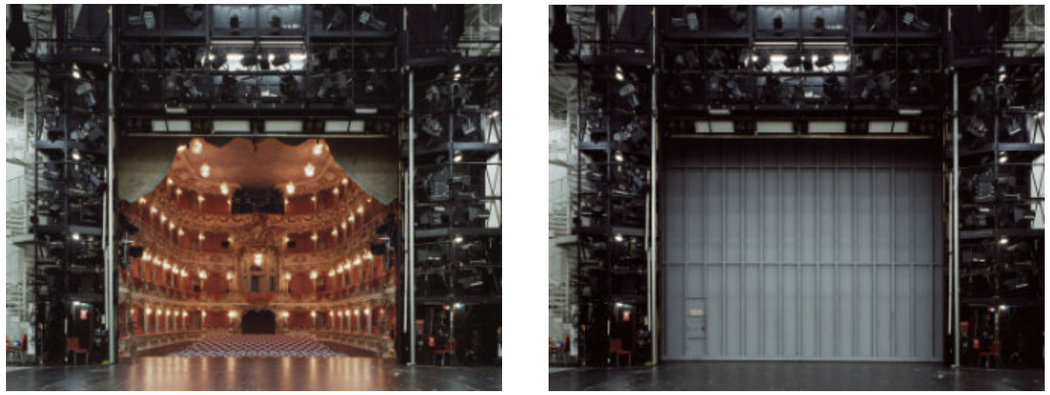
The safety curtain (or fire curtain in America, Q3626) is usually a heavy fibreglass or iron curtain located immediately behind the proscenium arch, sometimes referred to as the ‘iron’, regardless of the construction material.

Fires in theatres occurred frequently in the 19th century due to the use of gas lighting or open flames. In addition, the protection and extinguishing measures of the time were inadequate and often inoperable. In some theatres lightweight protective curtains were employed (so-called wire *courtines* made of iron wire mesh, first mentioned in Lyon, 1787), which were used like a normal fabric curtain. In 1794 the Theatre Royal, Drury Lane in London (Q7851) became the first theatre to install an iron safety curtain.

Following large fires in the last third of the 19th century, the unity of auditorium and stage was recognised as a weak point, leading to the introduction of safety curtains on a wider scale. In Austria, the iron curtain had been recommended by the fire brigade since at least 1864, and following the Ringtheater fire in Vienna in 1881, it was required by law (Q696). The Asphaleia Society, founded after the accident, made it its task to develop a fire-safe model theatre and mentions a ‘metal curtain’ in its documentation (Q19107). In Germany, the protective curtain also became compulsory from 1889 after several theatre fires, while the fire at the Theatre Royal, Exeter (Q9291) in 1887 – the worst in British history – was influential in the introduction of safety precautions for public buildings.

The introduction of the iron curtain in the theatre marked a turning point in theatre construction and

The safety curtain as a temporary exhibition space at Wiener Staatsoper



The safety curtain open and closed at the Cuvillié Theatre, Munich

significantly changed the demands on stage technology, as the curtain had to fit out of view above the stage in one piece. The large superstructures above the theatre roofs now housed the iron curtain in addition to the mechanical equipment for the scenery and lighting.

The curtain is extremely heavy and therefore requires its own dedicated operating mechanisms. In an emergency, the stage manager can usually pull a lever backstage which will cause the curtain to lower rapidly into position. In the UK, it is a requirement that a safety curtain must be fully down within the proscenium opening within 30 seconds of being released. A mains-independent warning signal must be audible during travel. Manual release must be possible in at least two places. The fire curtain may contain a door opening, and it must also withstand a pressure difference of 450 Pa in both directions.

In the event of a fire, the use of smoke ventilators above the stage and the fire curtain means that the stage area effectively functions as a chimney. The heated air rises and leaves through the smoke vents, and this puts the building into negative pressure, which in turn draws fresh air in through any open exit doors. Patrons waiting to exit will have fresh breathing air until the exit doors close. The exit doors which open out will be drawn closed tightly by this draft once they are no longer held open by evacuees. Once the doors are closed, the fire loses its oxygen source.

The line of the fire curtain must be kept clear of scenery and no cables may be laid across the ‘iron line’. The water spray extinguishing system required for large stages must also be capable of cooling the protective curtain in order to increase its service life in the event of fire. The safety curtain must be checked for proper function by raising and lowering it every performance day – in the UK, it must be lowered and raised in the presence of the audience, usually during the interval. It must also be inspected regularly by a qualified person.

Iron curtains can also be used for artistic purposes. At the Vienna State Opera, for example, a series of exhibitions conceived by the Vienna Museum has transformed the fire curtain into a temporary exhibition space for contemporary art since 1998. For each season, the curtain is designed by a different artist. In the National Theatre, London’s *Lyttelton* auditorium the safety curtain divides into two, one half rising up, and the other half lowering into the floor. It was used to great dramatic effect in the opening sequence of the 1992 production of ‘An Inspector Calls’.

The fire curtain at the Theatre Royal, Drury Lane in London is painted with a scene of iron gates, trees and sky, and features a quotation from Shakespeare’s *Hamlet*: ‘for thine especial safety’. Originating in the age of flame-based lighting, the fire curtain not only protects audiences in the event of fire, it also provides reassurance that their safety is guaranteed.

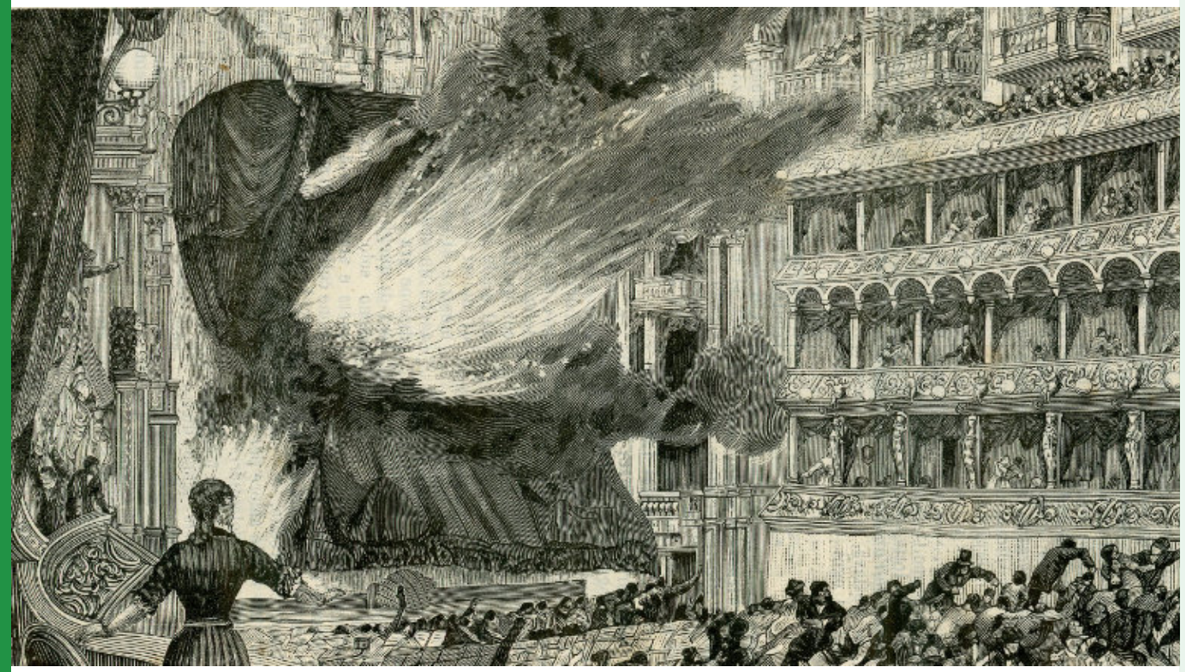
The fire at the Theatre Royal, Exeter

Learning from Tragedy

The fire at the Ringtheater, Vienna

In the age of candle, oil and gas lighting, theatre fires were frequent and often claimed many lives. The Ringtheater fire in 1881 was one of the biggest fire disasters of the 19th century, and it led to many developments in fire safety.

The fire at the Ringtheater took place on 8th December 1881, and according to official figures the death toll was 384; estimates put the number of dead at even higher, close to 1000. On that December evening, Jacques Offenbach's *Tales of Hoffmann* was performed at the Ringtheater in Vienna, Austria-Hungary (Q696), which had opened 7 years earlier. As the audience took their seats for the 7pm start of the performance, the gas lights were ignited backstage.



The Ringtheater fire, shown in a 1882 illustration

Due to the failure of the electro-pneumatic ignition devices, gas flowed out and exploded the next time the ignition was attempted. The resulting fire jumped to the scenery rigging before rapidly spreading to the rest of the stage and eventually to the auditorium. An existing wire *curtine*,a precursor to the iron curtain, was not closed.

It was not until half an hour later that firefighters attempted to rescue the audience, hampered by fundamental problems. The emergency lighting, consisting of oil lamps, is said not to have been lit because – due to lack of money – the lamps were only filled for inspections. In addition, the emergency exits only opened inwards, which hampered fleeing visitors trying to leave the building. A draft of air coming in through a side window further fanned the fire. Due to a misjudgement of the situation, the police in the theatre anteroom discouraged helpers from further rescue attempts by saying 'All saved!'.

In the following year, the so-called Ringtheater trial took place. All accused municipal officials were acquitted, while three theatre staff, the theatre director and two technicians, were sentenced to prison terms of between four and eight months and partial payment of damages. According to the court, they had failed to check each other and to install emergency oil lamps and had operated the wire curtine incorrectly. The director was released by imperial decree of clemency after only a few weeks in prison, but the stage technicians remained in jail.

The fire made an impact on preventive fire protection in Austria and internationally, especially in the theatre sector. The iron curtain was introduced to separate the stage from the auditorium, and scenery and props had to be impregnated with a fire-retardant treatment. The larger theatres were obliged to have uniformed security guards attend every performance, who had to make arrangements to direct the large crowds in the event of a fire. The guard had to remain in the theatre until the last spectator had left – a regulation that is still in force today.

After the fire, many theatres that were inadequate in terms of safety and lacked escape routes were closed. New buildings with innovative escape route concepts were built, and research was carried out into non-combustible decorative materials. In 1829, Vienna had put into place its first building code, comprising just 30 paragraphs. This was replaced by new building regulations in 1859 and 1868. The Building Code for Vienna of 1883, which took into account the Ringtheater fire and was a Lower Austrian provincial law, was valid until after the middle of the 20th century. It included, among other things, the requirement that doors in public buildings must always open outwards, which is still the case. In Germany, the *Polizeiverordnung* (police ordinance) for the operation of theatres came into being, which was replaced by the *Versammlungsstaettenverordnung* (assembly hall ordinance) that is in force today.

The Ringtheater after the fire

The fire also had an impact beyond safety regulations and procedures. The electrification of the theatres was also pushed forward, replacing gas lighting. The first public buildings with electric lighting were therefore theatres, which were not only better protected from fires, but accelerated the eventual development of stage lighting as a creative component of performance. The theatre reform movement of the early 20th century was thus able to move from two-dimensional images to three-dimensional space.

In wider society, as a spontaneous reaction to the fire, the Vienna Voluntary Rescue Society was founded. During the investigation of the fire, a method to identify the bodies based on the position of the teeth was practised for the first time, laying the foundation for the later renowned Vienna School of Criminology. It was the beginning of forensic dentistry.

The development of technical theatre throughout its history has been driven by new technologies, and people with new ideas about theatre. Sometimes, however, it takes the tragedy of a major disaster to force new and better ways of working.

The Ringtheater in Vienna

The Powered Stage

Hydraulics and motors

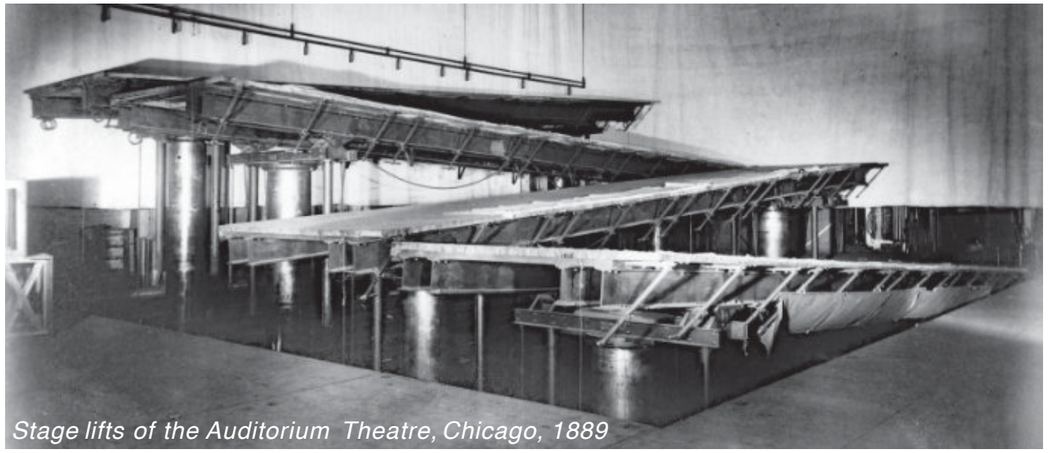
The late 19th century brought a revolution in stage mechanics, as hydraulic and electric power was used for the first time, enabling far larger and heavier machinery than could be operated by human power alone.

In the 1880s, there was a desire for new stage machinery that could support, on the one hand, naturalist drama, with its complete, realistic, three-dimensional scenery filling the stage, and on the other hand spectacle, with its appetite for ever more extraordinary stage effects. There was also a strong motivation to make stages safer by moving from inflammable wood to metal construction. At the same time, the industrial revolution made available several key technologies: hydraulics, steel and electricity.

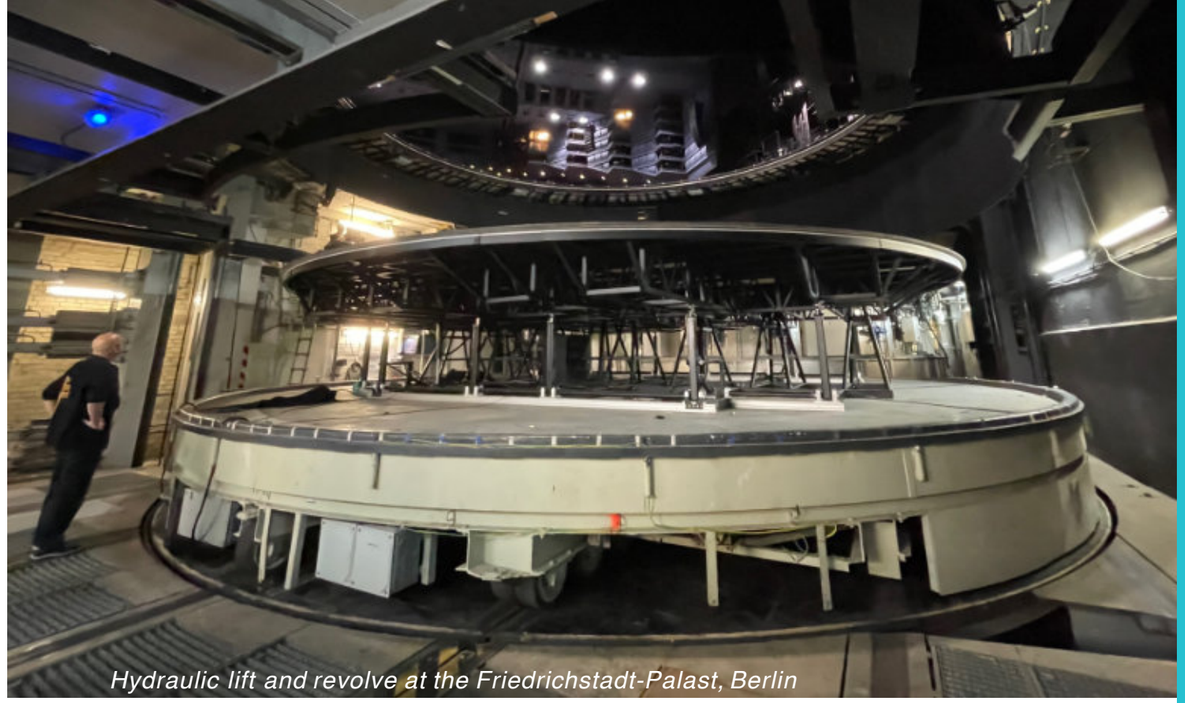
Hydraulic systems, using water or another fluid to transmit power, were known to the Greeks of Antiquity, who developed complex systems of water and hydraulic power. The Frenchman Blaise Pascal discovered the principles of hydraulics, which led to his invention of the hydraulic press, in which a smaller force acting on a smaller area is transferred to a larger force acting over a larger area, transmitted through the same pressure at both locations. Joseph Bramah patented the hydraulic press in 1795, beginning the industrial application of hydraulics, which developed over the course of the 19th century. In 1856 Henry Bessemer developed a new method of steel-making. The Bessemer process greatly reduced the cost of steel production, making it available as a construction material in the second half of the 19th century. In the same time period, numerous scientists and engineers contributed to the development of the electric motor.

Prompted by the Ringtheater fire in Vienna, the Asphaleia Society took advantage of these technological developments to design fireproof stage machinery with a steel structure that was set in motion by water hydraulics (I.06). By the power of hydraulic machines, different segments of the stage could be extended as platforms, lowered, set in an inclined position and even set in a rocking motion to simulate, for example, the motion of a ship. Hydraulics also powered the overhead flying systems. All of these mechanisms required larger backstage facilities, higher fly towers, greater depth and width of stages, and a strengthened grid. One of the advantages of hydraulic power is that it runs very quietly and smoothly, adding to the sense of magical transformation – a return to the sensibility of the baroque stage, but on a far larger scale.

The Asphaleia design was first realised at the Opera House in Budapest (Q7696) in 1884 on the stage of the opera house, and then was installed in theatres all over the world. The Budapest system divided the stage into a grid, each with an independently controllable lift. The lifts were stacked, one upon the other, so the system could create both raised platforms high above the stage, and lower deep below stage level. The platforms could also rotate, to create angled levels – a more dynamically flexible system than had ever been seen on stage before.

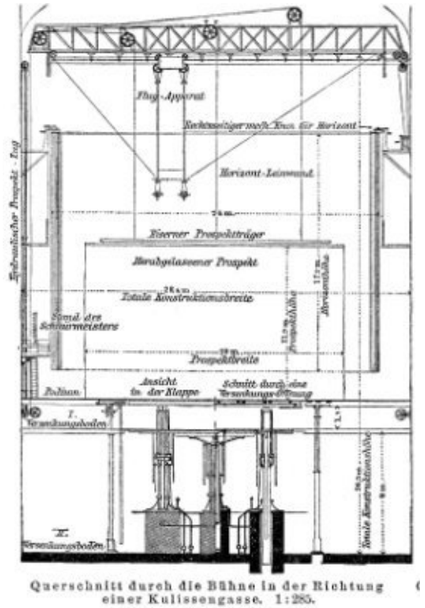


Stage lifts of the Auditorium Theatre, Chicago, 1889



Hydraulic lift and revolve at the Friedrichstadt-Palast, Berlin

At the Theatre Royal Drury Lane, London (Q7851), a system of two hydraulically powered stage 'bridges' were installed, covering the whole downstage area. Shortly afterwards, in 1898, an additional two bridges were installed, this time powered by electric motors, each of ten horse-power. Each of the four bridges was 40 feet by 7 feet. The term bridge, rather than platform or lift, is used to indicate the structures were supported at the ends only, so when raised above the stage the space below was completely clear. The downstage bridges had two independent hydraulic rams, one at each end. When the two rams operated at the same time at a constant speed, then the bridge rose or fell horizontally, but when the rams operated independently, the bridge could tilt, one end higher than the other. The rams were worked by pressurised water, supplied by the mains hydraulic supply of the mains of the London Hydraulic Power Company (Q30568) at a pressure of 800 lbs. to a square inch. The London Hydraulic Power Company was another crucial innovation for mechanised stages (and a variety of other industrial applications) in London – its network of 180 miles of pipes, buried just below the surface of the road, powered many of the West End's safety curtains, as well as the revolves of the Palladium and Coliseum theatres. In winter, the water was heated to prevent it freezing, with the side benefit of melting the snow in the streets above.



Hydraulic lifts and flying machinery, Residenztheater, Munich (Q13019)

As theatre entered the 20th century, it had gained the capacity to transform the stage, moving scenic elements on and off from the back, sides, below and above, to change the form of that apparently most stable of surfaces, the floor itself – all through hydraulic and electric power.

A.07

Infinite Skies

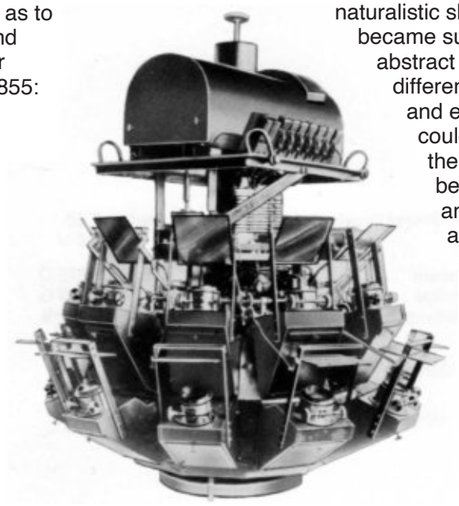
Lighting the cyclorama

The dome and the plaster or cloth cyclorama are used to create a sense of infinite space within the confines of the stage, lit to evoke the sky, to express the dramatic mood, or used as a projection surface.

In 1922, Kenneth Macgowan (Q29856) wrote,

> The dome, or some variety of it, is found in practically every German theater. Linnebach estimates that there are twenty true Kuppelhorizonts, cupping the whole stage with a curving dome; ten permanent Rundhorizonts, plaster cycloramas curving like a great semi-circular wall around the stage; and thirty canvas cycloramas which are quite as large as the Rundhorizont, and some of which are so hung as to make a most convenient and efficient substitute for either variety of plaster sky. (Q29855: 71)

This commitment – technical, financial, and artistic – to the representation of sky, and to providing an enveloping environment of light, was a distinctive feature of German stages in the first decades of the 20th century, and to a lesser extent elsewhere in Europe.



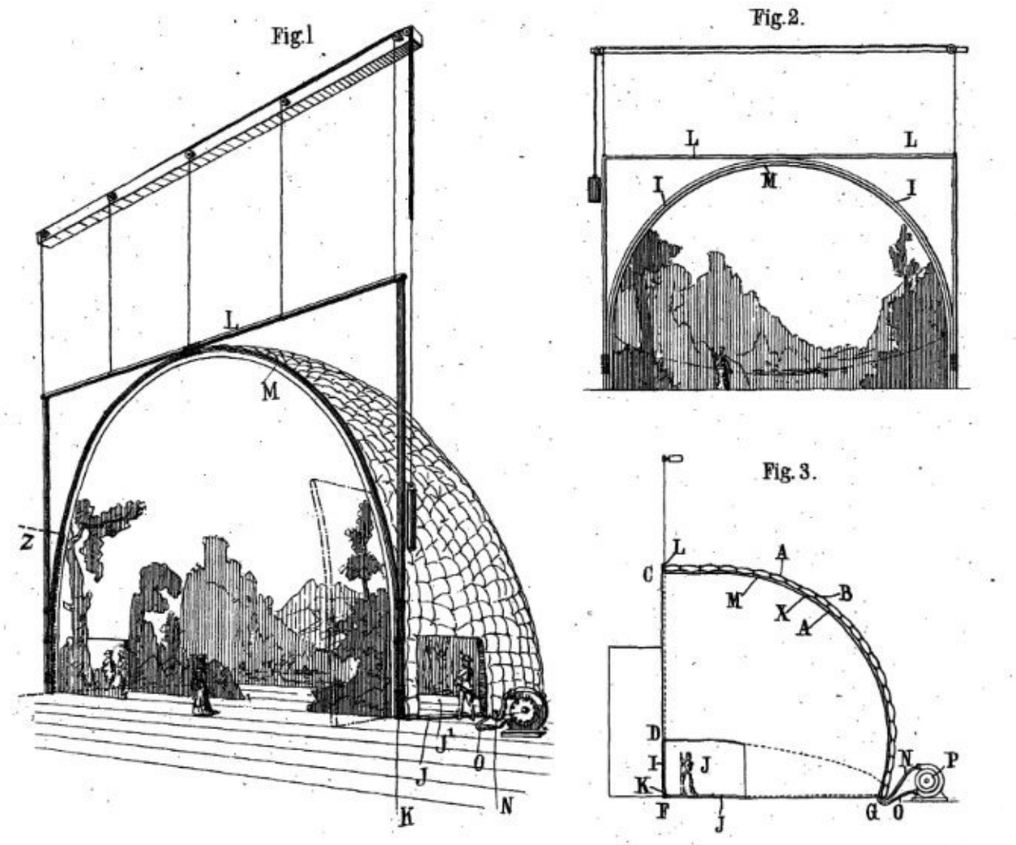
Reich and Vogel cloud projector, c.1960

At the start of the 20th century the Spanish polymath Mariano Fortuny y Madrazo (Q231) invented a sky half-dome to surround the stage, produced by exhausting air from between two curved surfaces of silk, the outer one fastened to a folding frame of steel (Q332). The light of arc lamps, coloured by reflecting it off strips of silk, created a dynamic space of colour and light. Although Fortuny's system was hampered by technical problems, the dome, and the simpler and more flexible plaster or cloth cyclorama, became an established feature of many theatres.

These domes and cycloramas required new methods to light them. In the 1920s, Hans Schwabe and Max Hasait developed a 7-colour mixing system using carefully selected colours that when mixed produced white, but which in various combinations could create a complete palette of colours (Q23493). Specially designed lighting fixtures used curved reflectors to give an even distribution, with glass filters creating the required colour. Companies such as Reiche & Vogel devised elaborate cloud machines that rotated slowly, projecting the image of clouds moving across the sky, through multiple lenses and mirrors. Simpler versions used a rotating disc in a single projector to create moving clouds.

The aim was not always to recreate a naturalistic sky. Domes and cycloramas became surfaces for the dynamic use of abstract colour; by lighting from different directions (above, below, and each side) blends of colour could be achieved. In a large theatre, with enough space between the lit area of the stage and the cyclorama, the effect of an empty void could be created by not lighting the cyclorama at all. These effects were used expressionistically, to underscore in light and darkness the emotional narrative of the drama.

Domes and cycloramas also became surfaces for projection. In 1917 Adolf Linnebach (Q419) developed a simple but effective system for projecting an image without lenses, comprising a single, powerful light source and a large glass slide (Q639). The required image was painted on the glass with translucent paints, and opaque cut-outs created shadows within the scene. Although the image was not optically sharp, the system made highly impressionistic effects that could be combined with lighting. Later, projectors were developed by companies such as Pani, with lens systems that produced sharply focused images.



Fortuny's designs for a sky dome (Q332)

Slides could be created by the painting method, or photographically. These projectors became standard equipment in large theatres and opera houses, until replaced by today's digital video projectors.

Equipment and techniques developed for the theatre were adopted in other fields. Cinemas of the 1920s and 1930s installed lighting and projection equipment to fill the auditorium with atmospheric effects of sky and clouds between the screening of films. The 'wrap around' cyclorama, together with its lighting equipment, became a standard feature of most television studios. Domes are now used in planetariums to give spectators the experience of the night sky, while video projection is used in art galleries to create immersive experiences, with images projected on every surface. In the 'fulldome' concept, films shot with 360-degree cameras are projected onto the inside of a dome containing the audience.

In theatre, changing fashions in stage design mean the permanent domes and plaster cycloramas have mostly been removed. Curved, cloth cycloramas remain, but flat, two-dimensional cycs are more common, with their associated equipment to light them from above and below. New lighting technologies have brought greater flexibility, however, with LED cyc lights offering a range of colours never seen previously. As Macgowan wrote in 1922,

> thus it is in some scenes a pale neutral wall, in some a curious violet emptiness, in others a faintly salmon background, in still another a yellow light against which figures move in tiny silhouettes … the dome becomes a misty void in one of the dream-scenes; and then upon this void move vast, mysterious shadows in circling procession. (Q29855: 72)

‘Naked Trashiness’

Theatre goes electric

The introduction of electric lighting into theatres had a profound effect on how light could be controlled and used on stage. Eventually, through many interconnecting developments, electricity unlocked lighting’s expressive potential.

In 1908 the English actress Ellen Terry wrote in her autobiography,

> Until electricity has been greatly improved and developed, it can never be to the stage what gas was. The thick softness of gaslight, with the lovely specks and motes in it, so like natural light, gave illusion to many a scene which is now revealed in all its naked trashiness by electricity. (Q29976: 172-3)

Terry was not alone in her criticisms of electric lighting when it first became widespread in theatres in the 1880s and 1890s. There were widespread concerns that it was cold in appearance, and too revealing of the scene-painting techniques of the time, making the scenery look dull and lifeless. Nevertheless, electric lighting was rapidly adopted in theatres. Theatre managers were not motivated by aesthetics so much as the greatly reduced risk of fire, which had been a major hazard previously. In some regions, electric lighting became a legal requirement in theatres for safety reasons, for example in Vienna following the Ringtheatre fire of 1881 (Q696). Electric lighting also eliminated the excessive heat and noxious fumes of gas.

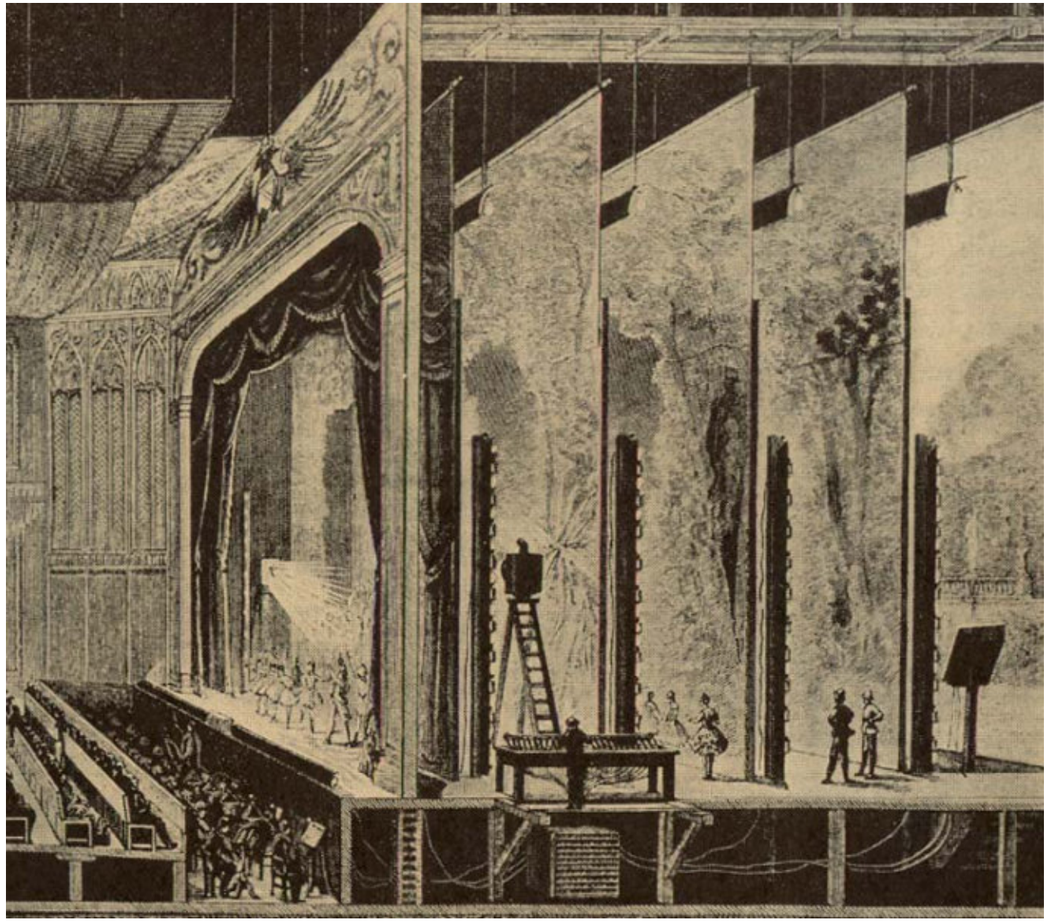
Strand mirror spot

The first electric light to be used in theatres was the carbon arc lamp, invented at the start of the 19th century by Humphry Davy (Q29974). However, while arc lamps produced a powerful output, they had two disadvantages that limited their use. They required an electricity supply, which was not readily available until the late 19th century. They also needed constant adjustment, and so an operator to be with each lamp, limiting where they could be positioned in the theatre. The limelight, although invented after the arc lamp, was preferred through much of the 19th century, since its gas fuel could be kept and transported in leather bags (Q176). In both cases, the intense, directional light was mainly reserved for special effects and ‘key’ lighting, such as representing sun or moonlight, rather than for general stage lighting.

Fully electric lighting in theatres did not arrive until the development of the incandescent light bulb (Q3120), in which a thin filament is heated to white heat by passing electricity through it. Although experiments had been made since the mid 18th century, there was great difficulty in finding a filament material that would not melt, or burn up in the air. The first practical lamps appeared at the start of the 1880s, using a carbon filament in a glass envelope from which the air had been evacuated. When the Savoy Theatre in London opened in 1881, it was the first theatre, and the first public building in the world, to be lit entirely by electricity (Q8188). Attempts to create a brighter and more efficient lamp using different filament materials eventually led to the tungsten lamp – tungsten having the highest melting point of any metal. By 1910, the tungsten filament in an evacuated glass envelope was the standard.

Early electric lamps were a similar brightness to gas burners, and were installed in the same locations, although being able to operate at any angle made it easier to direct light onto the stage from overhead, finally eliminating the need for footlights. Once the tungsten filament was established, attention turned to creating brighter, more powerful lamps. The power of each lamp rose from around 40W to as much as 3000W by the early 1920s. More powerful lamps meant that a single luminaire could have an impact, rather than relying on large quantities of small lamps in rows to achieve the required light levels (Q29977).

Reflectors and lenses gave control of the beam, although these systems demanded bright, compact filaments to provide as close to a ‘point source’ as possible. At first, the position of the lamp in the optical path needed to be laboriously adjusted to give the maximum light output and an even beam, but the invention of the pre-focus cap in 1951 meant that lamps were interchangeable without the need for individual adjustment (Q29978). Later innovations increased efficiency, power (up to 10,000W) and lamp life, but by the mid 20th century the key lamp and luminaire technologies were in place to deliver light on stage in the way we still do today: a large number of high-brightness spotlights, each giving precise control of intensity, direction, colour and distribution of light, building up the scene like a painting, brush-stroke by brush-stroke.

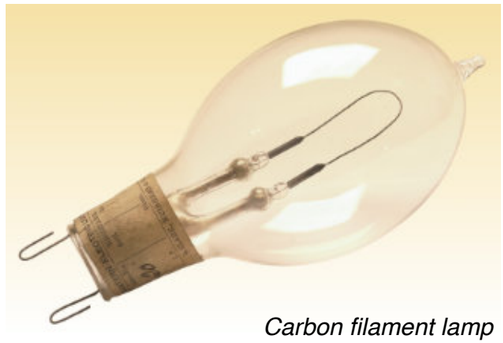


The stage at the Munich Electrotechnical Exposition in 1882: one of the earliest stage lighting installations employing the then newly-invented incandescent lamp.

In 1922, Kenneth Macgowan wrote,

> In the ‘eighties and ‘nineties, when electricity came into the theatre to take the place of gas, light was only illumination. By the first decade of the 20th century it had become atmosphere. Today it is taking the place of setting in many Continental theaters. Tomorrow it may be part of drama itself. (Q29855: 68)

One hundred years later, lighting is indeed a dramaturgical force in theatre performance, its potential unlocked by the coming of electricity.



Carbon filament lamp

Home Theatre

Hear the show by phone

The théâtrophone was a telephonic distribution system available in portions of Europe that allowed subscribers to listen to opera and theatre performances over the telephone lines. The théâtrophone was first demonstrated in 1881, in Paris. Subsequently, in 1890, the invention was commercialised by Compagnie du Théâtrophone, which continued to operate until 1932.

The origin of the *théâtrophone* (Q15905) can be traced to a telephonic transmission system demonstrated by Clément Adler at the 1881 International Exposition of Electricity in Paris to allow broadcasting of concerts or plays. Adler had arranged 80 telephone transmitters across the front of a stage to create a form of stereophonic sound. It was the first two-channel audio system, and consisted of a series of telephone transmitters connected from the stage of the Paris Opera to a suite of rooms at the Paris Electrical Exhibition, where the visitors could hear performances in stereo using two earpieces; the Opera was located more than two kilometres away from the venue.

The théâtrophone technology was made available in Belgium in 1884, and in Lisbon in 1885. In Sweden, the first telephone transmission of an opera performance took place in Stockholm in May 1887. In 1890, the system became operational as a commercial service in Paris, offered by Compagnie du Théâtrophone, which was founded by MM. Marinovitch and Szarvady. The service can be called a prototype of the telephone newspaper, as it included five-minute news programs at regular intervals.

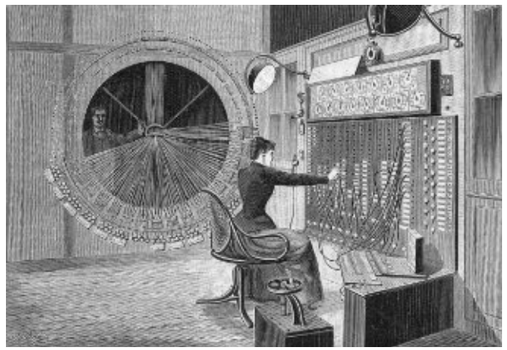
The Théâtrophone Company set up coin-operated telephone receivers in hotels, cafés, clubs, and other locations, costing 50 centimes for five minutes of listening. Subscription tickets were issued at a reduced rate, to attract regular patrons. The service was also available to home subscribers. Many technological improvements were made to the original théâtrophone system during the time it was in operation. The théâtrophone finally succumbed to the rising popularity of radio broadcasting and the phonograph, and the Compagnie du Théâtrophone ceased its operations in 1932. Similar systems existed elsewhere in Europe included Telefon Hírmondó (established in 1893) of Budapest and Electrophone of London (established in 1895).

