

Nothing is New, Even If It's Just Been Invented

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Abstract

“New technologies” are often hyped as unprecedented inventions, but they do not appear out of nowhere. The Canon Project mapped historical-technical information through open data concepts that are structured and visualised in a thematic, collaborative, open data platform called Canonbase. For four selected cases that are representative of modern technology, we trace back their (conceptual) history and discover that the “inventions” are in fact a slow process of improvements that often start back in the Industrial Revolution.

These “inventions” often respond to a need, a desire that is significantly older. One wants the audience to participate in a live experience without being physically present, to change the scenic environment on the spot, to show the un-showable. These concepts have been tried throughout history, but did not succeed at the time. Often the technology was not ready to fully develop the concept, the world and society were not ready for the concept or got bored because of the limitations, or other more exciting inventions or events crossed paths, with the result of the idea “dying”. But later the concept is picked up again with success. These successes are then hyped as “new technologies”.

Even with the sample of cases being limited, the results show the importance of understanding historic technology, on the one hand, and understanding the needs and desires of theatre makers and the audience on a conceptual level, on the other, to develop new technologies.

Keywords: Canonbase, performing arts, innovation, Industrial Revolution, live streaming, théâtrophone, Pepper’s ghost, 3D projection, moving lights, projection mapping

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The second Industrial Revolution, from the second half of the 1800s to the First World War, was a major turning point in theatre technical history. Structural steel gave the possibility of creating larger spans and lifting heavier weights. Electricity provided new (and safer) ways to create and control light. Drive systems (motors), be it hydraulic, pneumatic or electromechanical, created opportunities that continue to inspire inventors to develop new ways of creating dynamic effects.

High points in this era are the World Exhibitions, events where different new inventions and uses were presented to a worldwide audience. The arts, and specifically theatre, played an important role in these events, showcasing the technical innovations of the moment. This created a boost in innovation, based on the interdisciplinary exchange of knowledge and new insights.

We trace the origins of four examples of historic concepts and inventions that transformed into “new technology”, showing in the sideline that history needs to be studied, not only for the sake of history, but also as a drive for innovation.

Live streaming

Live streaming is seen as one of the achievements that follow from the inception of the internet. We can define streaming as the continuous transmission of audio or video from a server to a client. Live streaming is then defined as the streaming of video or audio in real time or near real time. Within the computer era, it is generally accepted that the first streaming was the “Trojan Room coffee Machine” at the University of Cambridge in 1991 (Stafford-Fraser, n.d.), a practical solution to avoid people going to the coffee room and finding an empty coffee pot.

But, in reality, the concept is about a century older and was seen as one of the first potential applications of the telephone. The Lille newspaper *Le Gaulois* reported a first attempt by Pierre Giffard, a scientific contributor to it, M. de Bar, an electrician interested in telephones, and Émile Marck, the theatre manager, as early as 1878. They connected the theatre and a private house with a telephone cable, bridging a distance of 40 m (Nibart, 2011: 191).

In 1881 inventor Clément Ader presented his “auditions téléphoniques” at the 1881 International Exhibition of Electricity in Paris. The Opéra Garnier and the Comédie-Française were connected by telephone lines to two listening rooms in the Industrial Palace of the exhibition. Up to 40 people could listen to a “streaming” of the performances. It was considered a great success and one of the key elements of the exhibition (Société des études du Comminges [Saint-Gaudens, Haute-Garonne], 1927? 1928?: 108). The system worked only at limited distances, within the perimeter of the city, due the lack of amplification systems for telephone lines.

In *La Science au Théâtre*, A. de Vaulabelle and Ch. Hémardinquer describe the théâtrophone as follows: “The théâtrophone is, as its name

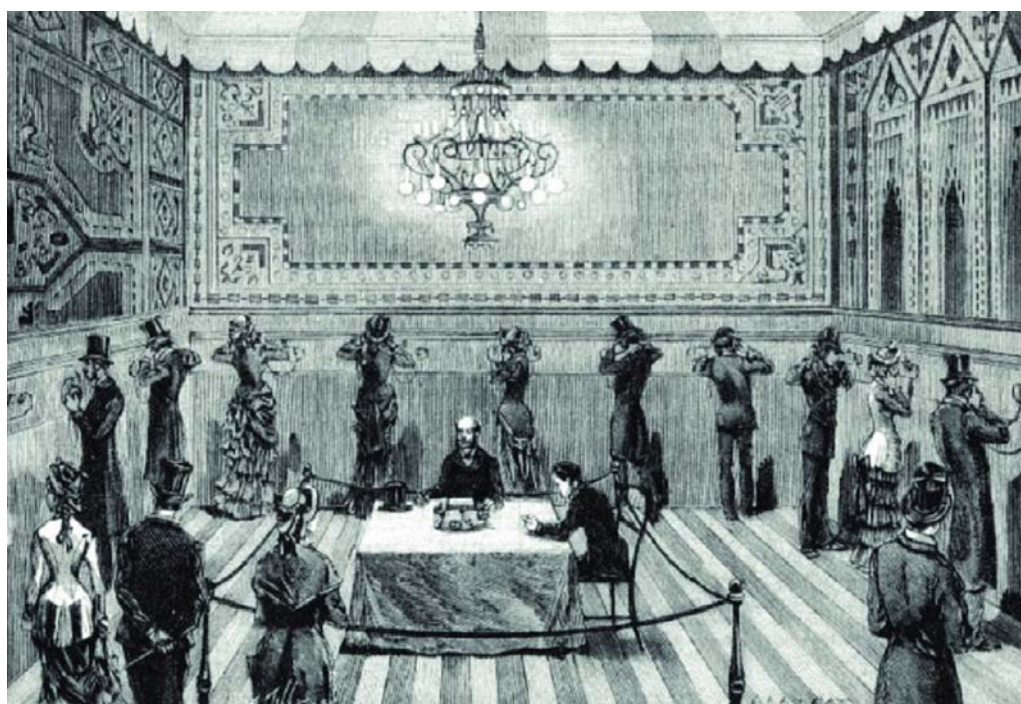


Figure 1. Listening rooms in the Industrial Palace, 1881 (retrieved from *La Nature*, no. 434, 24 September 1881, p. 257).

suggests, an application of telephony to theatrical auditions. It was in 1881, at the Electricity Exhibition at the Palais de l'Industrie, that the first experiences of this kind were carried out, to the great surprise and satisfaction of the public"¹ (De Vulabellé and Hémardinquer, 1908: 100; author's transl.).

With the théâtrophone, Ader created the first binaural immersive listening experience, the first stereo sound experience. The system used two microphones positioned left and right of the prompter's box. The listeners would receive the sound using two earphones. T. du Moncel describes the stereophonic effect as follows:

The sounds literally moved from one ear to the other, depending on the volume perceived on each side. As in a concert hall, each listener had a different experience of sound. Given that each microphone on stage supplied sound to a limited number of headphones, listeners listening simultaneously to the same piece did not necessarily share the same auditory perspective of the stage (Drie, 2019: 14; author's transl.).

And in an article in *Le Temps* he describes the experience as immersive:

As soon as two telephone receivers were placed to his ears, it seemed as if he were suddenly transported to the very stage of the Opera. By closing his eyes, the illusion was complete; one believed oneself to be attending the performance itself, to hear Lasalle sing, the illustrious Krauss, to hear the chords of the orchestra and the applause of the audience (Drie, 2019: 18; author's transl.).

Similar experiments were conducted in Berlin, Bordeaux and Oldham (close to Manchester) in 1881, and in Charleroi in 1884. In the same year the "Chalet Royal"² in Ostend and the Royal Palace in Laeken (near Brussels) were connected with the Brussels Théâtre de la Monnaie (Lefevre, 1894: 322) (Author's transl.).

At the 1883 International Colonial and Export Exhibition³ in Amsterdam a similar system was presented that would transmit music from several places in the city to a listening pavilion at the fairground. *The Journal of the Electrotechnical Association* in Vienna describes the system in great technical detail in the August 1883 issue:

In the listening pavilion 200 phone sets were foreseen, later reduced to 160 because of lack of space. In three existing theatres 10 to 12 microphones were installed: the Theater Frascati near the Plantation, approx. 3,500 m away; the Palais voor Volksvlijt, a garden concert in a music temple open on all sides, approx. 2000 m away.; and the Panopticum, distance approx. 3,000 m. A fourth space was rented, where a quartet of four musicians played two woodwind and two metal wind instruments, performing smaller or longer pieces throughout

1. Le théâtrophone est, comme l'indique son nom, une application de la téléphonie aux auditions théâtrales. C'est en 1881, lors de l'Exposition de l'Électricité au Palais de l'Industrie, qu'ont été faites les premières expériences de ce genre, à la grande surprise et à la vive satisfaction du public.

2. The royal summer house.

3. Internationale Koloniale en Uitvoerhandel Tentoonstelling.

the day. The distance was about 7,000 m, of which about 1,000 m was submarine cable. The whole system was built according to the well-known system patented in all European countries by Emile Berliner, Chief Inspector of the American Bell Telephone Co. in Boston.

The position of the microphones and the control of sensitivity is explained in detail. The whole system is conceived to ensure a transmission “without suffering even the slightest loss in terms of transmission clarity or purity of timbre” (Berliner, 1983) (Author’s transl.).

