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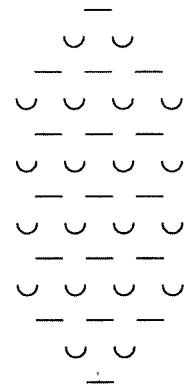
The Romance of Celluloid



Christian Morgenstern,
'Nocturnal Song of the Fish' (1905)

Physical Structure

Motion picture film stock manufactured in the period of silent cinema consists almost entirely of highly unstable organic materials. Some photographically obtained moving images were printed on carriers other than film: the Kammatograph (United Kingdom, 1898–1900), for instance, used a glass disc with about 550 frames arranged in a spiral (see Plates 26, 27 and 43; a similar technique was adopted for Charles Urban's Spirograph, which used a flexible disc, (Plates 24 and 25); the Mutoscope is a cylinder holding several hundred rectangles of thin card (see Plate 9), each of them bearing a photograph so that, if observed in rapid sequence through equipment for individual viewing, an impression of continuous movement is generated. The same effect is obtained through the Théoscope, produced in France by Théophile Lacroix using a principle similar to that of the Mutoscope.

From the end of the 19th century, cellulose film was established as the preferred material for the reproduction of moving images. Its components remained essentially unchanged for several decades: a base; a very thin gelatin adhesive layer; a light-sensitive emulsion – recognisable as the opaque side of the film – connected

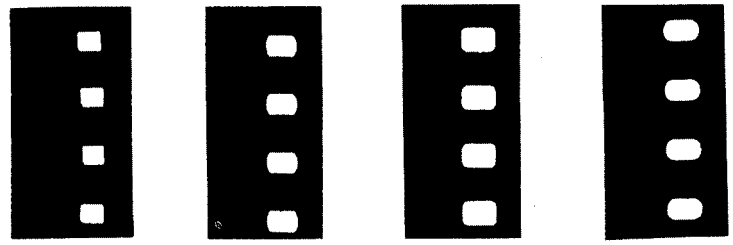
to the base by the adhesive layer, and normally consisting of a suspension of silver salts in gelatin. There are sometimes two additional layers: a thin gelatin layer, protecting the emulsion from mechanical damage caused during projection, and a further layer to prevent a haze from forming on the image, or to prevent the film from curling.

The base of most films produced up to February 1951 is cellulose nitrate, a highly flammable substance; from then on, nitrate was replaced by cellulose acetate – which is much less flammable – and, more recently, by polyester. From the first decade of the 20th century, however, some companies were already experimenting with the production of so-called 'safety' – that is, non-flammable – films, in cellulose acetate (this invention by Eichengrun and Becker dates from 1901) or in nitrate covered by non-flammable compounds (the first known examples of this film stock date from 1909). Ozaphane, a French patent for motion picture stock on extremely thin (0.05mm) cellophane film, was presented in 1927 and manufactured in various formats, sometimes without perforations (Plates 34 A–E).

The Birth of 35mm Film

The commercial development of cinema dates from the production of film – with perforations on either side of the frame so that it may be mechanically pulled through the projector – printed on a 35mm wide flexible carrier developed in 1889 by Henry M. Reichenbach for George Eastman from an invention attributed to, among others, the brothers J.W. and I.S. Hyatt (1865), Hannibal Goodwin (1888) and Reichenbach himself. This was the format which Thomas Edison adopted for his Kinetoscope, a device allowing one spectator at a time to see 50-foot strips of film. The Kinetoscope was so successful commercially that subsequent machines for the reproduction of moving images adopted 35mm as a standard format. This tendency was also encouraged by the Eastman company, as their standard film for still picture cameras was 70mm wide. This meant they could simply cut the film in half lengthways to obtain a motion picture film base of the desired size. The success of cinema as a form of mass entertainment is tied to this type of film, officially adopted by all production companies in 1909.