The idea for this early form of streaming and online services, as offered more recently by theatres closed due to the Covid19 pandemic, was created by giving each consumer two earpieces: one microphone on the left and one on the right side of the stage offered stereo reproduction. So, the ladies and gentlemen in evening dress stood in front of silent walls and listened spellbound until the roaring final applause, which roared in their ears as a violent storm, as one ear witness indicated with fright. The initially rather imperfect system was refined over the years. For example, care had to be taken that the percussion instruments and brass players did not stand too close to the microphones; also, the gas lights installed in all the theatres still disturbed the microphones considerably through their draught and the refraction of sound due to their heat. In addition, transmission by specially laid cable was very expensive: the first live broadcasts therefore took place in public rooms, in cafés or salons.

Although they still had a rather cumbersome appearance, the devices were portable and soon found their way into the households of upmarket Parisian society. It was fashionable not to be seen in the foyer of the opera house but to listen to the sounds and voices in the comfort of one's own home, but this had its price: the annual user fee was 180 francs, and another 15 francs had to be paid per performance. Nevertheless, by the end of the 19th century, there were already 1300 subscribers in Paris. To ensure the smooth running of the business, telephone operators were hired to find music lovers instead of people to talk to.

One of the subscribers from 1911 was Marcel Proust. The bedridden man had his theatre phone within reach, paid his fee and suddenly found himself in the middle of the Opéra Comique, the Comédie-Française, the Châtelet, the Théâtre des Variétés, or the Théâtre des Nouveautés. The writer (like the majority of subscribers in general) preferred operas to plays, concerts or variety performances. Addressing Madame Straus in March 1913, Proust became sentimental:

> Have you subscribed to the Théâtrophone? They now bring the 'Concerts Touche', and I can be visited in my bed by the brooks and the birds of the 'Pastoral Symphony', which poor Beethoven could no more enjoy directly than I could […]. Far from genius and without talent, I make pastoral symphonies in my own way, by depicting what I can no longer see.



Together in One Room

Hellerau and the fall of the fourth wall

Performance of Émile Jaques-Dalcroze's Eurythmics, 1912

In 1911, the Festspielhaus Hellerau was built in the garden city of Hellerau, near Dresden: a major work of 20th century architecture. In it, the proscenium wall that since the Renaissance had divided audience from stage was dissolved.

In October 1909, Émile Jacques-Dalcroze (Q22937), on a tour of Europe to spread his ideas about rhythmic gymnastics and the practice of his school, arrived in Dresden. Enthusiastic, the brothers Wolf and Harald Dohrn proposed they build a Bildungsanstalt (School of Education) in the garden city associated with their furniture construction company in Hellerau. In its simplicity and harmony, the style of the Hellerau buildings was in keeping with Dalcroze's ideology of eurythmy. In the new space of this garden city, Art, Industry and Life were to unite.

As early as 1906, Adolphe Appia (Q249), after attending a public demonstration of rhythmic gymnastics, had written a letter to Dalcroze expressing his intention to create spaces suitable for the development of the movement of the dancers' bodies. Between 1909 and 1910, Appia drew 'feverishly' (as he put it in a letter he sent to Dalcroze) his *rhythmic spaces*, from which he selected twenty to send to Dalcroze. They are austere architectures, which breathe a certain classicism and which are made, in Appia's words, for the 'enhancement of the human body under the orders of music. With no other destination'.

From the scenographies he had drawn in 1892 for Richard Wagner's *Das Rheingold* and *Die Walküre* to the *rhythmic spaces*,themimetic character of the drawing has disappeared. The shape of the rock in *Die Walküre*, for example, is distorted in the drawing for 'The Falls of the Dawn'. Appia thus learns from his attempts at Wagnerian stagings. A break, then, but also continuity in his work. The Festspielhaus (Q63) of the Hellerau Institute offered him the opportunity to create the stage space where these scenographies would be placed in harmony with the architecture that housed them.

The Festspielhaus brought together the work of the architect Heinrich Tessenow (Q21695), the artist, set designer and engineer Alexander von Salzmann (Q22936), and Appia, all at the service of Émile Jacques-Dalcroze. Its architecture, harmonious and simple yet monumental, with its large-scale portico surmounted by a pediment, conveys the image of a classical temple without reproducing it exactly. But it is the hall at the centre of the building which is a fundamental work in the history of theatre architecture. A pure light box, the walls and ceiling lined with a backlit white fabric, creates a space that profoundly breaks with the division between audience and spectacle that characterised the Italian theatre.

The fundamental element that defines the theatre is the lighting system designed by Salzmann, with a great array of electric lamps in a grid formation, placed behind the translucent fabric enveloping the space. Groups of lamps could be individually controlled by dimmers as desired, to vary the lighting effect. The breakthrough in Salzmann's contribution lay in the ability to shape the lighting effects, to achieve, if desired, a uniform effect, without bright spots of light or shadows between the different light sources. The enveloping surface of the room glows with a light similar to daylight, which hardly gives the impression of being an artificial light source. Spotlights could pick out and sculpt the forms of the performers, which, in combination with the diffuse light of the ceiling and walls, realised for the first time the radical reforms to stage lighting theorised by Appia years before.

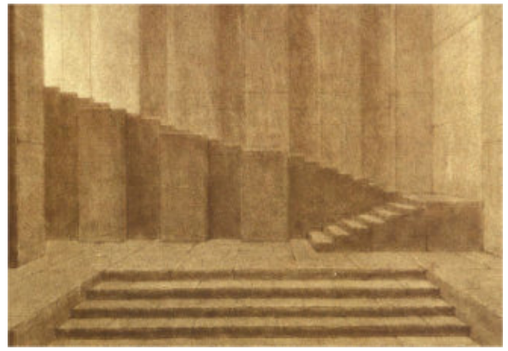
The system was controlled by a light organ that 'bathed spectators and extras in the same luminous atmosphere against the usual stage lighting', in the words of Albert Jeanneret, musician, professor at the Institute, and brother of the architect Le Corbusier, who, like other figures of modern architecture such as Ludwig Mies van der Rohe and Walter Gropius, visited Hellerau and admired the hall. A unique space was created in which Appia's scenographies were erected at one end and a seating bank for the public at the other. The images of the 1913 festivities suggest that the two spaces could be interchangeable.

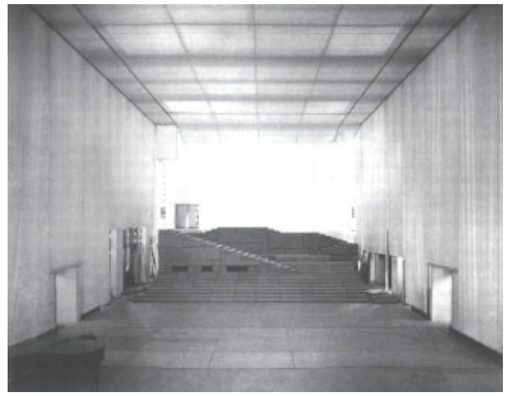
At the start of the First World War, the Festspielhaus closed, never to reopen in its original form. In the midst of war, in a time of destruction and death, Adolphe Appia ended up dreaming in *The Living Work of Art* (1919): the theatre must be a festival where the community is reconciled with itself through Art. The separation between actors and spectators must disappear.

Top: the Festspielhaus, Hellerau

Middle: one of Appia's rhythmic spaces

Bottom: the main hall of the Festspielhaus, showing the diffuse lighting system





Rejecting Naturalism

The expressionist and abstract scenography of Edward Gordon Craig

Early 20th century Expressionism sought to move away from the Naturalism of the late 19th century that attempted a facsimile of real life. Instead, Expressionism used light and simplified, abstract scenic forms to invoke strong feelings in audiences.

Expressionist theatre employed very different scenographies compared to the theatrical movements that came before it like Naturalism and Romanticism. Set pieces and props were typically used sparingly with much more emphasis on creating striking sound and light. The scenery was typically very symbolic and was a purposeful exaggeration or understatement of the setting, aimed at invoking intense emotions and uncovering the overlooked failure of societal systems. Commonly, Expressionism shifted emphasis from the text to aspects of the physical performance and highlighted the director's role in creating a vehicle to deliver theirs and the playwright's thoughts to the audience, as in the productions and writings of Edward Gordon Craig (Q325).

Edward Gordon Craig

Gordon Craig worked as an actor, director and scenic designer, building elaborately symbolic sets. He asserted that the director was 'the true artist of the theatre' and, controversially, suggested viewing actors as no more important than marionettes. He was also the editor and chief writer for the first international theatre magazine, The Mask (Q30609).

Gordon Craig concentrated on keeping his designs simple, so as to set-off the movements of the actors and of light, and introduced the idea of a 'unified stage picture' that covered all the elements of design, which he described in one of his most famous works, the essay The Art of the Theatre (Q704). Craig's idea of using neutral, mobile, non-representational screens as a staging device is probably his most famous scenographic concept. In 1910 Craig filed a patent which described in considerable technical detail a system of hinged and fixed flats that could be quickly arranged to cater for both internal and external scenes. Craig's second innovation was in stage lighting. Doing away with traditional footlights, Craig lit the stage only from above, placing lights in the ceiling of the theatre. Colour and light also became central to Craig's stage conceptualisations. The third remarkable aspect of Craig's experiments in theatrical form were his attempts to integrate design elements with his work with actors. He promoted a theatre focused on the craft of the director – a theatre where action, words, colour and rhythm combine in dynamic dramatic form.

Craig corresponded with Stanislavski, Appia, Duse, Reinhardt, Copeau and Dalcroze, among others. He was editor and director of three magazines devoted to the stage: The Page (1898-1901), The Mask (1908-1915, 1918-1919, 1923-1932), and The Marionette (1918). In these he wrote many studies, articles and notes under seventy different pseudonyms. However, Craig was not a rationalist theoretician, but a visionary artist; for him, writing was the means of fighting and convincing.

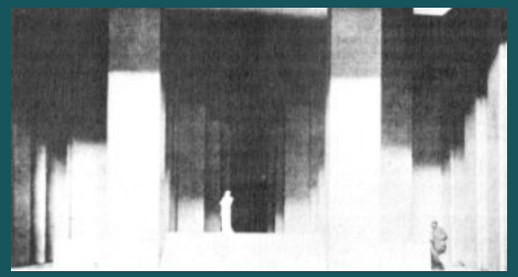
The new scenic art promulgated by Adolphe Appia and Edward Gordon Craig has embodied the changes that have established the basic principles of contemporary stage direction and design. Craig synthesised action, word, dance and gesture in a total show. He abstracted the literal to achieve a simplicity that allows light to highlight the space, austere and timeless. Until his intervention, the theatre was the support of the text. Thanks to Craig and Appia's proposals, the scenery becomes a laboratory combining screens, prisms, stairs and segments to obtain the maximum expression from the minimum number of forms, on which the light falls until they are endowed with the desired expression.

In *The Art of Theatre* Craig establishes a revision and renewal of theatre in opposition to the naturalism that prevailed in theatre at that time. To move away from realism on stage, he proposes the actor as a creator of signs and forms that reflect ideas that reach the viewer, making him a

Gordon Craig's design for the final scene of* Hamlet. *Moscow Art Theatre, 1911

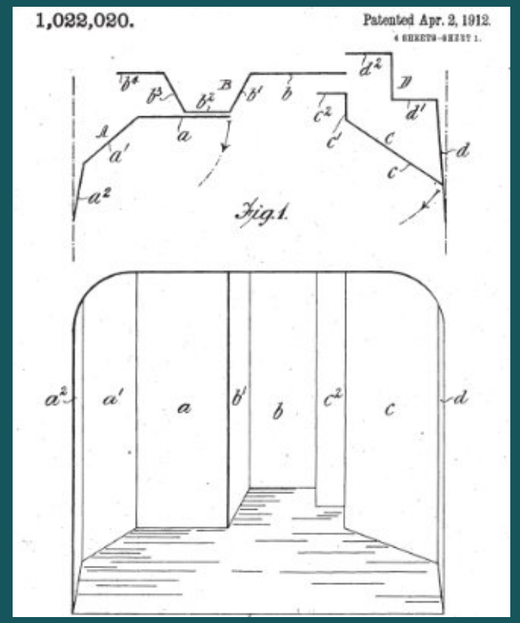
participant in what happens. The actor, therefore, must become an inanimate figure who builds the character, leaving aside naturalism, going one step further. The scenery is understood as a space for the action of the character. That is why Craig insisted on the use of simplified architectures and gave the main function to the stage floor.

He created environments, evoked and dematerialised objects to turn them into ideas and symbols. For Craig, lighting and colour were the main sources of evocation and spatial expression. His work has influenced subsequent theatre fundamentally in the way in which scenery, costumes and lighting merge into a unified conception of total scenography, central to the theatrical experience.



Below: Gordon Craig's patent for moving screens

Below left: Gordon Craig's model for the final scene of Hamlet

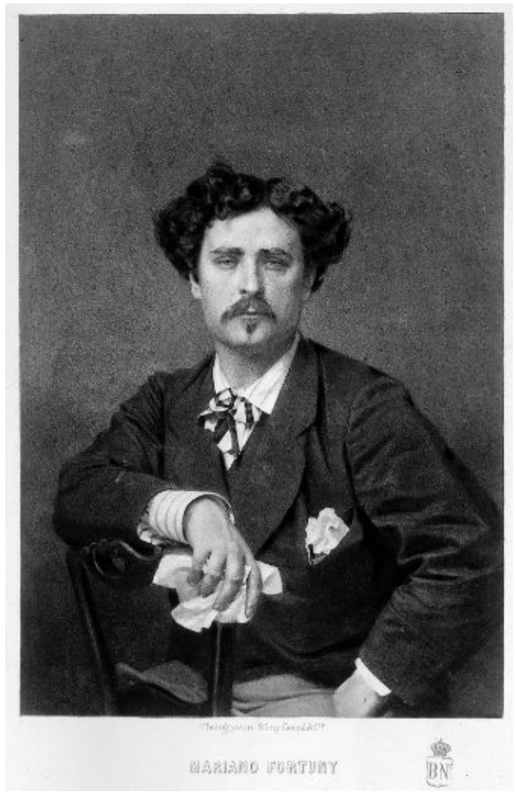


A Traveller Through Europe

The ideas of Mariano Fortuny

Mariano Fortuny y Madrazo was a tailor, fabric and fashion designer, painter, interior designer, engineer and inventor, especially known for his talent in theatrical stage lighting. Fortuny patented more than 20 inventions between 1901 and 1934.

In 1892, after seeing some of Richard Wagner's (Q30460) operas in Paris, Fortuny (Q231) travelled to Bayreuth (Q7857). He was mesmerised by Wagner's work and began to paint scenes for his operas when he returned to Venice. In Wagnerian drama, painting, architecture, song, dance, and poetry all worked together towards a common goal. This affected Fortuny's outlook and was the inspiration for a new type of theatre design where the designer and the technician would work together on a project from idea to realisation. Fortuny and other followers of this concept believed that one can only improve the quality of a product by having a good knowledge of the raw materials and the process of its construction. He also thought that the best type of design was created when the artist knew how to realise the design and controlled all the steps in the creative process.



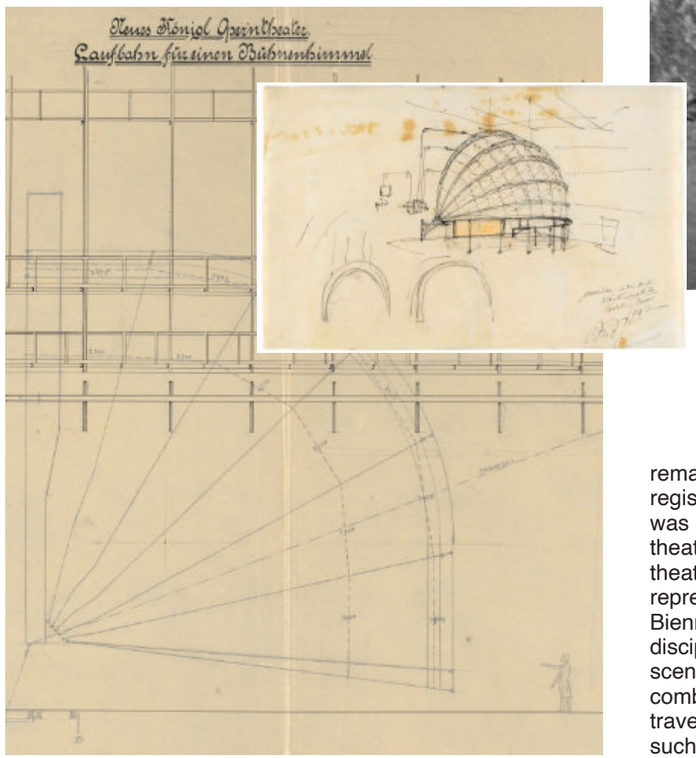
In collaboration with his French wife Henriette Negrin (1877-1965), an expert in natural dyes, Fortuny invented new methods of textile dyeing and printing on extraordinary fabrics, many with treatments whose secret formula they took to the grave. He adopted forms from antiquity for his designs for women's dresses. Characteristic of the Delphos dress and the Knossos shawl is the wafer-thin silk satin, permanently pleated and iridescent in the light, which Fortuny patented in Paris in 1909. He founded a silk fabric printing company, the *Società Anonima Fortuny*, in 1919, and shortly afterwards he opened a boutique in Paris, later adding branches in London, Madrid and, in 1929, New York City. In the 1920s and 1930s, famous actors and dancers such as Sarah Bernhardt, Isadora Duncan, and, in the United States, Martha Graham and Ruth St Denis were his clients.

As a set designer, he wanted to create a more seamless way of transitioning from one scene to another other than flying out a backdrop and bringing in anewone.Hebegan experimenting with light, and found that reflecting light off different surfaces could change its colour, intensity and other properties. His 1904 treatise *Eclairage Scenique* ('Stage Lighting', Q30480) describes the discovery that formed the basis of his indirect lighting technique. He concluded that, 'it is not the quantity but the quality of light that makes things visible and allows the pupil ... to open properly.'

He used these indirect lighting techniques with massive arc lamps in his invention, the Fortuny cyclorama dome, a half-dome structure of plaster or cloth (B.06). The shape created the appearance of an infinite sky, and could even have moving clouds projected onto it. His first patent, in England in 1901 (Q334), describes a projection device which throws light onto a length of fabric containing all the colours of the spectrum, mounted on rollers. As the fabric to passed in front of the arc lamp, the light reflected from the fabric, creating a source that was indirect, diffuse and coloured, with soft colour transitions. The second patent, applied for and granted in England in 1905, relates to a projection surface intended to represent the sky and its infinity.

During the 1920s, Fortuny's contribution to the theatre gained widespread recognition. He was soon contracted to install his dome in the famous opera house, La Scala of Milan. He also made it so that the dome was electrically controlled, and could fold and unfold like a giant accordion in the space of 90 seconds. Even more impressively, he invented a suction fan, specifically for this project, which extracted the air from between the two skins of the dome, to keep the inner dome smooth and taut. From the audience's point of view, this helped the backdrop's depth to seem almost infinite, as if you were looking at a night sky that never ended.

From the same concept of the dome, Fortuny created a lamp that could be used to recreate indoor lighting onstage, the Fortuny Moda Lamp. Although originally intended for use as a stage lamp and patented in 1903, this lighting fixture



Above: Fortuny's Delphos dress

Left: drawing and sketch of the cyclorama dome

remains popular as a floor lamp. Fortuny registered more than fifty patents as an inventor, was involved with indirect lighting effects in the theatre (Fortuny GmbH AEG Berlin), designed theatre sets and costumes and was also represented as a painter at all the Venice Biennales until 1942. He worked in multiple disciplines as a painter, fashion designer, scenographer and inventor, and it was this combination of skills and knowledge, spread as he travelled widely across Europe, that resulted in such a profound impact on theatre practice.

Theatres built to order

The professional theatre architect

Left: Hermann Helmer, Centre: design of the Rijeka theatre, 1882, right: Ferdinand Fellner

In the late 19th century specialist theatre architects emerged, responsible for building many new theatres to meet the demand of an expanding middle class. Standardised plans and architectural elements meant theatres could be rapidly built on demand.

During this period, theatre technology was developing rapidly, with the introduction of first gas and then electric lighting. The invention of the Bessemer process made steel cheaply available for the first time, creating the possibility of larger and more complex stage machinery powered by hydraulics. Architectural steelwork enabled deeply shelved, cantilevered balconies in the auditorium without the need for supporting pillars, which required new engineering skills to design. This industrialisation of the theatre building coincided with a fashion for highly elaborate decoration of the auditorium and foyers, with intricate plasterwork and painting. Tightened fire safety following disastrous theatre fires (for example, the Ringtheater in 1881 and the Theatre Royal, Exeter in 1887) made technical improvements to existing theatres necessary. All these factors meant that refurbishing an existing, or building a new theatre to meet the growing demand required a large team of specialists – teams that were brought together by a new breed of theatre architect.

Firms included Oskar Kaufmann and Heinrich Seeling in Berlin (Q20875 and Q20479), Martin Dülfer in Dresden (Q20487), Jakob Heilman and Max Littmann in Munich (Q20481), Carl Moritz in Cologne (Q20412) and Frank Matcham in London (Q20585). Austrian architects Ferdinand Fellner and Hermann Helmer (Q620), based in Vienna, designed and built forty-eight theatres between 1870 and 1910, which helped bind the Austro-Hungarian Empire together and cement Vienna as its cultural centre. While most of their theatres stood in the former central European empire, others can be found from Switzerland to Ukraine, and many were national theatres.

Fellner and Helmer placed a great emphasis on achieving the technical-operational needs of theatre buildings. The polytechnic training they received made them well suited to the task. Helmer, in particular, was intensively involved with fire safety precautions, tests and regulations and was active in a number of committees. The architects' almost monopolistic position can be attributed to the fact that the office community could guarantee high quality at low cost and fast execution, reliability, predictability and professionalism. At times, up to 20 architects were employed in the studio to cope with the commissions. They applied the latest known construction methods, and their architectural style ushered in a new epoch in 20th century architecture.

The changes introduced in these forty years of designing and building theatres shows process of adjustment of the architectural typology where technical progress made it possible to provide new answers to old problems, such as the shape of the auditorium or the fire protection curtain. In general, however, Fellner & Helmer's theatres are in the form of a block which is determined by the development of the functional requirements. The basic layout of Fellner & Helmer theatres follows a linear arrangement of the parts according to a logical sequence. The buildings had to combine three distinct functions: the foyer as a meeting space; the auditorium as a gathering space and the stage as a space for performance. Previously, these spaces had been placed under one roof, but in the theatres of Fellner & Helmer the links between them were loosened, resulting in buildings with three functionally distinct parts.

The standardised nature of these designs, driven by practical solutions to common functional requirements, were not always created specifically for a particular client or location. For example, the Fellner & Helmer design originally intended for the Free Royal City of Osijek in Croatia was transferred largely unchanged to a scheme in Klagenfurt.

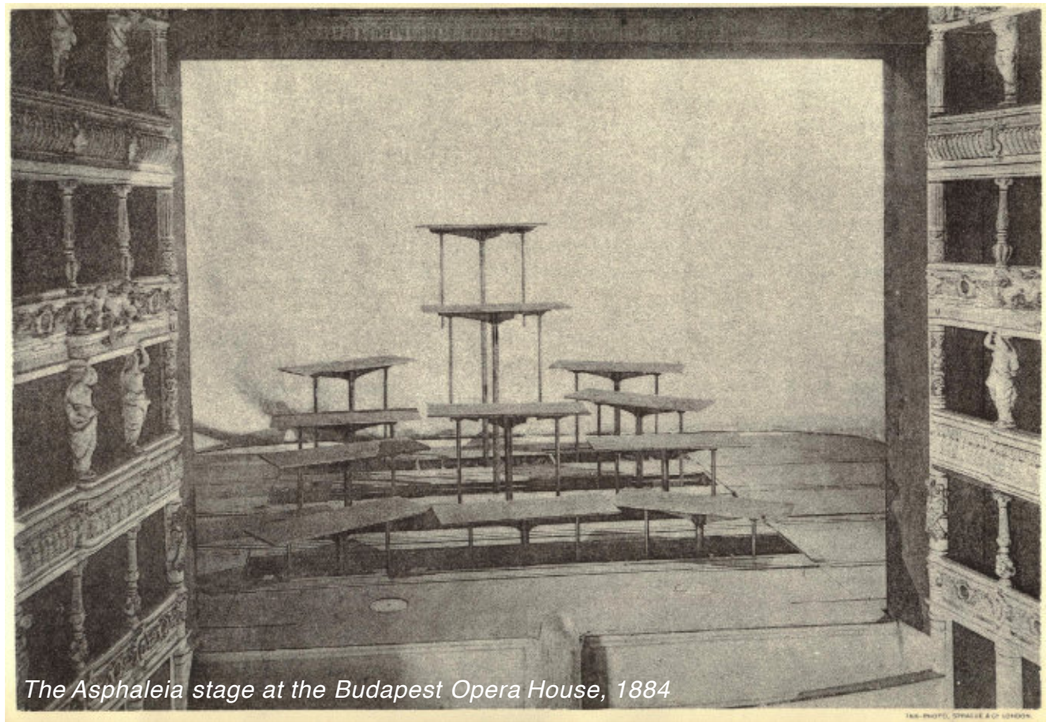
Fellner & Helmer's working relationship was of an unusual kind, as the company did not actually exist from a legal perspective – rather, it based upon the friendship between the two partners. This dependence on personal relationships rather than legal structures contributed to the precarious nature of the career of theatre architect in the late 19th century. Some met with great success following public acclaim of their designs, such as Gottfried Semper with his Dresden Opera (Q8069). In other cases, the poor public reception of a single project could end a career, or worse: Eduard van der Nüll hanged himself after the criticism he received, together with August Siccard von Siccardsburg, against their Vienna Opera (Q7826).

Despite many wars and fires, almost all the theatres are still in operation today and continue to serve the cultural life of many cities in Europe.

Frank Matcham's oldest surviving theatre, the Everyman, Cheltenham, UK

The Asphaleia System

A fire-proof stage



The Asphaleia stage at the Budapest Opera House, 1884

In the 19th century, the wooden theatres, lit by naked flames, frequently burned down, sometimes with great loss of life, and always at a financial cost. The Asphaleia system for building stages put safety first in all areas of theatre production.

The Viennese engineering Asphaleia Society for the Production of Contemporary Theatre (*Gesellschaft zur Herstellung zeitgemässer Theater 'Asphaleia'*) developed a comprehensive theatre-building concept towards the end of the 19th century (Q19107). Safety – the Greek word asphaleia – was the top priority, but aesthetic criteria such as sight lines and completely electric lighting were also included. The stage machinery system laid the foundation for modernity with hydraulics replacing manual operation.

The Asphaleia system had been devised by the engineer Gwinner and the decorative painter of the court theatres Johann Kautsky, both from Vienna. The system was a response to the Ringtheater fire (Q696), which triggered strict safety regulations in theatre construction; it replaced the hitherto customary wood as a building material with iron, and brought a number of improvements in stage machinery. The Asphaleia Society designed fireproof stage machinery with a steel structure that was set in motion by water hydraulics. This ingenious design was first realised in Budapest in 1884 on the stage of the opera house planned by Miklós Ybl and then built in only ten months (Q7696).

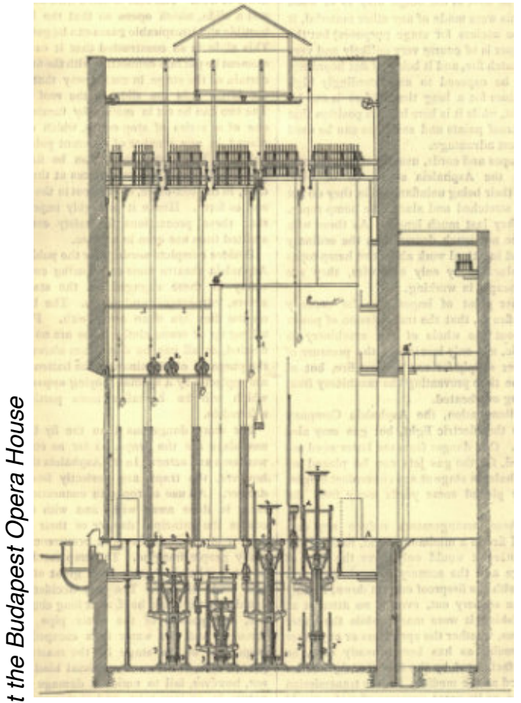
The originator of the machinery of the Asphaleia system was the Viennese engineer Robert Gwinner. His designs for stage equipment were used at many other theatres, including at the Landestheater in Prague, the Raimundtheater in Vienna, the newly built theatres in Halle an der Saale, Göggingen near Augsburg, the Theatre Royal, Drury Lane in London, and the Great Theatre in Chicago. In 1882, Gwinner and Co. were granted the patent of a 'theatre machinery which provides perfect mobility of the stage components with perfect safety in every respect'.

However, it was not only safety aspects that inspired the Aspahleia Society's new theatre construction concept. Rather, they saw the fire risk in the context of an urgently needed reform of the theatre, which they considered not only unsafe in its traditional form, but also aesthetically unsuitable to meet contemporary requirements. The previous backdrop/scenery system was not able to create a total illusion, but at best to suggest a situation. The stage set had to make the step from the flat to the plastic, from the two-dimensional to the three-dimensional. The Asphaleia Society therefore called for a complete, state-of-the-art system change in the theatre. The focus was on the stage system, especially the stage machinery, where they saw the greatest risk of fire breaking out. At that time, stages were built of easily combustible wood, and were to be replaced by steel.

The city theatre building in Halle in Germany (Q8074) replaced a wooden predecessor in 1883-1886. By the power of hydraulic machines, five segments of the stage could be extended as platforms, lowered, set in an inclined position and even set in a rocking motion. A semi-circular cyclorama took the place of the earlier wings and backdrops. Hydraulics also powered the flying machinery. The hydraulic system replaced completely the manual operating of the stage, which was revolutionary at that time. A control system allowed the operation by only one person. By this, they were convinced, the number of badly qualified stagehands could also be reduced and with this, the risk of accidents. Therefore, the Aspahleia system also demanded the introduction and improvement of the training of theatre machinists.

The safety installation included a circular iron pipe all around the auditorium and the stage tower. From there, vertical tubes went to all floors to transport water from the cellar to all parts of the building in case of fire. Electricity was generated by two steam engines of 60hp in their own cellar, so that the complete lighting could be realised, greatly reducing the risk of fire compared to the previous gas lighting. There was also a second system of emergency lighting.

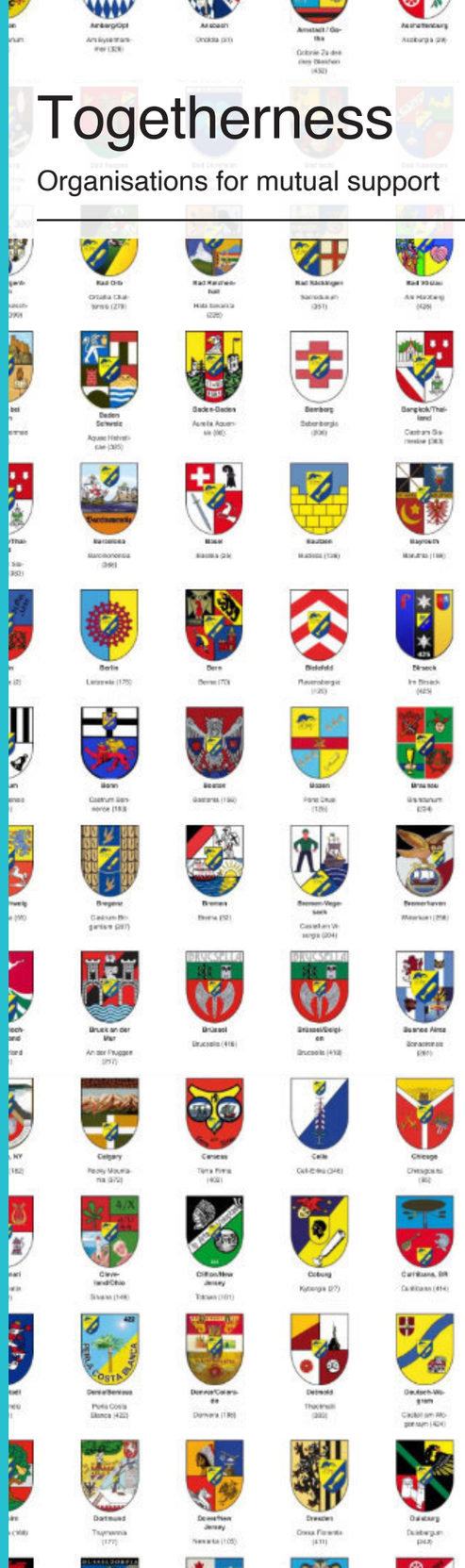
The Asphaleia system began with a concern for safety, and many of the safety innovations it introduced are still to be seen in theatres: steel construction of the stage structure and flying systems; secondary lighting in the event of power failure of the main system; drencher systems to spray water in large volumes in the event of fire. Powered machinery has reduced the need for manual handling and allowed for safety mechanisms to be built in. But the Asphaleia system's comprehensive approach to all aspects of theatre production also ushered in a new era of stage design, ended the 400-year reign of the wooden stage and laid the foundation for today's mechanised stage systems. The illusions of the earlier stages were replaced by spatial stage design, which opened up new artistic possibilities for modern theatre with electric stage lighting. Asphaleia's patented stage system with its ingenious technical solutions was later installed in theatres all over the world (A.06). Every stage technology of today is a further development of the Asphaleia system.



Hydraulic lifts and flying at the Budapest Opera House

Togetherness

Organisations for mutual support



Schlaraffia is a worldwide German-speaking society founded in Prague (then part of the Austrian Empire) in 1859 with a pledge of friendship, art and humour.

When in 1859 the director of the German Theatre, Franz Thomé, wanted to induct one of his young artists, the bass player Albert Eilers, into the Prague artists' association 'Arcadia', he was rejected because of his impecuniousness as an obvious proletarian. In protest, Eilers and his theatre colleagues founded a regulars' table, which they derisively named the 'Proletarians' Club'. From this, after many detours and setbacks, the present-day world-spanning 'Schlaraffia' developed.

The motto of the association is *In arte voluptas* (meaning approximately: in art lies pleasure). Schlaraffia is an exclusively male organisation and its members are generally middle-aged and in secure positions. The Schlaraffen meet in midwinter once a week in their Schlaraffen castle, which is equipped in the style of a knight's tavern from the Middle Ages, for 'Sippungen', gatherings which take place in the fixed ceremonial form of a knight's play. In doing so, everyday life is satirised as well as kept alive through recitations of literary and musical forms. An antiquated language with its own vernacular for everyday things, known as 'Schlaraffen Latin', gives the Sippungen their own humorous note – for example: 'powder pot' for tobacco pipe, 'gasoline horse' for car, 'castle monster' for mother-in-law.

Their mascot is the eagle owl (*Bubo Bubo*) symbolizing wisdom, virtue, and humour (the owl itself presents knowledge and wisdom). In 1874, the association's journal Der Schlaraffia Zeyttungen appeared for the first time in Leipzig. It still appears today several times a year.

The greeting of the Schlaraffen is *Lulu*.The onomatopoeic artificial word is also used in the Sippungen as an interjection (throw-in) of approval and praise. According to the folklorist Erich Kaessmayer, it may be the abbreviation of the translation of 'Play the game!' into Latin - *ludum ludite!* Since almost all the founding members were stage professionals, they used appropriate text quotations in their cheerful table conversations.

There is no connection with Freemasonry, and Schlaraffians clearly distance themselves from service clubs such as Lions Club or Rotary International, student associations or carnival clubs and similar associations.

During the National Socialist era and later under the government of the GDR, many local groups were forced to cease their club activities and were only able to survive these times in very isolated cases through secret meetings in safe surroundings (mostly private homes).

Local groups of Schlaraffia in cities are called 'Reyche' by Schlaraffians. The first Schlaraffenreych was founded in Prague (therefore called 'Allmutter Praga') by German artists. Now, there are 261 'Reyche' and 'Colonien' (local associations) worldwide in which German is spoken exclusively (although the members do not have to be German) and which are in close contact with each other. They are grouped together in the 'Allschlaraffia', which also publish the 'Allschlaraffische Stammrolle', a book of over 1200 pages, which every Schlaraffe receives updated annually and which provides an overview of all (including defunct) Reyches, Colonies and their predecessors (Stammtisch and Feldlager) as well as the 'Sassen' (members). Every Schlaraffe is welcome in every Reych in the world at any time. At present there are Reyches in Germany, Austria, Switzerland, Italy, Spain, France, Belgium, Sweden, the USA, Canada, Mexico, Venezuela, Ecuador, Brazil, Argentina, Thailand, South Africa and Australia.