For the 1885 World Exhibition in Antwerp a connection was made between La Monnaie opera house in Brussels to listening spaces in the World Exhibition and the Royal Palace in Laeken. To bridge the larger distances, the “système F. Van Ryselberghe” was used, which made it possible to transfer telephone signals through telegraphy lines, extending the distance that could be bridged (Verhelst, 2015).

But the théâtrophone was not limited to demonstrations of major companies. The entrepreneurial owner of the Café de la Paix on De Keyserlei avenue in Antwerp, a café with an orchestra, a mechanical dance organ, decided to use telephone lines to transmit the music to the Brasserie des Moines on Van Dyckkaai street in Antwerp, a coffee place he also owned, to attract a bigger audience. The system was promoted under the name Orchestrion Téléphonique (Verhelst, 2015).

The théâtrophone was exported as a concept and not necessarily as a ready-made product of the Parisian inventor. Experiments with the new telephone technology were happening everywhere at the same time. And each experiment led to a small improvement that was used again by the other inventors. Bit by bit, the length of the lines was extended and the quality of the transmission was improved by using new methods or reusing old ones (Bratishenko, 2023).

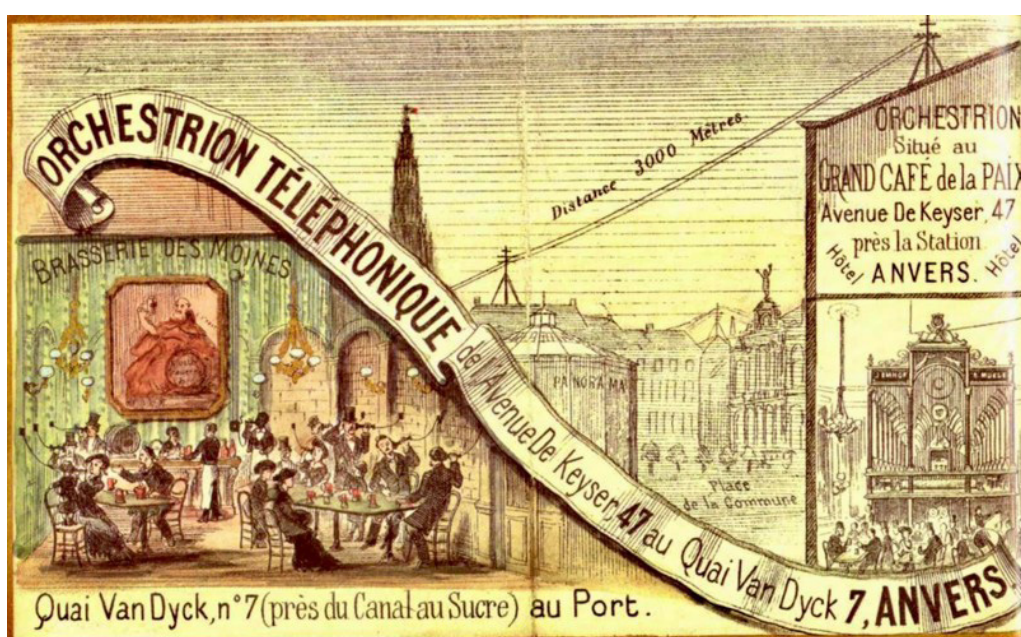


Figure 2. Publicity postcard for the orchestrion (Stroobants Collection, Antwerp - photo L. Lamberts).

When the king and queen of Portugal were mourning the princess of Saxony in 1884, they could not attend the premiere of the new opera *Lauriana* in the Lisbon opera. So an enterprising engineer from the Edison Bell Company installed a private system of six microphones onstage (*Scientific American*, 1884: 373).

In May 1887, the first telephone transmission of an opera performance took place in Stockholm. “The Stereophonic Théâtrophone connection was made between the Théâtre Royal (Opera House) and eight receivers at the recently opened telephone headquarters building. Directors of the telephone company could also benefit from the service in their homes” (Chronomedia, 2025). The service continued until the mid-1920s.

Later, the system would evolve to a news service. Callers could request “telephone news”. The operator would connect the caller to a pre-recorded phonograph, which would play a summary of the day’s news for the sum of 10 ören (Special Correspondence of The Eagle, 1915).

In 1887, a first international stereophonic théâtrophone connection was made between Paris and Brussels, allowing the Belgian queen to listen to *Faust*. The connection was repeated on a larger scale in 1888 between the Paris Opera and an audition booth in the cellars of the former 1880 Exhibition in Brussels. A try-out session with the opera *Les Huguenots* went very well, with perfect clarity of sound, but when guests were invited to listen to *Guillaume Tell* a few days later the quality was notably lower. This quality loss was attributed to the curiosity of “an employee who had diverted the current to his own benefit” (Lefevre, 1894: 324).

In 1889, Ader repeated the “auditions téléphoniques” at the Exposition Universelle de Paris with the addition of a system that allowed the audience to switch between different performances. In modern terminology, people could “zap” between performances.

In 1890, the Compagnie du Théâtrophone was founded in Paris by MM. Marinovitch and Szarvady. They commercialised Ader’s idea, broadcasting opera and theatre performances, and added short news bulletins to it. The system was fully developed, it was no longer a gadget, an experiment, but a desirable commodity for who could afford it (Wikipedia, 2025).

In 1893, Tivadar Puskás, a Hungarian who had previously worked in Edison’s laboratories in Menlo Park, developed the *Telefon Hírmondó* in Budapest, a telephone newsletter.⁴ Clients could call in to hear news bulletins that were updated hourly. Later, the service was transformed into a cable radio, delivering its own programmes, on their own dedicated lines (Bartolits, n.d.).

Already in 1892, the British National Telephone Company transmitted sound to the International Electrical Exhibition at the Crystal Palace in Sydenham from Birmingham, Manchester and Liverpool on the occasion of the International Electrical Exhibition. The Electrophone company was launched in 1895 in London. It stayed a popular service for over 30 years transmitting from theatres, concerts, and church services. (The church

4. Puskás demonstrated the “telephoned newspaper” in 1882 at the Paris Electrical Exhibition.



Figure 3. Lorgnette (retrieved from the Compagnie du Théâtrophone publicity folder).

microphones took “the form of a dummy bible lying in a natural position on the pulpit desk” as technical equipment was considered to be disturbing.) The service provided stereophonic sound over dedicated Electrophone receivers that came with twin “lorgnette” under-the-chin headsets to preserve hairdos and relieve arms (Bratishenko, 2023; Kitcher, 2021).

It is not clear if all connections used stereophonic théâtrophone lines. Mono signals only used half of the lines and could serve twice the number of listeners with the same amount of equipment. For as far as we know, the only permanent service dedicated to providing stereo music outside of Paris was London’s Electrophone.

The Compagnie du Théâtrophone launched a promotional campaign in *Tout Paris* magazine in 1911 for theatre at home. People who could afford it now could have their private listening device at home:

Theatre at home. To have auditions of: Opera - Opéra-Comique - Variétés - Nouveautés - Comédie française - Concerts Colonne - Châtelet - Scala, contact Théâtrophone 23, rue Louis-le-Grand, tel. 101-03. Price of the subscription allowing three people to have daily auditions: 60 F per month. Trial performances on request⁵ (Tobisch, 2023; author’s transl.).

The commercialisation of the théâtrophone and similar systems came with legal and copyright challenges:

Some composers and directors feared that the success of the théâtrophone would lead to a drop in theatre-goers. Others categorically refused to allow their music to be broadcast. Giuseppe Verdi filed a complaint with the Brussels court against the broadcasting service. The composer won his case in 1899, and obtained a ban on the broadcasting of his works (Bratishenko, 2023).

5. Le Théâtre chez soi. Pour avoir à domicile les auditions de : Opéra – Opéra-Comique – Variétés – Nouveautés – Comédie française – Concerts Colonne – Châtelet – Scala, s’adresser au Théâtrophone 23, rue Louis-le-Grand, tél. 101-03. Prix de l’abonnement permettant à trois personnes d’avoir quotidiennement les auditions : 60 F par mois. Audition d’essai sur demande.

It was a landmark decision in copyright law. Moreover, there was concern about possible inconvenience to actors, musicians and the audience, including what we would now call privacy infringements. Contracts between the Compagnie du Théâtrophone and the theatres, dating from 1889, state that the microphones may only be switched on when the audience is present in the opera house. The theatres demanded a fee for the transmissions and for the additional copyrights (what we would call now neighbouring rights) (Drie, 2019: 23).

The founders of the Compagnie du Théâtrophone negotiated exclusive rights to broadcast with the theatres. When business went slow, this became their main asset and a reason behind Radiola's acquisition of the Compagnie du Théâtrophone in 1923. With the acquisition, Radiola secured exclusive rights to broadcast the main theatre and opera performances (Drie, 2015: 75).

In the 1920s, the quality of services improved with the invention of tube amplifiers and more sensitive microphones but, at the same time, radio services improved and became more affordable for a larger audience. In 1923, Electrophone ended its services and in 1932 the Compagnie du Théâtrophone followed. Other companies transformed into wired radio services, delivering broadcasted programmes over dedicated lines or over the power grid. (And some of these would later transform into cable television services and even later to wired internet providers.) With this came an end to the early streaming audio services, until the internet provided new opportunities (Bratishenko, 2023).