The mechanics of Edison's Kinetoscope also determined the standard format of 35mm film with four vaguely rectangular perforations on either side of each frame. At the end of the 19th century, other inventors tried different types of perforation. The one most commonly used prior to the general adoption of Edison's design was that of the Lumière brothers: the film is drawn along by means of one single, circular perforation on either side of the frame (see Plate 1). Other shorter-lived systems were employed by Max Skladanowsky in Germany (three circular perforations on each side, two of them corresponding to the frame line, as in Plate 21; later, four perforations on both sides of the frame, as in the Edison system, but much smaller and also circular; see also Plate 42) and by the British company Prestwich (three circular perforations on each side of the frame).



35mm film perforations: (A) Small-gauge perforations, pre-1905; (B) Bell & Howell; (C) Kodak Standard ('positive'); (D) Pathé.

Until about 1905 the size and shape of perforations varied from one company to another. They were also smaller than the later standard negative and positive perforations (see A). Around 1905 their profile and size evolved to the point where the Bell & Howell company standardised the features of a larger perforation with straight top and bottom edges, and rounded sides. Perforations of this shape (see B) came into use for all films (both positive and negative) until 1924, when Kodak introduced a rectangular perforation with rounded corners – generally called 'positive perforations' or KS, 'Kodak Standard' – only for positive projection prints (see C). Since then, negative prints continued to have Bell & Howell perforations while all projection positives used the Kodak Standard perforations. The aim was to adapt the prints to different kinds of mechanical stress during shooting and repeated projection. A proposal to unify the two kinds of perforations (the Dubray-Howell system) met with little favour. From 1905 to the late 1920s, Pathé used a perforation of distinctive shape, similar to the Bell & Howell but with rounded corners (see D).

From 1895 to 1916, especially in the United States, a record was often kept of the images printed on 35mm film: the images were reprinted on strips of photographic paper, frequently including the perforations (paper prints: Plate 14). Clearly, these 'films' cannot be screened; each frame, however, can be reproduced on motion picture stock with good results. Many early American films are currently available only on copies obtained from these paper prints, deposited with the Library of Congress by producers in order to obtain legal copyright protection against possible forgeries.

Emulsion

Black and white film stock commonly used until the mid-1920s, called orthochromatic film, was sensitive to ultra-violet, violet and blue light, and partially sensitive to yellow and green radiations, while red had no effect on the silver bromide emulsion. In order to prevent certain objects appearing on the screen as indistinct dark stains, technicians had to monitor the colour balance on the sets, avoiding certain colours for costumes and even painting backgrounds in various shades of grey for interior shots. Orthochromatic film emulsion remained in use until the early 40s, mainly for special effects and for the blue strip in the three-strip Technicolor process after the late 1920s.

Panchromatic film, developed at the end of 1912 by the Eastman Kodak Company on behalf of Gaumont, was sensitive to almost the entire spectrum of visible radiation. At first, it was used only sporadically, partly because it was expensive. However, within a four-year period (from 1922 – the year of Ned Van Buren's *The Headless Horseman*, the first full-length feature shot entirely on a panchromatic negative – to 1926), panchromatic film became the standard stock used by all major production companies; it was less sensitive to light (and therefore forced a change in interior lighting systems), but it allowed for the reproduction of a much wider range of intermediate shades of grey.

Frame

Each frame of a 35mm positive film was about 23mm wide and 18mm high, with slight variations in the early years. Every metre of film held 54 images (16 frames per foot), like present-day film stock of the same format. The aspect ratio of the frame (ca. 1:1.28 to 1:1.31) remained basically unchanged until the soundtrack was introduced (the aspect ratio of silent films reissued with a variable density soundtrack is ca. 1:1.16, very close to a square image: see illustration B on page 61). In 1927 an anamorphic system was devised in France by Henri Chrétien, whose Hypergonar system was used, for instance, in Claude Autant-Lara's short film *Construire un feu* (1925–1929). With the exception of the films in which the widening of the field of vision was a consequence of changing the aspect ratio of the frame, or because the lenses of the projectors magnified the image size on the screen (as with Magnascope, 1926), the two most important attempts to expand the field of vision were Grimoin-Sanson's Cinéorama (1900), with its ten 70mm projectors arranged through 360 degrees to show an image surrounding the spectators, and the equally short-lived Polyvision system (1927) used in the famous triptych sequence of Abel Gance's *Napoléon* (1926): three adjacent 35mm cameras showing three abutting films simultaneously to form a widescreen image. Finally, we must mention Filoteo Alberini's experiment in Italy (1911) with a machine for a 70mm film whose shooting angle reached 110 degrees (Plate 11).