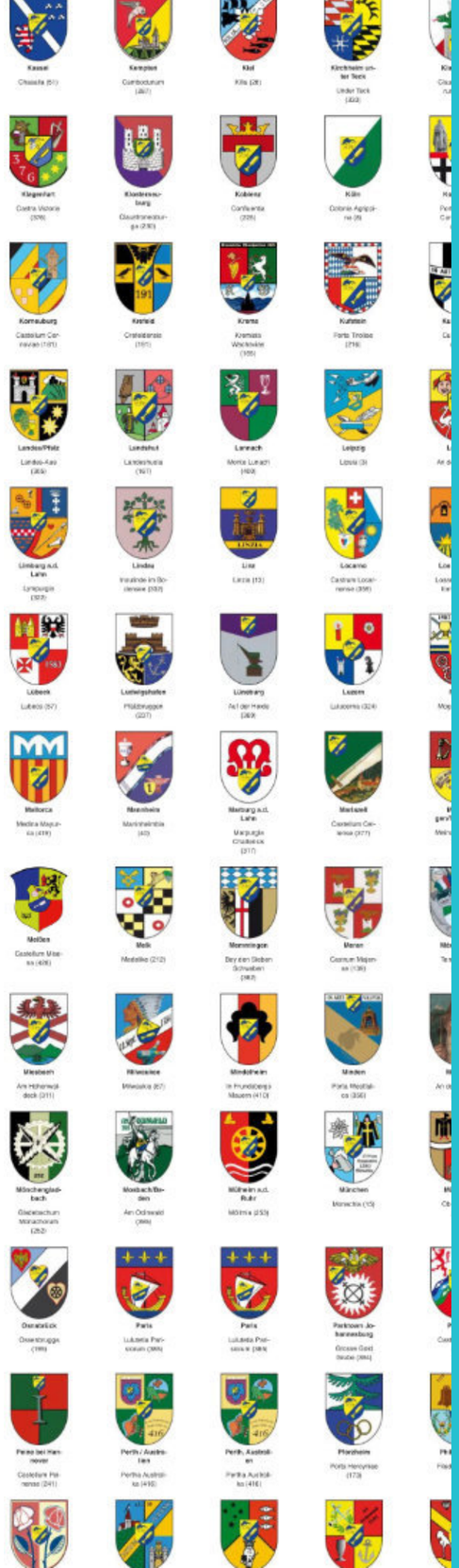
Artists, actors, writers and other public figures were and are Schlaraffians, including:

- the Prague theatre director Franz Thomé, founder of Schlaraffia
- the directors of the Vienna State Opera Wilhelm Jahn and Gustav Mahler
- the opera singers Anton Arnold, Eduard Bachmann, Hermann Becht, Walter Berry, Bruno Heydrich
- the founder of the Augsburg Puppet Box Walter Oehmichen
- the technical directors Friedrich Kranich and Rudolf Kueck

An overview of all events, including contact details, can be found in the brochure Sippungsfolgen, which is published annually by the All-Sharma Council. Schlaraffen are recognisable by the 'Rolandnadel', a small white bead worn on the left lapel, or by a sticker attached to the vehicle showing a winking owl's head.

Albert Eilers and his colleagues founded the Schlaraffia because they were looked down on by wider society. Since then, in many parts of the world, theatre workers have established clubs, associations, professional institutions and unions to share knowledge, improve working conditions and increase the recognition of their work. Organisations can, however, provide another equally important function – mutual support and friendship outside the workplace.

Locations of Schlaraffia Reyche



Stage Engineering Codified

The work and writings of Friedrich Kranich

In 1929, the year of a global financial crisis, the stage technician Friedrich Kranich published a book that for the first time systematically presented stage technology, its management and economic planning: Bühnentechnik der Gegenwart.

To this day, the publication, which was supplemented with a second volume in 1933, is regarded as the first comprehensive codification of stage technology in the German language and as a reference book that set historical standards.

Even before the publication of *Bühnentechnik der Gegenwart* (Q264) by the renowned Oldenbourg publishing house, Friedrich Kranich (Q58) had commented on fundamental questions of stage technology, such as standardisation, in the technical journal *Bühnentechnische Rundschau*. He had been a member of the professional association of stage managers since its foundation in 1906. Corresponding to the German rationalisation movement of the 1920s, shaped by Frederick W. Taylor's scientific management and an emerging science of work, the professional association was increasingly concerned with the organisation of stage technology and uniform standards for training and practice. At the same time, efforts were made to popularise stage technology. After 1918, theatres had been municipalised, so the theatrical relevance of stage technology – and its associated costs – had to be justified to the public, rather than relying on courtly privilege, as hitherto. Kranich's film 'How an Opera is Made' was just one attempt amongst others to give an interested audience an insight into the hidden world behind the scenes at the Magdeburg Theatre Exhibition in 1927.

Illustration of putting on counterweights, from Kranich's Bühnentechnik der Gegenwart

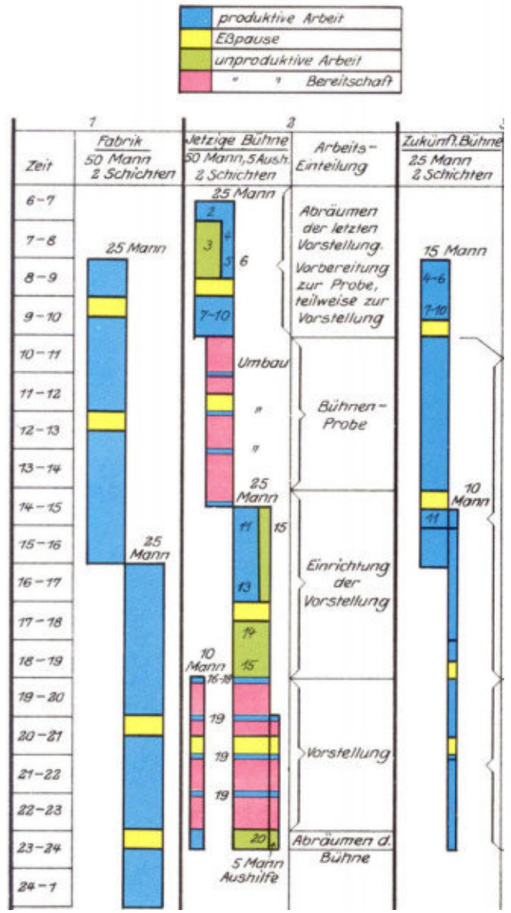
Against this background, the *Bühnentechnik der Gegenwart* attempts both to codify the place of stage technology in the theatrical artwork and to show its potential for improvement, through the rationalisation of the operation. The self-declared aim is to critically examine the 'entire technical stage operation', to show 'preconditions for the modification of stage houses', to make 'suggestions for improvements in machines', to explain 'all types of stage set change' and to determine 'whether work can be done more economically in the difficult financial situation'. In the course of the handbook, both the influences from stage-technical practice and the efforts to systematise technical stagecraft become clear.

Kranich's own professional practice and previously published material, mostly taken from the *Bühnentechnische Rundschau*, form the basis of his book. He was the technical director of the Städtische Bühnen Hannover and the Bayreuth Festival. Although there are a few examples of theatre facilities in the book that point beyond the European continent, the improvement of German stage technology remained the guiding principle. Visual material from Hannover and Bayreuth as well as his modernisation projects therefore form the basis of Kranich's argument. Illustrations showing practical activities seem to have been staged with Kranich's own staff. Some right-wrong illustrations, such as for carrying bigger pieces of stage scenery in a proper manner, give a textbook character in places.

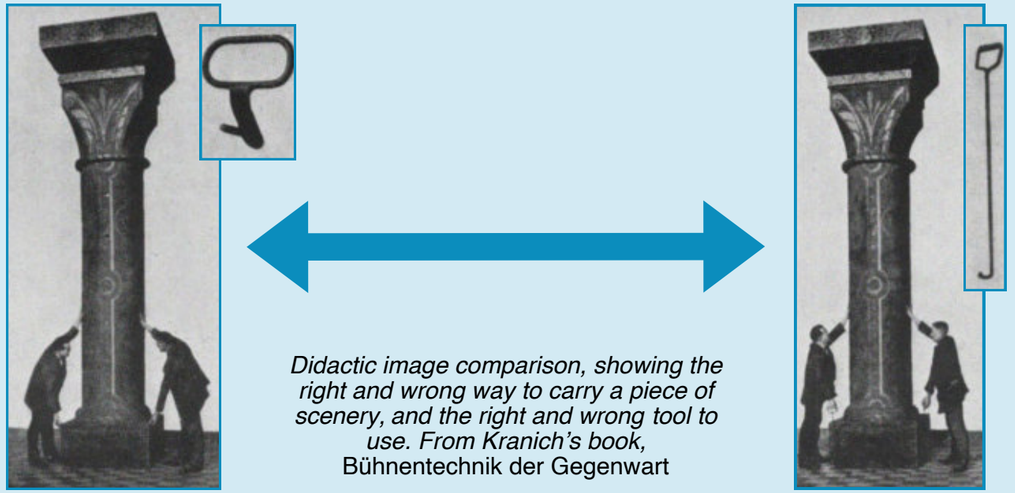
Nevertheless, the codifications of this practical theatre work, which show ideal functionality, take a back seat to organisational and economic questions of operation. Even the A4 format indicates that this book was intended less as a practical guide. It does better on a writing desk, as did the paper quality, which was too high for daily use in the workplace. The codified predecessors of Kranich's manual, such as Sabbatini's (Q13) or Furttenbach's (Q60), essentially codified the structure of *practical* knowledge, while the structure of the *Bühnentechnik der Gegenwart* is oriented towards an *abstract systematisation* of stage operations. It codifies the practice of the stage manager, rather than the stage worker, who is increasingly involved in scientific and economic planning. Stage logistics, standardisation and ideal solutions were the centre of attention, and the means of representation are correspondingly abstract: typologies, charts, and diagrams.

Despite all the systematisation, Kranich remained intent on fitting the codification of stagecraft into a specific genealogy of stagecraft knowledge. An ancestry of important stage practitioners prominently marks the starting point of the handbook, and gives it its legitimacy. First and foremost of these was the icon of bourgeois national cultural ideals in the Weimar Republic: Johann Wolfgang Goethe.

The 19th century saw the industrialisation of stage *technologies*; Kranich's work led the industrialisation of stage *practices*, through the application of scientific and systematic management.



Left: Scientific (Stage) Management. Chart showing the composition of productive and unproductive work, and eating breaks, in contemporary and future stage practice.



Didactic image comparison, showing the right and wrong way to carry a piece of scenery, and the right and wrong tool to use. From Kranich's book, Bühnentechnik der Gegenwart

A.08

Writing with Shadows

Gobos, textures and images

The introduction of the ellipsoidal reflector spot in the mid 1930s made the gobo possible – a metal pattern that creates textured light in a simple form of projection. Since then, gobos have greatly enriched the expressive potential of lighting.

Since theatre came indoors, light has been fundamental to the theatrical experience. Light, and its necessary counterpart, shadow. Adolphe Appia (Q249), in his reforms of stage lighting, recognised that light was only meaningful – only *visible* – in the presence of shadow. Sculptural light, that defines the shapes and form of the objects and people on stage, was central to his proposals. As the incandescent lamp (Q3120) was introduced and developed, intense, directional spotlighting became readily available, and a new language of light evolved that would continue to reshape stage lighting through the remainder of the 20th century.

In 1933, two American companies, Century Lighting and Kliegl Brothers, each launched their version of a new type of light: the ellipsoidal reflector spotlight (ERS, Q30007). The ERS had its lamp placed at one centre of an ellipsoidal reflector; at the other centre was a metal plate with a circular hole – the 'gate' – with a lens system that projected an image of the gate onto the stage. The ERS combined the optics of the spotlight and the projector, the result being a spotlight that could project the image of anything placed in the gate. The arrival of the ERS in Europe had to wait for suitable lamps to be produced, but it took even longer for the full potential of the ERS to be realised by lighting designers.

The gobo (Q3117) is a template, generally made of metal but sometimes a glass-metal composite, which can be placed in the gate of an ERS, so that the pattern cut into the metal is projected onto the stage. The origins of the gobo are somewhat unclear, but certainly by the late 1950s and early 1960s lighting designers such as Richard Pilbrow and Francis Reid were making gobos by drilling holes into sheet metal, to create what were then termed 'dapples' – because they made the effect of broken light coming through the foliage of trees. Careful and laborious work with drills and files could achieve different textures. Later, people experimented with other readily available materials, such as aluminium foil from pie dishes and take-away meals, metal drinks cans, and the litho-plate used in printing. For more detailed or precise images, manufacturers such as Rosco, Miltel and DHA started producing catalogues of manufactured designs.

Lighting designers soon discovered the rich potential of gobos for making textured light. The spotlight lens could be adjusted to give a reasonably sharp image of the gobo, but the best effects were created by defocusing the image. The limited optical quality of the lenses used in spotlights became an advantage, as the slight colour fringing added an additional organic interest to the light quality. This could be enhanced by using a 'split colour' gel, with two pieces of gel stuck together with clear tape. The effect was a mixture of the two colours, in complex textures. Animation wheels on the front of the light, made of textured glass or metal with holes cut in it, caused the gobo texture to undulate, adding movement such as rippling water or the wind in trees. Other devices allowed the gobo to rotate within the gate, making spinning effects, or to slide from side to side. As with gobos, what began as home-make devices were taken up by manufacturers and became products.

With the growth of automated 'moving' lights in the 1980s, gobos found a new role, bringing light textures not just to the theatre stage but also to clubs and live music events. Simple geometric shapes were intended less to create patterns of light on surfaces, but in the air – light beams, with bold textures revealed by haze, became a central element for music lighting. Moving the beams through the air, and rotating the gobos, added a new visual dynamism that could match the power of rock, pop and dance music.

Gobos also found uses in commercial and cultural contexts. In shops and for trade shows and business conferences, custom gobos with logos and slogans could temporarily display a company's brand in a space with great visual impact, while in museums, text and simple graphical images could be overlaid on the walls, floors and ceilings to add drama and increase engagement.

Light and shadow are inseparable counterparts, brought together in a single instrument by the gobo. The textures produced by gobos have light and shade built in, greatly enriching the expressive possibilities of stage lighting. One mystery remains – why are they called gobos? In the USA they are called patterns, and in France a *découpe*, but the term gobo is used in many parts of Europe and elsewhere. It may be a contraction of 'go-between', a term from cinema for an object that is out of shot, used to cast a shadow, such as light through a grill or window – but no-one knows for sure.

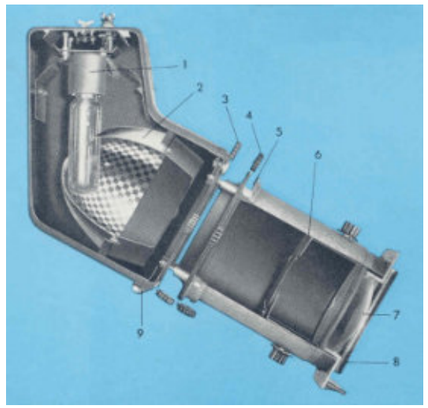
AWoman in Mind, *by Alan Ayckbourn, Swan Theatre, Worcester, UK, showing the use of gobos to create textures and semi-abstract imagery*

Painting with Light

The spotlight and the ‘multi-lantern complexity’

In the inter-war period, increasingly powerful electric lamps enabled the first spotlights, creating focused beams of light. A new lighting style emerged, based on large numbers of sources, each lighting a small portion of the stage with precision.

In 1967, the lighting designer Richard Pilbrow wrote an article titled ‘A Multi-lantern Complexity - Why?’ (Q30013). In it, he described in detail an approach to lighting the stage enabled by developments in lighting equipment that had taken place during the inter-war period, and further refined in the 1950s and 1960s. The basis of this approach was the precise control of the distribution of light in space, to an extent never previously possible, and which is the foundation of stage lighting today.



When electric lighting became commercially available towards the end of the 19th century, the lamps were similar in brightness to the gas flames they replaced. Lamps therefore continued to be located in the same numbers and places to the previous lighting: overhead, wings, and footlights. Carbon arc lamps (Q232) continued in their role of providing intense, single sources for effects such as sunlight and moonlight, but the practical limitation of needing the constant attention of an operator limited their use. Incandescent lamps (Q3120) improved in the 1910s and 1920s, becoming bright enough to be used as single sources, their light output gathered by a reflector behind the lamp, and a lens in front of it, concentrating the beam.

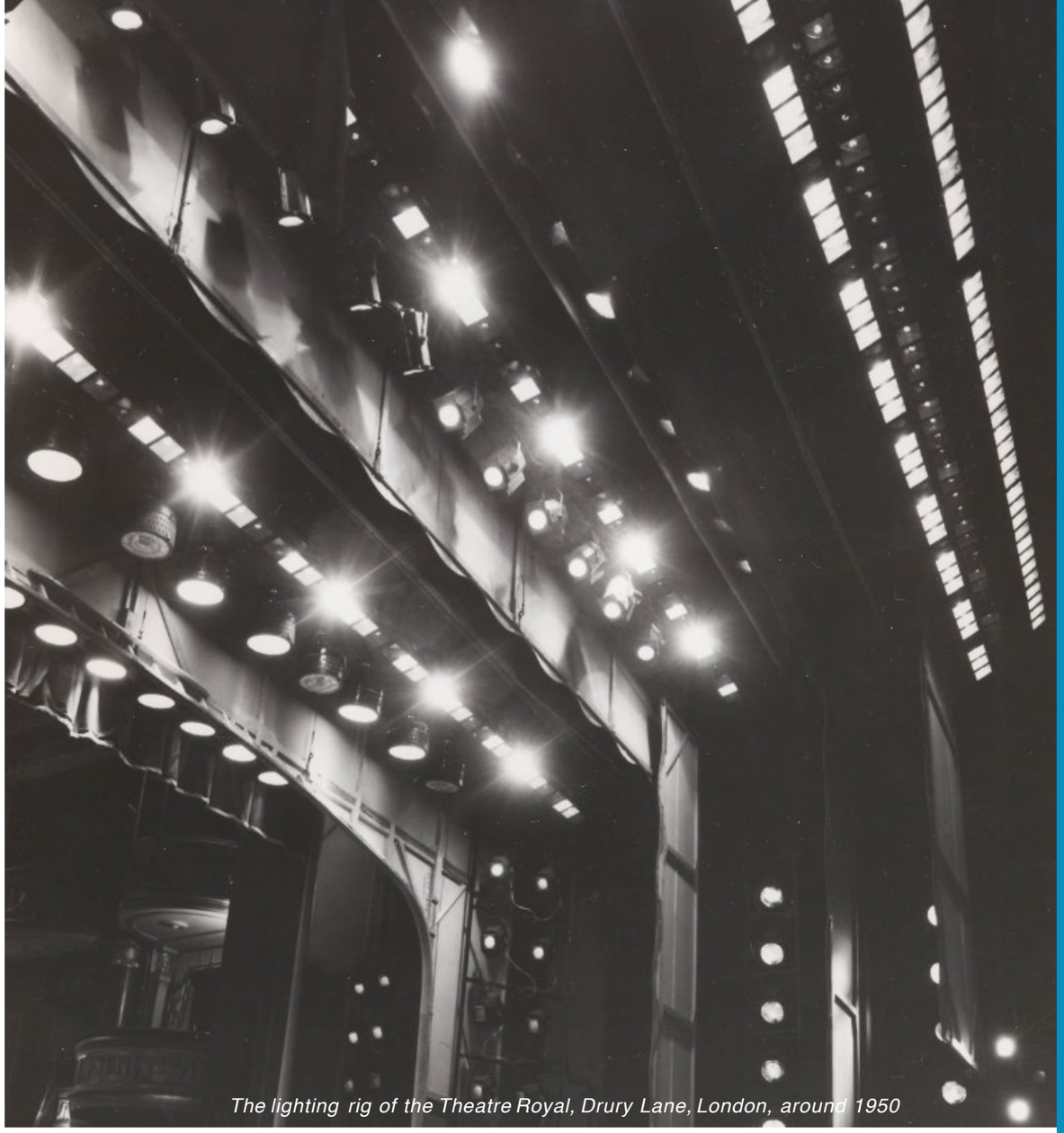
The first such spotlights used a single, plano-convex lens, in an optical arrangement still known as the ‘PC’ or focus spot (Q3198). They could be used from the wings and from overhead, and even from front of house, although auditoriums rarely had suitable lighting positions, so this application was limited at first. Lighting rigs were initially a mixture of spotlights and the older floodlights – the latter providing general washes of colour, while the spotlights could highlight specific areas of the stage, and create light and shadow to make actors and scenery looked more three dimensional. Adolphe Appia’s (Q249) concept of stage lighting, mixing diffuse light with directional beams, which he had experimented with at the Festspielhaus, Hellerau (Q63), was becoming available.

Innovations in the optics brought new types of spotlight, with greater control and different aesthetic possibilities. The ellipsoidal reflector spot (ERS, Q30007) uses a reflector in the shape of an ellipse, gathering the light at a point forward of the lamp itself. At this forward position is a metal plate with a circular hole, known as the gate, and in front of that is a lens. The result is a spotlight that creates a sharp, hard edged beam of light. Anything placed in the gate that changes its shape changes the shape of the beam, allowing masks with different sized and shaped holes, gobos, and shutters. As well as the beam shaping abilities of the ERS spotlight, it could also project a narrower, concentrated beam with little spill light, a great advantage for lighting from front of house.

Another important innovation was the fresnel spot (Q3113), that offered a softer edge than the PC spot, making it easier to blend lighting areas together seamlessly, especially in smaller venues. Beamlights, based on the optics of a searchlight, created soft-edged, narrow and very powerful beams of light, able to cut through the general light on stage. Josef Svoboda (Q91) built entire scenographies with beamlights, and their descendent, the PARcan (Q3147) was the defining light source in rock concert lighting in the 1970s and 1980s.

With the greater control of spotlights, the use of wash lighting gradually reduced, though it didn’t disappear entirely in many theatres until the 1950s and 1960s. The number of spotlights being used increased, so more dimmer circuits were required to take advantage of the detailed, precise lighting that spotlights allowed. The need for accurate and repeatable control of the brightness of each circuit drove the development of lighting consoles. Spotlighting also led to the development of lighting ‘systems’, the first, and still influential, being that of Stanley McCandless, described in ‘A Method of Lighting the Stage’ (Q65). McCandless set out the fundamental concepts of area lighting (dividing the stage into individually lit areas) and directional colour (slightly different colours from different directions, to provide additional modelling, especially of actors’ faces), which are still in use today.

Spotlighting and the ‘multi-lantern complexity’ is now the dominant form of stage lighting in the Western world, with each lighting state built up from many separate spotlights, lighting defined areas of the stage from many directions and with various colours and textures – the ‘brushstrokes’ that paint the stage picture.

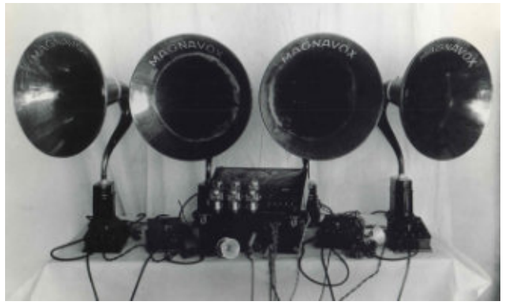


The lighting rig of the Theatre Royal, Drury Lane, London, around 1950

C.08

Filling the Space

Live sound reinforcement



Magnavox PA system, around 1915

Public address systems emerged in the inter-war period, using technologies developed for other purposes. Gradually, the 'PA' developed to the point all members of the audience could hear exactly what was intended, even in the largest venues.

From the beginnings of theatre until the first decades of the 20th century, actors and singers relied on their own vocal power, and the acoustics of the performance space, to be heard (D.01). With the development from the late 19th century onwards of the sound technologies needed to capture and amplify sound, it became possible to artificially reinforce the acoustic sound of performers - what we commonly call 'PA' (public address).

The three basic building blocks of all PA systems are a microphone (Q3374), an amplifier (Q3347) and a loudspeaker (Q3370). The first of these to be invented was the microphone – from the Greek words *mikrós* (small) and *phoné* (to hear). The conversion of sound into an electrical signal was first used in 1861 in the Reis Telephone developed by Johann Philipp Reis. In 1876, Emile Berliner and Thomas Edison invented the carbon microphone, which used carbon granules packed between two metal plates. The resistance between the plates changed proportionally in response to vibrations, thus modulated an electrical signal representative of those vibrations. Later microphone types gave a stronger signal, and a more accurate sound.

Throughout the 1870s and 80s, various loudspeaker-like devices existed, most notably on Alexander Graham Bell's telephone (1876) and Edison's phonograph (1877), but the moving coil loudspeaker, the forebear of most loudspeakers since, was invented by Oliver Lodge in 1898. It employed the same design used today: a diaphragm vibrated by a 'voice coil' which in turn was moved by the interaction of an electrical signal through the coil, and a magnetic field.

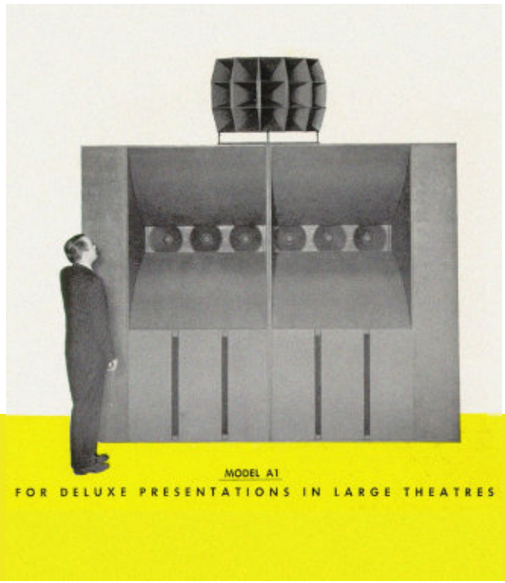
The final component required for a PA system came in 1906 when Lee DeForest invented the Audion, the first device capable of amplifying an electrical signal. He did this by taking a two-electrode diode and adding a third electrode so that a small current applied to one of the electrodes modulated a larger current between the other two. The small signal that came from a microphone could therefore be used to produce sound from a loudspeaker, which required a much greater current. The Audion was refined and became known as the triode, evolving into the 'valves' (or 'vacuum tubes') that were the basis of audio amplification until the development of the transistor.

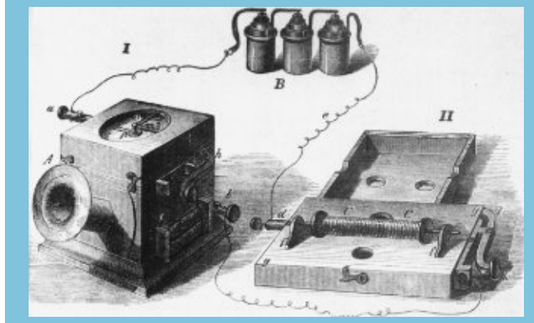
The first documented example of an electric PA system being used to amplify speech and music at a public event was at Christmas 1915 at San Francisco City Hall, when Jensen and Pridhams' Magnavox ('great voice') system was publicly demonstrated to an audience of 100,000 people. Despite the rudimentary system only being capable of generating about 10 watts of audio power, the use of large horn loudspeakers helped ensure that the crowd heard the music and speeches 'with absolute distinctness', according to reports. The Magnavox PA system used a carbon microphone, called a transmitter, mounted on a parabolic metal reflector to focus and amplify the vibrations.

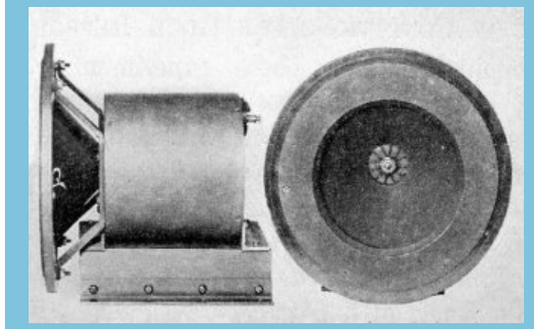
Early PAs were used for live music and large events. For theatre, it was some time before PA systems could be used to amplify the actors, because early microphones were not very sensitive, and could not be positioned close enough to the performer. Gradually, techniques were developed that allowed actors to be amplified. For revue shows, where the performers would sing from a fixed position, microphones rose up out of the stage on a counterweight, and lowered again to be out of the way of the next act. Microphones were placed on short stands along the front edge of the stage for musicals from the 1950s, so they could be as close to the singers as possible. The boundary mic was a further development; placed on the stage surface, these mics gave a cleaner sound.

The amplification of actors and singers was finally transformed by the lavalier microphone, clipped onto the performer's clothing or fixed to their head. Developed in the early 1930s, it ensured a constant distance between microphone and mouth. Once combined with a radio transmitter and receiver in the 1950s, the lavalier mic became the radio mic we know today. Actors no longer have to speak as loudly as possible; they can use the full dynamic range of their voice, and the number of people in the audience is no longer limited by the acoustic properties of the room.

Although many actors and directors are still reluctant to use sound reinforcement for drama, PA systems are increasingly used to provide a subtle but valuable improvement to intelligibility in larger theatres. For musical theatre, as well as live music, PA systems are seen as essential. With good design and skilled operation, the PA ensures everyone in the room can hear everything they are supposed to.







Top: Reis telephone, 1861.

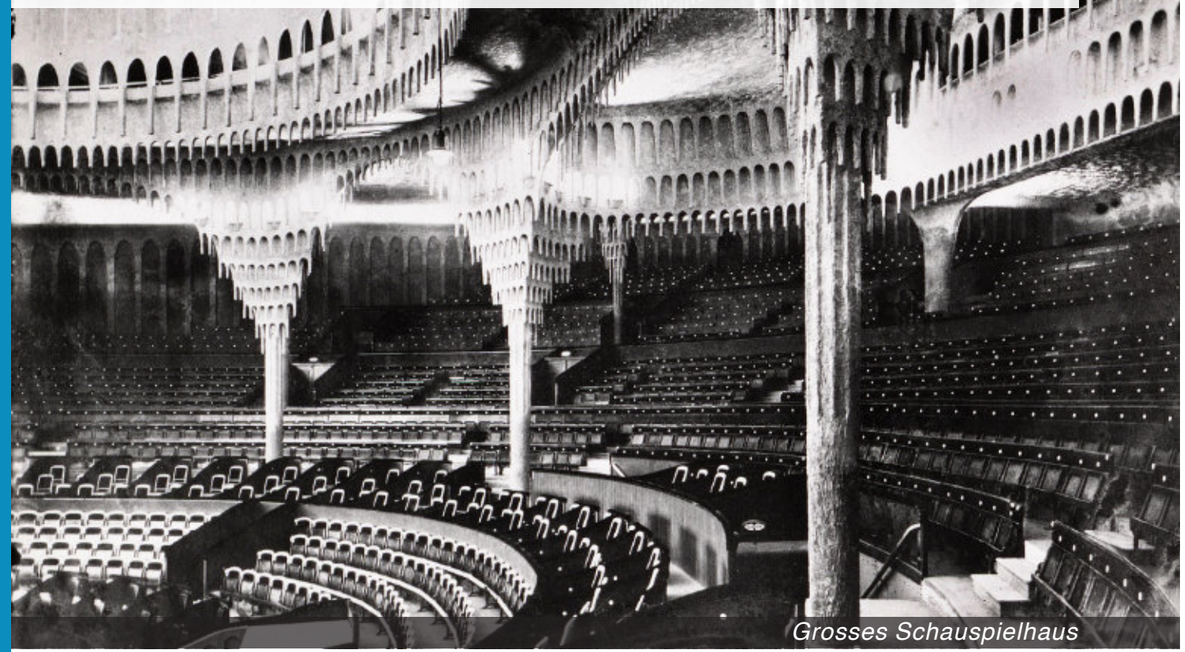
Middle: Direct-radiator loudspeaker by Chester Rice and Edward Kellogg, 1925.

Bottom: Audion vacuum tube by Lee DeForest, 1906.

Left: Altec Lansing 'Voice of the Theater' speaker, designed for cinemas but later used in theatres, and more recently by audio enthusiasts.

Utopias of the Imagination

Total theatre, new societies



Grosses Schauspielhaus

The Total Theatre was designed by Erwin Piscator and Walter Gropius. This immersive theatre concept aimed to abolish the separation between actors and audience, challenging the spectator to actively participate in what was happening on stage.

> For lack of imagination, most people do not even experience their own lives, let alone their world. Otherwise, the reading of a single newspaper should be enough to throw humanity into turmoil. So stronger means are needed. One of these is the theatre. (Q98765, 5)

Aged 21, Erwin Piscator (Q72) went to war. The First World War was, in Piscator's words, a 'gigantic hoover' that would force a generation to start all over again. It is not surprising then, that although theatrical utopias accompany the entire history of the performing arts, the conflict was an excellent breeding ground for them to flourish.

The war politicised Piscator, who came into contact with Dadaist circles and the Spartacist League in Berlin. Art was no longer an expression of feelings, but a means of protest and intervention; an instrument of the class struggle: propagandist, educational, effective. It must arouse enthusiasm; it must help people to take a stand. During those years, he founded the Proletarian Theatre in Berlin.

Piscator proposed that the use of the technical and expressive innovations of the theatrical avant-garde should not be an end in itself, but a means to achieve a social and political end. He advocated transforming the spectator/spectacle relationship by creating a theatre that does not seek to affect feelings, but reason.

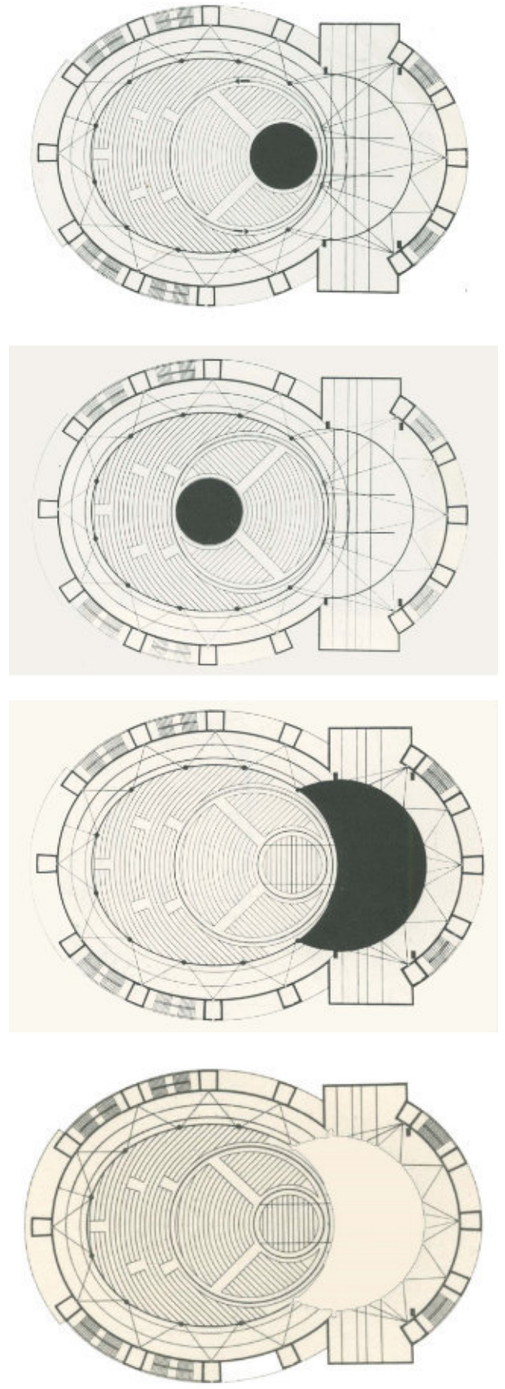
In this way, he created *Trotz Allem* (In Spite of Everything) as a political document on the occasion of the congress of the KPD (the communist party in Germany): a gigantic montage of authentic speeches, writings, press cuttings, proclamations, photographs, films. New and diverse languages corresponded to a new form of staging, for which the traditional Italian-style space was inappropriate. On 12 July 1925, the work premiered in the Grosses Schauspielhaus, designed by the architect Hans Poelzig. The architecture of the theatre was particularly suited to creating a sense of coming together – of assembly. Max Reinhardt had already experimented with this in Georg Büchner's *The Death of Danton*, when he turned the space into an immense parliament.

But Erwin Piscator needed a new venue for his Political Theatre. He needed a theatre machine that had the technical perfection of a typewriter. He needed a new theatre, and in 1926 he commissioned the architect Walter Gropius (Q21731), founder and director of the avant-garde Bauhaus art academy. The Total Theatre (Q30524) was intended to finally achieve the modern theatre's quest to invent new technical and spatial means to introduce the spectator into the dramatic action, to a greater extent than ever before.

The design for the Total Theatre drew on the history of the performing arts: the Greek theatre, the circus, the Italian theatre, and at the same time made new innovations, such as the corridors at the back of the hall, where the dramatic action can take place or images can be projected. The dome of the hall itself was to contribute to the creation of an enveloping atmosphere. The Total Theatre is the triumph of spectacle. In it, the stage space imposes itself absolutely on the spectator. Technology becomes an instrument of persuasion.

Bertolt Brecht (Q69), who had a deep respect for Piscator's work, criticised him: 'He found it easier to achieve a critical approach to great themes through ingenious and imposing stage effects than through the work of the actor.' Vsevolod Meyerhold's (Q71) project to build a new theatrical form to meet his dramaturgical needs were also shaped by Piscator's radical questioning of the dominant theatrical typology, albeit with different aims and proposals. And we would say the same for the utopian and never-built projects for circular theatres of: Oskar Strnad's Ringtheater (1915-1920, Q30639); Jacob Levy Moreno's Theater ohne Zuschauer (1920-1923, Q30642); Friedrich Kiesler's Raumbühne and Endless Theatre (1923-1925, Q30553); or in fascist Italy the proposals of Filippo Tomasso Marinetti's TeatroTotale Futurista (1933, Q30643) and Gaetano Ciocca's Teatro di Massa (1933, Q30644).

As for Piscator's monumental Total Theatre project itself, planned for the Mehringplatz in Berlin, no financial sponsor was found, and it remained unbuilt; equally, the intended immediate identity of stage and audience has remained an unfinished theatrical vision of Piscator.