3D projection

3D projection is a technique used to display three-dimensional (moving) images in a way they are perceived in a 3-dimensional space. This technique is often wrongly described as holographic. Holographic 3D projection creates 3-dimensional images using interference patterns and diffraction of light, which is an entirely different technique.

The result of a real 3D projection would be an image that is perceived in space, having three dimensions. This works fine with different techniques, unless there is a real 3D object interfering with it. In other words, a real 3D object should be able to penetrate a 3D projection while all three dimensions stay realistic. It should be possible for a real actor to stick his hand through the virtual object and one should see the hand moving within the object.

The technique is in fact not based on projection, but on reflection of a lit object on a transparent material. This reflection creates a distance, just as a reflection in a mirror does.

A first version of this technique was described in 1658 in *Natural Magick in XX Bookes* by John Baptist Porta a Neapolitane:

How we may see in a Chamber things that are not.

I Thought this an Artifice not to be despised: for we may in my Chamber, if a man look in, see those things which were never there; and there is no man

so witty that will think he is mistaken: Wherefore to describe the matter, Let there be a Chamber whereinto no other light comes, unless by the door or window where the spectator looks in: let the whole window or part of it be of Glass, as we use to do to keep out the cold; but let one part be polished, that there may be a Looking-glass on both sides, whence the spectator must look in; for the rest do nothing. Let Pictures be set over against this window, Marble statues, and such-like; for what is without will seem to be within, and what is behind the spectators back, he will think to be in the middle of the House, as far from the Glass inward, as they stand from it outwardly, and so clearly and certainly, that he will think he sees nothing but truth. But lest the skill should be known, let the part be made so where the Ornament is, that the spectator may not see it, as above his head, that a pavement may come between above his head: and if an ingenious man do this, it is impossible that he should suppose that he is deceived (Porta a Napolitane, 1658: 370).

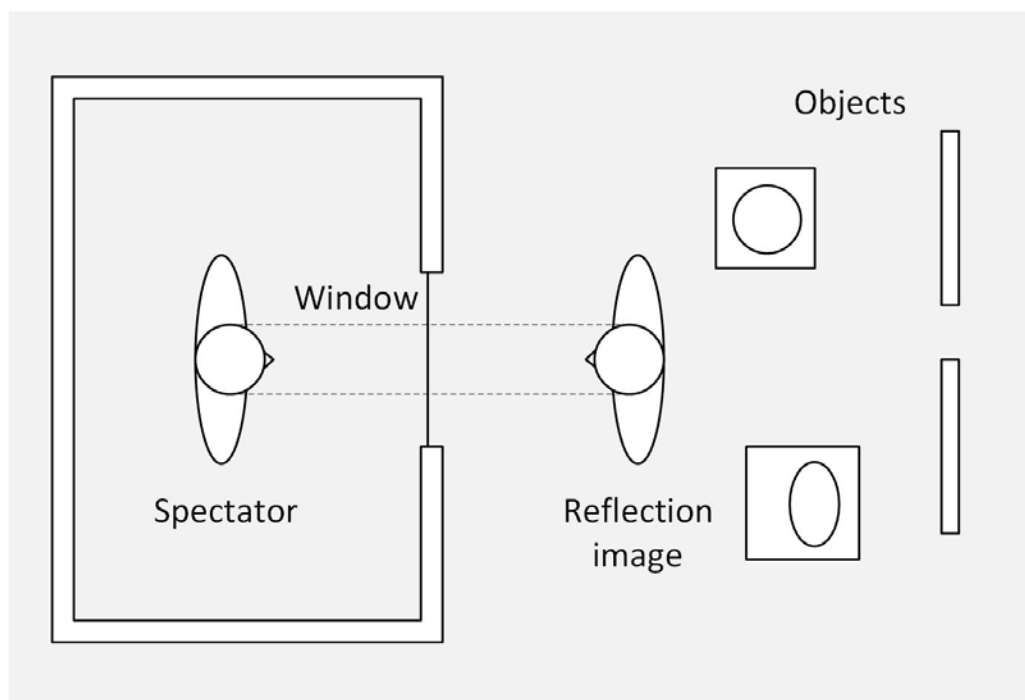


Figure 4. Porta's setup (author's drawing).

In this setup, the 3D reflection image was the spectator's own face, which shows the concept but is far from useful for performing arts. The next serious step in the development of a 3D projection is Dr. Pepper's ghost. In fact, there have been many predecessors of this effect. These predecessors were limited to demonstrations on scale or could only be used in limited circumstances. Professor Pepper developed the effect into a usable setting for performing arts and popularised it. He describes the whole journey of the ghost, including the development, the legal battles, and the original patent in a small book called *The True History of the Ghost and All About Metempsychosis* (Pepper, 1890).

Henry Dircks, who built a model, but came to the conclusion he would need to build an entirely new theatre to accommodate it in full scale, showed his results to Dr. John Henry Pepper. Pepper was at that time Professor of

Chemistry and Honorary Director of the Royal Polytechnic Institute, organising popular classes for very low fees in order to encourage working men to attend.

Pepper brought out the illusion in quite a different manner from that contemplated by Dircks, and so improved and simplified the ghost so that it could be shown in any lecture hall or theatre if sufficiently large to contain the necessary apparatus.

On Christmas Eve 1862, the first production, *The Haunted Man and The Ghost's Bargain* by Charles Dickens, took place with great success.

On 5 February 1863, Dircks and Pepper filed a patent for the invention of "improvements in apparatus to be used in the exhibition of dramatic and other like performances." The patent took a long time to be accepted because many competitors disputed its originality.

The principle of a Pepper's ghost effect is rather simple. In figure 6 we show the vertical version. The view of the audience is limited by black wings. There is a glass plate mounted diagonally on the stage. When the real actor is lit, the audience will see the actor through the glass plate. When we add light to the ghost actor, who is invisible for the audience, the ghost reflection appears at the same distance behind the glass plate as the distance between the ghost actor and the glass plate. As the distance between different body parts and the screen is different, the reflected body parts will also appear at different distances. This ensures the image seen by the audience is really three-dimensional and the real actor can walk through the reflected

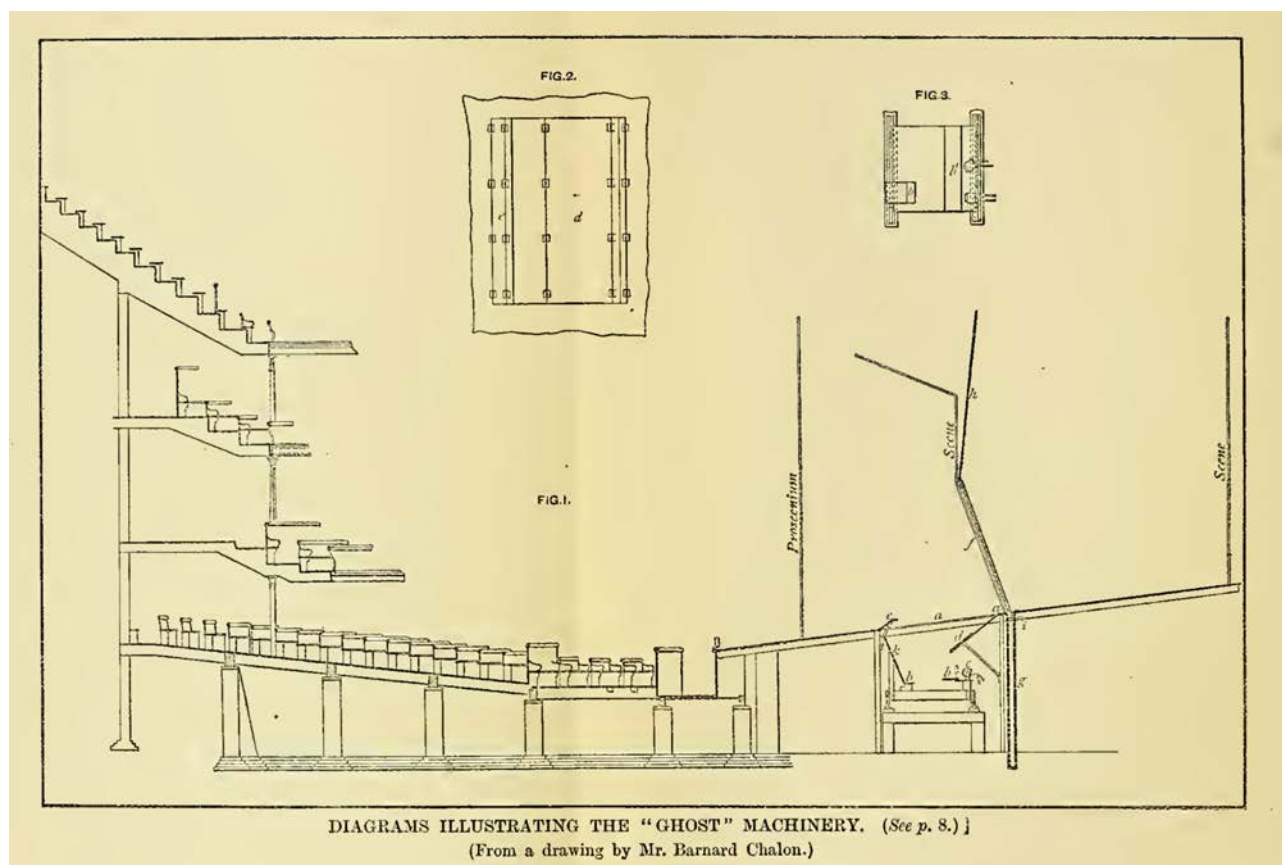


Figure 5. Original Pepper's ghost drawing (retrieved from *The True History of the Ghost* by John Henry Pepper, 1890).