Non-Standard Formats

In spite of its success, 35mm had several rivals in the theatrical and amateur market. The majority of them met with little or no commercial success, but a few became highly popular formats for home distribution, or the ancestors of systems adopted in later years. For instance:

- the first cameras used by the American Mutoscope & Biograph Company, active between the end of the 19th century and the beginning of the 20th century, employed 68mm films without lateral perforations. The ratio between the height and width of the frame (the aspect ratio) is about 3:4; as there are no perforations, the image takes up almost the whole width of the film (Plates 9 and 10). The original intention was to produce the individual images on cards for use in the Mutoscope peepshow device; but when a projector was developed to match the films, the resulting picture projected on the screen was substantially sharper than that of the standard 35mm image, and contributed to the company's success;

- from 1896 onwards, some 60mm films were produced. A 60mm Prestwich film, with four perforations along the edges of the frame and an aspect ratio similar to the 35mm image format, is preserved at the National Film and Television Archive in London. The 58mm film by Georges Demenÿ (France, 1896; see Plate 2) has 15 perforations every four frames. In 1897, the American Veriscope Company made a 63mm film of which only one specimen is known: *The Corbett-Fitzsimmons Fight*, the chronicle of a boxing match (Plate 3). The Veriscope format has five perforations per frame on each side; the aspect ratio of the frame is 1:1.75. The 75mm format (with a frame 45mm high and 60mm wide) was suggested, as an experiment, by Louis Lumière in 1898 (Plate 29). Two years later, in 1900, Gaumont distributed the Chrono de poche, a portable motion-picture camera which used 15mm film with central perforations (Plate 15). In 1902, the Warwick Trading Company introduced a 17.5mm film for amateur use in the Biokam, a machine which could shoot, print and project film. Here, too, there is only one perforation, on the frame line; this idea was taken up by Ernemann, in Germany (with a different-shaped perforation: Plate 6) and by Pathé in the 20s, among others;

- after the 68mm film stock used by the American Mutoscope and Biograph, the next alternative format to 35mm that met with a degree of success (perhaps because its frame is only slightly smaller than that of 35mm film) was the 28mm film introduced by Pathé in 1912 as the Pathé-Kok brand. The Pathé-Kok was a popular and unusual home projector: the hand-cranked mechanism not only operated the film movement, but also the generator to power the electric illuminant. A characteristic of the Pathé-Kok film, printed on a non-flammable (safety) base starting from nitrate negatives, is the asymmetric perforation system:

three perforations per frame on one side, one perforation per frame on the opposite side (Plate 12). In the copies printed in the United States from 1917 (Pathescope) there are three perforations on each side;

- the amateur film *par excellence*, 16mm, was invented by Eastman Kodak in 1920. The first version of this format, known as Kodascope, is a 'reversal' positive film: it could be taken directly from the camera and transformed into a positive copy which could be screened straight away. Almost all film in this format was produced on safety stock (Plate 13). In 1923, Pathé launched another amateur format, 9.5mm (Pathé-Baby), a strong competitor with 16mm for some years. Positive copies in 9.5mm were made on safety film (Plate 17);

- different producers thought up even more unusual formats, and sometimes reached bizarre extremes: for instance, Itala Film of Turin tried a 35mm frame divided into four parts to accommodate four different shots; Edison's 22mm film (Home Kinetoscope) accommodated three strips of frames just over 5mm wide, each of them separated by a line of perforations (Plate 5); the German firm Messter's Kino-Salon had four series of frames and two lines of perforations on a film just under 35mm wide (Plate 7); Oko film by Kazimierz Proszynski (Poland, 1913) was a 120mm film divided into rows of 15 frames. Experiments in 3-D film were also made from the very early years to the end of the silent era, some of them with standard 35mm film to be viewed with anaglyph glasses (Plate 56). None of these systems (with the partial exception of the Home Kinetoscope) went past the experimental stage or achieved wide sales. The often unique images recorded on these 'orphans' of technology (some other examples are given in Plates 4, 8, 16, 20, 30–3 and 35–8) are in danger of disappearing sooner than the others because the machines needed to project them are extremely rare and it is difficult and expensive to transfer them onto more familiar formats.