Designs for Gropius' Total Theater, showing the different staging configurations

E.08

Theatre as Art, Art as Theatre

Oskar Schlemmer and the Triadic Ballet

The Triadic Ballet, *created by Oskar Schlemmer, became the most widely performed avant-garde artistic dance of its time. While the ballet toured between 1921 and 1929, it helped to spread the ethos of the Bauhaus.*

The Bauhaus school (Q76) was a German art school that combined crafts and the fine arts. It became famous for its approach to design, which attempted to unify the principles of mass production with individual artistic vision and strove to combine aesthetics with everyday function.

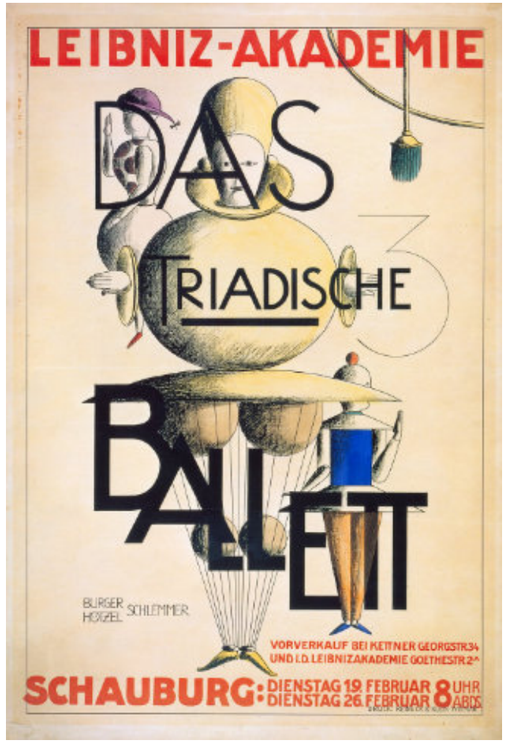
Inspired in part by Arnold Schoenberg's *Pierrot Lunaire* and his observations and experiences during the First World War, the painter and sculptor Oskar Schlemmer (Q30528) began to conceive of the human body as a new artistic medium. He saw ballet and pantomime as free from the historical baggage of theatre and opera and thus able to present his ideas of choreographed geometry, of man as dancer, transformed by costume, moving in space.

Oskar Schlemmer saw the movement of puppets and marionettes as aesthetically superior to that of humans, as it emphasised that the medium of every art is artificial. This artifice could be expressed through stylised movements and the abstraction of the human body. His consideration of the human form (the abstract geometry of the body, for example a cylinder for the neck, a circle for head and eyes) led to the all-important costume design, to create what he called his 'figurine'. He saw the modern world driven by two main currents, the mechanised (man as machine and the body as a mechanism) and the primordial impulses (the depths of creative urges). He claimed that the choreographed geometry of dance offered a synthesis, in which the Dionysian and emotional origin of dance becomes strict and Apollonian in its final form.

From 1923 Oskar Schlemmer directed the theatre workshop, an essential subject at the Bauhaus and whose research gave rise to projects that played with projections of light and shadow, emphasised the study of the human body, and experimented with puppets and marionettes and the constant change of scenery to destabilise theatrical conventions.

Opposite, top, and below: costume for the Triadic Ballet

Opposite, bottom: poster for an unrealised performance of the Triadic Ballet, *1924, designed by Oskar Schlemmer*



The *Triadic Ballet* (Q30527) is considered one of the most significant dance creations of the 20th century. Schlemmer turned the Bauhaus theatre workshop into a laboratory in constant search of the relationship between human and geometry. The workshop was divided into artistic creation and the creation of sets and costumes. Ballet and pantomime were the starting point as they were considered by Schlemmer himself as free forms that do not depend on the word, sound or story. In his works converge art, abstraction, mechanisation, mathematics and metaphysics. The ballet fuses dance, music, pantomime and costumes. The costumes of the *Triadic Ballet* limited the movement of the dancers due to the weight of the materials themselves, glass and metal among others. The forms of geometric lines of the costumes and the masks that transformed the dancers into anonymous characters resulted in structures with comical and clumsy movement. Schlemmer was not looking for the expressive virtuosity of the human body, but rather the visual interplay of basic elements, elementary forms of scenographic representation.

The idea of the ballet was based on the principle of the trinity. It has three acts, three participants (two male, one female), twelve dances and eighteen costumes. Accompanied by the music of Debussy, Haydn, Mozart, Händel and Hindemith, each act was defined by a colour. The first act is a burlesque arranged on a yellow stage, the second shows a series of solemnities on a pink stage and the last act is a mystical meditation on a black stage. The number three represents collectivity, the three dimensions of space, the basic geometric shapes (sphere, cube and pyramid), the basic colours (red, blue and yellow) and the three units (costumes, dance and music). Here Schlemmer openly makes manifest the search for lost harmony through abstraction, the limitation of movement caused by costumes and the idealisation of figures and spaces.

With the beginning of National Socialism in Germany, Schlemmer's designs were considered obscene and provocative (*Entartete Kunst*) because they did not fit the image of the new absolutist regime. Schlemmer, in social exile, died in 1943 in Baden-Baden, Germany.

David Bowie declared himself an admirer of Schlemmer's works and his colourful, geometric and dynamic compositions, which inspired Bowie's spectacular costumes for the 1974 Ziggy Stardust character – a style icon even today.

New Purpose, New Techniques

The spread of political theatre

In the inter-war period in Germany, the director Erwin Piscator developed a new theatrical form, 'epic theatre', aiming to spread his socialist political message. He employed radical new staging techniques and influenced many other theatre-makers.

Erwin Piscator (Q72) was born in 1893, and started a career as an actor before being drafted into the German army during the First World War. His battlefield experience inspired a hatred of militarism and war that lasted for the rest of his life. After the war, he joined the Communist Party of Germany, and formed a theatre company, going on to become stage director at the Volksbühne Berlin (1924-1927, Q8354), and later managing director at his own theatre, the Berlin Piscator-Bühne on Nollendorfplatz (Q30633). Piscator created performances by playwrights such as Ernst Toller and Walter Mehring, with artists including Bertolt Brecht (Q69), George Grosz and John Heartfield. He developed an approach to staging, intended to promote his political agenda, and coined the term 'epic theatre' to describe it during his first year as director of the Volksbühne.

The term epic theatre does not refer to the scale of the production, but to a new way Piscator wanted the audience to engage with it – not to suspend their disbelief, but to see their world as it is. He used montages of many media and effects, such as revolving stages, photograph and film projection, moving scenic elements and scaffolding structures on stage instead of conventional scenery. The combination of fragmented and simultaneous acting scenes, and in-view scene changes created an effect of documentary, rather than a fictional dramatic world. Aesthetics and emotions were not the aim, but were harnessed to the political purpose.

Piscator wrote *Das Politische Theatre* (The Political Theatre) in 1929, containing discussions of the theory of theatre. He later wrote that it was intended to provide 'a definitive explanation and elucidation of the basic facts of epic, i.e. political theatre', which at that time 'was still meeting with widespread rejection and misapprehension.' Piscator's writings were among those that influenced Joan Littlewood and Ewan MacColl, and their socialist theatre groups in the UK, Theatre of Action and the Theatre Union. Littlewood went on to form Theatre Workshop, which was hugely influential in Britain, and made use of Piscator's epic theatre techniques in productions such as A Taste of Honey and Oh, What a Lovely War! (F.08). Piscator's influence also spread through the people he worked with, most notably Bertolt Brecht, who went on to develop his own version of epic theatre, which spread around the globe through productions, play texts and other writings.

Piscator hoped to reach larger audiences by building a radical new theatre. He commissioned Walter Gropius (Q21731), the director of the Bauhaus (Q76), to create a design for a 'total theatre' with him (Q30631). The utopian plan envisaged three possible configurations: the viewing box, an arena and a circular stage enclosing the auditorium. Projectors were to offer the possibility of placing the audience in the middle of a demonstration, or of covering the ceiling with a starry sky. However, due to the enormous costs, the plans could not be realised. Not only that, but Piscator's technical requirements at the Piscator-Bühne were so expensive the theatre could not survive financially, further hampered by the financial crisis and very high inflation of the 1920s and 1930s. After the collapse of the third Piscator-Bühne 1931, Piscator went to Moscow. With Hitler's rise to power in 1933, Piscator's stay became exile, and he later moved to France and the United States.

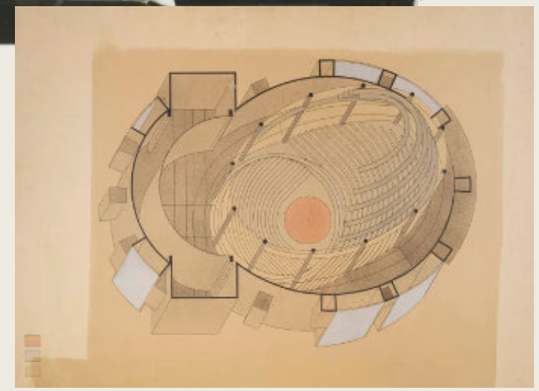
Piscator returned to West Germany in 1951 and in 1962 he was appointed manager and director of the Freie Volksbühne in West Berlin (Q30632). Until his death in 1966, Piscator was a major exponent of contemporary and documentary theatre, as well as influencing theatre movements involved in the many protests that took place internationally in 1968. In 1959, three decades after its first release, Piscator's book *Das Politische Theatre* was republished. In the forward to the new edition, Piscator said that:

> The justification for epic techniques is no longer disputed by anyone, but there is considerable confusion about what should be expressed by these means the *functional* character of these epic techniques, in other words their inseparability from a specific content (the specific content, the specific message determines the means and not vice versa!) has by now become largely obscured. So we are still standing at the starting blocks. The race is not yet on…

Although his ideas had been hugely influential in changing the way theatre is staged, he felt the political *purpose* of the techniques of epic theatre had been lost. Piscator substantially reshaped how we use technology and design to speak to an audience. As always, the content of the message depends on our aims as theatre-makers.

Above: profile of Erwin Piscator. Set design for Hoppla, Wir leben! *by Ernst Toller*

Scenes from Hoppla, Wir Leben!



The Total Theatre, designed by Walter Gropius for Erwin Piscator (1927).

G.08

Women Take the (Back) Stage

Women in technical theatre

In the early and middle years of the 20th century, women began to take on roles previously barred to them. The male-dominated world of theatre, as with all of society, began to shift, although change was slow, and equality is yet to be achieved.

For long periods of its history, theatre has been considered morally problematic, and a risk to social order. This applied especially to women in the theatre, with being an actress associated with having low morals, even being a prostitute. At various places and at various times, women were banned from the stage altogether. Theatre, holding a mirror up to society, reflected a social order that privileged men in every way possible. In the 19th century, the status of theatre itself began to change; as theatre grew rapidly as an entertainment popular with all strata of society, the reputation of actors rose, with the most successful becoming 'stars' in the sense we understand it today. Some actresses, too, achieved fame, but backstage workers remained almost exclusively male, and their contribution largely unacknowledged. In the late 19th century, a shift began that was to accelerate after the First World War, as a small number of women took on significant roles in theatre production.

Marie Louise Fuller, later known as Loïe Fuller, was born in Chicago in 1862 (Q323). She was a professional child actress, and performed as a dancer in burlesque and vaudeville shows. She went on to develop a unique type of dance, involving flowing costumes and carefully controlled lighting. Having failed to find the serious artistic reception she sought in America, she moved to Paris in 1892, where she became recognised as part of the artistic Avant-garde. In this environment of experimentation and innovation, she continued to develop her performance style, so that costume and light became the principal, almost the sole, elements of her dance. The abstract imagery of her performances was an inspiration to the Symbolists and Futurists alike.

Fuller's lighting was highly rehearsed, using a team of between 14 and 38 technicians to manually control the brightness, colour and direction of the lights, sometimes uplighting through a glass floor. The lighting and its operators was as much part of the choreography as Fuller herself. She also took out numerous patents to protect her innovations, including chemistry to create specific lighting gel and costume colour effects. In the language we might use today, Fuller was an artist, a performer, a designer and a technologist.

In London in the 1930s, three women formed a theatre design collective called The Motley Theatre Design Group, or simply Motley (Q30012). Two sisters, Margaret (known as 'Percy') and Sophie Harris, and Elizabeth Montgomery had met at art school, and rapidly started designing productions for John Gielgud and Michel Saint-Denis. They went on to design many productions in London's West End, in New York, and elsewhere – sometimes working together, and sometimes separately, but always under the name of Motley. Saint Denis went on to found the London Theatre Studio (1936–1939), a new theatre school which incorporated courses in theatre design taught by the Motleys – the first time theatre design had been taught within a drama school, rather than an art school, in the UK. Percy and Sophie went on to teach theatre design at the Old Vic School, London (1948–1952) and Percy subsequently set up the Motley Theatre Design Course (1966–2011).

The shared ethos of the three women was one that built on the new philosophies of theatre art that had been in development since the start of the 20th century: they believed set and costume design should be an integral part of the performance, responding to and supporting the themes and narratives of the play, not superficial decoration. Their success as designers, and in particular their involvement in education – with many of their students going on to successful careers – means their influence on theatre design in the UK and beyond has been substantial.

Motley is significant not just for its impact on theatre design practice. It is also an important example of the role of collectives in developing emerging fields of practice. Other examples include Richard Pilbrow's Theatre Projects

Portrait of Fuller by Frederick Glasier, 1902

(Q29724), which gathered a generation of lighting designers together for mutual support and to share work, when that professional role was nascent, and the designers' collective Mesmer, which more recently fulfilled a similar role for the emerging field of video design for theatre. When young practitioners are trying to establish not just themselves but a new way of working, operating as a collective provides support, sharing of knowledge, experience and contacts, and a more visible identity. For Motley, carrying the additional burden of being women in a world almost exclusively of men, the collective model was key to their success.

Since the formation of Motley in the 1930s, there have been notable women practitioners in all fields of theatre design and technology: the stage manager, Maud Gill (Q30582); the lighting designer, Jean Rosenthal (Q23051); the live music sound engineer and tour manager, Berenice Hardiman (Q30580); the lighting technologist Anne Valentino (Q30578), and more. But these names are disproportionately few. Today, with women's equality gradually improving but far from achieved – in theatre as in society – women have banded together in new ways, forming associations for mutual support and to raise the profile of the issue of inequality: Women in Lighting (WIL), Women in Stage Entertainment (WISE), Parents in Performing Arts (PiPA), Stage Sight, and others. Inequality – measured in terms of gender but also of other underrepresented groups – is perhaps the greatest challenge the theatre industry is facing today.

H.08

Working Together

Standardisation and compatibility

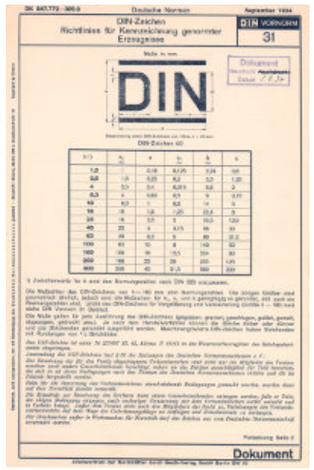
Since the early 20th century, national and international standards organisations have existed to create technical and safety standards ensuring our equipment works as we expect, and works with other equipment. Above all, standards also keep us safe.

The history of standards goes back a long way. The Indus Valley civilisation used standards for weights and measures around 5000 years ago. Technical standards became increasingly important during the industrial revolution, to ensure products met the required specification, and machinery parts made by different manufacturers were compatible. One example of this was the British Standard Whitworth (BSW) standard, devised in 1841 - the world's first national screw thread standard. Safety regulations and standards also developed during the 19th century, such as the revised building codes following the Ringtheater fire in Vienna (J.05).

It was in the 20th century, however, that standards began to be put into national and international frameworks. The first half of the 20th century saw the development of national standards authorities in many European countries, especially the more industrialised ones. The Engineering Standards Committee was founded in London in 1901, later extending its standardisation work and adopting the name British Standards Institution (BSI) in 1931. In Germany in 1879, Werner von Siemens and Heinrich von Stephan founded the first *Elektrotechnischer Verein* (Association of Electrical Engineers) in the world, which later becoming part of the *Verband Deutscher Elektrotechniker* (German Electrical Engineers Association, VDE). VDE presented its first *Normalien-Buch* (Book of Standards) in 1904, and in 1906 it helped found the International Electrotechnical Commission (IEC), which now sets over 10,000 electrical and electronic standards, used in 173 countries.

In 1917 the *Normenausschuss der Deutschen Industrie* (German Industrial Standards Committee) was established – later renamed the *Deutscher Normenausschuß* (German Standards Committee). Only a few weeks after being founded, it published the first DIN (*Deutsche Industrie-Norm*) standard, defining the dimensions of and materials for taper pins under the title DI-Norm 1.

This rapid development of standards organisations in the first decades of the 20th century helped improve safety and support national and international trade in many different areas of industry. Electrical systems, equipment and connectors were a particular focus, because of the rapid growth of the electricity infrastructure. At first, without agreed standards, each manufacturer produced its own – often patented – type of connector. Plugs and sockets were sold in pairs, to ensure compatibility. Successful products became *de facto* standards, subsequently formalised as official national and international standards. One of the earliest was the 1915 British Standard 73 for wall plugs and sockets.



The DIN standard for the DIN's own mark, 1934

A further British Standard was issued in 1934, BS 546, covering two- and three-pin plugs and sockets. The standard covered a range of connectors, rated at 2, 5, 15 and 30 amps. Adoption in the theatre industry was slow, but by the 1950s and 1960s, greater flexibility of lighting rigs was expected, so lights needed to be easily moved and replugged. The 15A round pin connector became widely adopted, with the 5A connector sometimes used in smaller venues. With some safety updates, the 15A connector remained the theatre lighting 'standard' in the UK until the late 20th century when it was gradually replaced by the 16A ceeform.

In Germany, the Schuko-system three pin plug dates from 1926. Schuko is an abbreviation of *Schutzkontakt*, which means 'protective contact'.

Two important safety features of the Schuko connector standard are the earth clips that make contact before the other pins, and the recessed sockets, ensuring live pins can't be touched. The original design of a safe, earthed plug and socket was the idea of Albert Büttner. The plugs had earth clips rather than a (third) earth pin. Further developments resulted in a version that was patented in 1930 by the Siemens-Schuckerwerke in Berlin. This patent describes the plug and socket that is still in use, showing that standards can have long lives.

By the 1960s, the CEE (*Commission internationale de réglementation en vue de l'approbation de l'équipement électrique* - nowpart of the IEC) had introduced a standard for industrial power connectors: CEE 17. This standard gave rise to the 'ceeform' plugs and sockets that are widely used in industry, including in theatre and live events. The standard specifies a range of ratings for current, voltage and environmental protection (resistance to dust, water, and so on). The specification includes several safety features: colour-coding makes the different types easy to identify, while pin layouts are designed so it is impossible to connect plugs and sockets of different types, or to connect them incorrectly. The design of the shell ensures it is impossible to accidentally touch the live pins while connecting and disconnecting.

Electrical connectors are just one type of equipment where a common standard has made the life of theatre technicians easier and safer. Creating standards is overseen by national and international bodies, including since 1947 the International Organization for Standardization (ISO) that is global in its scope. The job of developing standards is done in conjunction with industry experts, and while it is not glamorous and seldom recognised, it is important work that industries benefit from greatly. The work is marked by Standardization Day (also known as Weltnormentag or World Standards Day), celebrated annually on October 14 in honour of the resolution, passed in London in 1946, to found an international organisation to simplify standardisation. We are all the safer for it.

'Tripin' 3-pin earthed plug manufactured by A. P. Lundberg & Sons of London, 1911

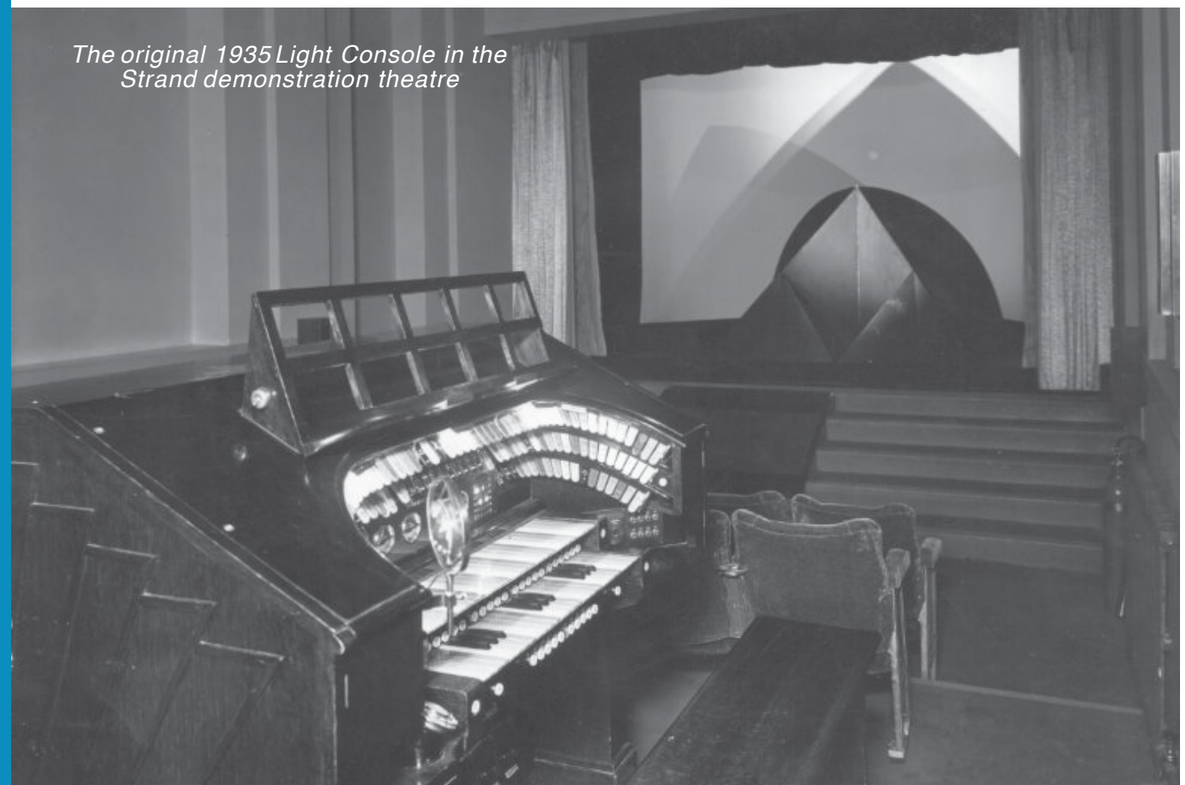
Colour Music

An art on the margins

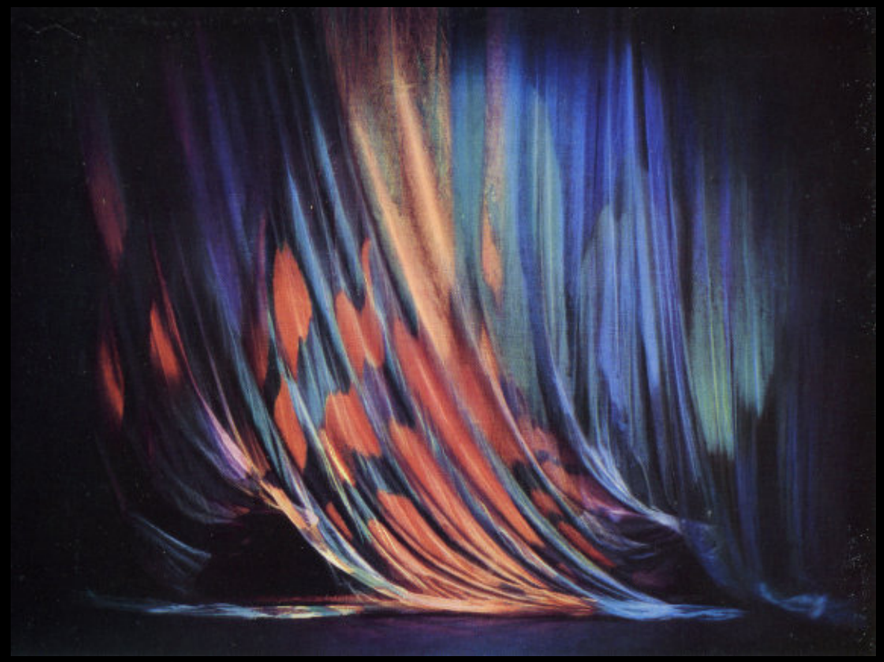
For centuries, people have dreamt of a kind of performance that uses light and colour in the way music uses sound. Many attempts have been made, including one by the theatre technologist Fred Bentham, but Colour Music has remained a marginal artform.

In the early 1930s, a young employee called Fred Bentham (Q429) persuaded the directors of the Strand Electric and Engineering Company where he was working that they should invest a substantial amount of money in a new lighting control system: the Light Console (Q30599). At a time when lighting control in the UK and most of Europe was based on the mechanical operation of resistance dimmers (Q3922), Bentham's system was quite unlike anything that had come before. It used technologies from cinema (the electric organ), the telephone industry (the cross-bar relay) and the Mansell magnetic clutch to remotely control a bank of dimmers, now motorised, from a control interface that would have been familiar to any cinema or church organist. With the Light Console, coloured light could be played as a musician plays music – what Bentham called Colour Music.

Bentham was not the first to have the idea for a performance of coloured light. In the 1720s the French Jesuit and mathematician Louis-Bertrand Castel experimented with a *clavecin pour les yeux* – a harpsichord for the eyes – the keys of which opened up shutters that let light shine through 60 small, coloured panes of glass. Around 1742, Castel went on to propose the *clavecin oculaire* (light organ) – an instrument to produce both sound and associated coloured light. The British painter Alexander Wallace Rimington spent many years developing an instrument that could project colours in harmony with music. He patented his ideas in 1894, and gave talks and demonstrations, accompanying music by Frédéric Chopin and Richard Wagner. He went on to publish a book in 1912, *Colour Music: The Art of Mobile Colour*, in which he described the mechanism of his colour organ: a powerful arc-light of 13,000 candlepower produced white light that was passed through two prisms to provide a colour spectrum. These colours were then mixed and projected onto a screen, controlled by a keyboard and pedals.



The original 1935 Light Console in the Strand demonstration theatre



Bentham performed colour music by lighting drapes or abstract geometric forms, accompanying classical or jazz music

Castel and Rimington are just two of the many people, particularly in the late 19th and early 20th centuries, who promoted the idea that coloured light could be performed in a way equivalent to music, either on its own or combined with sound. While Bentham was not alone, he was perhaps the first to connect theatre stage lighting and colour music, through his development of the Light Console. While his personal passion was for colour music, to get the console made and to have an opportunity to operate it, he positioned it as a lighting control for theatre. The first to be built, in 1935, was installed in Strand's demonstration studio in London, where Bentham could show it – along with Strand's other stage lighting products – to potential customers. For most people in the theatre industry, however, the Light Console was a solution to a non-existent problem. Mechanical controls such as the Grand Master (Q3219) were seen as sufficient, cheaper and simpler to operate.

The Light Console had limited success commercially. Between 1935 and 1955 a total of 17 were made, installed in theatres in the UK and internationally. It particularly suited light entertainment shows, with rapid changes and music, and where speed of operation was more important that exact reproduction of timings and levels. For drama, there was a growing need for the reproducible control of many lights set to precise levels for each lighting state (C.07, C.08), and the Light Console did not meet that need. For theatre lighting, Bentham and his Light Console made a proposal – at a time when the lighting designer did not exist as a district professional role – that the lighting operator should be the person with creative responsibility for lighting. The industry had other ideas, and with the emergence of the lighting designer, the operation of lighting during the performance remained a matter of accurately reproducing the lighting that had been predetermined.

Bentham continued to perform colour music using the Light Console when he had the opportunity. He formed the Light Console Society, which met and gave recitals of colour music in the late 1930s; it had 101 members at one point. In 1939 Bentham designed a display for the London Daily Mail Ideal Home Exhibition, with a 23m high internally illuminated tower: the *Kaleidakon.* A Light Console and a conventional Compton cinema organ played the lighting and music. However, colour music – Bentham's and that of a long list of other proponents – remained a marginal, specialist artform. Today, lighting for rock concerts fulfils something of the same role, and light is an established medium for visual artists, but the idea of *light performance,* as a distinct art, has yet to find its moment.

A Moving Experience

The revolving auditorium at Český Krumlov

The revolving theatre in Český Krumlov Castle gardens

Revolving stages are commonplace, but systems to rotate the audience are rare. The outdoor revolving theatre in the grounds of Český Krumlov Castle in the Czech Republic, dating from 1958, is one example.

For more than a half of century, the revolving theatre in the gardens of Český Krumlov Castle has been a significant and unusual example of an outdoor theatre with a unique design and utilisation of scenic space. This open-air amphitheatre, with a revolving auditorium designed by Joan Brehms, is set amongst trees many hundreds of years old, and has been progressively remodelled over its lifetime.

Joan Brehms (Q21388) was a theatre architect, stage designer and painter, strongly influenced by the Bauhaus. In the late 1920s and early 1930s he worked as a stage designer at the German Drama Theatre in Riga, Wrocław and Gdańsk. He participated in productions in non-theatre environments and was at the birth of new theatre spaces, the most famous of which is the revolving auditorium from 1958.

The purpose of the revolving theatre was to disrupt, to destroy deliberately and functionally the convention of a proscenium stage, to use inversely the principle and functions of the stage revolve, to create dynamics in the theatre by the movement of the auditorium, to search for a new stage design, modes and means, and specific directional procedures and means of actors' expressions. As the audience turns, it faces different parts of the gardens, where the scenes are played out, with the various vistas and the summer palace providing the backdrops.

The origins of the Český Krumlov revolving auditorium (Q12843) are in the Jihočeský divadelní festival (South Bohemia Theatrical Festival) in the summer months. The first seasons of theatre productions in the Český Krumlov castle occurred in 1947 and 1948 and several performances took place in front of the Bellarie summerhouse, as well as the cascade fountain in the castle garden. The construction of the revolving theatre as a circular rotating auditorium was initially complicated; the first small wooden constructions were soon being replaced by larger variants.

A new auditorium with the considerably higher capacity of 400 seats was installed for the summer of 1959. Since then, the basic construction scheme has not changed over the years: a platform with rows of seats ascending over the circular base, and topped by a lighting and technical cabin. To begin with the auditorium was rotated manually, powered by 40 soldiers, but later it was driven by an electric motor.

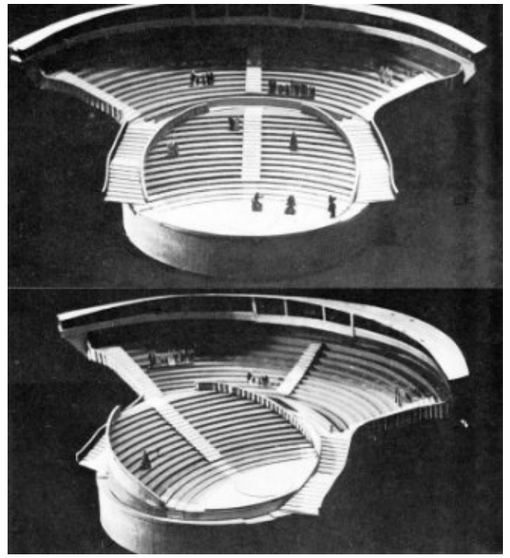
A large reconstruction of the rotating base occurred in 1960s and 1970s. The auditorium was given a new drive system (bantam wheels), the wooden seats were replaced by laminate ones, the capacity was increased to 800 spectators, and dressing rooms were created in the Bellarie summer palace basement.

In recent years, there has been a great deal of debate about the suitability of this stage and its location immediately in front of the summer palace in the castle gardens. Opinions in favour of the theatre emphasise the unique atmosphere of performances at night, while the opposing opinion points out, among other things, the problematic aesthetic qualities of the auditorium and its unsuitable placement on the central axis of the geometric Baroque gardens.

Brehms returned several times to the idea of the folding and portable auditorium for 1200–1500 spectators over the years since the theatre at Český Krumlov. An indoor revolving theatre, which Brehms was also experimenting with in later years, was realised in 1959 by Jacques Polieri in Paris. The 1972 New London Theatre in London, UK (Q9377), has a central revolve 60ft across which accommodates the stage, orchestra pit and the first eight rows of seats, which form a theatre-in-the-round when the revolve is turned.

These theatres have earlier precedents: the Roman emperor Nero had an octagonal banquet hall which would imitate the movement of the Earth while allowing the emperor to see all the guests from his central position. This concept was taken up by Joseph Furttenbach (Q60), in his 1650 design for a play about the triumph of Christianity over the Roman Empire. Furttenbach arranged four stages around the central auditorium, each with a different scene, much as Brehms did 300 years later with the four garden views.

The idea of revolving theatre must also be understood in the context of the Totaltheater project of 1926. The main inspirational source for Brehms was unquestionably the founder of the Bauhaus, architect Walter Gropius (Q73), who developed the Totaltheater concept together with Erwin Piscator (G.07, Q72).



Top: model of polydimensional theatre in two configurations, by Joan Brehms

Above: revolving theatre, by Jacques Polieri

Architectures of Space and Image

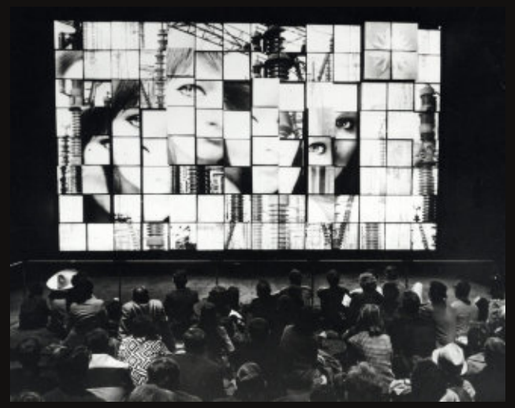
The light beams and projections of Josef Svoboda

The Czech designer Josef Svoboda developed an anti-illusionist approach to stage design, placing light, projection and film at the centre of his designs. He co-founded the Laterna Magika multimedia theatre, and devised the multiscreen Diapolyekran.

By the middle of the 20th century, the technologies of electric stage lighting and projection were well developed, and those of video images (television) were emerging. The technical means were available for a radical new approach to the staging of performances, fulfilling the ambitions of earlier theatre theorists and practitioners such as Adolphe Appia (Q249) and Edward Gordon Craig (Q325) – a theatre of light, space and image.

The Czech stage designer Josef Svoboda (Q91) joined the National Theatre in Prague (Q12648) in 1948, where he developed his rigorous approach to scenography. For Svoboda, each production was a unique puzzle to solve, to find the ideal solution to the staging of the performance. He worked closely with technicians to find unique solutions to his design requirements – even to the point of having a member of the stage staff collect eggshells from the breakfast serving at a nearby hotel, as the shells provided the ideal texture to light onto, on a piece of scenery.

Svoboda developed techniques of using narrow beams of light to create spatial architectures in the air – the curtains of backlight creating



DiaPolyekran, EXPO 67, Montreal

Mediterranean heat for Verdi's *Sicilian Vespers*, and the spiral of rising beams for Wagner's *Tristan and Isolde.* Lighting fixtures were created specially to make these effects, but were soon put in production for commercial sale, such was their success (Q13146). Svoboda developed his use of physical materials on stage with light in mind – gauzes, steel mesh, tensioned cords, mirrors and transparent plastics were surfaces to take light and projected images. Beamlights (Q3189), using intense, low-voltage lamps provided soft-edged follow-spots that could highlight the performers anywhere on stage, without compromising the remainder of the lighting and the projection.

In the National Theatre in Prague, there was enough dust in the air to make the beams of light visible, but when productions transferred to other, cleaner theatres, Svoboda worked with technologists to develop a system that sprayed very fine water droplets. The droplets were statically charged, and so remained suspended in the air, until the charge was reversed and the droplets fell to the stage, 'magically' clearing the air.

For Svoboda, the scenography must function dramatically, as a part of the evolving action. Dynamics were therefore very important to his work, sometimes involving complex stage mechanics. The fluidity of light and image, however, were vital to delivering this philosophy.

In 1958 Svoboda worked with the theatre director Alfréd Radok (Q30556), his brother Emil (Q30557), and scriptwriter Miloš Forman (Q30558) to create Laterna Magika (Q16340) to promote Czechoslovakian culture at the international exhibition Expo 58. The project combined film with live stage action on a multi-screen projection system, and has been claimed as the first multimedia theatre. From its start in 1958, Laterna Magika developed into a permanent theatre company, with Svoboda taking the role of artistic director in 1973. The company is still operating today, making new productions as well as performing older works.

The concept of Laterna Magika was to find ways to create a theatre that synthesises all the elements, able to tell a story using a greater variety of means, especially through multimedia projection combined with the work of live performers on stage. The

Sicilian Vespers, Metropolitan Opera, New York, 1974

basic principle, the interactive integration of film projection with movement and acting, has gradually been complemented by new technologies such as digital projection or new media including real-time programmable software. Since the beginning, Laterna Magika's productions have combined genres: drama, dance, pantomime and black-light theatre (Q3165). Each performance has a different way of combining stage and image, but the fundamental principle remains: the projection is not just a moving backdrop, nor does it merely create the appearance of reality. The action on the stage is always closely linked to the action on the screen.

Svoboda also created other multimedia systems. These technological experiments were developed for exhibitions, but the results were often subsequently used in the field of theatre. These systems used multiple screens or three-dimensional objects as projection surfaces for still and moving images; combined with a recorded musical score, the result was an audio-visual composition without live performers. Polyekran (literally, 'multi-screen') was presented at the EXPO 58 in Brussels at the same time as Laterna Magika, and had eight projection screens. Polyvision and Diapolyekran were both created for the 1967 EXPO in Montreal. Polyvision used three-dimensional, moving scenic elements on which the images were projected, while the Diapolyekran system had 112 independently rotating screens. These installations made a lasting impact on narrative cinema, video art and interactivity.