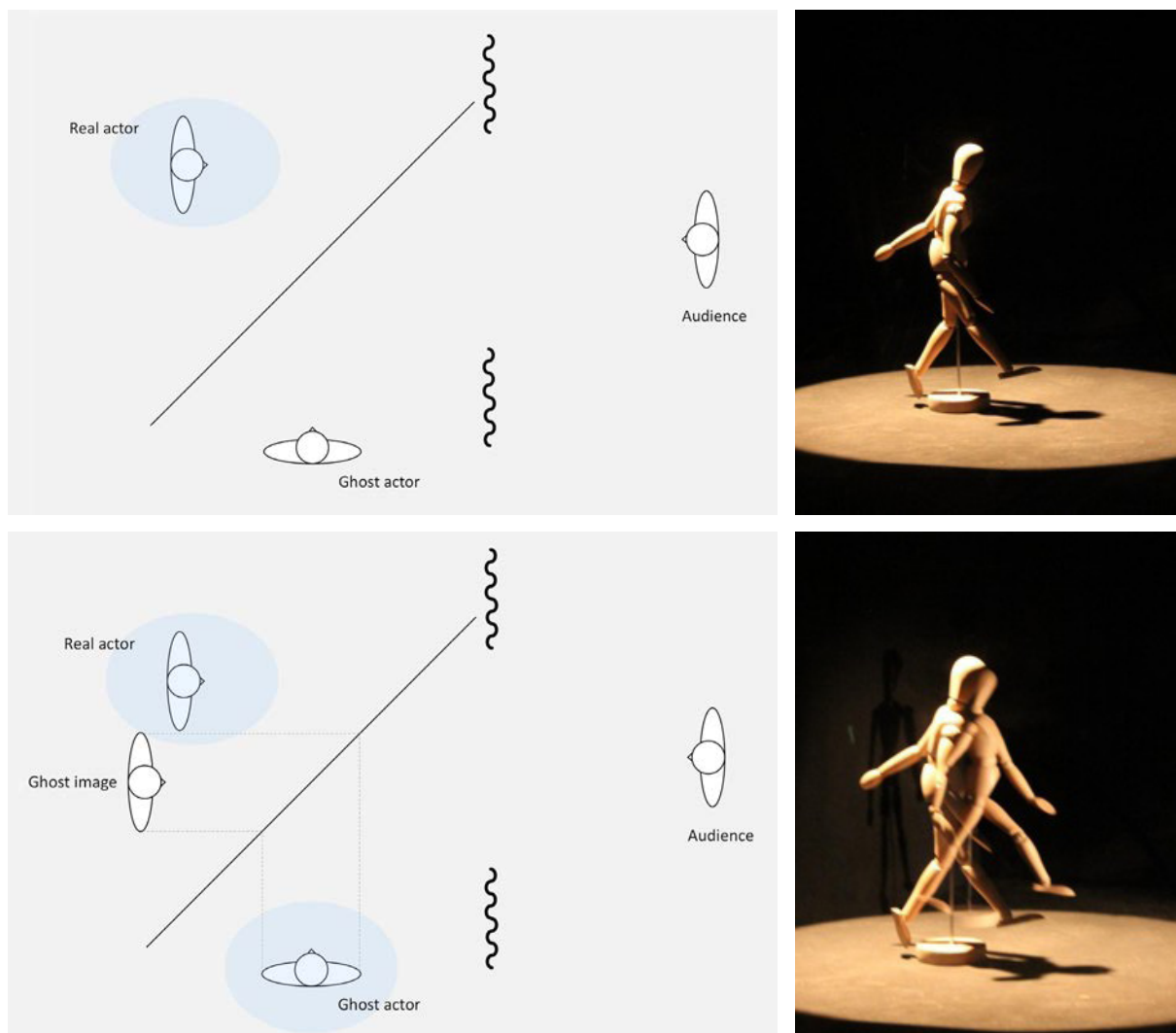


Figure 6. The principle of Pepper's ghost (author's drawing and pictures).

image. This setup only works perfectly if the audience is in the middle line of the screen. If the audience moves, the reflected image moves as well, which complicates the interaction with the real actor, who stays in the same spot.

But as simple as the principle is, the effect is equally as astonishing. Charles Dickens attends one of the performances and describes the effect on the audience in his *Journal* of 27 June 1863:

But the ghost was a very different matter; when it appeared, not a sound in the pit, not a whisper in the gallery; all open-mouthed, eager, tremulous excitement! The old grandmother clasped the umbrella like a divining-rod, and muttered a hoarse "Deary—dea—ry me!" the mother let the infant fall flat and flaccid on her lap, the youth's arm unbent, and the maiden, rising stiffly three inches from her seat, said, "Go'as!" and remained rigid. Only one sound floated on the air, and that was emitted by a French gentleman, with more buttons on his waistcoat than I ever saw on a similar amount of cloth (how on earth did a foreigner penetrate to Hoxton?), who clutched his curly-brimmed hat between his fat fists and hissed out, "A—h! Superbel!" It was his testimony and it is mine! (Dickens, 1863).

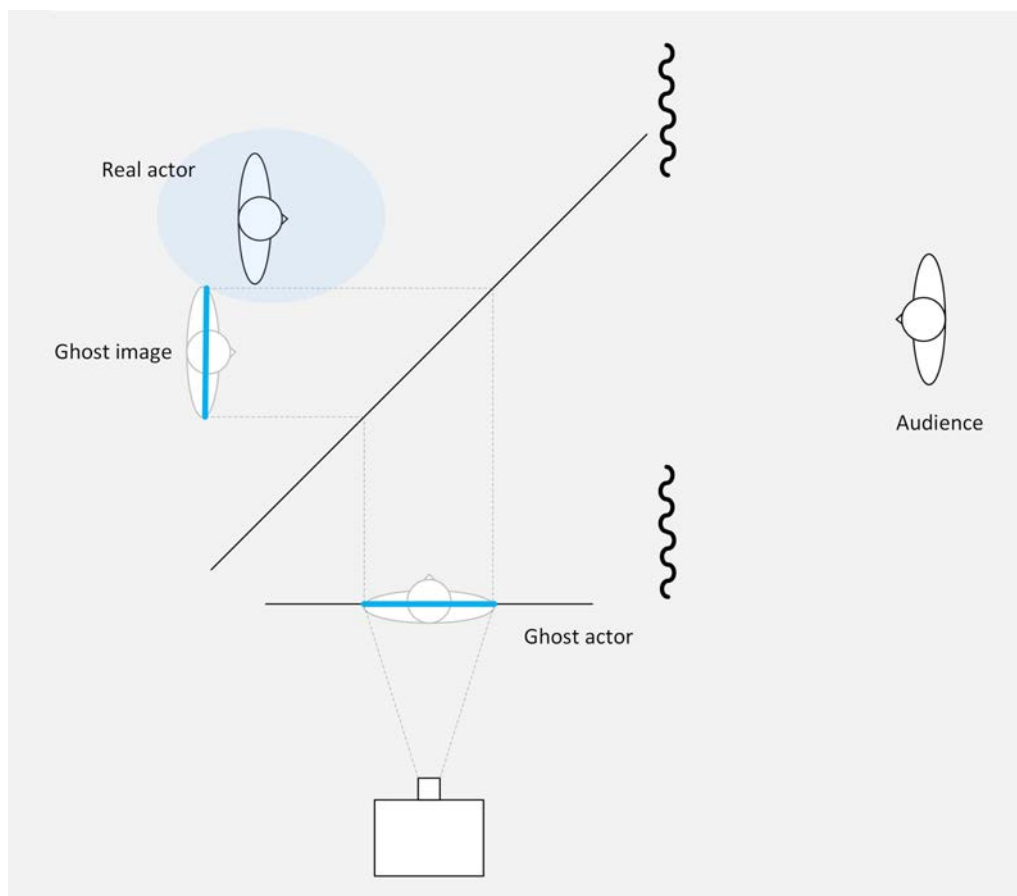


Figure 7. Principle of a Pepper's ghost with projection (author's drawing).

After initial success, the effect was used in several performances, but was costly, limited by the size of glass, and needed a rather complex construction in the under stage. However, it was intensively used in theme parks, haunted houses, museums, and so on, where the limitations are no issue and the audience could be directed to the ideal viewing position.

The big revival came with the development of polyester foil material with invisible joints that could be stretched over the full size of the stage around 2000. This, in combination with the development of large-screen projection, created the opportunity to project actors in space. To be exact, the actor is projected on a screen that is reflected on the polyester foil. But because we reflect the 2D screen, the image in the space will also be in 2D. This is in most cases not a problem; only when the reflected image interacts with a real actor will we see a difference with the original Pepper's ghost setup.