Sound

From the outset, silent cinema had an aesthetics and a technology of sound. In the beginning, performers had accompanied the projection of moving images with comments and interpretations for the benefit of the public. This had both an educational and a dramatic purpose: the showing of Edwin S. Porter's *Parsifal* (1904) involved the presence of actors in the cinema hall, the projection of magic lantern slides alternating with episodes from the film, and the performance of arias from the Wagner repertoire. Two actors accompanied the Russian short, *Boris Godunov*, produced by the Khanzhonkov company in 1912. For many years, in the long era of silent cinema in Japan, film screenings were integrated by the voice of interpreters known as *benshi*, who emphasised the content of the action with movements and prepared or semi-improvised texts.

A group of technicians performing sound effects behind the screen of a projection hall. Illustration from a Gaumont catalogue of film equipment, US edition, *c.* 1912 (George Eastman House).

With words came music. Initially, music was improvised on a piano; later it was adapted from the current musical repertory, and sometimes composed on commission and performed by orchestras, choirs and opera singers on great occasions, by chamber music ensembles or pianos again in more modest establishments. Camille Saint-Saëns' score for Calmettes and Le Bargy's *L'assassinat du Duc de Guise* (Pathé, 1908) is often said to be the earliest landmark of live music for silent films. The event was particularly significant, since an academic composer had finally agreed to write a score for a product of the new art distrusted by intellectuals. There were also some extreme examples of the alliance between music and the moving image: on 5 September 1916 the first official public showing of D.W. Griffith's *Intolerance* was accompanied by a 46-piece orchestra and a 16-voice choir; the following year, in the Netherlands, Johan Gildermejer made *Gloria Transita*, a film set in the world of opera which required performers to stand beside the screen and sing in time with the characters' lip movements.

Exhibitors who could not afford such luxuries usually had two options. The first was to entrust a pianist, an organist or a small instrumental group with brief scores summarising the tunes thought necessary to accompany each episode in the film; often they were not even true scores, but cue sheets indicating which widely known popular or classical pieces to play (from these cue sheets it is sometimes possible to reconstruct the narrative structure of films preserved in an incomplete form). The

other, more drastic solution involved doing without musicians and using mechanical instruments, from pianolas to huge poli-instrumental carillons driven by compressed air, into which rolls of perforated paper were fitted reproducing the music scores. The repertory available from the many companies which produced these rolls was vast; even well-established academic musicians such as Paul Hindemith contributed to it. Sometimes 'noise effects' were produced live in order to enhance the realism of the events depicted in the film. To this end, noise machines or noise performers were deployed to simulate the sounds of natural or artificial occurrences. They relied on ingenious and at times bizarre devices.

The fathers of the moving image had demonstrated from the beginning that they had even greater ambitions. As far back as April 1895, Thomas Alva Edison had presented a system for synchronising a cylinder phonograph with his kinetoscope: while watching the moving images through a peephole viewer, the spectator listened to a sound recording through earphones (Kinetophone: Plate 41). According to some sources, the synchronisation between phonograph discs and film was supposed to have started in 1896 with the use of the Berliner Gramophone by the French company Pathé. From then to 1906 many tried to follow the same direction: among them were Gaumont (Plates 19 and 46), Pineaud and Joly in France, Goldschmidt and Messter in Germany. All, to some extent, had to contend with the problem of amplifying the feeble sound of the phonograph in large halls.