Svoboda led the development of an approach to both scenography and dramaturgy that uses architectures of space, light and image as its primary medium. Building on the theories and experiments of earlier 20th century innovators, he demonstrated how the newest theatre technologies could be harnessed in the service of the arts of performance.

B.09

Dynamic Light

Controlling light in time

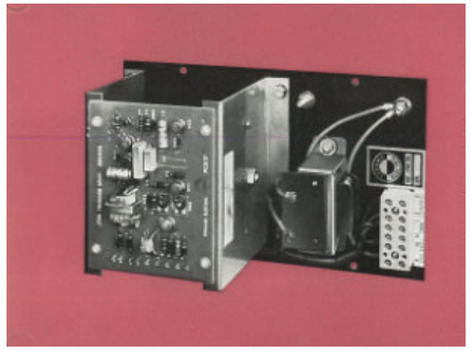
Modern stage lighting is all about control: where and when do we want it, and what kind of light do we want? In the post-war period, as ambitions for lighting grew, the precise control of light levels over time was a matter of urgent importance.

Early 20th century theatre visionaries dreamt of dramatic light in constant motion, with colour dynamically shifting the audience's emotions. James B. Fagan wrote,

> The day is not far off when we shall see the electrician an artist as well as a technical expert - seated at his switchboard like a player at an organ - sending forth rhythmic harmonies of light that shall be as music to the eyes, swaying strange sub-conscious moods in the audience, in perfect tune with the unfolding of the drama in which he himself is playing a part of no mean importance. (Q30585)

However, having the vision was one thing – realising it technically was another.

Through the first half of the 20th century, various efforts were made to develop better lighting control methods. Early resistance and variable transformer dimmers had to be operated mechanically with levers and large control wheels (Q3922, Q601). They were large, heavy and generated alotofheat,andwere therefore generally placed backstage, where the operator could not see the stage action. The need was to separate the control surface (the part the operator used to set and change the lighting) from the dimmers (the part that regulated the power going to the lamps and so their brightness). The key to splitting the control system in this way was a dimmer that could be controlled by an electrical signal sent down a small wire, rather than a mechanical linkage of rods or steel cables.



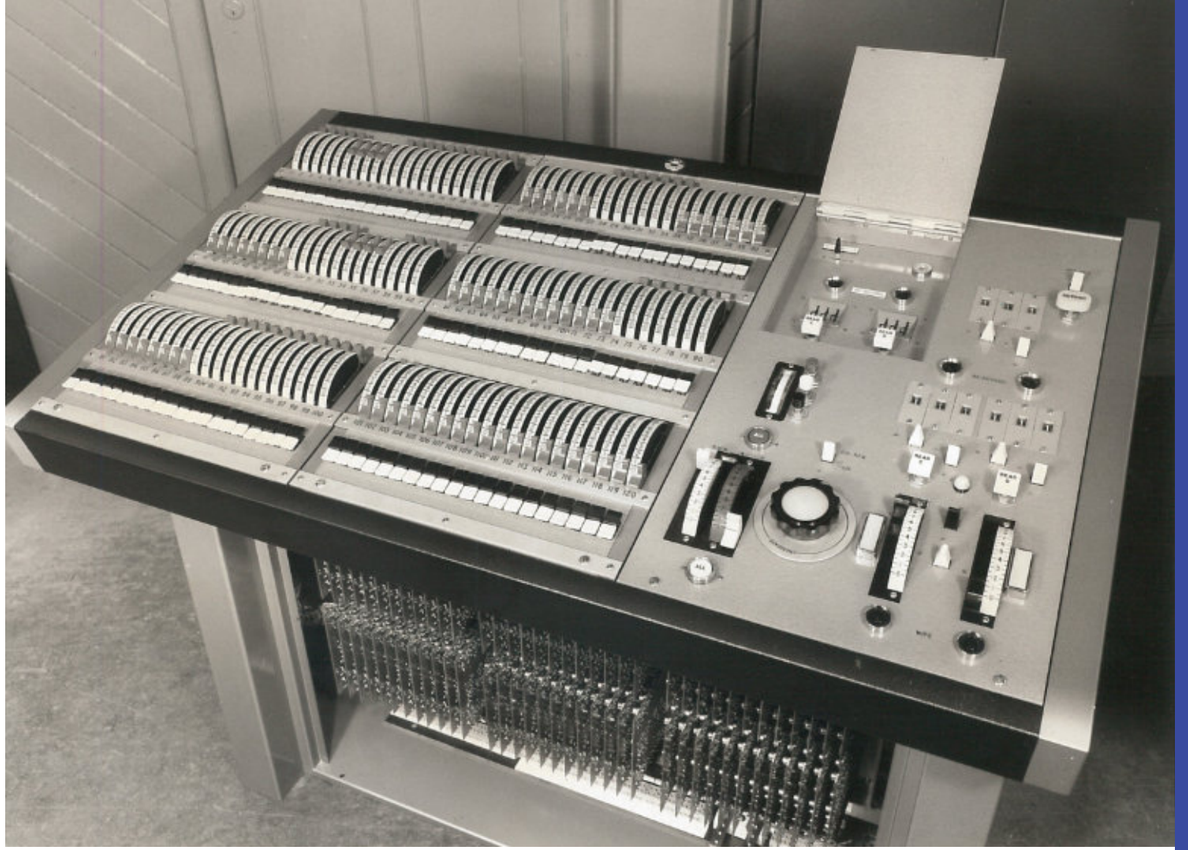
JTM thyristor dimmer module, by the Strand Electric Company

The first electrically controllable dimmer was the saturable reactor in the 1930s, which worked well but was too expensive for most theatres (Q30587). Also in the 1930s, the thyratron dimmer (the first electronic dimmer, Q12964) was developed in the USA, and imported to Europe the following decade; however, it was both expensive and unreliable. Nevertheless, it pointed the way towards the thyristor (Q3906), based on solid-state electronics rather than the vacuum tubes of the thyratron. Developed in the late 1950s, the thyristor found many industrial applications for controlling power, and as a result rapidly became a cheap and reliable technology – one that is still in use in theatre lighting dimmers today.

Once dimmers could be controlled by electrical signals, with no mechanical connection needed, new possibilities for control became available – most significantly the shift to 'pre-setting'. Mechanically operated controls offered limited or no ability to set the levels of each dimmer in advance – arriving at a precise and pre-determined balance of lighting levels at the end of a fade was down to the skill and dexterity of the operator. A 'preset' lighting console had several presets, and each preset had an individual small fader for each dimmer. Small controls had two presets, and large ones up to eight or ten. One preset was 'live', determining the light levels on stage, while other presets could have the required levels for each dimmer set on them for the forthcoming cues. When a change was required, the operator would cross-fade between presets. The result was precise and repeatable lighting for large numbers of dimmers – meeting the increasing ambition and technical complexity of lighting at the time (C.07).

In the 1960s, memory controls automated the process of presetting, using electronic memory systems to record and recall the levels of each dimmer needed for each lighting state. Soon the operation of the fades between states was also automated, according to a preset timing for the cue. This automation brought some advantages: many cues could take place in rapid succession, with no need to wait for the operator to set the levels; the replay of the cue was completely consistent, and long fades over several minutes could be done easily; it also became possible to create complex 'multi-part' cues, with multiple groups of dimmers changing brightness at different speeds at the same time. The earlier dream for lighting was beginning to come true – lighting in continuous flux throughout the performance.

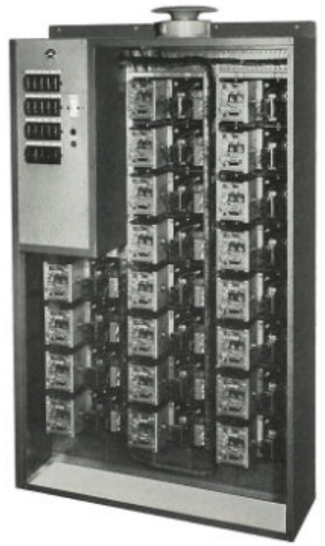
Nevertheless, this highly automated way of working has its critics. For some, the method of determining the speed of each lighting change in advance is unsuited to theatre as a living, 'real time' art form. We have gained accuracy and repeatability of levels and transitions. We have lost the vision of the operator as a stage artist – almost a performer – making subtle judgements about just how the lighting ebbs and flows in relation to the other activates of the stage. It is notable that lighting for live music has either committed fully to electronic control, with the whole show (including the musicians) using time-code to stay in perfect synchronisation, or stayed with manual control, the operator able to respond to the feel of the music and the response of the audience on the night.



Above: Instant Dimmer Memory (IDM) lighting console.

Below: JTM thyristor dimmer module

Both by the Strand Electric Company



Sound on Cue

Anew dramaturgy

In the 1950s, the new technologies of the panatrope and, later, the tape recorder, allowed pre-recorded sound to be replayed on cue, so establishing the creative potential for sound as a central dramaturgical element of performance.

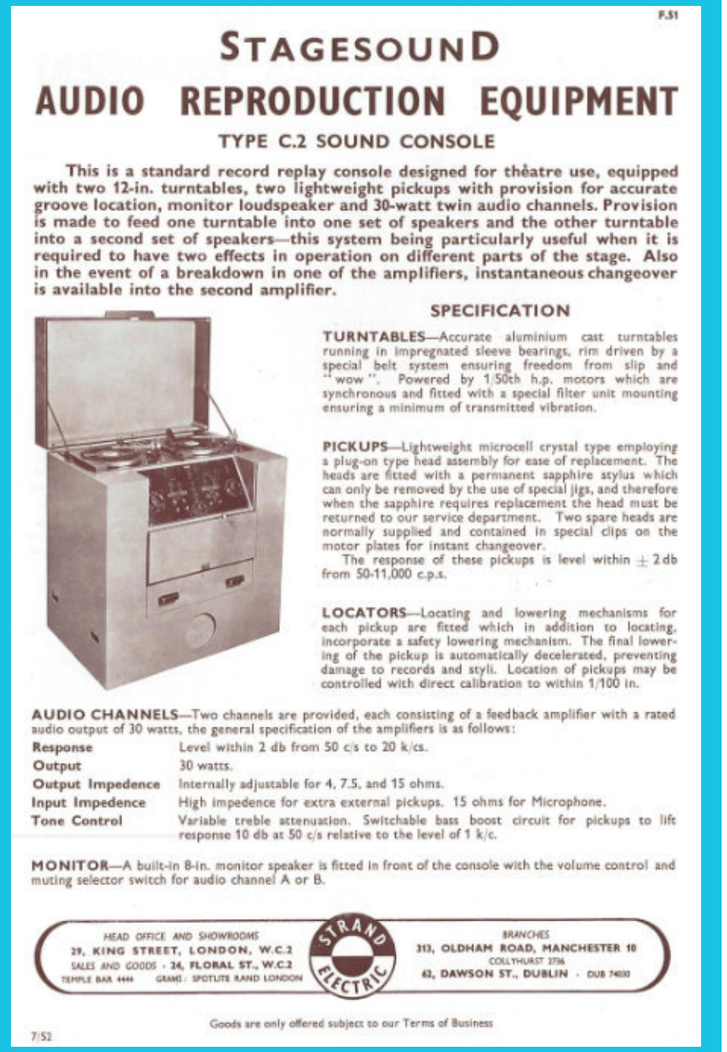
The 1953 catalogue of the Strand Electric Company (Q64), based in London, featured the 'Type C.2 Sound Console' – a large cabinet equipped with two 12-inch turntables, able to replay sound effects recorded on phonograph records. The unit had two built-in amplifiers each rated at 30W, ready to connect to loudspeakers front of house or on stage, as well as a sophisticated system for lowering the stylus at the correct point on the record to start the sound precisely on cue. A speaker allowed the operator to monitor the sound before fading it up on stage, and the two turntables meant that two effects could be played simultaneously, or could be cross-faded from one effect to another. The C.2 Sound Console was the state of the art for theatre sound effects reproduction in 1953, offering the fundamental features required for this purpose: multiple sources, accurate cuing, control of volume, and monitoring independent of the stage output.

Revox A77 tape recorder (1967-1977). The A77 was the workhorse tape machine in many theatres in the 1970s and 1980s.

The Strand C.2 was not the first such device. In the late 1930s, a company called Simon Sound created a similar machine with two turntables and an amplifier, specifically to play theatre sound effects. These became known as panatropes, borrowing the name from 'the first purely electrical reproducing musical instrument', launched in 1925 in the USA by the Brunswick Company, though the Brunswick machine was intended for domestic use and only had one turntable.

After the Second World War, Jack Bishop was running an electronics shop in London, and supplying recorded effects discs for theatre productions. To meet demand, he obtained some Simon Sound panatropes, but then developed his own, improved version (Q23450). The most important innovation was the cuebar – a metal rod with a movable collar that positioned the pick-up head over the disc, so that when it was lowered it landed at exactly the right spot on the record. To avoid a click as the stylus landed, the operator would only raise the volume once the stylus had landed in the groove. The cuebar could be swapped for each cue, allowing several cuebars to be set in advance, one for each cue, ensuring accurate replay at each performance. Bishop hired out the panatrope with a pair of loudspeakers for £4 a week, plus sixpence for each cuebar. Bishop's panatrope, and its Strand equivalent, became a standard piece of equipment in theatres in the 1950s. More complex shows would use more than one machine, with several operators required for busy effects sequences. Other companies began to hire out panatropes, such as RG Jones and Stagesound, and the UK theatre sound industry was created.

While the panatrope brought together the key requirements for sound effects replay, it had several limitations. Recording the sound effects discs was a specialist job, so theatres would either use 'off the shelf' ready-made effects, or commission discs for the production. The maximum length of a sound effect was also limited, and the discs wore out and had to be replaced every few weeks of the show's run. These problems were solved with the development of the reel-to-reel tape recorder. The technology to record sound onto tape – initially a band of steel, but later a plastic tape with a magnetic coating – had been invented and progressively developed in the 1920s and 1930s. In the late 1950s, Stagesound adapted the technology for theatre use, launching its Cue Tape machine, which incorporated a device to stop the tape automatically when it reached a piece of metal tape edited into the recording tape. For theatre producers, the tape recorder was advantageous: it cost the same to hire as a panatrope, but there was no need to replace the discs every few weeks. Also, the tape recorder operated at the press of a button, and didn't require a skilled 'pan operator'.



F.51

STAGESOUND

AUDIO REPRODUCTION EQUIPMENT

TYPE C.2 SOUND CONSOLE

This is a standard record replay console designed for theatre use, equipped with two 12-in. turntables, two lightweight pickups with provision for accurate groove location, monitor loudspeaker and 30-watt twin audio channels. Provision is made to feed one turntable into one set of speakers and the other turntable into a second set of speakers—this system being particularly useful when it is required to have two effects in operation on different parts of the stage. Also in the event of a breakdown in one of the amplifiers, instantaneous changeover is available into the second amplifier.

SPECIFICATION

TURNTABLES—Accurate aluminium cast turntables running in impregnated sleeve bearings, rim driven by a special belt system ensuring freedom from slip and "wow". Powered by 1/50th h.p. motors which are synchronous and fitted with a special filter unit mounting ensuring a minimum of transmitted vibration.

PICKUPS—Lightweight microcell crystal type employing a plug-on type head assembly for ease of replacement. The heads are fitted with a permanent sapphire stylus which can only be removed by the use of special jigs, and therefore when the sapphire requires replacement the head must be returned to our service department. Two spare heads are normally supplied and contained in special clips on the motor plates for instant changeover.

The response of these pickups is level within ± 2 db from 50-11,000 c.p.s.

LOCATORS—Locating and lowering mechanisms for each pickup are fitted which in addition to locating, incorporate a safety lowering mechanism. The final lowering of the pickup is automatically decelerated, preventing damage to records and styli. Location of pickups may be controlled with direct calibration to within 1/100 in.

AUDIO CHANNELS—Two channels are provided, each consisting of a feedback amplifier with a rated audio output of 30 watts, the general specification of the amplifiers is as follows:

Response	Level within 2 db from 50 c/s to 20 k/cs.
Output	30 watts.
Output Impedence	Internally adjustable for 4, 7.5, and 15 ohms.
Input Impedence	High impedence for extra external pickups. 15 ohms for Microphone.
Tone Control	Variable treble attenuation. Switchable bass boost circuit for pickups to lift response 10 db at 50 c/s relative to the level of 1 k/c.

MONITOR—A built-in 8-in. monitor speaker is fitted in front of the console with the volume control and muting selector switch for audio channel A or B.

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Page from the 1953 Strand Electric Company catalogue, showing the C.2 Sound Console

However, the move from discs to tape was not welcomed by everyone. For some young directors interested in the dramaturgical possibilities of sound, tape was the less flexible medium, requiring everything to be recorded on the tape in the order it would be used in performance. With a skilled pan operator, a director could try out different sequences and combinations of sound by having a collection of discs in rehearsal, and swapping them as required. This was particularly helpful as the overall effect could only be judged once the sounds were being played in the acoustics of the actual theatre, rather than in the rehearsal room; the ability to experiment offered by discs only re-emerged with the advent of the digital sampler, with its instant-access memory. For some productions, the sound would initially be played from discs until everything was settled after the first few performances, and then transferred to tape for the remainder of the run.

The panatrope, and later the tape recorder, brought the possibility of pre-recorded sound, replayed to selected speakers in the theatre space at a controlled level and on cue, thus opening up new possibilities for sound as a component of theatre performance. Previously, sound was limited to what could be created acoustically live during the performance, using musical instruments, machines or the human voice. Now, any sound that could be recorded was available, greatly increasing the possibilities of sound. While the early equipment still had significant limitations, it pointed the way, and – as a side effect – it triggered the creation of a new professional role. Directors needed someone with both the technical expertise and creative understanding to pre-plan the dramaturgical use of sound: the sound designer.

A Democratic Stage

We all see everything now

Responding to the rapid social and cultural changes of the 20th century, post-war theatres were often designed in a new spirit, intended to be democratic social meeting places, without hierarchy, and with a transparent cultural purpose.

The devastation caused by the Second World War created the opportunity to construct new theatres. Those built after the war sought to give a light and transparent image, open to the public in a new way, and providing a new kind of audience relationship with the performance.

anchors. The case of the Lincoln Center (Q17983) in New York is paradigmatic. In 1955, as part of the Lincoln Square Urban Renewal Project, it was proposed to build the Lincoln Center complex of theatres. The façades of the Metropolitan Opera House, the David Geffen Hall, home of the New York Philharmonic, and the David H. Koch Theater, home of the New York City Ballet, exhibit monumentality and transparency in the new model of public openness, while the auditoria are more traditional, with hierarchical stalls and balconies, not greatly different to the theatres of 100 years

Lincoln Center, New York

A series of projects and buildings from the 1950s and 1960s responded to this desire, such as Ludwig Mies van der Rohe's design for the Mannheim Theatre competition in Germany in 1953 (Q30647), an immense transparent glass box contains two theatres, revealing the activity within to the passing public outside in a radical gesture of openness.

Theatres are part of a system of facilities that organise the cultural consumption of citizens. New theatres are often linked to large-scale developments of cities that use cultural facilities as

before. These buildings open their foyers to one of the few squares in Manhattan, welcoming their patrons, but concealing the urban renewal operation that expelled the previous inhabitants, mostly African Americans and Puerto Ricans, who lived in that area.

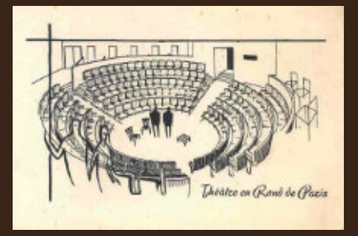
The New York development provided a building for each auditorium, creating a kind of theatre city, while in London at Denys Lasdun's National Theatre (Q9343) a single building housed all the performance spaces. On the bank of the Thames, opposite the theatre district of the West End, the

National stands imposing and dominant, a true example of the Brutalist style. The building has three auditoria: the Olivier, modelled somewhat after the Greek amphitheatre, with good sightlines but problematic acoustics; the Lyttelton, a proscenium stage facing an auditorium with two seating levels, more cinema than theatre; and the Cottesloe (now named the Dorfman), a small flexible courtyard space surrounded by galleries, added to the plans as an afterthought, and the most successful in promoting intimacy and emotional engagement. And a fourth space – a 'theatre' of architecture – to promote human relations. For the architect, the terraces and balconies, inside and outside the building, were to become another 'Hyde Park Corner', filled with life day and night – a vision only properly fulfilled years later after subsequent urban design actions overcame the brutalist minimalism of the original scheme.

In the post-war period, the proscenium, Italian-style stage, with its privileged position of the prince, continued to be questioned, as the avant-garde stage movements had already advocated at the beginning of the 20th century. The values of the circular stage, heir to classical Greek theatre, Elizabethan theatre and the circus, re-emerged in the Théâtre en Rond in Paris (Q3513), the Stratford Shakespeare Festival Theatre in Ontario, Canada (Q25645) and the Arena Stage in Washington (Q27210) – all spaces where the audience envelop the spectacle.

In the UK, the theatre innovator Stephen Joseph advocated for and pioneered 'theatre in the round', with audiences on all sides. Joseph was committed to the idea that the audience and the performance should come together in a single space – a democratic opposite to proscenium theatre, with the audience in one room facing the stage in another. The New Vic Theatre in Newcastle-upon-Lyme (Q30648) and the theatre named after him in Scarborough (Q30649) are his legacy. Here, the space does not automatically provide a 'backstage' where performers, technicians and equipment can be hidden (J.04). While there are ways to reduce or eliminate the visibility of the theatre 'machine', the presumption is of a democratic sharing of the experience, audience and theatre-makers in the room together.

A final, even more radical proposal was made in 1932 in Antonin Artaud's Manifesto of the Theatre of Cruelty, in which the spectator is 'placed at the very centre of the action, will be surrounded and traversed by it'. Artaud, as always, makes us question: is theatre a sharing, or a confrontation?



Above: Théâtre en Rond de Paris, 1954

Below: Royal Exchange Theatre, Manchester, UK

Scenography as Dramaturgy

The stagings of Brecht, Littlewood and Beckett

In the post-war era, a generation of practitioners made use of all aspects of stage design – total scenography – to create theatre that promoted their artistic, philosophical and political aims. Scenography was now central to the making of meaning.

Despite the radical visions of the preceding decades, in the mid 20th century much theatre was as yet untouched – still predominantly commercial, conservative, and middle class. The post-war period saw a generation of theatre makers who brought their radicalism to new audiences, and began a process by which the new techniques of the avant-garde would become mainstream, even if the ideas and principles that motivated them were often left behind. For practitioners as diverse as Bertold Brecht, Joan Littlewood and Samuel Beckett, scenography was central to this project.

After *The Threepenny Opera* (1928) and *The Rise and Fall of the City of Mahagonny* (1930), Bertold Brecht (Q69) and his stage designer Caspar Neher (Q30589) developed their concept of 'epic theatre' further in the 1950s: the decisive criterion was not its beauty but its 'realism'. For Brecht this meant presenting human behaviour to show not only its outward appearances, but also the social laws underlying it – a departure from the portrayal of tragic individual fates, from the classical illusionary stage and its illusory reality. In theatre, reality should not only be recognised, but also seen through. Therefore, the means must be recognisable not only in the play but also in the stage design. For this purpose, Brecht's long-time stage designer Caspar Neher invented a stage style in which everything decorative and not relevant to the action was only hinted at. Rather than creating an illusion, the aim was to draw attention to the artifice of theatre – a principle Brecht described as *Verfremdungseffekt* (translated as 'alienation' or 'defamiliarisation' effect). Audiences should not empathise with the characters, but be moved to action. This aim was served by bright lighting, almost exclusively with white light, with the spotlights in view. Commentaries were projected onto the (half-height) intermediate curtain, and scene changes took place with the curtain open. Together with a stage that was extremely sparsely but carefully furnished in detail, Brecht hoped to activate the audience's imagination.

In the 1930s, Joan Littlewood and Ewan MacColl set up a series of theatre companies, with overtly political intentions. They were concerned about the rise of fascism in Europe, and wanted to promote trades unions and the rights of workers. They were inspired by many avant-garde European practitioners and theorists, reading extensively the writings of Bertolt Brecht, as well as Vsévolod Meyerhold (Q71), Erwin Piscator (Q72), Rudolf Laban and Adolphe Appia (Q249). In 1945 Littlewood founded Theatre Workshop, initially as a touring company and later based at the Theatre Royal, Stratford East (Q8197). Littlewood mixed many traditions to make her work, using whatever techniques would help her engage the audience and get her messages across. The 1963 musical *Oh, What a Lovely War!*, about the First World War, make use of projection of archival material such as newspapers, as well as a device that could display short texts in a grid of light bulbs, announcing casualty numbers and other headlines, as well as many sound effects. These techniques were those Littlewood had developed over many productions, from her studies of the work of Brecht and others. The designer John Bury (Q30588) worked with Littlewood before going on to the Royal Shakespeare Company and the National Theatre, taking an ethos with him of distilling a design down to its essentials, to communicate ideas effectively to an audience.

The plays of the Irish dramatist, Samuel Beckett, are not overtly political, as with the work of Brecht and Littlewood. Rather, they can be seen as an absurdist, nihilistic response to the events and culture of the 20th century. In Beckett's plays the scenography is frequently embedded in the text, where stage directions are often as important to the meaning of the play as the spoken lines. The characters in *Waiting for Godot*, inhabit a largely empty space. The sun and moon rise and set, indicating the passing of time symbolically, with no attempt at illusionistic realism. While many interpretations of the play and its scenic environment are possible, demonstrated by different productions over the years, some things are fixed by the author's intent: decoration and the superfluous is impossible, for to add to the sparse space of the script would be to give opportunities to the characters – a chair to sit on, an object to comment on. It is a central premise of the play they have no such possibilities, only their own limited resources.

Some of Beckett's other plays require even more specific staging: in *Not I*, we see just a mouth speaking, picked out by a narrow beam of light in otherwise total darkness. In *Happy Days*, the central character is trapped in a mound up to her waist, and later to her neck. In *Breath*, a play that lasts only about 35 seconds, no characters appear on stage, but light, human sounds and a pile of rubbish, revealed and then hidden by the curtain, create the minimalist narrative. Again and again in Beckett, the scenography is not a pleasing backdrop to the play, it is not a 'container' or a 'world' within which the action takes place, it is not a commentary on the play or its characters. It is an integral part of the meaning and its communication to the audience, without which the play would not, could not be itself.

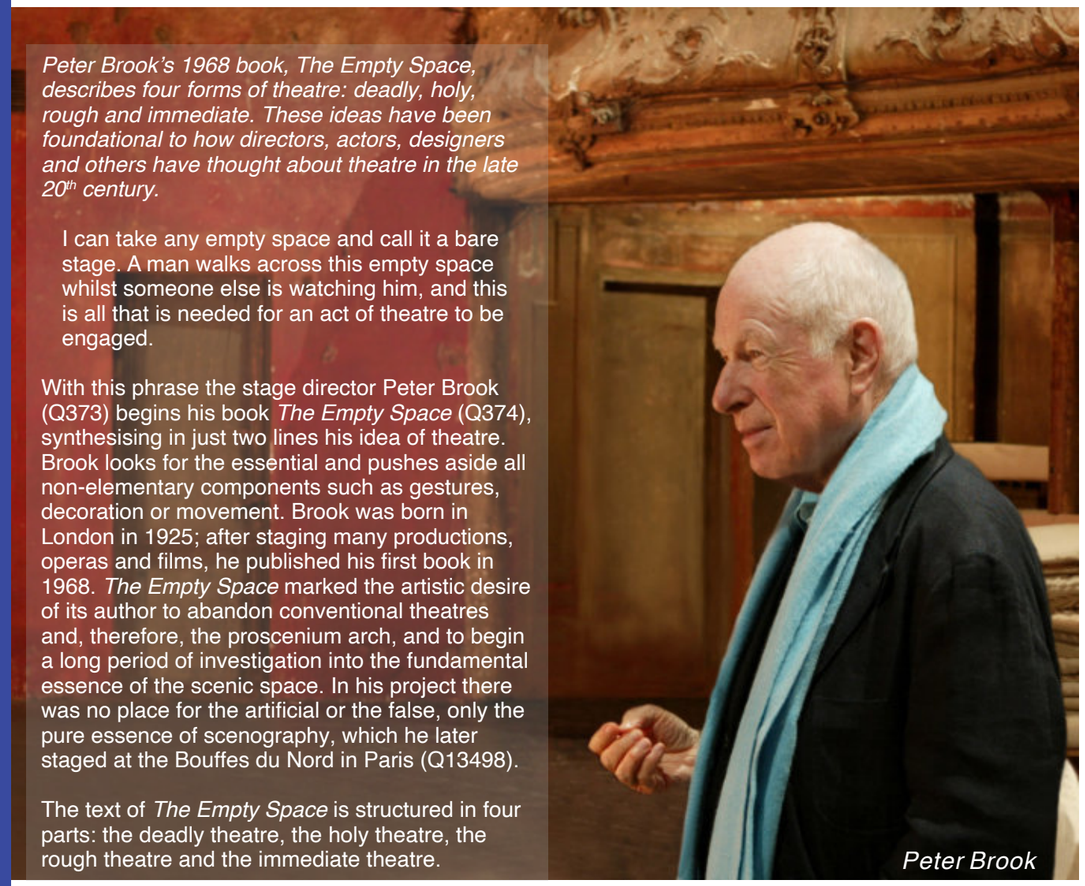
Brecht, Neher, Littlewood, Bury, Beckett and many other post-war theatre makers contributed to a significant shift in the role of the materials of performance: costume, light, sound, image, scenery are no longer contextual, but part of the meaning-making of the work: scenography as dramaturgy.

Left: Joan Littlewood outside the Theatre Royal, Stratford East

Right: Samual Beckett's Waiting for Godot *at the Avignon Festival, 1978*

The Empty Space

Rethinking what makes theatre



Peter Brook's 1968 book, The Empty Space, describes four forms of theatre: deadly, holy, rough and immediate. These ideas have been foundational to how directors, actors, designers and others have thought about theatre in the late 20th century.

> I can take any empty space and call it a bare stage. A man walks across this empty space whilst someone else is watching him, and this is all that is needed for an act of theatre to be engaged.

With this phrase the stage director Peter Brook (Q373) begins his book *The Empty Space* (Q374), synthesising in just two lines his idea of theatre. Brook looks for the essential and pushes aside all non-elementary components such as gestures, decoration or movement. Brook was born in London in 1925; after staging many productions, operas and films, he published his first book in 1968. *The Empty Space* marked the artistic desire of its author to abandon conventional theatres and, therefore, the proscenium arch, and to begin a long period of investigation into the fundamental essence of the scenic space. In his project there was no place for the artificial or the false, only the pure essence of scenography, which he later staged at the Bouffes du Nord in Paris (Q13498).

The text of *The Empty Space* is structured in four parts: the deadly theatre, the holy theatre, the rough theatre and the immediate theatre.

In the first part, Brook analyses the deadly theatre, which is the theatre that not only fails to inspire or instruct, but hardly entertains, and that can be found in grand opera, in tragedy, in Brecht's work and, above all, in the works of Shakespeare. He reflects on the actor as an instrument of the dramatic art and compares it with the instruments of other arts. He also reflects on the public, on the flexibility of current staging, on the contradiction between literary and theatrical, and on the density of silence. Deadly theatre is a theatre that loses the public since it is not capable of inspiring or teaching, nor of entertaining – it is an insufficient theatre for society.

In the second part, he enters into the holy theatre which he calls 'theatre of the invisible made visible'; that is, he reflects on the stage as a place where the invisible can appear, in the same way that in music we recognise the abstract through the concrete. He considers the loss of the original rite in the current theatre, except in certain oriental theatres. 'The truth is that we don't know how to celebrate, since we don't know what to celebrate.' (Q374, 68). He recounts his experiences with the theatrical group Teatro de la Crueldad, which was created in order to investigate the sacred theatre. 'We can try to capture the invisible but we must not lose touch with common sense: if our language is too special, we will lose part of the viewer's faith.' (Q374, 90).

In the third part, dedicated to rough theatre, Brook recognises popular theatre, the popular theatre that saves entire eras. He reminds us that the long popular tradition, apart from partying with harmless and happy people, is also fierce satire and grotesque caricature. He places this theatre in opposition to the sacred theatre.

In the last, most personal part dedicated to the immediate theatre, Brook expresses himself by way of an autobiographical conclusion. The immediate, the moment in which the theatre affirms itself in the present, is when the theatre becomes real, and also disturbing. Its immediacy characterises it, a representation that is unrepeatable, even if it needs repetition. The theatre not as an art in itself, but a reflection of life, which for its representation needs the observation and formation of values.

In 1969 Brook and producer Micheline Rozan created the Centre International de Recherche Théâtrale (CIRT), a multinational company of actors, set designers and directors. The company toured widely in the early 1970s through Asia, Africa and the United States, playing in villages, at immigrant hostels and in refugee camps, sometimes for people who had never seen theatre before.

In 1974, Brook and Micheline Rozan made a home for CIRT at the abandoned theatre of Bouffes-du-Nord (Q7983), in Paris. The theatre responds with its proportions and state of conservation to an aesthetic that the group had been formulating in its travels and with his research. While the theatre has been renovated, many original features have been retained, not restored but with the patina and distress of age – a carefully curated space that is both theatre and scenography, in line with Brook's ideas about theatre.

Developments in theatre practice, as in other fields, rely on the sharing of knowledge and experience. Peter Brook's book, *The Empty Space*, and his practice as a director, have ensured his ideas have been highly influential.

Interior of the Bouffes du Nord theatre, just before the start of the performance of The Magic Flute*, 2010*

Theatres by Design

The rise of the theatre consultant

The role of the theatre consultant emerged in the 1960s and 1970s, meeting the need for expertise both in the rapidly changing technologies of theatre production, and the innovations being made in the design of performance spaces.

In the middle years of the 20th century, the young Richard Pilbrow (Q435) was passionate about theatre. He later wrote:

> my number-one ambition was to be a stage manager. I had read everything I could find by Edward Gordon Craig … he foresaw a theatre of the future that was to be a new art form, primarily the creation of the director, whom he termed the 'stage manager' and defined as 'a master of the art and science of the theatre.' (Q30492, 11)

He went on to begin a career in lighting design in the 1950s, at a time when the role of lighting designer was almost non-existent. To get work, Pilbrow bought some old lights, so he could hire the equipment out to producers, and also offer his services to light the show. This was the beginning of Pilbrow's company, Theatre Projects – the name a signal of his continuing ambition to be in control of all aspects of theatre-making, not only lighting.

Theatre Projects (TP, Q29724) proved to be highly successful. The lighting hire and design business expanded, soon TP moved into the rapidly developing area of theatre sound. Pilbrow also began some consultancy work on new theatres, first for the Gulbenkian Centre at the University of Hull (opened in 1969), and then for some of the many new theatres being built as part of the Arts Council's 'Housing the Arts' programme; a new division of TP had come into existence.

When a new, purpose-made building for the UK's National Theatre (NT, Q9343) was being planned, Pilbrow was asked to consult on the stage lighting systems. The new building was very ambitious, with three different auditoria, and demanding technical requirements. Pilbrow joined a team of experts who advised and guided the development of the technical facilities at the NT – lighting, sound, acoustics and stage engineering. Over time, TP's theatre consultancy separated from the other parts of the business, and expanded its operation globally – at first in the United States, and then elsewhere. Today it has offices in London, New York, Paris, Denver, Shanghai and New England, and works not only on the design of theatres, but also concert halls, exhibition spaces, museums, galleries and places of worship.

Richard Pilbrow and his colleagues at Theatre Projects set the template for the theatre consultant. Theatre experts had previously advised on how best to meet the technical needs of theatres, but TP was central to the establishment of the theatre consultant as a distinct professional role. The ever-increasing complexity of the technologies used in theatres has driven the need for such experts, but so too has an increase in the expectations of audiences, producers and funders. Theatres are unusual buildings, with very specific requirements, and poor design decisions can cost money unnecessarily, limit the scope of what is creatively possible in the building, and degrade the audience's quality of experience through poor sightlines, uncomfortable seats, uncontrolled temperatures (too hot or too cold), and long queues for the toilet at the interval.

Most architects only build a small number of theatres and may win the role of designing a prestigious project through a competition, judged by people who themselves know little of what is involved in making a successful theatre. Theatre consultants therefore play a key role, acting as a bridge between the client, the architect and the contractors building and fitting out the theatre.

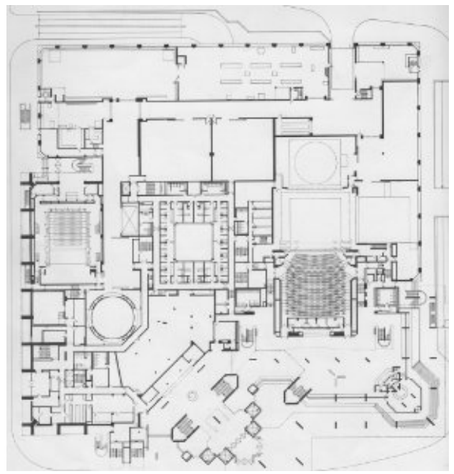
They provide a wide variety of services, depending on the project. As well as advising on the technical facilities, theatre consultants will often help with the auditorium design: sightlines, aesthetics, and audience experience, plus technical issues, such as heating and ventilation, fire regulations, emergency evacuation, and access requirements.

In some cases, theatre consultants will be involved in the early stages, helping develop the project's concept, starting from the initial brief, and going on to support fund-raising and planning permission through visualisations and cost estimates. They may also advise on the refurbishment, renovation and re-purposing of existing buildings, and conservation issues in older buildings.