In reality, most projection-based Pepper's ghost effects are not done vertically but horizontally. The actor is projected on the ground or ceiling, invisible for the audience, and reflected on the screen accordingly.

Pepper's ghost effects are now used in massive concert tours and product presentations, often wrongly promoted as "holographic experiences". The ghost is replaced by CEOs that talk remotely, deceased artists like Maria Callas, Michael Jackson or Tupac, avatars of living artists like ABBA, or virtually created avatars like Hatsune Miku.

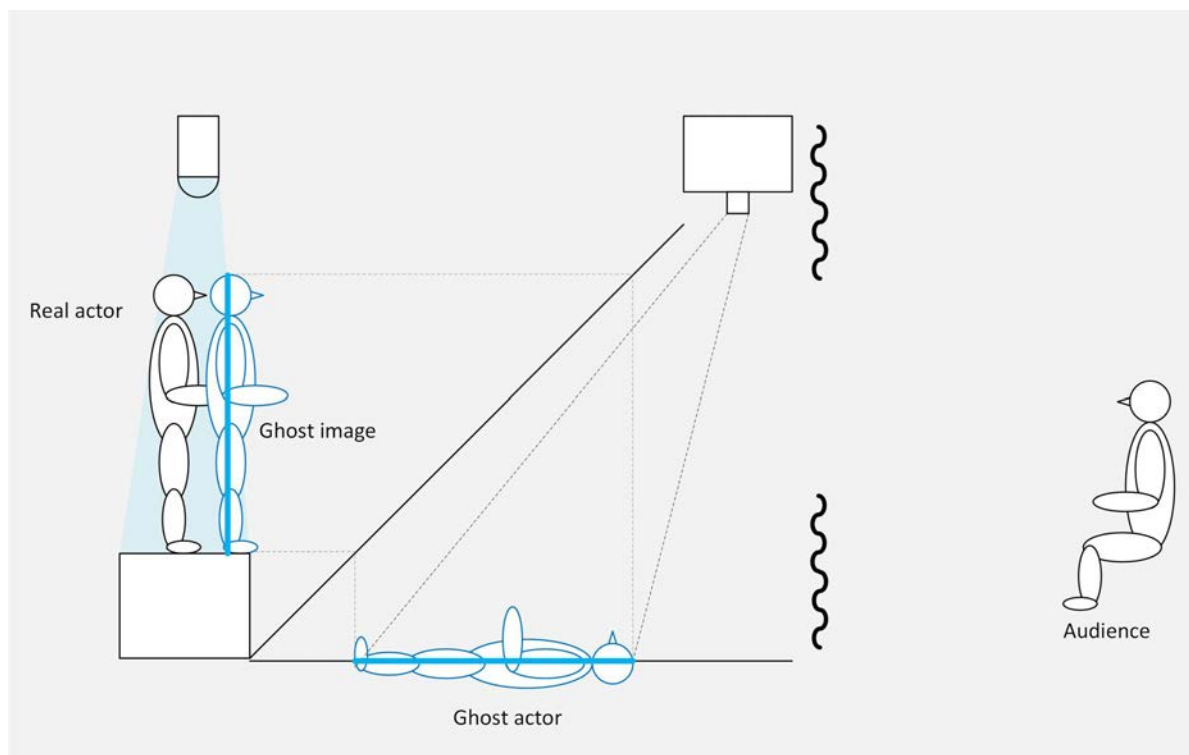


Figure 8. Principle of a horizontal Pepper's ghost with projection.

Moving lights

Moving lights could be defined as “lighting fixtures that allow the designer to assign remotely and in sync with the actions of the performance, multiple attributes, including direction, color, shape as well as intensity.” In other words, the movements, colour changes and effects must be executed while the results are visible on stage. This excludes motorised spotlights that are only meant to position the light beam remotely.

Generally, it is perceived that moving lights are part of the emerging rock history in the late 1970s. But, in reality, the roots of the moving light lay centuries further back in history and mainly in theatrical production.

The control systems of the separate attributes were often developed earlier in time. The oldest trace we find are the mechanical dimmers that are described in Nicola Sabbattini's *Pratica di fabricar scene e machine ne' teatri* in 1638 (Sabbattini, 1638: 86).

Movement of lighting sources did already occur with the advent of gas-lighting. A drawing in the Brandt archives from the 1880s shows a translucent sphere containing a gas burner that moves over a rail, representing the rising sun behind a backdrop.

Thomas Drumont developed the limelight burner around 1836. A limestone heated by the flame of a hydrogen-oxygen mixture creates a small surface that emits light. This was the first point source in history. The importance of the limelight for contemporary lighting technology cannot be underestimated; after all, to build a sound optical system, a point source is needed. The light must start from (ideally) a single point. As far as we know, based on a billboard (Herne Bay Grand festival, 1836), the first performance

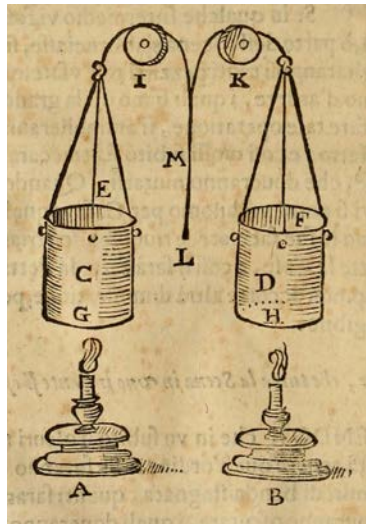
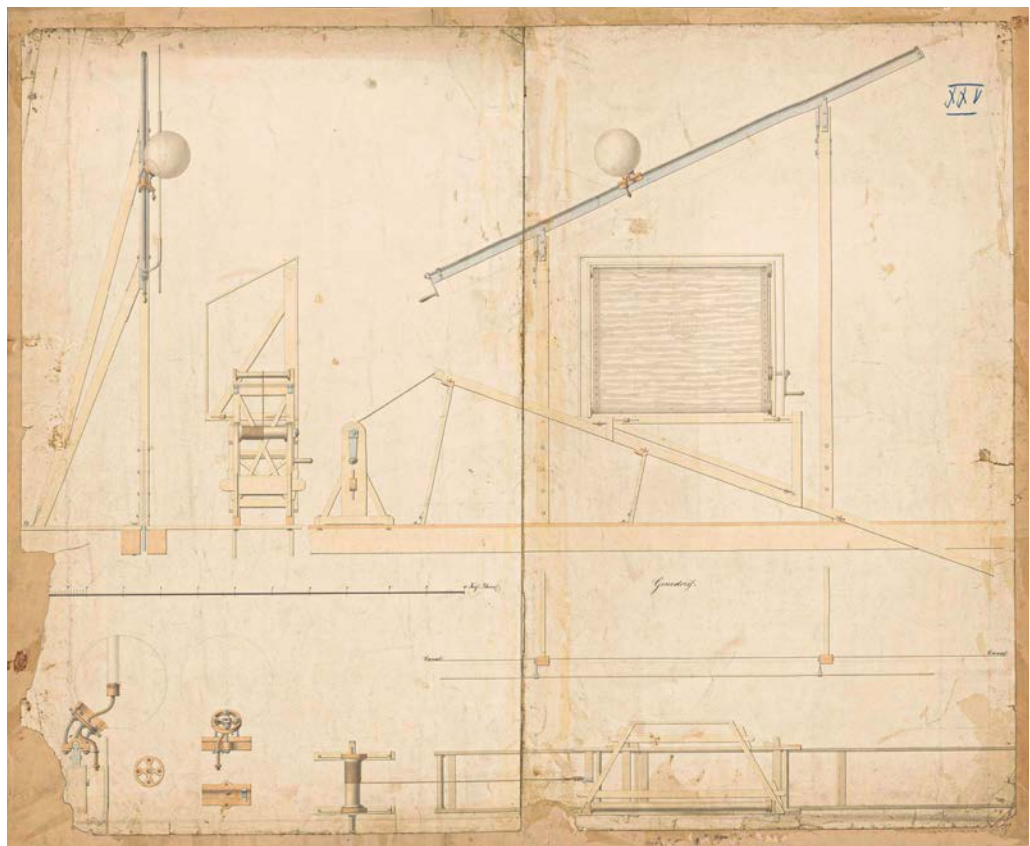


Figure 9. Sabbattini's mechanical dimmer (retrieved from *Pratica di fabricar scene e machine ne' teatri*, 1638).

Figure 10. Moving moon (retrieved from Freie Universität Berlin, Institut für Theaterwissenschaft, Theaterhistorische Sammlungen, Nachlass Brandt).



in which it was used as a lighting device was on 3 October 1836 by juggler and “magician” Ching Lau Lauro in Kent. The beam was most likely controlled with a mirror.

In the 1864 *Catalogue des appareils employés pour la production des phénomènes physiques au théâtre* by FiJules Duboscq, we see for the first time, in addition to the limelight, an electric point source for theatrical use. The carbon arc light source is the forerunner of the discharge lamps and consisted in its early form of a supply voltage connected to two carbon rods between which an arc was created, thus creating a point source. Adding a mirror allowed the light to be focused, and glass plates provided colour (Duboscq, 1864: 2).