In 1900, the year of the Universal Exhibition in Paris, Ernst Rühmer in Germany, William D. Duddell in United Kingdom and Th. Simon, working independently, perfected a revolutionary idea aiming to reproduce sound photographically on film. This was taken up and developed in 1906 by Eugène-Auguste Lauste, who patented a machine capable of recording images and sounds simultaneously on the same strip of film. However, for some time, production companies went on using synchronised discs. For example, Oskar Messter in Germany (1908), Giovanni Pastrone in Italy (1909) and Léon Gaumont in France (1909–10) distributed short films accompanied by texts and arias from light theatre and opera.

The premonitory signs of the real revolution, and the end of the silent era, emerged around 1918 in Germany, thanks to Vogt, Engel and Massolle. Their equipment for recording sound photographically on a separate film (the Tri-Ergon system) was presented to the public four years later in Berlin. Also working in this field were V.N. Kovalenkov in the Soviet Union (1920), Axel Petersen and Arnold Poulsen in Denmark (1922), Theodore W. Case, and Lee de Forest, whose Phonofilm (United States, 1923) involved reading a soundtrack, placed on the same film stock which held the images, by means of a photo-electric cell. In 1926 Warner Bros. presented *Don Juan*, starring John Barrymore. The film was synchronised to several 33⅓ rpm records with a 40cm diameter, played with a stylus which started in the centre of the record and went out to the edge (the Vitaphone system). Meanwhile another American company, Fox, was buying the rights to the Tri-Ergon and Phonofilm systems, and adding sound to previously made silent films.

The year 1926 thus marks the beginning of the history of sound cinema in the current sense of the term. In the same year, P.G. Tager published in the Soviet Union the results of his research on a variable density soundtrack; a few months later, Fox was proud to show Lindbergh, Mussolini and George Bernard Shaw with their own voices (Movietone News, April 1927). For some time films synchronised with records would run parallel to those with a soundtrack; but in less than two years the latter definitely became dominant. Soundtracks were added to works which had recently been finished as silents or to those which belonged to a past that suddenly seemed remote, almost intolerable without sound and dialogue (Larry Semon's pre-1920 Vitagraph comedies, for example, were provided with a soundtrack for their revived commercial exploitation).

Projection

What differentiates projected film from its ancestors (including the Kinetoscope patented by Edison and Dickson in 1891) is not only the fact that the resulting image could be seen by a community of viewers. In the Kinetoscope, the film strip was run continuously in a peepshow machine. Lumière's *cinématographe* (Plate 40) is based upon a radically different principle: each image would be held still in front of the lens for a small fraction of a second, and then replaced by another one at regular intervals with the aid of a metal claw taking down the film one frame at a time. British pioneer Robert William Paul further developed the idea with a mechanism called the 'Maltese cross', where a tiny pin connected to a cam would engage with the slots which were cut between the arms of a cross-shaped device, thus ensuring that the film moved down one frame. The intermittent movement obtained through this ingenious method is still the operating principle of modern-time film projectors.

Until the end of the silent era the projectors through which most films passed were variable in speed, operated by hand or driven by an electric motor. The operator had to adapt the projection speed to the rate at which the film had been shot, which in turn depended on various factors: the quality of lighting on the scene, the film's sensitivity, the kind of action the camera had to record. In order to ensure that the movements of characters appeared natural, projectionists of the late 19th and early 20th century showed films at speeds between 14 and 18 frames per second. If projected at less than 14 frames per second, the flickering of the image would have been too annoying for the eyes and heat from the projector lamp likely to ignite the film.

The ideal projection speed might vary even within the same film because the shooting conditions had changed, or the director and cameraman had wanted to obtain particular comic or dramatic effects. Projectionists might also drastically increase the projection speed (sometimes causing protests from the public) in order to add to the number of daily shows, or change it at the suggestion of the musicians to enable them better to follow a certain action, or give a scene the desired emotional impact.

The average projection speed increased with the passing years, until it became established – although after many uncertainties and much debate – at 24 frames per second by the second half of the 20s. Higher speeds were used occasionally for experiments with colour films: 32 frames per second for the Kinemacolor system (1909–14), 40 to 70 frames per second for the various equipments patented by William Friese-Greene from 1898 (Plate 58). The opposite tendency was seen, on the other hand, in some amateur film formats whose projection speed was brought down to 14 or sometimes 10 frames per second (9.5mm projectors were even kept on a standstill for the showing of intertitles).