In his autobiography, Pilbrow wrote:

> In the late 1960s, I did not know the paramount importance of emotion and intimacy; I did not understand that, in a theatre, it is not enough to see and hear. Our audiences must feel … Theatre architecture must pull us all together. (Q30492, 231)

Theatre consultants have a vital role in ensuring theatres meet the physical needs of the spectators and are effective functional machines for mounting productions. Above all, though, they are experts in working with all those involved to make spaces where audiences will have the powerful, shared experiences that live performance can create.



The National Theatre, London

Moral Safety

The Windmill Girls, censorship, and protecting the public

'Health and safety' is generally taken to refer to physical safety. In various places at various times, the law has also sought to protect the public's moral safety, as well as safeguarding the reputations of governments, monarchs and authorities.

Between 1932 and 1964, the Windmill Theatre in London's Soho district presented variety performances, with singers, dancers, comedians, and showgirls. Initially it lost money, but the theatre soon found success when it began to present acts with glamorous nude women, based on the established shows at the Folies Bergère and Moulin Rouge in Paris. In Britain, the Theatres Act of 1843 banned the performance of plays if 'it is fitting for the preservation of good manners, decorum or of the public peace so to do', effectively outlawing nudity. The theatre argued that, since nude statues filled museums and art galleries, then presenting nude women on stage in static poses should also be permitted. It was on this basis the 'Windmill Girls' became famous, appearing on stage in a variety of *tableaux vivants*, following the rule: 'if you move, it's rude'.

The phrase 'health and safety' is generally used to refer to physical health and safety – preventing accidents and disease. However, alongside these physical protections, there is a much longer history of controls to protect the public from immoral and indecent content, and to protect the authorities from criticism. In Britain in 1737 the Licensing Act came into force to control and censor what was being said about the government through theatre. At a time when there was concern about the spread of revolutionary ideas and political uprisings, this act gave powers to the Lord Chamberlain – an official within the Royal household – to approve all plays before they were presented. It also created the office of the Examiner of Plays, who read the plays and advised on their content. The Examiner also had a responsibility to visit theatres, to ensure the safety and comfort of audiences, so linking physical safety with protecting the public (and of course the government) from dissenting voices.

The 1843 Theatres Act greatly limited the Lord Chamberlain's powers of censorship, so that he could only ban plays for the 'preservation of good manners, decorum or of the public peace': censorship shifted its focus from protecting the government to protecting public morals. It was under the rules of the 1843 act that the shows at the Windmill Theatre took place. They used various strategies to attract audiences while staying within the letter of the law. A fan dance was introduced, in which the naked dancing girl and four clothed assistants held large fans of ostrich feathers to conceal the nudity during the dance, only removing the fans when the dancer held a static pose at the end. In another act, a stationary nude girl was suspended from a spinning rope – since it was the rope that was moving, not the girl, this was allowed by the authorities.

Censorship didn't just apply to strip shows. In the post war era, playwrights increasingly wanted to address serious social and political concerns that reflected the rapid changes in society at the time but were finding themselves blocked by the Lord Chamberlain. Edward Bond's play, *Saved*, showed a group of young people from an impoverished background, and included a scene in which a baby in a pram is stoned to death. When the play was submitted to the censor, changes and cuts were required which were unacceptable to the writer. In 1965 the play was presented as a private performance – a common means of avoiding censorship at the time – but those involved were still prosecuted and fined. The resulting public outcry against censorship from this incident and others like it led to the 1968 Theatres Act, which abolished the Lord Chamberlain's role as censor.

Under the 1968 act, 'obscene' plays – those that might 'deprave and corrupt' those attending – and plays that might provoke a breach of the peace were still illegal. But the need to get plays approved in advance was gone. On the first night after the act came into force, the hippie counter-culture rock musical 'Hair' opened, featuring drugs, anti-war messaging and a small amount of nudity. The 1960s cultural revolution had finally reached the theatre stage.

Although legal censorship has largely gone, it continues in other, less well-defined ways. Funding authorities have an influence on artistic policy, while public protests lead to work being cancelled, such as the play *Behzti* (2004) and the live art installation *Exhibit B* (2014). In both cases, the makers responded to police guidance that to continue would create health and safety risks due to the likely protests that would follow. Suppression also operates through self-censorship: work that is not made, and things that are not said, by people who fear the consequences and so remain silent.

In the early 2020s, the debate between people's rights to be protected from offensive content versus the right to free speech is particularly strongly contested. In a time when physical safety in our theatres is perhaps better than it has ever been (I.08), and despite the abolition of censorship in 1968, the question of moral safety is as divisive as ever.

The Windmill Girls

Sticking with It

The unexpected success of gaffer tape

Gaffer is a very tough adhesive fabric tape with that can be removed without leaving a residue. Widely used in the theatre, live event, film and broadcast industries, it was invented in the USA 1959 by Ross Lowell.

The origins of adhesive tape lie in Hamburg, Germany. The Merkur Pharmacy in Hamburg was taken over by the pharmacist Paul Carl Beiersdorf in 1880. There he worked to develop a quick wound dressing. In 1882, he finally developed the wound plaster from the latex derived from the gutta-percha tree, and from gauze soaked in hot ointments. He applied for a patent and concentrated completely on the production of the plaster but without success. The plaster held well, but critics claimed that the skin tore off when the plaster was removed. A few years later, the field of application of the highly adhesive plaster was redefined. It was now intended to seal punctured bicycle tyres and thus became the world's first technical adhesive tape.

20 years later in Detroit the US company 3M was manufacturing abrasive paper. While testing a new product in an automobile production plant in 1923, 3M employees learned of problems with the two-colour paint process, which was new but popular at the time. Manufacturers lacked a suitable way of masking finished paintwork while applying the second colour, to ensure a clean join. In 1925 Richard G. Drew presented a 5cm wide crepe strip with a thin layer of adhesive around the edges. The crepe strip failed the test because it did not stick, so the painter raged, 'Take this tape back to those Scotch bosses of yours and tell them to put more adhesive on it!'. In the vernacular of the time, the word 'Scotch' was a pejorative insult because Scots had a reputation in the early 20th century for being overly thrifty and 'stingy'. As a result, Drew coated the masking tape completely with adhesive. The first crepe tape was thus invented. The engineer remembered the painter's angry words and named the tape 'Scotch Masking Tape'. Due to the outstanding success of the masking tape, the company focused on the development of new adhesive products. In 1930, it invented the world's first transparent adhesive tape. Originally, the tape was used mainly by bakeries, butchers and food retailers to seal their cellophane packaging. But due to the economic depression, it became an unexpected success: the population, forced to economise, used the tape for small repair jobs.

Gaffer tape (Q4334) was invented in 1959 by Ross Lowell (Q30482) – an American inventor, author, photographer, cinematographer, lighting designer and entrepreneur. In addition to his patented quick-clamp lighting mount system, he saw the need for an adhesive tape that could be used to temporarily stick down cables or attach small pieces of equipment, and then be removed without leaving a residue. Lowell used the adhesive from Johnson & Johnson's Permacel tape, also known as duct tape, and applied it to silver fabric, so creating gaffer tape. He marketed it through his lighting company, Lowel-Light. The origins of the name are unclear, but the gaffer is chief lighting technician on a film set, so the name may come from 'gaffer's tape'.

Today, gaffer tape is available in a wide range of colours from neon yellow to pink and green, in a range from very conspicuous to extremely inconspicuous, and in widths from 6mm to 100mm. To attract as little attention as possible and reflect as little light as possible, the classic gaffer tape is offered in matt black, and this colour, 50mm wide, is probably the most commonly used type.

Gaffer tape is heat-resistant, water-resistant and tear-resistant. With these properties, it is the ideal helper on stage and in the studio - and even beyond! Just laying a cable on the stage floor so that you don't trip over it? No problem with black gaffer tape. Need a little marker on the floor so you know where to stand in the perfect light? Yes, you can simply use gaffer tape for that too. You can mark everything with it and write on it. You need to fix something to a truss? We've even seen complete spotlights dangling from the aluminium pole with silver gaffer tape – please don't copy it! Gaffer tape is extremely resistant to tearing, but there are proper fasteners for that. By the way, with a short transverse tear you have interrupted the tensile strength in no time and cut off the desired length from the roll – without any annoying scissors!

And for techie Star Wars fans:

Q: Why is gaffer tape like the Force?

A: Because it is dark on one side, light on the other, and it holds the universe together.

Leukoplast, first made in 1901

3M Scotch Tape advertisement, 1930

The Temporary Stage

Truss, chain hoists and entertainment rigging

Entertainment rigging is used to create temporary stages, indoors and out. Truss systems and chain hoists support lighting and sound equipment for a wide variety of events, and even becoming part of the scenography itself.

The development of truss (Q3773) as we know it today began towards the end of the 1970s when the entertainment industry was searching for a simple and efficient mean of manufacturing light but also safe supporting structures. The huge growth in demand for popular music during the 1960s had propelled a move from indoor venues with their own permanent sound and lighting installations to arenas, college campuses, gymnasiums, city squares and – above all – rural fields. The pioneering large-scale, outdoor festivals such as Jazz Bilzen (from 1965), the Isle of Wight Festival (1968), and Woodstock (1969, Q74) started to create the stage, and the required supports for lighting and sound equipment, by using lightweight wooden structures and standard steel scaffolding from building sites. Festivals and concerts rapidly became a new industry, fueled by the growth of record sales. Bands and their promotors wanted to put on bigger and better shows to draw an audience and build a following for the band's music; lighting needed to be more spectacular, and sound needed to reach much larger audiences. Early rock concerts used only the 'backline' speakers on stage, and a couple of speakers for vocals, but to reach a big crowd, the speakers needed to be raised up. All this required lighting and sound equipment to be suspended above and to the sides of the stage, and scaffolding structures were no longer sufficient.

Manufacturers started to develop truss systems specifically for stage use: structures able to take substantial loads and span the width of large stages. Aluminium quickly became the preferred material, as it is not only durable but also lightweight, making rigging easier and reducing transport costs. Connection systems were developed to make assembly and disassembly as quick as possible – especially important for shows that toured, as many bands did.

Aluminium is difficult to weld, requiring specialist equipment and skilled welders. This created an opportunity for new manufacturers, who brought the needed know-how from other industries – for example, James Thomas Engineering, which started in a small garage in Bishampton, England in 1977, making truss systems and related staging equipment, mainly for the live music industry. The company grew rapidly, moving into a converted office unit, then to a much larger 464.5 m² space in 1980. Innovation was rapid at that time, as manufacturers tried to satisfy the needs of concert touring. In 1983, James Thomas developed a pre-rigged truss design, so that the lights could stay rigged to the truss for transport; sections of truss with the lights still attached could be rolled directly onto a truck, then rolled straight onto stage and assembled at the next venue.

As the scale and creative ambitions of the shows developed, truss became not just a place to hang lights, speakers and other technical equipment, it became integral to the design of the show itself. Lighting designers recognised that, as well as creating architectures of light beams in the air, they could use the shape made by the truss structure as part of the aesthetics; trusses were built in the form of triangles, fans, stars. Later, these shapes were made mobile, changing during the show into different configurations.

Truss systems are just one part of entertainment rigging. A truss structure is either ground-supported, with vertical legs of truss holding up the part over the stage, or flown, suspended from the roof of the venue. Either way, the truss needs to be raised into position. The electric chain hoist (Q30610) first appeared in the 1930s, as a development of earlier manual hoists, which were themselves based on 'block and tackle' systems from Antiquity. Chain hoists became the standard way of lifting truss structures and other loads. On larger or more complex installations, control systems were developed to operate multiple hoists together, ensuring they worked in synchrony.

During the 1980s, the corporate event industry took off, producing large scale productions such as product launches and trade shows. Drawing on the skills and understanding of how to make thrilling experiences for an audience found in theatre and the live music industry, rigging became a central part of the expanded field of the entertainment industry. Whenever a temporary stage is required – indoors or out, for theatre, music, festival, corporate events, sports and other ceremonies – entertainment rigging, born on the rock concert stages of the 1960s, will be present.

Left: Donington festival 1983

Below: The band Mayhem*, Jalometalli 2008*

Alife of Its Own

The multimedia stage

Experimental performance-makers in the late 20th century responded to the advent of new media (television, video, computers, the internet) with many innovations in how they made performances, and by making work about the impact of those technologies.

In the 1960s and 1970s – decades of great artistic, social and political upheaval and change – telecommunications and media technology were rapidly advancing. Television, video and early computer equipment became more accessible, creating a climate for artists to turn this 'dead' technology and data into something living, and to address the impact of these new technologies, both freeing and overwhelming.

Between 1975 and 1977 artists Kit Galloway and Sherrie Rabinowitz created a series of projects under the heading *Aesthetic Research in Telecommunications*, seeking to investigate how the new technologies could be used to create telecollaborative arts. *A Space with No Geographical Boundaries* embodied this new age of satellite telecommunications by allowing several performing artists from different geographical locations to perform, communicate and to appear as though they were occupying the same physical space. The artists explored the transmission delays over long distance networks, and performed several telecollaborative dance, music, and performance scores to determine what traditional genres could be supported, while exploring new genres intrinsic to these new ways of being-in-the-world. It was thought that by integrating multiple-media telecollaborative technologies with the culturally diverse creative communities throughout Los Angeles, a powerful new context for cultural sharing would emerge to facilitate a creative conversation between people even if they didn't speak the same language.

The Wooster Group's 1984 production *LSD…Just the High Points*, based on Arthur Miller's *The Crucible*, placed multiple television screens on the stage, displaying pre-recorded video sequences and live feeds from cameras on stage, giving close-up images of the actors, showing point-of-view walking, and so on. Sections of the text of *The Crucible* were skipped by 'rewinding' and 'fast-forwarding' on the screens, and dialogue could take place between an actor on stage and an actor on screen. *LSD…Just the High Points* was innovative in many ways, but perhaps most crucially it established that media images on stage could be fully integrated into the dramaturgy, rather than being something contextual as a background or environment.

Left: Dawn Stoppiello, wearing MidiDancer sensors. Troika Ranch, Tactile Diaries*, 1990.*

Troika Ranch is a dance/theatre/media (the troika) company founded by Dawn Stoppiello and Mark Coniglio. They aim to produce work that values live interaction between viewer and viewed, performer and image, movement and sound, people and technology. The works may be presented as performances, installations, or in portable formats, drawing on contemporary technologies and innovations. Like Galloway and Rabinowitz, they have created networked performances utilised online networks to deliver a performance from a distance, known as 'telepresence'. Their 1990 production *Tactile Diaries* explored the ways we touch one another: emotionally, physically and virtually. The piece was performed simultaneously at The Electronic Cafe in Los Angeles and The NYU Television Studios, New York City, with images gradually transmitted over ordinary phone lines between each location. In 1996, only 5 years after the world wide web was made available to the public, Troika Ranch created *Yearbody*, a year-long dance piece in which an image of a dancer was posted to a website each day, and then made into an animation of the dance at the end of the year.

Troika Ranch developed MidiDancer in 1989: a system with eight flex sensors fitted on the elbow, wrist, hip and knee of a dancer, which send data wirelessly to a computer about the flexion and extension of the dancer's joints. This data was used in various performances, including In Plane, a duet for a dancer and her video image representation. MidiDancer allowed the performer to control the generation of music, the recall of video images, the theatrical lighting, and the movements of a robotically controlled video projector. Coniglio also created the software Isadora (Q30634) to make incorporating digital technologies and multimedia into performances easily accessible to other artists; the software is now widely used by performance-makers who want to use rich media and interaction in their work. The creation of custom-designed technologies is a characteristic feature not just of Troika Ranch, but of many experimental and avant garde performance arts groups, especially in the field of dance. As well as meeting the specific needs that may not be addressed by commercial products, many artists see the creation of the technologies they use as an integral part of the creative process – their work is often about the technology, our relationship with it, and its social, cultural and political impact.

In the last decades of the 20th century, with the growing availability and potential of media technologies, performance-makers experimented in a wide variety of ways with the use of media on stage. The performing arts became a mode of investigating the possibilities and limitations of various technologies to create new contexts for art, including: the emergence of telecollaborative arts reaching across cities, countries and continents; the use of sensors to capture the movement of performers and integrate them into a hybrid human-technology performance system; presenting performances on the web in unexpected ways; and combining visual media with live stage action as part of a holistic dramaturgy. These, and many other innovations were creative strategies for embracing apparently 'dead' media technology, making it into a rich hybrid with the established live performance forms of theatre, dance, and music: a breathing expression of life which can now be seen as an accepted element of mainstream performances in the 21st century.

Troika Ranch, In Plane*, 1994*

Changeable Everything

Automated lighting

Until the late 20th century, the colour, focus and other adjustable features of stage lights were almost always set manually, with only the brightness remote-controlled. In the 1980s a revolution began: the automation of all the variable parameters.

With the growth of the music industry from the 1960s, bands and promotors sought to deliver larger and more impressive shows to attract the audience, with lighting a key part of the spectacle. In the late 1970s, the Dallas, Texas-based light and sound company Showco wanted a light that could change colour, and were working on a system that did this by turning dichroic filters (Q3326) to different angles in the beam. It is reported that Jack Maxson, a founding partner of Showco, said: 'Add two more motors and it moves'. Motors to move the light from side to side and up and down (pan and tilt) were added, and the result was demonstrated to the rock band Genesis in 1980, which invested $1m in what was to become the first Vari-Lite (Q30539).

Although some moving lights had existed before 1980, the Vari-Lite was the template on which most moving lights have since been based.

Showco became Vari-Lite the company and started production, with successive models adding further features: more flexible colour systems, motorised gobos, variable beam size, and control of the edge hardness of the beam. Wash lights were added to the original profiles, for a wider, soft-edged beam of light. Vari-Lite also created a lighting console to control and programme the new lighting equipment, using a proprietary digital control protocol to communicate between the console and the lights. It was not possible to buy Vari-Lite equipment, only rent it directly from the company as a system, complete with a Vari-Lite operator.

In the late 1980s, other manufacturers began to develop their own automated lights. Unlike Vari-Lite, these companies used the then new DMX 512 control protocol (Q3957), so the automated lights didn't have to be a separate system to the rest of the rig. After various legal disputes with Vari-Lite over patents, these other manufacturers became successful in the market, and Vari-Lite lost its near-monopoly position, eventually having to abandon its rental-only business model. From the 1990s, Vari-Lite introduced models that could be purchased, controlled by the now standard DMX protocol. Vari-Lite became just one moving light manufacturer amongst several, and the market has since grown further, with a wide variety of manufactures and products available for lighting designers to specify.

Parallel to this development, driven mainly by live music, the needs of the disco and club market were being fulfilled, generally by other manufacturers. Here, the requirement was for lights that could move and change very rapidly, to provide high-energy dynamic effects to accompany dance music. Moving mirror lights ('scanners') were ideal, and these developed from the mid 1980s. They used a light-weight motorised mirror that could move extremely rapidly to direct the beam, while all the other functions (light source, colour mixing, gobo wheels, and so on) were contained in a static housing.

For the concerts and clubs, the emphasis was on bright lights that could move rapidly, with rich colours and lots of beam effects such as gobos and prisms. For theatre and opera, the needs were different. Speed of movement was largely unimportant; the need was for subtle colours with excellent colour rendering to match the non-moving lights, very precise positioning, and above all, quiet operation without motor and cooling-fan noise. Specialist theatre lighting manufacturers introduced such products, for example the 1988 Niethammer (Q13353) Varimot motorised profile light, controlled with its own control protocol from the AVAB Viking console, and the 1987 Strand Lighting (Q64) PALS system, controlled via a PC computer with cues triggered from a Strand console. Motorised brackets to automate existing, conventional spotlights with pan and tilt were also manufactured. Later, the main moving light manufacturers created dedicated theatre models.

The work at Showco in the late 1970s to develop colour changers for rock concerts that led to the Vari-Lite led to another significant piece of lighting technology: the colour scroller (Q3184). Pieces of gel, taped together without a frame, were wound from one spindle to another by motors, passing in front of the light as they did so. LED colour-mixing lights have replaced the scroller, but for several decades they were key to adding flexibility to rigs.

Since the 1980s, stage lighting has been revolutionised by the automation of lights. Previously the emphasis was on the control of intensity over time; now all the parameters are controllable during the performance, greatly increasing the possibilities available to lighting designers. Automated lighting has changed the technology, the practices and the very way stage performances are lit.

Left: Genesis in concert in Nancy, France, 1987

Right: Vari-Lite price list, 1996

LUMINAIRES

Series 200™

	Daily	Weekly
VL2B™ spot luminaire	50.00	150.00
VL2C™ spot luminaire	60.00	180.00
VL2x™ library gobo supplement		9.00
VL4™ wash luminaire	43.00	129.00

Series 300™

VL5™ wash luminaire	26.00	78.00
VL5B™ wash luminaire	28.00	84.00
VL6™ spot luminaire	48.00	144.00
VL6™ accessory supplement		9.00
VLM™ moving mirror unit	16.00	48.00

CONTROL

	Daily	Weekly
Artisan®/ Mini Artisan® system	270.00	810.00
Mini Artisan®/ Mini Artisan® system	184.00	552.00
Mini Artisan® 2 / Mini Artisan® 2 system	184.00	552.00
Dual Artisan® control console system	356.00	1,068.00
Additional Artisan®	178.00	534.00
Additional Mini Artisan®	92.00	276.00
Additional Mini Artisan® 2	92.00	276.00
VLD® dimmer interface/Smart DMX™	42.00	126.00

CREW

	Per Day
Operator	185.00
Crew chief / Senior Tech	175.00
Technician	160.00

Crew charges do not include:
Accomodation, transportation & catering

Power and Control

The right sound where you want it

On theatre and concert stages, good sound requires the ability to produce the required sound in the right place, under the control of the sound engineer. The fundamental methods for achieving this were set in the 1960s.

In Germany after the Second World War, there was a great investment of public money into rebuilding the theatres that had been destroyed in the bombing. These theatres were equipped with the latest technology, including sound. A control room was placed at the back of the auditorium, with clear sight of the stage, staffed by the Tonmeister and his team. In London's West End in the 1950s and 1960s, the situation was quite different: sound didn't have its own department, it was operated by a junior member of the stage management team from backstage, using a panatrope, or later, reel-to-reel tape machines (D.08). The role of the sound designer was only just emerging.

Theatre sound control with mixing desk and turntables, around 1970

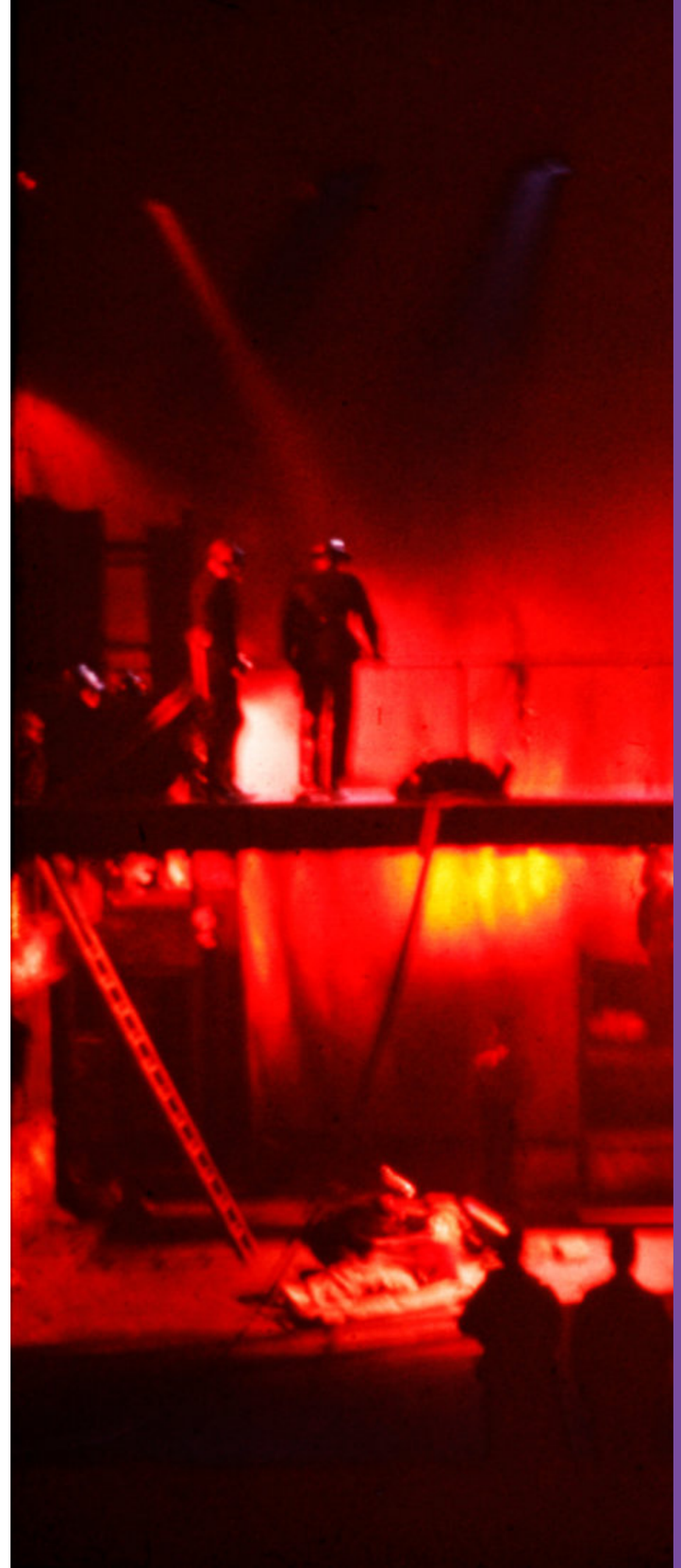
The musical *Blitz!*, by Lionel Bart, opened in London in 1962. Set in the East End of London during the aerial bombings of the Second World War, the show – scenery, lighting and sound – was on a more massive scale than anything that had been seen in the West End before. The sound designer and operator, David Collison, argued that he needed to be in the auditorium to control the sound, so he could see and hear the show and integrate the very complex sound plot into it. No West End sound operator had ever been located front of house before, and the producer initially refused, but eventually three seats at the side of the auditorium were allocated, when it became clear the huge, mobile set pieces and cast of 40 actors left no room backstage for the sound operator.

The sound for *Blitz!* was innovative in other ways. Fourteen speakers were placed around the stage and auditorium, and Collison designed a custom mixer, build by Stagesound, to allow him to send sound from any of the three tape recorders, via four master faders, to any combination of the speakers. The flexibility of this system was unique in the West End at this time, allowing Collison to move sound around the stage – for example, panning the sound of an underground train across the stage. A separate sound system handled the reinforcement of the singers, with microphones placed along the front of the stage. While there was much further development to come over the following decades, at the start of the 1960s the sound for Blitz! was the template for theatre sound as we know it now: the operator in the auditorium, able to hear what the audience hears; a speaker system that can locate sound spatially with precision; multiple sound sources mixed and fed to any combination of speakers.

The period was also important for rock concert sound. Until the late 1960s, bands used amplifiers for their guitars, and vocal mics. With the amps at the back of the stage, the vocals could not be turned up without causing feedback, restricting the loudness of the whole system. Column speakers, with several drivers, were added, but the low power of the available amplifiers was still a limitation. In 1965, the Beatles played the Shea Stadium in New York – the first stadium rock concert – and were completely drowned out by the screaming crowd. In the UK, Charlie Watkins of WEM was seeking a higher-powered amplifier. RCA had recently introduced a 100W transistor amplifier, and Watkins, in conjunctions with his colleagues, had the idea to combine up to ten of the amplifiers, to achieve a 1000W output. He tested the new amplifiers at the 1967 jazz festival in Windsor, UK, driving ten of his largest speakers, plus 20 column speakers, plus high frequency horns, and bass speakers. It was the breakthrough he'd been looking for.

News spread rapidly. Watkins received requests for systems from Rod Stuart, Pink Floyd, and many others. When Bob Dylan gave a concert at the Isle of Wight festival in 1969, he insisted on buying the sound system afterwards. In the same year, Watkins provided sound for the Rolling Stones in London's Hyde Park, mixing it from the side of the stage. Mick Jagger asked Watkins to tour with the band, saying the mixing position should be in the middle of the crowd; Jagger even had a special scaffolding platform designed for the sound control position. At around the same time, Watkins had introduced on-stage foldback, so bands could hear themselves and each other clearly.

As with theatre sound, by the end of the 1960s the key components of sound for live music were in place: backline for the guitars; main PA speakers with bass, mid and high cabinets each optimised to the task, driven by powerful amplifiers; the main mix for the audience controlled from a front of house position; a separate foldback mix for the band. On both the theatre and the concert stage, the late 20th century saw the development and refinement of sound production, with many technical innovations, but based on templates set in the 1960s.



Scene from the musical Blitz!

Any Theatre You Want

Flexible and adaptable spaces

In the inter-war period, the theatrical avant-gardes felt the need for a theatre that would allow them to carry out their proposed innovations. The empty space, with only walls, floor and ceiling, became the model for black-box and flexible theatres.

Edward Gordon Craig wrote in 1922:

> A necessity appeared to me: the theatre must be an 'empty space' with only a ceiling, a floor, and walls; within this space, a new kind of temporary stage and auditorium must be built for each new play. In this way we will discover new theatres, because each type of drama demands a special type of stage. (Q325)

The theatre of the 1960s renewed the desire of the avant-garde to escape from the Italian model, which was too limiting, too codified and representative of an aesthetic from which they wanted to break away. In the same spirit as Gordon Craig, it was advocated that the theatre space should not pre-establish or condition any spatial solution, but should leave the field free to all investigations. Each show must impose its own scenography, its own form, its own space, and establish a unique relationship between actors and spectators. Each show needs a transformable container, technically equipped – a 'black box', adaptable to any need of the director.

The small black-box studio became established for experimental and fringe work, and for training purposes, from the school drama studio to the technical laboratory. In the UK regional theatre building boom of the 1960s and 1970s, the black box studio was an essential adjunct to the more traditional 'main house' theatre. In 1976 at the new National Theatre in London (Q9343), the amphitheatre Olivier and the proscenium-arch Lyttelton were joined, as an afterthought, by the flexible, courtyard-like Cottesloe (now called the Dorfman). Many would claim this third auditorium is the most successful of the three.

However, the flexible, black-box concept brings difficulties as well as opportunities. If every production must create a new scenography within the empty container, then every production must have the technical, financial, creative and human resources required to fill it, otherwise a minimal production becomes an empty production, devoid of life and warmth.

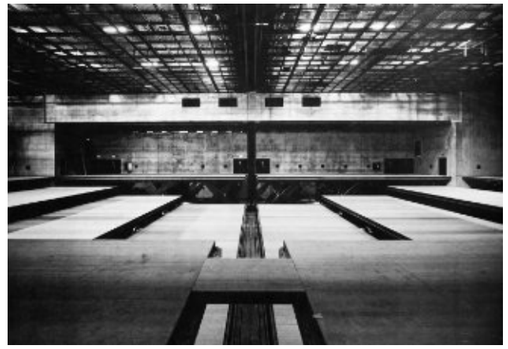
Not all flexible spaces are black boxes. The Schaubühne (Q13102) was born in West Berlin in 1981 with all the ingredients to become a model theatre machine. Located in a central area of the city, it occupies a well-known work of modern architecture: The Schaubühne am Lehniner Platz is part of the Woga complex planned by Berlin architect Erich Mendelsohn in 1926-28, in a space originally built as the Universum Cinema.

The new house is the largest spoken theatre in western Berlin, intended to overcome the supposed limitations of the company's previous ramshackle home in Hallesches Ufer, where the company had established itself in 1962. There, the group had made a name for itself. On 18 November 1970, with the staging of *The Mother*, Bertolt Brecht's adaptation of Maxim Gorki's novel, the Schaubühne had begun a new phase under the direction of Peter Stein (Q30555). Inspiration was to be taken from previous productions: from Ibsen's *Peer Gynt* (1971), a hilly topography with the audience situated on the two long sides of the nave. From *Übungen für Schauspieler* (Exercises for Comedians, 1974), and from Euripides' *The Bacchae* (1974), unique, distressing spaces: the former because of its mysterious luminosity and the strange sensation of the asbestos-clad walls, the latter because it is too cold. From Gorki's *The Holidaymakers* (1974), a real forest. Any work offered the opportunity to transform the space of the theatre.

The Schaubühne, before it was divided into three spaces

In the new premises, the machines installed on the roof and in the basement were to be the means to achieve these transformations more easily and more completely. This was to be the multi-purpose theatre, divisible into rooms of varying dimensions, in a display of mechanisation unusual in the group's practice before then. However, as the years went by, the mobile multi-purpose rooms tended to become fixed, and the structures of the audience seating were built over the mechanisms that should have transformed the floor.

In theory, Schaubühne had not appealed to the machine as a sign of fidelity to the spirit of modern times. Advanced technology was only to be used to achieve greater creative freedom. Experience has shown that this confidence was unjustified. Due to financial constraints, the many possible configurations are not being used, and today the three separate auditoria are played individually in isolation and do not change. The lifts that reconfigure the many modules of the floor are out of use. Nevertheless, the possibilities of a grand vision in theatre architecture and performance show the limits we can attempt to exceed.



Left: the Schaubühne

Right: the reconfigurable floor sections on lifts

Theatre without Theatres

Site-specific performance and found spaces

20th century theatre makers have often sought to reform the spaces where theatre takes place, in some cases abandoning purpose-built theatres altogether. Instead, they have made work for a specific, found location, adapted to the purpose.

The term *site-specific* refers to a type of theatrical production or artistic work specifically designed for a particular location. A *found space* is an existing space adapted to be used as a theatre, though the work presented there may not be made specially for the space. Vacant industrial buildings are often converted into theatre spaces after they are no longer required for their original purpose.

During the development of the coal and steel industry, the German Ruhr region became the largest conurbation in Europe. However, the coal crisis in 1958 heralded the end of this era. With the decline of the coal industry, the region had to reorient itself economically. Previously neglected, art and culture as well as an awareness of nature and quality of life took on new significance. Many event spaces and exhibition halls were founded after the end of the coal and steel industry, and the terrain, buildings and history of the industrial era themselves became the subject of culture.

The International Building Exhibition Emscher Park (IBA) project between 1990 and 1999 developed new uses for former industrial wastelands, and played a major role in this change. Buildings and places of the industrial era were converted into monuments or venues for art, for example the Zollverein Coal Mine Industrial Complex ('Zeche Zollverein' in German) in Essen.

The Ruhrtriennale music and arts festival in the Ruhr region happens every three years, with its own theme and under different artistic directors. The Ruhrtriennale locations are industrial heritage sites of the Ruhr area, transformed into venues for music, theatre, literature and dance. The main venue of the festival is the Jahrhunderthalle, a former power station from the early 20th century in Bochum. Other locations include the Zeche Zollverein coal mine in Essen, the Landschaftspark in Duisburg-Nord, and the Maschinenhalle Zweckel in Gladbeck. The festival's central feature is interdisciplinary 'creations' or productions that unite contemporary developments in fine art, pop, jazz, and concert music. Artists who have appeared include Ariane Mnouchkine, Peter Brook, Robert Lepage, Bill Viola, and Patrice Chéreau.

Jahrhunderthalle im Westpark, Bochum

The idea is to perform in totally unconventional places, to generate innovative results that provoke new sensations. In these productions there is a strong interrelation between the piece and the space, in such a way that if the piece moves from the specific place where it has been mounted, it loses a substantial part of its meaning. The place not only acts as the scenic environment in which the action takes place but is also the subject that triggers the action itself. The place is the origin of the dramaturgy, and research into the place and its history constitutes a large part of the work. The spaces used are usually those that have a particular historical charge or a certain atmosphere: a hangar, a disused factory, a specific neighbourhood of a city, a house or an apartment.

Site-specific performances can be classified according to the different types of space they use, and the types of relationship between performers and spectators. Performances in theatres, public buildings and private homes are characterised by the occupation of different parts of the building, so that the spatial arrangement of the audience and the performers creates new forms of relationship and new modes of perception of the theatrical event. In the city, disused buildings or apartments and private rooms are also used. Performances in public spaces have been used to create scenographies in which the viewer has the possibility of experiencing a familiar space in a new way. Places such as train stations or the metro network have been widely used. Performances in natural spaces use the environment of nature to provide either a background to a more conventional stage, such as with the floating stage of the Bregenzer Festspiele on the Bodensee lake, or as an immersive environment for the performance in parks, forests, and similar nature locations.

Carmen *on the floating stage at the Bregenz festival, 2017*

In general, *site-specific* theatre is more interactive and immersive than conventional theatre. The spectator is taken from their usual place in the stalls to an unfamiliar environment. The events that take place in these places are usually of an ephemeral nature and are linked to the moment of their execution and the environment in which they take place. It is a fruitful scenographic practice that continues to grow and evolve, often favoured by artists who wish to escape what they see as a stale theatre culture, to find new ways of communicating ideas and new kinds of experiences for their audiences, and indeed to find new audiences – those that might never set foot in atraditionaltheatre.

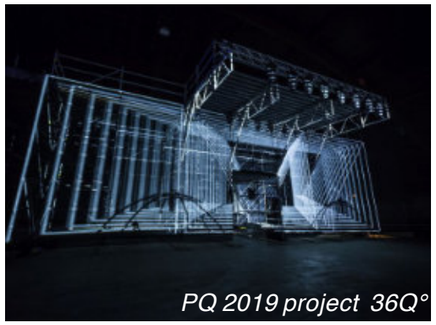
Ruhrtriennale festival, 2018

The Prague Quadrennial

An international meeting place

The Prague Quadrennial of Performance Design and Space (PQ) started in 1967 and has been held every four years since. It is a key international event for those in the fields of design for performance, scenography and theatre architecture.