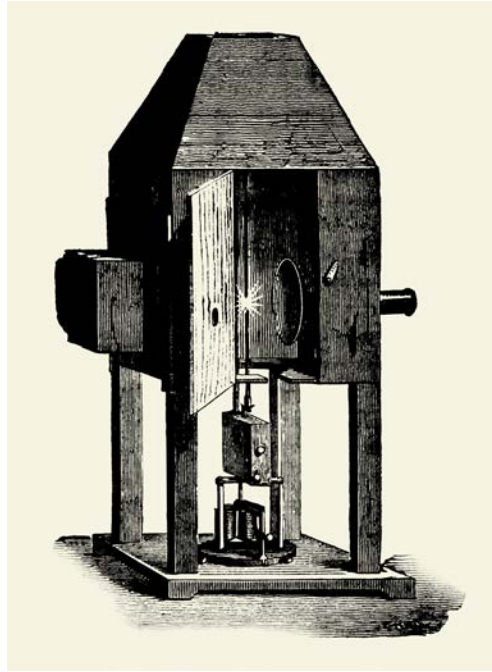


Figure 11. Duboscq arc light
(retrieved from Catalogue des appareils, 1864).

At the International Electrotechnical Exhibition in Munich in 1882, we see remote-controlled colour changers for the first time. Both the footlights, the sidelights and the *herzen* (top lights) were equipped with a rotating cylinder with different colours that could be rotated by means of a rope (Guerout, 1883).

And in 1893, Alexander Rimington's colour organ that was intended to give "concerts" with colour projections instead of/or together with music was presented. The techniques used to include overlapping sheets of glass coloured in a *degradé*, abstract shapes pushed into the light track, mechanical dimmers, mirrors and prisms to move the projected image. The organ had multiple light sources, each projecting an image to create a complex overall image (Bentham, 1992).

The first servo mechanism was developed as early as 1896 by H. Calendarin. It was perfected by Joseph Michalke, who worked for Siemens Halske

Figure 12. Colour changers (retrieved from Guerout, 1883).

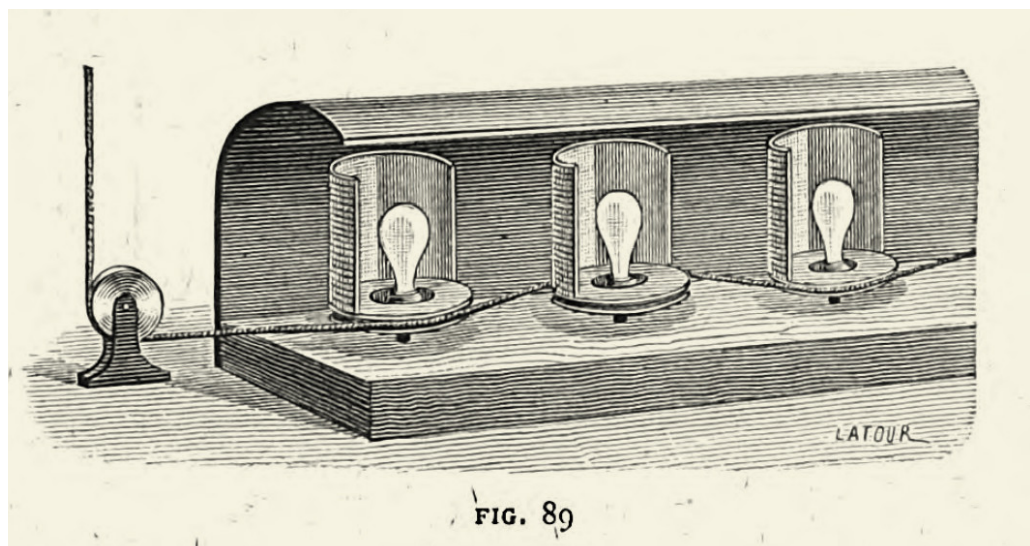


FIG. 89



Figure 13. Rimington's colour organ (retrieved from Wikimedia Commons).

in 1901. He patented the Selsyn principle that uses a motor that is turned manually as a control to make a second motor run synchronously with the first (Owen, 1996). This principle would later be used by Joseph Levi and Jules Fisher to control moving spotlights.

By then, all the elements for a moving light were ready to be implemented. Edmond W. Sohlberg, a Kansas City inventor, filed a patent for a remote-controlled spotlight in 1906. It is a kind of follow spot with a colour wheel. The patent states: “The object of my invention is to provide an apparatus by which an operator located at a point distant from the light-projecting-mechanism — as for instance, from some place on the stage — may quickly change the direction, colour and focusing of the rays of projected light” (US819611A, 1906). Most of the movements are done with a type of rope, but the colour wheel is controlled by an electric motor that stops at the correct position with a cam wheel.

Until that point, there was remote-controlled motion, but it still had to be physically manipulated by a technician. Herbert F. King changed this in 1928 with a patent for an electrically driven pan/tilt system for any spotlight (US1680685A, 1928). The movement could now be electrically controlled, which of course opened up a lot of new possibilities. Those possibilities become clear when Mary Hallock-Greenewalt, in a 1929 patent (US1731772A, 1929), describes in great detail a colour organ like Rimington's, with the difference that now the light sources are arranged externally from the controls and each light source can move both pan and tilt controlled by the organ. Furthermore, each source has an aperture, focus, colour wheel and moving film controlled by motors. The organ itself has a number of features to “program” the complex controls.

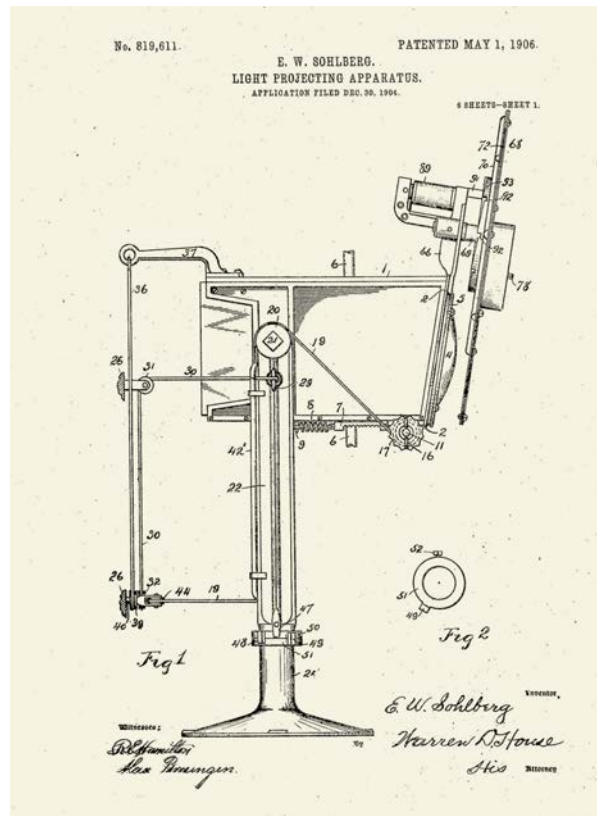


Figure 14. Solberg's patent drawing (retrieved from the original patent).

From this moment on, improvements and variations on earlier patents appear. An example is Charles Andreino, who filed a patent in 1930 that “relates to improvements in light projecting apparatus and has for its primary object to provide a projecting apparatus which can be conveniently adjusted to project the light beam at various angular positions” (US1747279A, 1930).

But there are also entirely new developments. We find a 1936 patent by J. Levy for a “Remote control for directing projected light”, an early form of a joystick (US2054224A, 1936). The joystick controls a moving mirror that can be set in front of any spotlight. The system uses Selsyn servo motors, one of the earliest forms of motors that can be positioned. The system is the embryonal form of a moving mirror system.

In the late 1930s, George Izenour in the R&D Laboratory for Technical Theatre at the Yale School of Drama also experimented with a spotlight with remote-controlled pan, tilt, focus, opening angle and colour. His goal was to provide an entire theatre with remote-controlled and, as time went on, programmable devices. However, the technology was not yet sufficiently developed to bring this to fruition. He continued to work on this idea until the 1960s. The prototypes are in Penn University’s archives (Cadena, 2006: 8).

From the 1960s on, motorised spotlights became commonplace in theatre. They were mainly used in hard-to-reach places and usually only have a PTF (Pan - Tilt - Focus) function, sometimes extended with a colour changer. But the movements were too slow to be used visibly in a performance.