The quality of projection was also affected by the size and the material adopted for the screen (which was often smaller than those used in the second half of the 20th century) and the lighting sources adopted. Before the introduction of electric light, there were at least four other available systems:

- oxyetheric light, produced by a small cylinder of caustic lime made incandescent with a flame produced by a mixture of oxygen and ether;
- oxyhydrogen light, based on a similar principle but using a mixture of oxygen and hydrogen;
- oxycalcic light, where caustic lime became incandescent in a jet of oxygen combined with a flame produced by alcohol;
- acetylene was tried briefly at the end of the 19th and the very beginning of the 20th century, but was eventually abandoned because the light from the gas was very weak, and the vapours released had an unpleasant smell.

Production

How many films were produced during the silent era? There is no certain record, and perhaps we shall never know. The few attempts at setting out a general filmography of the period failed because the number of titles was too large and reliable documents too scarce, especially for the first decade of cinema's life. According to one very approximate estimate, the copies of silent films currently preserved in the world's most important film archives are no less than 30,000 (including both fiction and non-fiction films). More are being found every year, some decompose before having been saved. If we are to believe the film historians' and archivists' estimate that more than 80 per cent of the world production of silent films has been lost, a complete list of titles made in the first thirty years of cinema would easily reach more than 150,000 entries.

Distribution

When dealing with the above hypothetical figures, we must also consider the number of copies made available for each film by the trade through four procedures:

- the direct sale of films, typical of the first ten years of cinema;
- vertically organised, integrated distribution as practised in France by Pathé Omnia between 1907 and 1909. The company controlled the film from beginning to end: manufacturing the raw stock, producing the film, distributing it and finally showing it in theatres owned by the company;
- rental, introduced in 1909 and established as a standard practice in the following years;
- second-hand sales, which derived from the practice of direct sale but survived the period after which this was replaced by the practice of renting films.

There is little information available on this at present, but it is assumed that an average of fifty to one hundred prints were struck for a fiction film produced by a major European company around 1910. The same applies for films produced in Denmark by Nordisk in its heyday, though for an international success like *Den hvide Slavehandel II* (August Blom, 1911) at least 260 copies were struck at the time of its initial release. On the other hand, some early American films which regularly appeared in company lists sold only one or two copies, or were never actually printed at all (and therefore never existed in the form of positive prints) because nobody requested them. On average, a 1914 Keystone comedy was released in a little over thirty prints, although forty copies of Chaplin's *Dough and Dynamite* and 41 of *His Trysting Places* were struck. Chaplin himself stated that 135 copies of the first film he made for Essanay, *His New Job* (1915), were already booked by the end of shooting. When Mutual released Chaplin's *The Floorwalker* in May 1916, seventy-five prints were needed for New York City alone. It is worth pointing out that any inquiry on the dissemination of a film in its country of origin and abroad must take into account the geography of contemporary distribution: in 1919 there were more than 15,000 cinemas in the United States, and it is certain that any ambitious company had to consider the size of the territory to be covered for a nationwide release.

Before the United States established its worldwide hegemony in the market, the film industry was dominated by European productions (France, Denmark and Italy). The distribution of films made by the most important European and American companies became an industry in itself within a few years: well before 1910, the chief firms had branches and agencies in almost every continent. Intertitles in different languages would be supplied in different ways: filmed and already inserted in each copy; as single frames (called flash titles) for reference; provided in the form of title lists, to be printed and newly filmed; or with a separate negative created for the purpose (shooting a film with two cameras side by side became a common practice within a few years of the invention of film): the second negative was sent overseas, where distributors would often make their own intertitles and sometimes add new ones (especially in France and Italy) whenever they felt it necessary.