The core of every PQ edition is an international exhibition of countries and regions. From the beginning of PQ until about the turn of the millennium, exhibitions of models, sketches of designs, and performance photographs presenting the international developments in scenography were the central focus. Since 2003, more and more countries have been bringing exhibitions that include performative elements, drawing the viewer into new imaginary spaces, and turning audiences into active participants. The festival that gradually emerged around the main exhibitions from these impulses has grown in size and popularity. Both of these developments opened PQ to other art professions and showed the multidisciplinary nature of performance design/scenography.



PQ 2019 project 36Q°

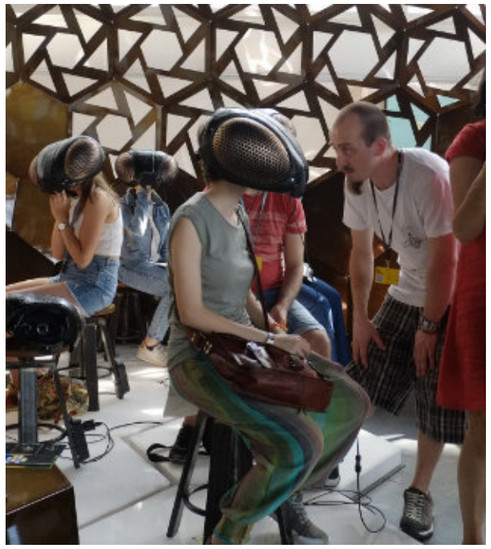
The first edition of the Prague Quadrennial, named 'International Exhibition of Stage Design and Theatre Architecture', opened on September 22, 1967 in the Brussels Pavilion at the Prague Exhibition Grounds. The overall concept for the PQ was in part inspired by the São Paulo Art Biennial (Q30554), an exhibition of painting, sculpture, and the graphical arts that had been held on a regular basis since 1951, and in 1957 expanded to include scenography as an independent discipline. Czechoslovak scenographers continued to enjoy success in São Paulo and brought home gold medals from every edition between 1959-1965. The catalogue for the first edition of PQ briefly summarises how scenography was approached by both events:

> Compared to the Biennial of Stage Design in São Paulo, where the artistic aspects are the main criteria for judging the exhibited works – apparently because this particular section was only subsequently included within the context of the Biennial of Visual Arts – the Prague Quadrennial is led in an effort to capture the specificity of stage design, the inseparability of scenography from the direction and all other components of a dramatic work, and the synthetic nature of this field.

As the organiser of the Prague Quadrennial, The Ministry of Culture charged the Arts and Theatre Institute with the realisation of the event. Invitations to participate in PQ were sent out diplomatically through the Ministry of Foreign Affairs, via the countries' embassies. Given the bureaucratic demands of this official form of communication, information was also disseminated using the network of national centres of the International Theatre Institute (ITI, established in Prague in 1948), making PQ an important cultural event on the UNESCO programme calendar. Additionally, OISTT, the International Organization of Scenographers and Theatre Technicians (which was later expanded to also include theatre architects), was closely linked with PQ – its founding meeting was held in Prague in 1968, one year after the first PQ.

The preparations for the second edition of the PQ were significantly affected by events in August 1968. The occupation of Czechoslovakia by the armies of the Warsaw Pact nations under the baton of the USSR was followed by the reintroduction of a strict totalitarian Communist regime, reflected also in arts and culture. Although the new restrictions also had an impact on the composition of the PQ Committee, fundamental changes in the concept and structure of the PQ were successfully prevented. Artists from several Western European nations were planning a boycott as a protest against the occupation, but thanks to the intervention of ITI and OISTT the boycott was averted. This made it possible for PQ to become one of the very few events where, for the next twenty years, artists from both parts of the divided world could meet in relative freedom.

Nowadays the PQ offers new ways of networking, learning, and knowledge exchange through a wide range of activities, including workshops and masterclasses, performances, discussions and round tables, online educational platforms, and accompanying specialised exhibitions.



PQ 2019 Bulgarian exhibit, Conglomerate

Prague Quadrennial of Performance Design and Space

PQ 1967 Canada-Quebec day

PQ 1975 exhibition

Shelter or Building?

Companies that create their own space

Home of the Théâtre du Soleil

Theatre artists work within organisations and buildings that are not always suited to their artistic purpose. Sometimes, they set up their own companies and find their own spaces, to make the most suitable environment for creating their work.

There is a tension in most theatre companies. On the one hand, theatre is made by artists – directors, designers, actors, technologists – who are motivated to experiment, to collaborate, to work in close, personal relationship with each other to make their art. On the other hand, theatre companies and theatre buildings operate as corporate entities, that have budgets, funders, management, contractual arrangements, employees, legal obligations. Mostly, the corporate identity is dominant, and artists make work within the institutional structures as best they can. Sometimes, artists set up their own companies, and run them in new ways, better suited to their particular artistic ethos. Two such companies are the Théâtre du Soleil at the Cartoucherie, a former munitions factory in the Bois de Vincennes in Paris, and the Odin Teatret, based at a former farm in Holstebro in Denmark.

In 1964 the young Odin Teatret company arrived at a farm in Saerkjaergaard, a suburb of Holstebro, founded by Eugenio Barba. The members were four young people who had been rejected from the Oslo State Theatre School. In the early days it created street theatre; today it has a permanent and paid staff of about 20 people, including actors, technicians and administrative staff.

The French theatre collective Théâtre du Soleil was founded in 1964 by Ariane Mnouchkine. The international company has its main venue at the gates of Paris, in the old, abandoned munitions factory of Vincennes (La Cartoucherie), where other theatre groups are based today. The Théâtre du Soleil sees itself as a politically active theatre that wants to influence social reality in a critical way. It is oriented towards the theatre of the Far East and Greek tragedy, as well as the traditions of popular theatre such as the Commedia dell'arte.

And in both spaces, territories are liberated from everyday life. Crossing the entrance door of both spaces gives the impression of entering a different space and time, an emotion that Soleil seeks to reinforce through a protocol of rituals, the first of which is the welcome. Thus, Ariane Mnouchkine, the director and alma mater of the troupe, often welcomes the audience by interrupting the spectators' entrance.

The feeling of being part of a community, of constituting an audience, is present in the companies' rooms. At the Odin, in a warm, welcoming atmosphere, upholstered with carpets and with the presence of posters showing the life of the company. At the Soleil, the foyer, which is also the dining room, is a particularly well cared for area, changing according to the work being staged. It is perhaps this desire to create a community of audience and artists that is the reason for opening the dressing rooms in the Cartoucherie to the view of the spectators, another singularity of the company's spaces.

Theatre is a space and a time of encounter, of the audience with itself and with the work of art. Also, the theatrical work of the companies is also constructed as an encounter of genres and theatrical traditions – a new form of theatre needs new kinds of theatre-makers. The Soleil actors explore a diverse range of techniques: clowning, commedia dell'arte, kabuki, puppetry... Arts, trades, industry make up the organic body that gives life to theatre.

The Odin Teatret and the Théâtre du Soleil are builders' houses. The halls of the farm and those of the Cartoucherie offered the space, the proximity necessary for collective creative work. In the Teaterlaboratorium, as Eugenio Barba called it, and in the Theatre-Workshop required by the Soleil in the Cartoucherie, the structure of the old pavilions could be adapted to house storage, workshops for scenery, costumes or props, office space, a magnificent library and study centre for theatrical anthropology in the Odin's house in Holstebro, or kitchens and dining rooms. The kitchen and dining rooms of the companies are as important as the workshops or even the stage.

In his article *L'abri ou L'édifice* (The Shelter or the Building, 1978), Antoine Vitez was able to capture very well the antithetical condition that the architecture of theatres can assume, either as a 'perfect technical instrument' building, more or less monumental, an eloquent sign that seeks to distinguish itself, or as a refuge that shelters theatrical activity. The halls of the former Holstebro farm, enlarged over time, and those of the Cartoucherie, offered the refuge sought by the companies. They offered just the right place, ready to host any stage proposal, they formed an empty space, though not a neutral one. The Soleil's treatment of the theatrical space also avoids the black box, the tabula rasa. The rooms must be transformable, but they must not become a theatre-machine. The technique is used, but not exhibited. In the case of Odin Teatret and Théâtre du Soleil, and other companies founded by artists with particular intentions, the theatre company is organised, and the physical environment arranged, to be the best possible context within which to make the work.

Nordisk Teaterlaboratorium, home of Odin Teatret

A Matter of Principle

The UK Health and Safety at Work Act 1974

The UK Health and Safety at Work etc. Act 1974 has transformed the culture and practice of health and safety since its introduction, dramatically reducing the number of fatalities and serious injuries in all kinds of workplace, including theatres.

Through the 19th century in the UK there was a growing belief that regulation was required to address the dangers of the industrialised workplace. Government inspectors were appointed in key industries, including factories (1833), mining (1842), and railways (1894), with various industry-specific regulations being introduced over time, but there was no overarching legislation. By the 1960s the shortcomings of this ad-hoc approach were apparent: deaths and injuries at work rose from 450,000 in 1961 to 513,000 in 1969.

The radical and far-reaching Robens Report of 1972 established a principle that has shaped workplace health and safety ever since: 'those that create risk are best placed to manage it'. The Health and Safety at Work Act (HASAWA) came into effect in 1974. Previous laws that specified very detailed requirements were replaced with general duties to reduce risks 'so far as reasonably practicable'. Rather than trying to dictate the specific risk controls needed, the act stipulated that employers have a duty towards both employees and other persons to ensure their safety. Employees in turn also have responsibilities.

Key concepts were introduced. Employers have to appoint one or more 'competent persons' to manage health and safety, where competence is defined as a combination of training, skills, experience and knowledge that enable someone to perform a task safely. While training and qualifications might be appropriate, the act recognised that these things alone do not guarantee competence. Risk assessment became a vital part of the process of managing health and safety – again, allowing and requiring those close to the activity to respond to the specific circumstances when deciding how to ensure safe working.

Responsibility for regulation was to be tripartite, with workers' representatives such as unions having a formal role, together with the state and employers. This distributed model of responsibility again was based on principle: ensuring safety is *everyone's* job, and everyone has a role in developing safe working practices.

The HASAWA created the Health and Safety Executive (HSE) as the national regulator for workplace health and safety. It is 'dedicated to protecting people and places, and helping everyone lead safer and healthier lives'. Its role 'goes beyond worker protection to include public assurance … to ensure people feel safe where they live, where they work and, in their environment'. The HSE undertakes inspections, enforcement and investigations, as well as providing guidance. It has the powers to carry out criminal prosecutions of companies and individuals, and to require changes to working practices and to the physical working environment. Employers are required to report fatalities and serious injuries to the HSE. The emphasis of the HSE, as with the HASAWA, is on the role of employers and employees in preventing accidents and ill-health, rather than detailed regulation.

Nevertheless, since 1974 a wide range of regulations have come into effect under the act, covering all aspects of health and safety. Those relevant to theatres include the Personal Protective Equipment (PPE) at Work Regulations 1992, the Lifting Operations and Lifting Equipment Regulations 1998 (LOLER), the Management of Health and Safety at Work Regulations 1999, and the Control of Substances Hazardous to Health Regulations 2002 (COSHH). These regulations are supplemented by codes of practice, which may be created by the HSE, or they may be developed by specific industry sectors and adopted by the HSE, so ensuring they are closely tailored to the way particular industries work.

The HASAWA has had a far-reaching impact on the theatre industry. The Association of British Theatre Technicians (Q30488) has taken on a role providing guidance, disseminating best practice, and organising industry-specific training. Its Technical Standards for Places of Entertainment is a primary reference point for technical theatre production, developed from the combined

expertise of the association's members. Many theatre companies now have dedicated health and safety officers, who take on the challenging role of balancing the sometimes unique creative demands of productions with the need to ensure the safety of all involved. Unions too have recognised they have an important function, representing their members and helping ensure employers meet their responsibilities. The result has been the embedding of health and safety in the daily lives of theatres and theatre workers. Risk assessments and method statements are an established part of the planning process, and safety is routinely built into contractual arrangements between individuals and companies.

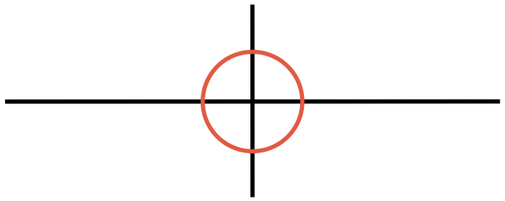
Sometimes health and safety is used as an excuse to say 'no'. It is often the butt of jokes: the cry of 'it's health and safety gone mad!' is regularly heard. The benefits though of the HASAWA's principled approach are undeniable. In the UK, fatal injuries at work dropped by 85% from 651 in 1974 to less than 150 in 2014. And the total injured at work fell by 77% from 336,701 to 77,310 over the same period. As a result of the Health and Safety at Work Act, Britain is now one of the safest places to work in Europe and the world.

Nevertheless, there is further work to do. Occupational and mental health are still significant, and growing, issues. Work-related stress is common in the pressurised environment of theatre production, and in the post-pandemic environment of the early 2020s, the UK 'Reset Better' and US 'No More Ten Out of Twelves' campaigns are pointing the way to a theatre workplace that emphasises a holistic approach to wellbeing, not just physical safety.

Zero Point

Shared conventions, standards and reference systems

The Zero Point is a reference point on the stage, from which measurements can be taken in a standard way. In a proscenium theatre, the zero point is usually the place where the centre line of the stage and auditorium meets the line of the curtain.



The zero point (Q3660) is a mark in the stage, serving as a reference point for all departments in the theatre. In proscenium theatres, the centre line runs from upstage to downstage, defining a mirror-symmetry about a central axis for both the stage and the auditorium. At right angles to the centre line is the setting line, which is usually defined by the back face of the proscenium arch, or the line slightly upstage where the curtain or 'house tabs' fall, or where the safety curtain (the 'iron') meets the stage when it is lowered. The setting line is therefore sometimes called the 'plaster line' (where the decorative plaster of the auditorium ends), 'curtain line' or 'iron line'. Where the setting line and the centre line meet is the zero point – also known as the centre point or setting point.

The zero point is an essential tool in planning productions. It gives a reference point for placing scenery, and lighting, sound and other technical equipment. The zero point, with the centre line and setting line, are marked on plans, so all departments share a common reference, to avoid errors and misunderstandings. When placing scenery or equipment on the stage, measurements can be made from the zero point, based on the measurements shown on the plan. The zero point is therefore a vital tool in translating from a drawing of the space to the actual space.

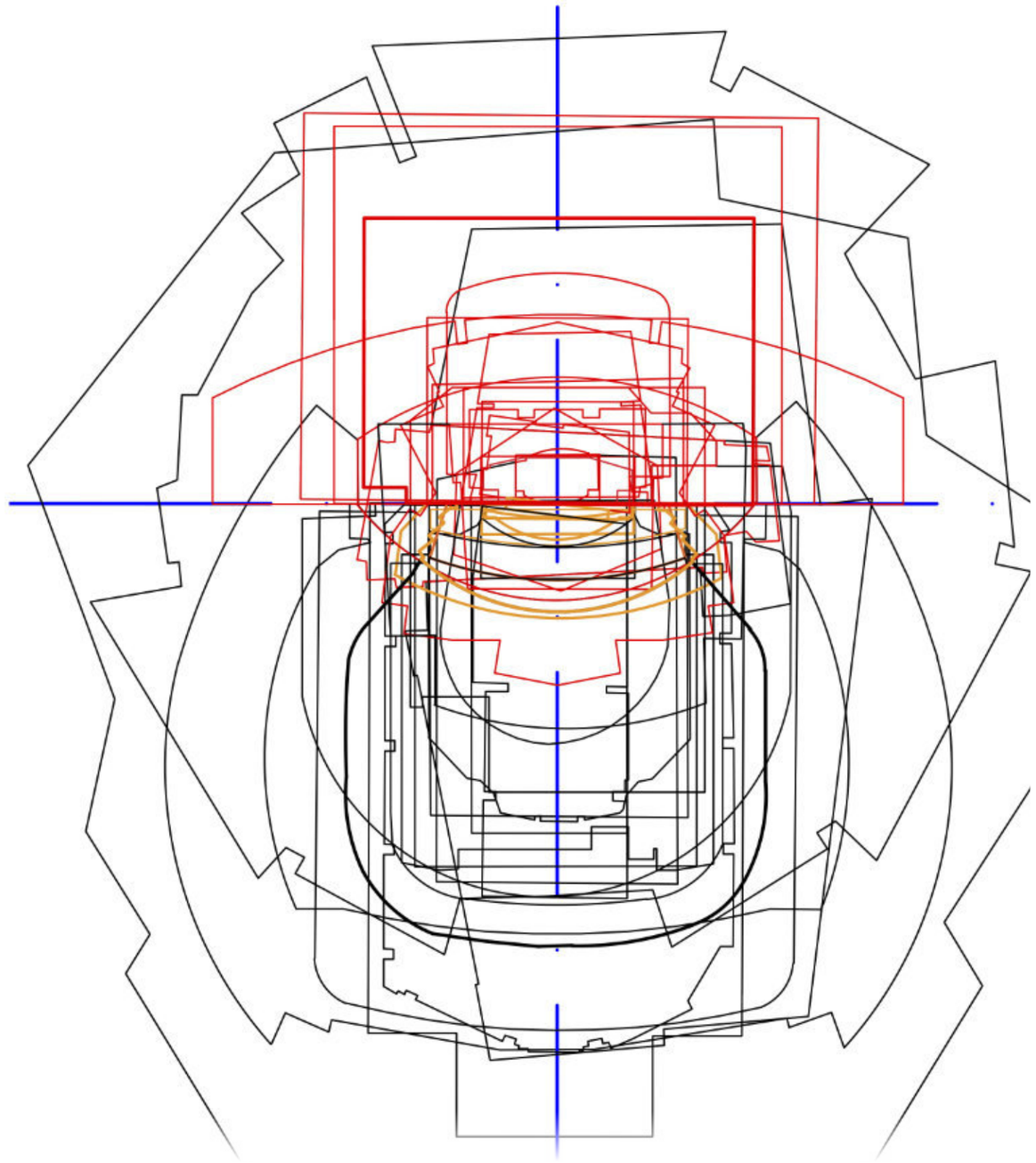
The zero point is particularly important in touring. Technicians and designers working in their own theatre get to know what will fit, and what the most important measurements are, but for a production that has to fit in many different theatres, each different in size and shape, having a system for making measurements is vital. Designers, technical and production managers can plan their touring production by overlaying a drawing of the set onto a drawing of each venue, aligning the zero points, to see if the scenery will fit into each theatre, and make any adjustments required.

In the mid 20th century the development of large, complex and three-dimensional scenery made standardising reference systems essential. In particular, the growing complexity of lighting, sound and video systems, which require very precise positioning to work as intended, has greatly increased the need for detailed planning of how everything will fit together in the space. A standard system of reference points is fundamental to this work.

The zero point is not just a conceptual point, it is often physically marked on the stage. This is usually done with a small brass plate embedded into the stage surface, with the zero point engraved into it. In the Netherlands the zero point is given the name Koperen Kees, suggesting the mark is made of copper, though it is usually made of brass. It can be found as a mark in almost every theatre, and owes its name to Kees van der Wilk who carried out the first technical inventories. Nowadays the technical inventories and the digital drawings are managed by the foundation 'Stichting Teken', founded by Bert Middelweerd. He has been placing 'Bronzen Bert' in theatres since the 1990s.

The zero point, used by the scenic and technical departments, is not the only referencing system used on the stage. Lighting designers will often divide the stage space into areas, each lit separately to give an 'area cover'. They sometimes mark these areas out temporarily in chalk or tape while focusing. In repertoire theatres, grids may be marked on a stage cloth to help focus lights, when the actual piece of scenery to be lit is not on stage. Choreographers also may mark the front edge of the stage with numbers, to help dancers locate themselves.

The concept of the zero point, defined by a presumed centre line and proscenium line, is particularly related to proscenium arch theatres. The increase in theatres that are not proscenium stages has brought the zero point into question, both practically and conceptually. For a theatre in the round, or a thrust stage, or a traverse with audience on opposite sides, where is the universally understood reference point? In a proscenium arch, 'downstage centre', where the zero point is, is the most powerful position for an actor to address the audience, but in other types of spaces, where is that position? The zero point is a practical method to eliminate errors and failures of communication, but it also reminds us that proxemics – the way that people relate to each other spatially – is fundamental to the theatre experience.



Overlay of theatres in Berlin Tiergarten, with the zero points aligned

Six Degrees of Freedom

Stage automation and control

In the early 21st century, stage automation made it possible to control large scenic elements in complex ways, and integrate their movement into elaborate performances with performers, light, video and sound.

From the late 19th century, stage machinery began to change from being moved by muscle-power to being powered by hydraulics and electric motors (A.06). Large stage lifts and revolves by their nature need to be powered, but flying systems have in many cases stayed with the older technology of manually operated counterweights. However, by the early years of the 21st century, powered flybars were increasingly common, especially in new, or larger, well-funded theatres. The adoption of powered systems has been driven both by an artistic demand for larger, heavier scenery, as well as safety concerns.

As soon as powered stage mechanics began to be used, the question arose of how to control them. Permanent installations in theatres, such as flying, stage lifts, trucks and revolves, came with their own, bespoke controls. The same was true of the temporary stage machinery built for specific shows. The 'mega-musicals' of the 1980s, such as *Les Misèrables* and *Miss Saigon*, had substantial mechanised scenic elements, powered and controlled by systems built specifically for the show. From the early 1990s, however, companies such as Stage Technologies (now part of TAIT, Q30635) began to develop re-usable components such as winches, motors and controllers. The control system became more than a series of manual controllers; adopting principles established in lighting control, the new breed of 'automation controllers' could be pre-programmed with cues, so that multiple scenic movements could work in perfect synchronisation. They differed from theatre lighting consoles by offering immediate manual override, and a large 'emergency stop' button. The powered stage was now stage automation.

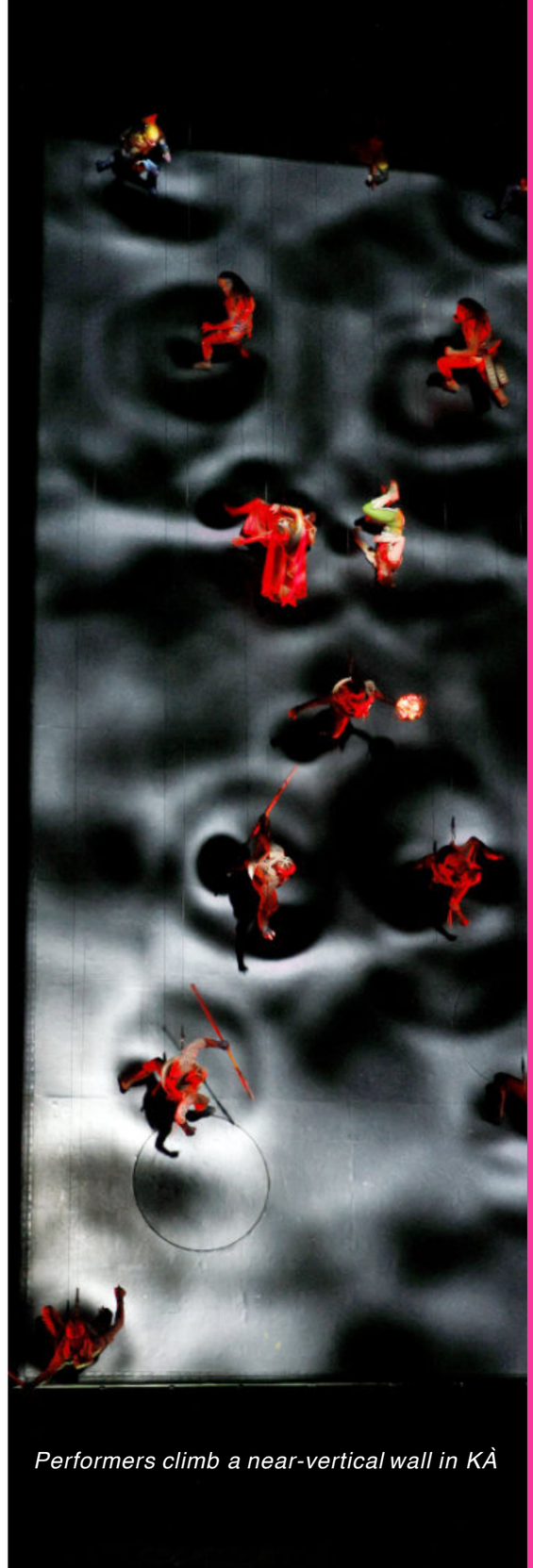
Through the first two decades of the 20th century, the systems continued to evolve. Stage automation systems can now integrate with other technical systems, so that lighting, sound and video can be perfectly synchronised. Motion control systems mean the automation controller can know exactly where the scenic element is in space, correcting for any errors to give very precise positioning. This allows, for example, two pieces of scenery to move together and meet exactly, or a video image or a moving light to precisely track the moving scenery. Large shows such as *KÀ*, the 2005 production by Cirque Du Soleil, directed by Robert Lepage (Q436), make extensive use of these types of technologies, and give a sense of what can be achieved.

The floating stages of KÀ

KÀ is a story about the journey of self-discovery for twins who are separated and fight to find their way back to each other. The KÀ Theater inside the MGM Grand, Las Vegas, Nevada, has a capacity of 1950 people. Its unique floating stages help immerse the audience in the story combined with complex automation, pyrotechnics, puppetry, and multimedia projections. *KÀ* lacks a conventional stage with a permanent floor; instead, two giant moving platforms and five smaller lifts and platforms appear to float in a bottomless space. A narrow boardwalk separates the audience from a deep abyss where the stage floor would normally be. From the stage level of the boardwalk up to the grid is 30m, and the pit drops 16m below. The width and depth of the performance area are each 37m. The performance space is reconfigured with each scene change by the movements of the show's lifts and platforms.

The largest moveable platform employed in the show, the Sand Cliff Deck, measures 7.6 x 15.2 x 1.8m and weighs 50 tons. A vertical gantry crane supports and controls the Sand Cliff Deck, lifting the platform up and down 22m, rotating it 360 degrees and tilting it from flat to 100 degrees. This is attached to four 23m long hydraulic cylinders that run along two support columns. The Sand Cliff Deck has circular elevators to bring performers in and out, 80 'rod actuators' that sprout from the floor surface to enable performers to climb it when it is tilted vertically, and video tiles that allow computer-generated images to appear on the floor. The second largest platform, the Tatami Deck, is a cantilevered 9.1 x 9.1m platform located upstage of the Sand Cliff Deck, and slides in and out like a drawer to provide a horizontal stage and carry massive set pieces such as the Wheel of Death. These two decks can appear alone or together or simply disappear from view; they can move in front of, behind, above or below each other.

An object on stage can move up and down, from side to side, or forwards and backwards: movement on the three axes, X, Y and Z. It can also rotate about these three axes – it has six 'degrees of freedom'. While not every object on stage – every prop, every piece of scenery, every person – can move or turn in any direction, stage automation has brought us closer to this possibility than ever before.



Performers climb a near-vertical wall in KÀ

Every Surface is a Screen

Projection and pixel mapping

Since the start of the 21st century, projection and pixel mapping have developed as new ways to integrate video content into all kinds of live performances, from experimental dance to large-scale public celebrations.

In Edinburgh in the summer of 2001, at the international entertainment lighting Colloquium *Showlight* (Q30645), a novel product was previewed. Catalyst combined a high-power video projector fitted with a unique moving-mirror head that allowed it to point in all directions, and a software that controlled video content in real-time via DMX, the lighting control protocol (Q3957). For the first time, a video projector could be controlled in the same way as other lights: the video content could be resized, stretched, colour tinted, started, stopped, sped up and slowed down, faded in and out, and overlaid in multiple layers, all from a standard lighting console. As far as the console and the lighting operator were concerned, Catalyst was just another (very complicated) moving light.

It turned out that the real power of Catalyst was in using the software to feed content to standard video projectors. For lighting designers wanting to control all the visuals, particularly for live music concerts, clubs and similar applications, it brought video into the same technical system, and the same workflow, as lighting. If you wanted to match the colour tint of the video to the lighting, you could – just programme Catalyst in the same way you programmed a moving light. For video designers, almost everything could be done in real time. Rather than having to edit and re-render the video files when the content had to be rescaled or colour corrected, it could be done live. Video design could be as responsive as lighting and sound design. Following Catalyst's success, other manufacturers started to make their own version, and a new product category was born: the media server.

One of the features of media servers is they allowed video content to be distortion-corrected to counteract the effect of the projector hitting the screen at an angle – something previously requiring difficult graphical or photographic techniques. As well as this type of distortion correction, media servers facilitated more complex ways of relating the video content to the surface it was projected on – a technique known as *projection mapping*. The first projection mapping was analogue. In 1969 Disney created their Haunted Mansion ride at Disneyland with its singing busts known as the 'Grim Grinning Ghosts' which were created by filming head-shots of five singers and projecting the footage onto three-dimensional sculptures of their faces. On a larger scale, the 1986 musical *Time* featured a huge head of the actor Laurence Olivier, animated by a projected film of the actor. For projection mapping onto buildings, where the content related to the features of the façade, elaborate systems were developed using layers of large format film, with one layer masking out the others as the film scrolled through the projector. The result was effects such as fish seeming to swim between the pillars of the building, or only appearing in its windows.

With the advent of digital video and media servers, all of these effects became easier to achieve, and could be more sophisticated. Today, projection mapping is used to animate buildings for festivals, public events and *son et lumière* performances, as well as on stage for theatre, opera, dance concerts. By integrating the media server control with other stage systems, video content can track the movement on stage of objects and people. For the 2004 musical *The Woman in White*, the stage scenery of moving and revolving walls was painted grey, with projected scenes for each location made using games software. The video tracked the moving walls, so the images appeared to be 'painted on'.

Taking a step further, Troika Ranch's 2006 dance production *16 [R]evolutions* used an infra-red camera to track the motion of the dancers, so the video content could respond to the dancer's movements on stage. In one sequence, white bars projected on the back wall outlined the maximum extent of the dancers moves, so the dancer appeared to be pushing the bars away as if to make space to dance in.

The Catalyst software was not just the first media server, opening up the possibilities of projection mapping. Its creator, Richard Bleasdale, added a feature to output DMX data based on video content: the result was the new technique of *pixel mapping*. The colour and brightness of any pixel in a video could be used to control the colour and brightness of a light on stage. Suddenly, video could be used to make rich, organic, non-repeating lighting effects which previously would take many hours to programme with a traditional lighting console. Pixel mapping has many uses, but it is perhaps most frequently seen in television light entertainment shows, controlling individual lights, strips of LEDs built into the set, and so on (C.10).

Since the start of the 21st century, the technologies of projection and pixel mapping have developed as remarkable new ways to integrate media content into live performances and events. The results can be seen in almost every sector of performance, from opera to theme parks.

Sydney Opera House, projection mapped during the Vivid Sydney *festival 2013.*

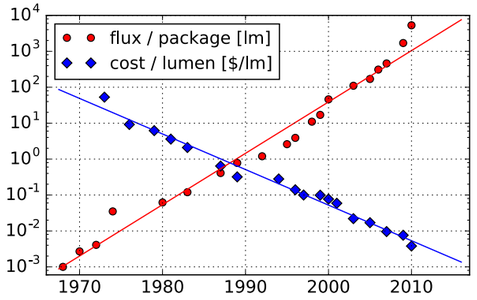
ALight-emitting World

LEDs everywhere

By the end of the 2010s, LED lighting was on the brink of taking over as the light source for stage lighting. This shift was controversial for some lighting professionals, but now we have LEDs almost everywhere.

From its introduction in the late 19th century, the incandescent lamp (Q3120) became the dominant light source not only in theatres, but in almost all situations where artificial light was needed. In many ways it was ideal – the warm colour was flattering to actor's skin tones, the full spectrum ensured the colours of scenery and costumes were seen correctly, and the lamps could easily be dimmed smoothly to zero. However, it had disadvantages: a relatively short life, and low efficiency, with most of the power consumed being converted to heat, not light. Alternatives were developed, which found applications outside theatre, but both fluorescent tubes (Q30636) and the various types of discharge lamp (Q3093) had the same problems for stage lighting: they had poor rendering of colours and could not be dimmed smoothly to black. They found some limited applications in theatres, with fluorescent lamps being used, combined with special dimming systems, for lighting cycloramas where their linear, smooth light distribution was ideal. Discharge lamps were used for high power applications, and later for moving lights, combined with mechanical dimming systems.

Light-emitting diodes (LEDs, Q3195) are electronic devices that produce light by electroluminescence when an electric current is passed through them. The first commercial LEDs appeared in 1968, but they were inefficient and could only emit a deep red colour, restricting their use to numeric displays and indicator lights. Further development over the following years produced yellow, green and eventually blue LEDs, as well as an exponential rise in brightness and reduction in cost – a phenomenon known as Haitz's Law.



With the development of high-efficiency and high-power LEDs, it became possible to use them in lighting applications. In 1997 the very first LED stage lights were presented at the LDI trade show in Las Vegas. They used red, green and blue LEDs that could be controlled separately, allowing a wide variety of colours to be produced. However, the three colours when mixed did not produce a clean white, and colour rendering was poor. For producing an impact with strong colours, the early LED spotlights were effective, but the quality of white light for theatre use on performers was inadequate. By the mid 2010s the first white LED were being produced, employing a phosphor coating to partially convert the emitted blue light to red and green frequencies, creating a light that appeared white. It seemed at that point that LEDs were the future of lighting, with the benefits of greater efficiency, long life and compact size. LEDs could also be used to produce light sources with variable colour, the new white LEDs ensuring that a good quality white light could be included in the range of mixable colours.

However, in 2018 the European Union announced proposals to ban the sale of tungsten lamps, as part of its measures to address the climate emergency. Lighting designers in the live event and architectural fields were concerned that the available LED lights could not meet their requirements, in particular the quality of white light on skin tones, and launched a 'Save Tungsten' campaign. Industry representatives met with the EU to argue the case, pointing out that not only could tungsten incandescent lamps not meet the efficiency requirements in the proposed regulations, neither could the new LED stage lights – their colour mixing and optical systems required for stage use reducing the overall efficiency below that required. They were able to negotiate some adjustments to the regulations, with exemptions for the main types of lamp used by the entertainment lighting industry.

Technology advances, and most of the disadvantages of LED have been addressed by manufacturers, though it has taken several years to win over the most sceptical lighting professionals. Manufacturers have developed colour mixing systems using up to seven different colours, to ensure accurate, high-quality colour rendering, especially the subtle near-white tones that are required for lighting people on stage and on camera. Experiments suggest that even experienced professional lighting designers can no longer tell a high-quality LED source from a tungsten one, in a blind test.

While the introduction of LEDs to main stage lighting has been controversial, LEDs have quietly taken over another important role on stages and television studios. The features that made LEDs a useful light source in their early days – compact size, low heat output, and a range of colours – meant they are now the main solution whenever a light source needs to be embedded in the set. Strips and panels of LEDs create graphic, radiant lines that mark out the edges of scenery, or create architectures of pure light in space. Not only are the overhead lighting positions full of LED sources, now almost any surface, any scenic element, can glow and colour-shift with rippling, strobing illuminations: LEDs everywhere.

From left to right: Haitz's law – the luminosity of LEDs increases exponentially over time, while the cost per lumen falls exponentially

LEDs in the set of the game show Jeopardy!

LED walls and ceiling at Outernet, an immersive entertainment venue in London.

Sonic Objects

The development of spatialised sound

Since the beginning of recorded and mediated sound, attempts have been made to replicate hearing sound in 3D space. In the early 21st century, technologies based on sonic objects are enabling new kinds of aural experiences for audiences.

When sound recording first started, and recorded sound was first replayed in theatres, the audio signal was in mono – that is, it didn't include any directional information. While stereo sound was first experimented with in the 1880s (D.06), and there was some adoption in cinemas from the late 1930s, stereo was only adopted widely in cinema, radio, television and home music replay from the 1960s onwards. Stereo gives a spatialised sound – so the listener can place different sounds in different spatial locations between the two loudspeakers – but only for listeners in a particular position relative to the speakers. For listeners 'off axis', the illusion of a sonic space collapses, much as the visual perspective of the Italianate Renaissance and Baroque theatres failed for off-axis viewers (F.03).

In theatres, bespoke systems for particular productions were developed from the 1960s onwards (D.09), allowing sounds to be directed to one or more speakers located around the performance space, for example from behind the audience, or from off stage left. One early example of multichannel sound for a live audience was the Philips Pavilion at the 1958 Brussels World's Fair (Q30637), designed by Iannis Xenakis (Q30638), which used 425 loudspeakers to move sound throughout the pavilion. In 1967, the rock group Pink Floyd experimented with quadrophonic sound, performing the first-ever surround sound concert at Games for May, at London's Queen Elizabeth Hall. The custom sound system used four channels to move sound around the space, controlled by the purpose-built 'Azimuth Co-ordinator' with its dual joysticks.

By the 1980s, surround sound was becoming established in cinemas, and later in home cinema set-ups, as some consumers sought to replicate the cinema experience in their living rooms. Various systems have been developed, based on stereo, with extra speakers for sounds behind and to the side. In addition to these commercial systems, there have been many experiments in more immersive sound, which include height information as well as horizontal direction, using overhead speakers. All these methods have the same disadvantage, however: the sound must be recorded, edited and processed specifically for the system that will be used to replay it. For theatre and live event use, where each venue, and often each show, is different, and some sound may be live as well as pre-recorded, these surround-sound technologies have been too inflexible.

Theatre has occasionally experimented with other kinds of sonic experience. In *The Encounter* (2015), by theatre company Complicité, directed and performed by Simon McBurney, the audience all wore headphones. The sound design made extensive use of a 'binaural head' – a life-size model of a human head with microphones in the ears. By feeding the binaural signal into the audience member's headphones, they were, in sonic terms, placed in the position of the head on stage. At the start of the performance, McBurney introduced the audience to the head and demonstrated the binaural effect, walking around it as he talked, whispering and blowing in the head's ear, and so on. The effect combed great intimacy in the sound domain with a sense of distance in the visual domain, which was central to the experience of sharing the main character's journey deep into the Amazon rain forest.