Jules Fisher worked on a Peter Pan production at the Casa Mañana arena theatre in Texas in 1965. To portray Tinkerbell in front of and in the audience sitting 360 degrees around, he developed a PAR 64 fixture with a

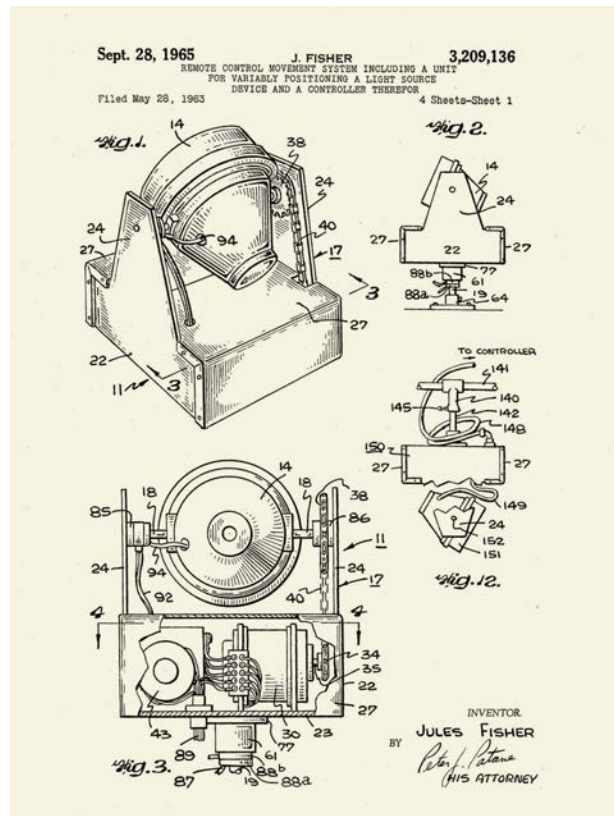


Figure 15. Fisher's patent
(retrieved from original patent).

very narrow beam moved by a Selsyn motor. He later patented the system (US3209136A, 1965). The lamp was mounted in the centre of the grid and could reach any point on the stage and in the audience. As far as we know, it was the first time the movement was visible during a performance. The manual control could control not only movement, but also intensity and a “heartbeat”.⁶ Lighting equipment manufacturers did not see a future in this kind of equipment. However, that would soon change.

When lighting designer Stefan Graf was on tour with engineer and inventor Jim Fackert in 1972, he became increasingly frustrated with local follow spotters. Jim Fackert devised a solution in the form of a remote-controlled mirror spotlight. Although Graf hardly believed in the idea, he nevertheless provided the necessary resources; the Cyclops, the first moving mirror spotlight, is born! (Cadena, 2006: 14).

In 1979 in France, Didier Leclercq, together with the rental company Regiscene, designed the Telescan, a moving mirror spotlight, primarily intended as a follow spot, but eventually also very popular as concert lighting. Some of them are still in use today; Jocelyn Morel⁷ collects and still uses them in productions. The moving light is no longer an effect or replacement for a follow spot, but a full alternative for a fixture (Morel, n.d.). Meanwhile, on the other side of the ocean, Peter Wynne-Wilson built the PanCan, a moving mirror that can be put on different types of spotlights (Cadena, 2006: 21).

6. A control that made the intensity of the light change like a heartbeat.

7. French lighting designer.

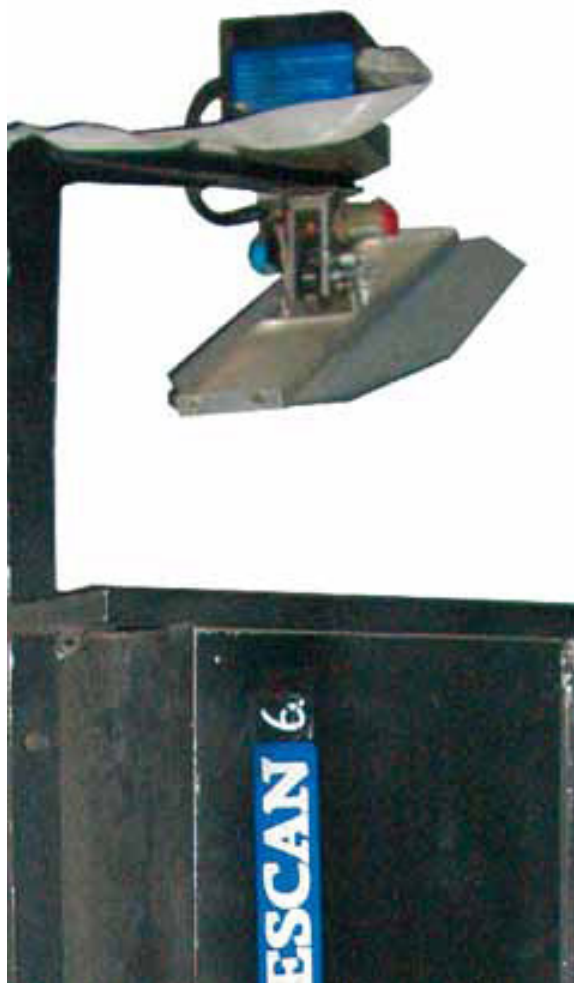


Figure 16. Telescan Gerriets Collection (author's picture).

The rental company Showco had its own R&D department to develop devices for its own use. In 1978, they were looking for a way to make PARs change colour remotely. The PAR was always the basis of any rock and roll lighting. Several ideas were discussed, including fast semaphore devices and a system with three chambers into which liquid of a different colour could be pumped. None of the experiments was a great success. When Jim Bornhorst joined the team in 1980, they started experimenting with dichroic filters. After all, these were less sensitive to the high temperatures. When there was a working prototype, the idea of making the spot move arose immediately. The VL zero, the forerunner of the Vari-lite moving heads, was born. Besides dichroic colour mixing and pan and tilt control, it also had a dimmer and an adjustable iris, all controlled by a digital signal. Soon after, Vari-lite was established as a company (Cadena, 2006: 16).

However, it would still take a long time before moving lights were accepted as a fixture fit for theatre. The early types were also noisy during movements because of the fans needed for cooling. They were also perceived as “rock and roll” and so not “theatre”, with the exception of musicals. At the turn of the century, they started to sneak into operas and drip through to theatre performance. The change to LED sped up this process because of fewer cooling issues. Bit by bit they became standard equipment for theatres.

Projection mapping

Projection mapping, similar to video mapping and spatial augmented reality, is a projection technique used to turn objects, often irregularly shaped, into display surfaces for projection. The projected image is corrected based on the shape of the projection surface to ensure that the viewer gets a correct image.

There are several issues when we want to project from an angle on a projection surface. First of all, our image will be distorted. Secondly, the image will not be sharp on the entire surface of the projection. And, thirdly, there will be differences in brightness on the surface. These issues are the result of differences in distance between the lens and the projection surface. A projection can only be sharp at one distance, and when the distance is longer the beam will open up further, spreading the light over a larger surface resulting in less brightness per surface unit and an image that is “stretched” further on the side of the image that is farther away.

The problem with sharpness can only be solved by a “hardware” solution. Theodor Scheimpflug describes a method in a patent issued in 1904 titled “Improved Method and Apparatus for the Systematic Alteration or Distortion of Plane Pictures and Images by Means of Lenses and Mirrors for Photography and for other purposes” (GB190401196A, 1904). The concept is known as Scheimpflug’s law and states that if all planes of a projection converge in one point, the projection is sharp everywhere. In other words, if the line through the image plane, the lens plane and the projection plane end up in one point, the image will be sharp. This is done in a technical camera by turning the lens in relation to the image receiver, and it can also be done with a projector.

The two other issues need a “software solution”. As all optical laws are reversible, we can distort the projected image, resulting in a not distorted projection. The distortion inverses the effect. The brightness issue can only be solved by limiting the translucence of the brightest side of the projected image.

Still images

We find a first description of distorting an image for projection purposes in Ridge and Aldred, in *Stage Lighting, Principles and Practice* (1936). They describe how a Linnebach projector is used to define the distortion needed. A Linnebach projector, invented in 1917 by Adolf Linnebach, is a lensless projector with a point source and a hood containing the projection image on a glass plate. It is a wide-angle projector that can be placed close to the surface and cover the whole of a backdrop.

The projector is positioned in the exact spot where it will be used, with a transparent plate without a drawing fitted, and focused on the projection surface that will be used. Then a grid is marked on the glass plate to fit the geometry of the projection surface. Once this is done, the plate is removed and painted with the desired image adapted to the distortion of the grid. When projected, the image will be straight and adapted to the geometry of

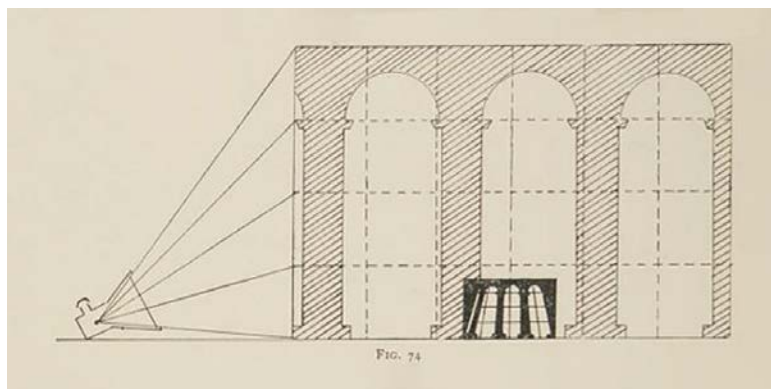
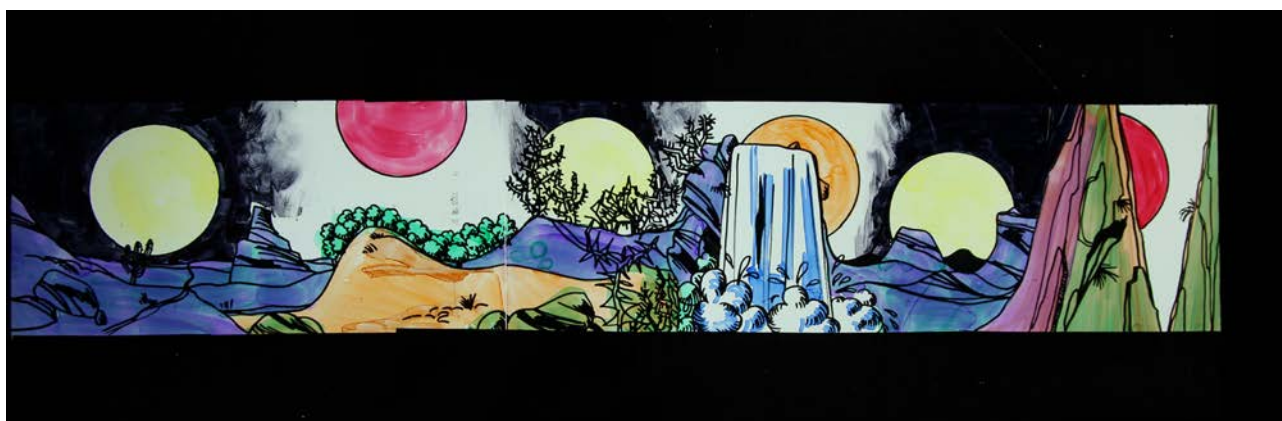


Figure 17. Linneback's projection mapping (retrieved from Ridge and Aldred, 1936).

the projection surface. This can be done with projection surfaces in an angle, but also with curved surfaces.

Ridge and Aldred also describe the “continental system” with high power projectors known as G.K.P., named after the inventors Remigius Geyling, Dr. Leopold Kann, and Ing. Paul Planer. Little is known about these persons or their brand. Their system is perfected in Vienna and used in the Burg Theatre and the Odéon in Paris. They insisted on making the slides themselves, safeguarding the secret on how they were made. A first patent (AT107235B, 1927) filed by Dr. Leopold Kann about a “Process for producing (projection) images for oblique projection (especially for stage purposes)” explains a method in which the image that needs to be projected is made at scale in a model. The camera is put, at the same scale, in the exact spot where the projector will stand. The resulting photographic slide can be used for projection. This method could even be used for curved objects. The patent presents several variations of the method. For simple images a grid can be projected. The projected grid is photographed and used to draw the expected result directly with distortion. If the model is a flat surface, the image can also be projected using an episcopic or diascope projector and photographed again from the right angle. In all methods, the colouring is done manually with a type of transparent glass paint.⁸ In a secondary patent (AT113832B, 1929) filed on 10 October 1928 Ir. Paul Planer refines the grid method.

Figure 18. Hand painted slide (TEAD Collection).



8. Often referred to as Ecoline paint.

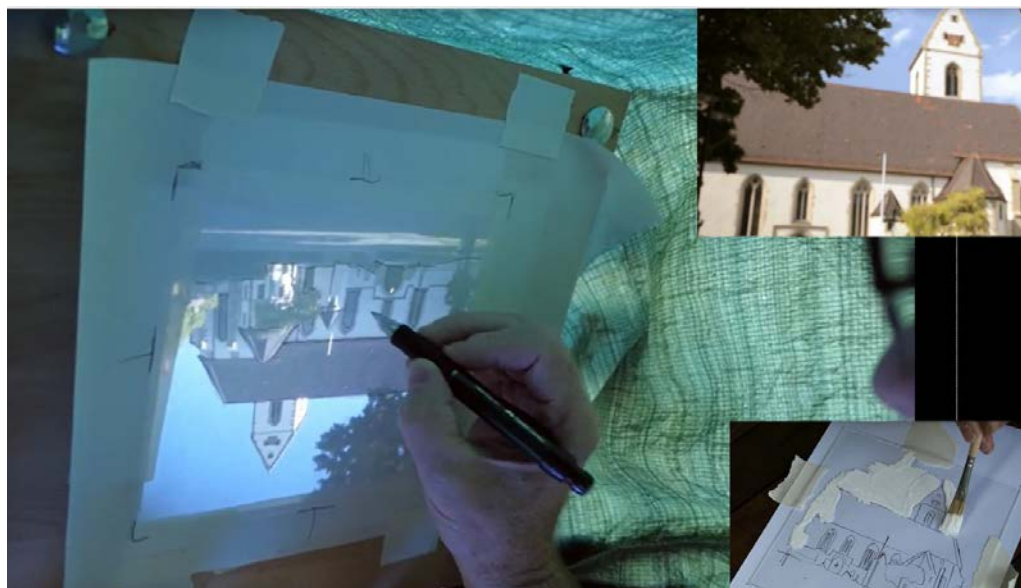


Figure 19. Pani mapping (author's collage based on Contag-Lada, 2020).

Pani, another Austrian manufacturer, later developed another alternative to map directly on the object, probably in the late 1940s. The projector and the projector surface are put in the exact position they will be used. Then the lamp house is removed from the projector and exchanged with a cassette containing a translucent plate and equipped with a black cloth like the first plate cameras. On the plate, the projection surface can be seen and the shape can be traced. After this, the plate is removed and painted (Contag-Lada, 2020?).

In *Stage Lighting*, the iconic book by Richard Pilbrow (1979), he describes how they managed to calculate the deformation and create the distortion photographically for a huge cyclorama and a very short throw distance. In the same book, he describes multi-image projection with synchronised slide projectors.

Moving images

Of course, these are all still projections. The first moving projection mapping was probably “Madame Leota, and 5 Singing Busts” in the Haunted Mansion ride in Disneyland that opened in 1969. The five heads sing *Grim Grinning Ghosts*, the theme tune of the ride. The faces of the singers were filmed on 16mm film and projected with a film loop on the three-dimensional busts. The effect was developed by Yale Gracey and Rolly Crump (The Grim Grinning Singing Busts of the Haunted Mansion, 2021).

Michael Naimark, an installation artist, built an immersive film installation called *Displacements* in 1980. In this art installation, two performers were filmed in a living room with a rotating camera, then the camera was replaced with a projector. The result is rotating projection mapping. The Belgian theatre company CREW would later use a similar technique between two rooms, using a half-bowl mirror in front of the camera in one room and another in front of the projector in another room (The Illustrated History of Projection Mapping, n.d.).



Figure 20. Disneyland Haunted Mansion Singing Busts (retrieved from Wikimedia Commons).

ETC-Audiovisuel in France developed the PIGI projector in 1981. This projector is a bit of a sideroad in the development, because it uses still images that move. The projector has two film scrollers mounted on a rotational turret. Using a 6 kw Xenon light source the PIGI projector is capable of upwards of 80,000 lumens of light output. This can be considered as the start of dynamic large-scale and building projections (PIGI projector, 2023).

The first show to use moving mapping was the Stephen Sondheim original Broadway production of *Sunday in the Park* in 1984. Bran Ferren, American special effects designer, developed a digitally-processed projection mapping (pre-processed, geometrically corrected 35mm film projection) for this show, enabling the possibility of projecting on a spherical shape.

In 1991, Walt Disney filed a patent for an “Apparatus and method for projection upon a three-dimensional object”. The system consists of a computer on which the images are created and an overhead projector with an LCD screen used as a projection image (US5325473A, 1994).

Large-scale mapped video projection

Another patent was filed in 2003 by French multimedia creator Yacine Aït Kaci and Belgian architect Naziha Mestaoui (FR2860379A1, 2005). This patent presents the video mapping concept as we know it, being able to split the image over several objects that are at different distances and controlled by software.

The evolutions in video projector technology around the same time made it possible to use video on stage with a light output that could beat the environmental lighting and with a resolution that was acceptable for live performance. All the elements were there to use mapping as we use it now in our daily work.

Reflection

All four cases start from a concrete artistic or audience need. Live streaming starts from the need for remote but live participation, 3D projection answers to the need to make the invisible visible, and moving lights and mapping respond to the need to control the transformation of the spatial environment.

Even if these needs may be older, they all find their initial technical solutions in the era of the Industrial Revolution, but encountered limitations

that kept them from breaking through in their full capacity. Live streaming originated in the availability of communication lines but was limited to audio, and the audience lost interest because of the upcoming broadcasting services. 3D projection became possible through new lighting sources, but was limited by the size of glass plates that could be made. Moving lights are initially a result of the availability of point sources, but the development was hindered by the lack of technology for instant control at the needed speed for a performance. Projection mapping is also a result of the availability of point sources, but was limited to static projection.

All these concepts fully developed into a useful application in the electronic-digital era. Live streaming became popular with the upcoming internet and the addition of moving image. 3D projection could be done on a full stage size due the use of Polyester screens (even if we are still waiting for “real 3D” images). Moving lights became possible with the development of high-speed electromechanical devices and electronics to control and program them. Projection mapping became “live” with high power digital projection and software control of moving images.

We can wonder what the next era will add to these inventions. Live streaming could develop further with individual immersive appliances that are accepted by the audience. 3D projection could gain from the development of new holographic techniques that make it possible to walk around the image. Moving lights could gain from AI-supported control or be exchanged for video as lighting when adapted control would be developed. Projection mapping could be supported by AI tracking and content creation.

All the inventions build further on the initial needs and the previous concepts developed by others. They are picked up again with each technical revolution. The inventions are rather milestones in the evolution than truly new inventions. Nothing is new, even if it's just been invented.



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