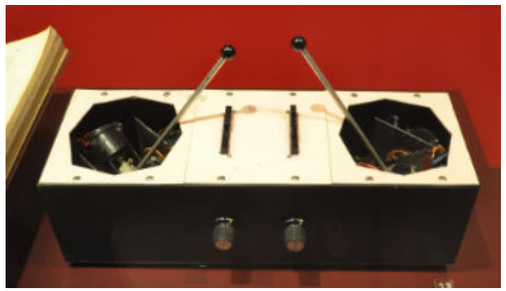
In general, however, headphones are unsuited to theatre or live performance use. What is needed is a way separate the audio content from any particular configuration of speakers, so it can be replayed in any environment. After some false starts, including the 1979 Ambisonics system, technologies are emerging that can provide this separation, and may have a substantial impact on spatial audio. Dolby's Atmos system is based on 'sonic objects' – a sound source that is associated with a particular position in space relative to the listener. The same audio content can be deployed in different contexts, with the decoder maximising the spatial effect for the listener with the speaker system being used, from a cinema sound set-up to a pair of earphones. Soundscape, developed by d&b audiotechnik, is a system using sonic objects that can also simulate different acoustic environments. Soundscape is targeted specifically at live performance; it can place up to 64 sonic objects in three-dimensional space relative to the listener, aiming to align the sound's position with it's visual position. Soundscape has been used on the 2022 production MJ the Musical, a jukebox musical featuring the music of Michael Jackson. The system both ensures the sound heard through the speakers is spatially aligned with the performers on stage, and emulates various acoustic spaces for different scenes, as Jackson performs in different venues from an intimate club to an enormous stadium.

The story of spatialised sound began in the 1880s. Now, in the early 21st century, new technologies and new methods are giving theatre-makers ever-greater scope to position sound in space, extending the kinds of sonic experience they can offer audiences.

Top: Dolby Atmos studio

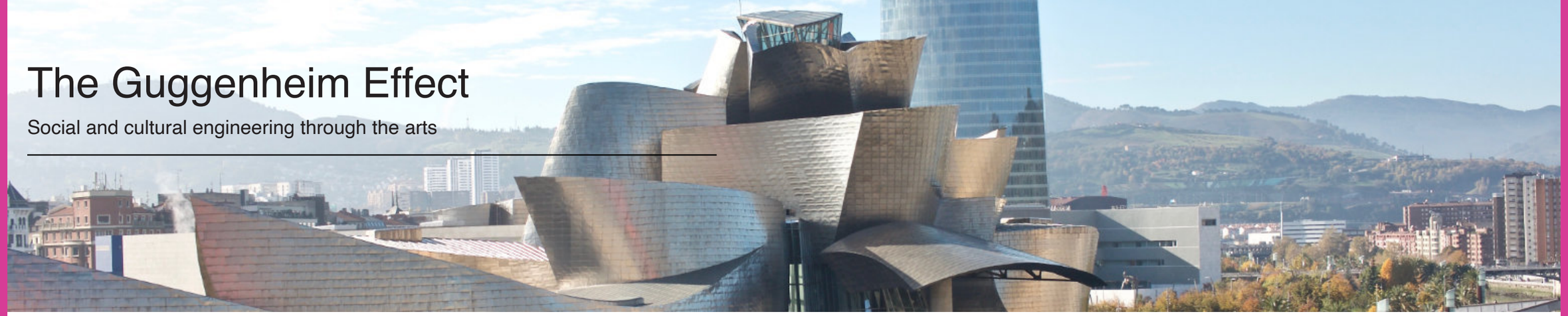
Below left: Dolby Atmos system

Below right: Pink Floyd's Azimuth Coordinator



The Guggenheim Effect

Social and cultural engineering through the arts



The Guggenheim Effect is named after the 1997 Guggenheim Museum, Bibao, Spain, where the museum helped transform the fortunes of the city. Prestigious performing arts centres and opera houses have since been built in the hope of re-evoking the effect.

A single building can change an entire cityscape. Frank Gehry's Guggenheim Museum put Bilbao on the world map, and was pivotal in the transformation of the northern Spanish city from a post-industrial conurbation in decline to a prosperous centre for the service industries. The museum was the first of a series of cultural, commercial and infrastructure developments, and such was the impact of the developments the Museum triggered, the phrase Guggenheim effect, or Bibao effect, has come to describe the influence of any new cultural centre that transforms its location.

Other cultural developments have attempted to trigger the Guggenheim effect: the Elbphilharmonie in Hamburg, by Herzog/de Meuron; the Taipei Performing Arts Center, by David Gianotten and Rem Koolhaas; the Peking Performing Arts Center, by Paul Andreu; the Grand Theatre Tianjin, by gmp; and the Grand Theatre Guangzhou, by Zaha Hadid. These developments have four factors in common:

- a central location
- they are near bodies of water
- they have innovative, but often less functional (or even impractical) architecture…
- …which is both provocative and spectacular.

These factors also apply to the *Operahuset* –the Opera House in Oslo, and Norway's most important performing arts centre (Q10937). It is a 21st century opera house, having opened in 2008 and designed by the Norwegian architectural firm Snøhetta. Its architecture aims to combine the urban landmark, an opera house with the character of an urban monument, with an integration with nature. The roof of the building rises from ground level, forming a slope that is accessible to the public. The building is clad entirely in white Carrara marble and glass, completing the intended effect of an iceberg emerging from the sea of the Oslo fjord. Interior surfaces are covered in oak to bring warmth to spaces in contrast to the coolness of the white exterior, while the main auditorium is illuminated by a large oval crystal chandelier – all contributing to the feeling of a modern but opulent space.

The building itself is not only a home for the performing arts, it is also an artwork in its own right, and hosts visual artworks inside and out. *She Lies* is a sculpture constructed of stainless steel and glass panels by Monica Bonvicini, floating in the fjord, moving in response to tides and wind. A perforated wall panel in the lobby was designed by Olafur Eliasson, featuring hexagonal openings and illuminated from below and behind to create the illusion of melting ice. The main stage curtain is the work of Pae White who designed it to look like crumpled aluminium foil.

The curtain from wool, cotton and polyester with a three-dimensional effect was manufactured by the German-based theatrical equipment company Gerriets GmbH, and measures 23m x 11m and weighs 500kg.

Plans for the opera house began in 1989, when the Norwegian Opera initiated a study to consider the creation of an independent opera house in Oslo. After the plans for the opera house were presented, there was an intense and time-consuming public debate about whether an opera house should be built in the city. Critics pointed to the level of costs, needs and architectural expression of the building, and this debate has continued after the building was started and opened.

The public, on the other hand, has embraced the theatrical and operatic event. The Oslo Opera's attendance numbers have increased significantly since moving into the new opera house, to the point where all performances are sold out at the beginning of the season. The public and urban character of its architecture has also attracted many visitors who want to see and walk on the roof of the building, which invites pedestrians to climb up and enjoy the panoramic views of Oslo. The roof has also been the venue for several outdoor events, and the Oslo Opera House has won the culture award at the World Architecture Festival in Barcelona in October 2008, and the 2009 European Union Prize for Contemporary Architecture.

It has long been understood that cultural development can help underpin economic and social development. The Guggenheim effect is named after the Museum in Bibao that had a far greater impact than had been anticipated, and which governments have sought to repeat since then – sometimes with success, and sometimes not. Despite early criticisms, the Oslo Opera House has proved popular with audiences, locals and tourists, though whether it has in the end been value for money is a more subjective judgement.

Above: The Guggenheim Museum in Bilbao, Spain

Below and left: the Operahuset, Oslo, Norway

Virtual Stages

Immersive technologies and hybrid spaces

With the rapid growth in the third decade of the 20th century of technologies for virtual (immersive) and augmented (hybrid) realities, theatre has available many new, virtual stages.

In *Theater als Zwischenreich*, Richard Alewyn wrote, 'So this is the material the world of the stage is made of: a mixture of reality and appearance' (1989). Theatre has always been a place for creating fantastic stories, a retreat, and a place of longing at the same time. As 'world builders', theatre-makers enable their audience to visit diverse places and travel through time to the future and the past. In theatre, different forms of narration are continually being re-explored and reinvented, in a constant interchange with new technologies, inventions and spatial arrangements. Accordingly, new technologies such as virtual and augmented reality (VR and AR, kinds of mixed reality) are not to be understood as 'new' technologies: theatre itself has a long tradition of being an immersive medium.

The medium of virtual reality – like theatre – holds great potential for experience through the interaction of different disciplines (film, literature, music, scenography, architecture, visual arts...). By putting on VR glasses, one steps out of ones immediate environment and shifts ones presence into a digital world, into a new reality. This complete dive into the virtual experience is called immersion. The gap that is created in most narrative formats by the viewing distance between the user and the experience is eliminated. Virtual reality enables a multitude of shifts in perspective, whether by embodying different characters or 'roles', or travelling to other times or to inaccessible places and situations. Physical laws and social conventions can be suspended: spaces can not only be entered but also flown through; leaps in scale become possible, the viewers themselves become actors.

Augmented Reality works differently: it is a mixing of reality and digital content, each enriching the other. The theatre has been familiar with this effect for a long time: in 1862, a ghost magically appeared on a stage and triggered a veritable illusion hype: the Pepper's Ghost effect (B.05, Q305). The method of enriching the visible stage action with immaterial content is exactly what happens – figuratively speaking – when using augmented reality: the overlaying of reality with digital content. The potential of augmented reality lies in its fusion with our directly experienceable environment, so the city is also a stage.

Spatial Encounters, *bydigital.DTHG*

Mixed Reality technologies open up completely new kinds for audience experience and artistic approaches. Digital theatre artists like the Cyberräuber with their dance experience *Things Fall Apart* or Raum+Zeit with their Brecht experience *Berlau: Königreich der Geister* explore the possibilities for Virtual Stages. AR installations such as Evelyn Hriberšek with *EURYDIKE*,or Nico and the Navigators with their *Verrat der Bilder*, show that those new realities have to be understood as an own artistic medium – and not as a substitute or supplement.

To explore the possibilities of these new realities, the research project Im/material Theatre Spaces by the German Theatre Association DTHG (Q19499) gives some useful examples. In the hybrid-real stage performance *Spatial Encounters*, developed by the digital.DTHG Team in 2021, explored the possibility of the audience co-creating the performance in a hybrid-real stage setting. In an open space of about 150 square metres, audience members (up to 9 VR users) were immersed in a virtual scene, which was then designed, made and experienced together for the next 20 minutes. They moved freely in these digital landscapes and generated visual effects and sculptures through their encounters and spatial relationships. The resulting immaterial spatial bodies and virtual sceneries were musically interpreted live. At the same time, the musicians themselves gave stimulating impulses and moods to the performative interplay. Through these diverse interactions, the shared experience in virtual space becomes a catalyst for a co-creative process of creation, at the intersection of analogue and digital worlds.

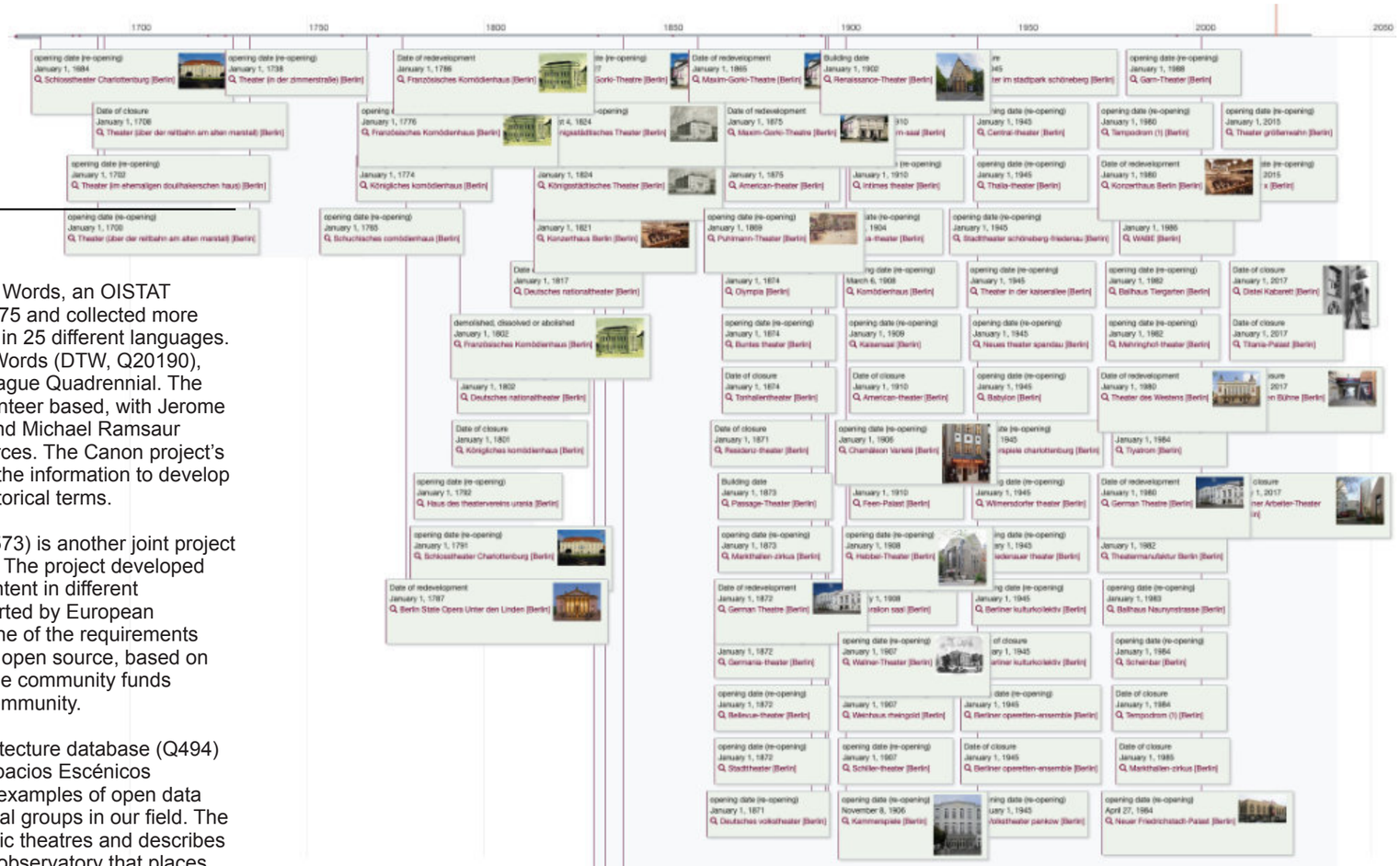
As well as being the medium through which an audience experiences a performance, virtual and augmented reality can also serve as tools for the production process. Theatres have experimented with virtual 'Bauprobe' (Q30656), in which stage designs can be developed and discussed virtually, or the future renovation process of a theatre building can be discussed online in a shared virtual space. Immersive technologies can also give access to im/material cultural heritage. With the virtual reconstruction of the Große Schauspielhaus, Berlin (Q9256), users can experience 3 different stories while 'walking' through the reconstructed building in 3D, and see historic theatre objects such as the cloud machine (Q30496) in action.

The arts have always been the impetus and source of inspiration for the development of new media technologies – and the arts, conversely, see new technologies as a space of possibility for the development of new forms of expression and design. Immersive and hybrid realities have become our new, virtual, stages.

Virtual reconstruction of the Große Schauspielhaus, Berlin

What is Ours is Yours

The CANON database and open sources



The Canon project builds on previous research and resources relating to the history of technical theatre. More than that, it continues a significant tradition of sharing information and ideas, based on principles of mutual support and cooperation.

Open knowledge is knowledge that is free to use without restrictions. The starting point is that knowledge is a common good that belongs to everyone, and that sharing knowledge benefits everyone.

Even if open source, open knowledge, crowd sourcing and similar concepts seem to be recent phenomena, in reality their history dates back to, for example, the *Encyclopédie, ou dictionnaire raisonné des sciences, des arts et des métiers* of Denis Diderot in the 1750's (Q30590). He allowed re-use of his work in return to him having material from other authors. In the 1950s and 1960s, much computer software was open source, and the early days of the internet in the 1990s gave the movement a boost. The start of Wikipedia in 2001 gave it a visible face to the world. In the same year Lawrence Lessig and Eric Eldred designed the Creative Commons License (CCL) because they saw a need for a license between the existing modes of copyright and public domain status. Version 1.0 of the licenses was officially released on 16 December 2002.

Within the theatre technical field, sharing information is crucial. Most professional organisations like OISTAT (Q30470), STEPP (Q92) and others have in their mission statements such as 'to stimulate the exchange of ideas and innovations', 'to share knowledge', 'to encourage life-long learning', 'Informing our members', and so on. Often the sharing is more informal between members, but some collaborative projects have received international recognition.

One example is Theatre Words, an OISTAT project that started in 1975 and collected more than 2000 theatre terms in 25 different languages. In 2011 Digital Theatre Words (DTW, Q20190), was presented at the Prague Quadrennial. The project was entirely volunteer based, with Jerome Maeckelbergh (Q758) and Michael Ramsaur (Q30592) the leading forces. The Canon project's Canonbase has reused the information to develop a taxonomy and add historical terms.

The ETTE project (Q30573) is another joint project that is Open knowledge. The project developed basic safety learning content in different languages. it was supported by European Erasmus funding, and one of the requirements was to publish results in open source, based on the principle that what the community funds should go back to the community.

The EUTA Theatre Architecture database (Q494) and Observatorio de Espacios Escénicos (Q30593) are two other examples of open data generated by international groups in our field. The first lists important historic theatres and describes them. The second is an observatory that places the theatres on historic maps.

The Canon of Technical Theatre History project started in 2019 and builds further on this tradition. The project developed one hundred stories that reflect the main turning points of the technical theatre history, a series of tools to be used in education, a set of inspirational methodologies for teaching, and a network of interested parties in heritage and history of technical theatre. All this information is gathered in a database that is called Canonbase. Everything developed in the project can be reused by anyone without restrictions.

The Canonbase integrates and safeguards information from different open sources and makes collections accessible that are otherwise hard to find. It links the information together so new relations become visible and the information is enriched with source documents. Moreover, it visualises the information by means of timelines, maps, trees and word clouds. The project also created new information by researching in depth the information gathered in the database.

The information is structured in an open data format, so it can be reused by querying the database or exported after the project to the world-wide Wikidata platform. The project setup and methodology guarantees that research from both teachers and students feeds back into education and to the wider professional field. The results can be used by local stakeholders, which reinforces the link between the local community and the educational field. The network that originates from this cooperation guarantees future development and sustainability of the results.

After the project the Canonbase will be used as a collaborative platform where researchers can put their raw research information and link it to the results of others, enriching the common knowledge base. At the same time, it can be used to crowd source information based on a growing network of volunteers and professionals.

Because 'What is Ours is Yours' and 'every day there is one day more of history'.

'every day there is one day more of history'

It's All Data

Digital Working Methods

Digital technologies have radically changed almost all human activities, including how theatre is made. Many production processes are greatly assisted by digital technologies and workflows.

Making theatre is a collaborative process – people must work together to make the performance happen. The largest productions require hundreds of people, organised into many different departments, to all work together towards the same goal: the moment of performance. This work requires the communication of information, and often requires the archiving of information for future use. In the first two decades of the 21st century, digital working methods have become central to the creation, distribution and recording of the information needed to make a performance happen.

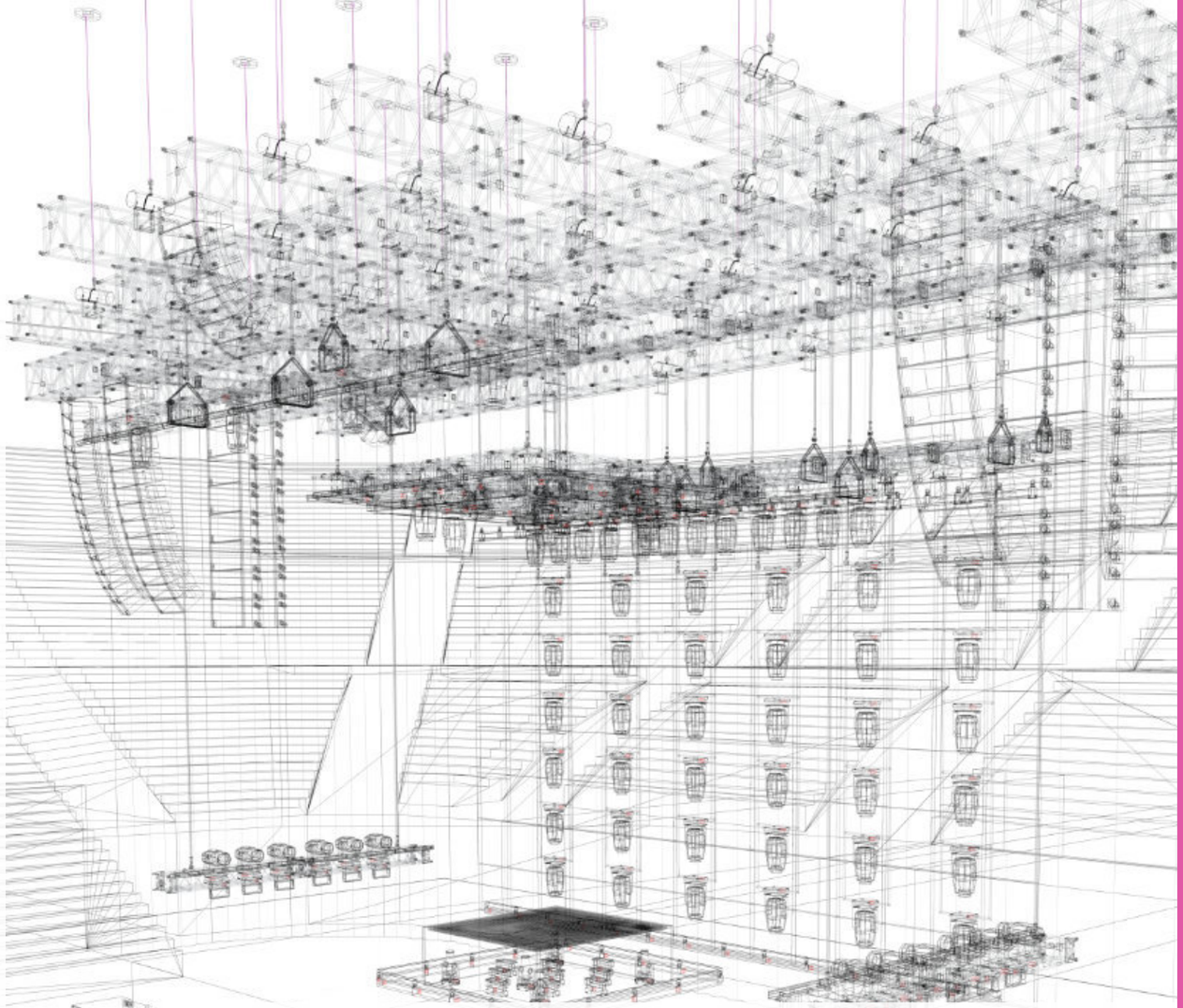
One of the first digital working methods to be adopted in the theatre industry was computer-aided design (CAD) – the use of computers to aid in the creation, modification, analysis, or optimisation of a design. Starting in the 1960s, when computers were still very expensive and difficult to use, early CAD software provided an alternative to hand-drafting for technical and construction drawings. Initially adopted in engineering and architecture, as CAD became more readily available it began to be used by theatres for the construction drawings from which scenery was built. The advantages were considerable – repeated elements could be duplicated with a couple of mouse clicks, and updates didn't need the whole drawing to be redone. Different information could be put on layers, so that different users could see what they needed, and hide the rest. Modern CAD software can work in 3D, making it easier to check that parts fit together, the set fits into different theatres for a tour, and to visualise the end result. CAD can also produce bills of materials, calculate weights, and create other data about what has been designed, saving time and reducing errors. Most recently, CAD has become CAM – computer aided manufacturing – whereby CAD drawings can directly control machine tools, for example to cut complex shapes out of sheets of plywood with speed and accuracy.

At an earlier stage of the set design process, many designers now build digital models of the scenic design, either as well as or instead of the traditional card model. 3D modelling tools allow rapid changes during the ideation phase, so many different ideas can be tried out quickly. Rendered versions of these models can show surface finishes and give an approximate idea of how the production will look. With a digital model of the theatre building, sightlines can be tested, and technical issues checked.

Lighting design has followed a similar path, with designers starting to use CAD to draw lighting plans in the late 1980s. Originally, lighting design packages were 2D, and focussed on reproducing the earlier, hand-drawn plans, together with some data management such as generating fixture lists. In the mid-1990s, the Canadian company CAST developed WYSIWYG – a 3D modelling tool that could show what the lights were doing in real-time. Initially it could only display a wireframe view of the lighting, but the technology developed, and today it is possible to visualise the entire lighting rig in a realistic way, while programming the show in a virtual model of the venue.

Lighting visualisation has combined with other departments and processes. At the Royal Opera House in London (Q7853), the visualisation studio is used not only for lighting, but also to plan complex scene changes, involving lighting, sound, video and stage automation. Video departments have developed their own workflows, using tools such as Disguise to plan complex video designs. Virtual projectors can be placed in a digital model of the performance space, so that screen sizes, lens choices, and so on can be planned. The same tool is then used as a media server to run the show during the performance, generating live the video feeds to the projectors.

Sound design also makes use of digital models, which can emulate the acoustics of the space, and calculate loudness levels based on the planned speaker layout. This can help ensure all members of the audience get high quality sound, as the sound designer intended it. Technical issues such as cabling, the number and type of amplifiers, rigging weight loads, and so on can also be worked out.



Digital technologies have not only brought a revolution in how we can model and visualise the production, they have also transformed how we communicate. Email, file sharing platforms, video conferencing, instant messaging, budget spreadsheets, Gantt charts and satellite navigation systems are now all part of the toolkit of theatre professionals. Challenges remain, however. Communication between departments, or between companies, is not always seamless. Software incompatibilities, and different standards and protocols, can cause breakdowns in communication or – worse – errors that are only discovered on stage, in the final days before performance. Fields such as film, computer games and architecture have established, industry-agreed workflows, to ensure a smooth and accurate flow of information without misunderstandings. Theatres, especially those working at the largest scales involving touring and co-productions, would benefit from such a system.

While the fundamentals of theatre performance remain the same – people gathering in a room to share an experience in real time – digital technologies have radically changed the way theatre makers work together to create the performance.

Sharing Safe Practices

The international ETTEC safety passport

Building a culture of safety requires a shared understanding of safe working practices. In the highly international theatre and live event industries, the ETTEC safety passport provides a way to test and certify a common standard for safe working.

The ETTEC (Q30573) safety passport is a certificate that proves that a professional can work safely on stage or in an event environment. The Passport reflects the vision that safety is a way of life. Everyone on stage, from stagehand to project manager, should be able to behave safely, understand the mechanics behind working safely and develop a critical safety mindset. Unlike other safety courses, the ETTEC safety passport focuses not on legislation but on competence, on mastering safe working practices. It is about 'being able' rather than 'knowing'.

The origin of the project lay in an informal meeting in the side-lines of an OISTAT (Q30470) gathering during the Prague Quadrennial. During the discussion the people present came to the conclusion that it was hard to prove that a worker, coming from another country, was able to work safely. To their surprise, they realised there was a lot of information on high level safety and safety management, but hardly any definition or concrete text on what it means to work safely on a basic level. And so the project was born.

The passport was developed in a Erasmus+ European project (September 2014 to August 2017), led by DTHG (Q19499) and with VPT (Q30569), OSAT (Q30570), STTF (Q30571), STEPP (Q92) and RITCS (Q13001) as partners. The passport indicates that the employee has demonstrated that he can work safely, tested through a practical standardised international assessment. Based on the input of a wide group of stakeholders, the partners wrote a set of ten competences that were later proposed to the European ESCO (Q30572) database:

- Working with respect for your own safety.
- Contributing to a safe and sustainable working environment.
- Working ergonomically.
- Use personal protective equipment.
- Fire prevention in a performance environment.
- Safe working at height.
- Working safely with mobile electrical systems under supervision.
- Working safely with tools.
- Working safely with chemicals.
- Fitting up and rigging stage equipment.

These competences were further described in a sectoral layer, with detailed description of skills knowledge and attitudes that can be used for education, training and assessment. The project went on to develop a student's handbook and an extensive teacher's manual in English, German, Dutch and Swedish (Q30577).

Finally, the partners also developed a practice-based assessment procedure that guarantees objective and independent measurement of candidates for the passport in different countries. It consists of a practical test in a simulated environment. A candidate is led through a series of real-life situations that contain typical risks that occur in an event or theatre context. Two assessors observe the candidate's behaviour and decide at the end if they are able to work safely on stage.

The assessors are trained, certified and accredited to carry out the tests by an international consortium. They work independently from the assessment centres to ensure their objectivity and independence in judging the candidate. The validity of the certificate is based on mutual recognition, each assessment centre recognises the certificates of the other centres, making it, *de facto*, an international certificate. The assessment centres all use the same occupational standards and quality procedures, and safeguard collectively the quality of assessment. In this way they can be sure that a certificate delivered by another member of the scheme has the same value as their own.

The content of the project is published under a Creative Commons 'Attribution-NonCommercial-ShareAlike' licence. This means that everyone is allowed to use or translate it for free. It has been translated in Finnish, Russian and Chinese. In 2021 the Flemish social fund for the performing arts developed an online training based on the passport content.

In 2019 the partners founded a new organisation called ETTEC (Q30573) to coordinate the continued activities. The mission of this association is the mutual recognition of certificates and qualifications in the field of live performance and entertainment between the member organisations. Aside from the founding members, IGVW (Q30574) and Metropolia (Q30576) have also joined. The organisation wants to extend the mutual recognition to other certificates. To reach this goal, they are working together with different projects and organisations in the field(s) of event and technical theatre.

Above: demonstration of the European safety certificate during Stage Set Scenery, Berlin.

Below: training assessors in Cologne.

Learning to Say No

The Love Parade disaster and the identity of technicians

The Love Parade, Duisburg, 2010

The Love Parade disaster in Duisburg, Germany led to the deaths of 21 people. Many factors contributed to this tragedy, and the many others like it; how do technicians and other theatre professionals learn to say 'no' when it is necessary?

The Love Parade was a popular electronic dance music (EDM) festival and 'technoparade' that originated in 1989 in West Berlin, Germany. It was held annually in Berlin from 1989 to 2003 and in 2006, then from 2007 to 2010 in the Ruhr region, sometimes attracting over 1 million people. The event was not without problems: in some years the organisers failed to get the necessary permits, there were complaints about the behaviour of people attending, and the lack of proper facilities for them, such as toilets.

The 2010 The Love Parade in Duisburg took place on 24 July, with between 200,000 and 1.4 million people reported to be attending the event. Admittance to the festival grounds was supposed to begin at 11am but was deferred until around 12 noon. There was only one main entrance to the festival area, a ramp reached from a 240m long tunnel and several underpasses. The crowd, unable to enter the festival, kept pushing into the confined space, despite being told by the police by loudspeaker they should turn back. The result was a crush in which 21 people died from suffocation, and a further 652 people were injured.

None of the organisations or officials involved took any blame for the disaster. The organiser of the festival, Rainer Schaller, said the police had not managed the crowd control correctly, while the interior minister of North Rhine-Westphalia said the blame lay with Schaller and his company Lopavent and its staff, for not putting in place the right security measures. Later, the mayor of Duisburg, Adolf Sauerland, admitted he had misled the public regarding the number of people expected to attend the event – the claimed 1.4m turned out to be less than 250,000.

Criminal charges were brought against ten employees of the city of Duisburg and of the company that organised the event, but they were eventually rejected by the court due to the prosecutors' failure to establish evidence for the alleged acts of negligence and their causal connection to the deaths. After years of investigation and many days of trial, the proceedings were dropped in May 2020. The court found the area was not suitable for the Love Parade 2010; none of the ten defendants were sentenced.

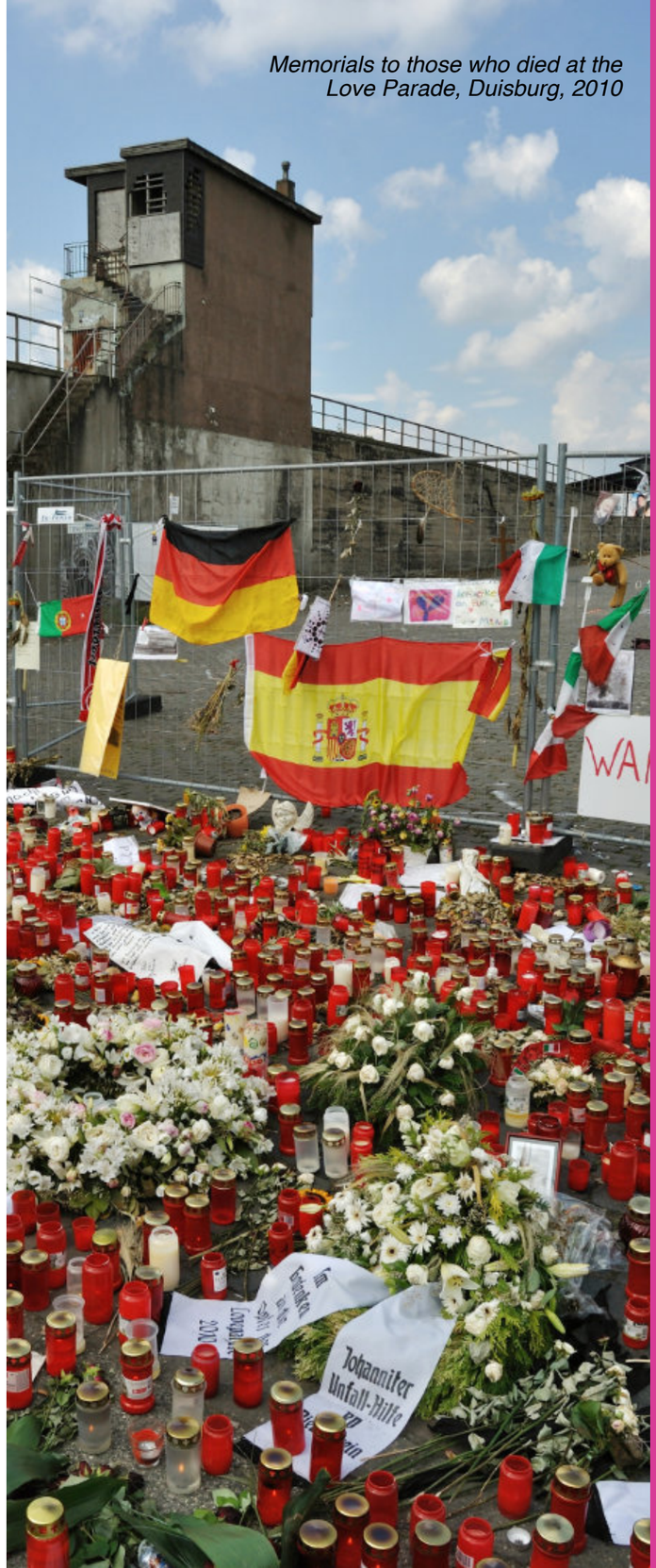
The Love Parade disaster is just one of many occasions where safety planning has failed, and these incidents are not new: more than a century before the Love Parade disaster, a similarly large-scale tragedy occurred, the fire at the Vienna Ringtheater in 1881, claiming 384 lives. A gas light failed to ignite, and when it was relit there was an explosion, spreading fire rapidly backstage, then to the stage and auditorium (J.05). The following year, the so-called Ringtheater trial took place. All accused municipal employees were acquitted, while three theatre employees, the theatre director and two technicians, were sentenced to prison terms of between four and eight months and partial payment of damages. The director was released by imperial pardon after only a few weeks in prison, but the stage technicians remained in jail.

Beyond the specific failures that led to each of these disasters, they can teach us something else. Technicians, production managers, designers, and all those who are involved in planning and delivering an event or show are the 'yes' people – the people who make things happen. When there is not enough time, not enough money, not enough people, they do the apparently impossible to delight, amaze and move an audience. This is their professional identity: that they quietly and without fuss produce the magic, night after night. It is what audiences, directors, producers, city officials, and many others want and expect. And yet this identity, as the 'yes' people, sometimes comes into conflict with another identity, as the people with the knowledge and expertise to know when it is necessary to say 'no'.

Saying 'no' can be hard. It is doubly hard when your whole identity is about saying yes. How can we learn to do better, perhaps even to prevent the next tragedy? Firstly, we must continue to vindicate the figure of the professional by learning to say no when you yourself, as a professional, know that the safety processes are not being complied with. Secondly, we must recognise that saying 'yes' comes with a lot more than we perhaps are able to see – the reason we say 'yes' may be because we want to perform well, please the people we work with, and avoid conflict, rather than because it is the right answer.

Thirdly, and perhaps most importantly, we need to recognise that it is not our responsibility to carry alone. The people we are saying 'yes' or 'no' to, also carry responsibility, especially when they have more power than us. They have a responsibility to listen, to recognise the 'no' that they may not want to hear, that may lead to great difficulties, is still the correct answer and must be listened to. We must try to teach them this truth.

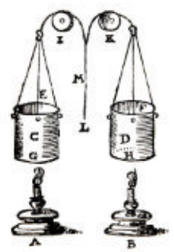
The identity of technicians arises from a long history of practice within the theatre industry. By under-standing that history better, we can perhaps strive for a professional identity that is able to say both 'yes' and 'no' at the right times, and for our voice to be listened to by those who need to hear it.



Memorials to those who died at the Love Parade, Duisburg, 2010

Not the End

“Every day, there is one more day of history…”



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