If an ending seemed inappropriate to public feeling in a certain country, reels of

film containing alternative endings were made available. They were called 'Russian endings' when the print was made for eastern European countries, where a tragic conclusion was generally preferred to a happy one. In the first decade of the 20th century, film was sometimes made available in colour or in black and white, at appropriately different prices. Finally, the film underwent a further revision almost everywhere through censorship: two or more copies of the same American film, where they have been preserved, may look different from each other because the censors in each state or nation have taken different decisions according to prevailing mores.

Decay

Several things happen to a film between the time of its first screening and its entry into a moving image archive or a collection. This segment of time shapes the 'internal' history of the copy: the history of the places where it was shown and kept, and of the people who, with varying degrees of awareness, preserved it. It is also the history of the changes that have taken place within the object in the course of time: the history of its progressive self-destruction and, perhaps, of its final disappearance before it could be restored. The study of this process implies a fundamental distinction between a 'film' as a generic entity and the 'prints' through which the film is known. For example, in referring to the 1905 'film' *Rescued by Rover* by Cecil M. Hepworth, we gather within a single definition every 'copy' and 'version' of this title.

The cellulose nitrate stock on which almost every film from the silent period was made is a resilient yet vulnerable entity. It cannot be used beyond a limited number of showings, and it seems that its average expected life outside a climate-controlled environment seldom exceeds about a hundred years (some Lumière films still look in excellent shape, though, and other early titles suffer little more than a slight shrinkage). Film archives are trying to transfer it onto more long-lasting media, but it is an unequal struggle, made even more dramatic by the enormous quantity of material to be duplicated, the limits of the technology and the scarcity of financial resources.

'Nitrate won't wait' is a catchphrase once fashionable in film archives. From the moment it is produced, film stock begins its decomposition process, even in the best storage conditions (that is, at very low temperatures and in ideal humidity). In the course of this process the film emits various gases, especially nitrogen dioxide, which combined with the water in the gelatin and with air forms nitrous acid and nitric acid. These acids corrode the silver salts in the emulsion, destroying the image and the support that bears its traces, until the film is completely ruined.

The stages of this gradual death of a film are sadly familiar, even if the speed of the process is, to a large extent, quite unpredictable. The film shrinks, and the distance between perforations decreases, making projection impossible and copying problematic. There is a strong pungent smell, the image tends to disappear, and the

base takes on a brownish colour. The emulsion becomes sticky and it is increasingly difficult to unroll the film. Then eruptions of soft dark matter form on the surface of the reels. This continues until the film becomes an indistinct mass covered by a brown crust. In the final phase of decay, the film is reduced to a whitish mass, or even to powder.

A nitrate film in perfect condition burns at a temperature of 170 degrees Celsius (338 degrees Fahrenheit); a decomposing film can also burn at lower temperatures, down to 41 degrees (105.8 degrees Fahrenheit). If substantial quantities are stored at high temperatures in sealed cans with no air exchange, nitrate film explodes. There is no way to extinguish the flames: the film gives off the oxygen that feeds the fire even under jets of water, sand or carbonic acid. In the initial phases of decay, the film can still be saved by being copied to another carrier, but cellulose nitrate film must be treated with extreme care. In almost every country the projection of nitrate film is illegal or subject to severe restrictions. In our own interest and in the interest of the object's integrity, we must never try to examine nitrate films unless the correct equipment is available. The temptation to look at what may be in the reel we have just found is undoubtedly strong, but giving in to curiosity risks ruining or destroying an already timeworn object.

A nitrate copy can often be recognised by the words 'nitrate film' on the edge of the print. If the writing says 'safety film', we can be almost certain that there is no danger, but that does not mean that we are entitled to treat the print carelessly. When in doubt, it is best to leave the film as it is (and we should not throw away the box it comes in, at least not before taking note of what is written on it).

RULE 1

In the event of finding a nitrate film,
do not try to project it!
Contact a competent film archive immediately.
The archive staff will preserve it safely
and, if necessary, duplicate it.

A film on safety stock is not to be considered stable, either. The base of non-flammable film produced during the silent era (16mm film, for instance) is cellulose diacetate, which is safer than nitrate but, like all polymers, is subject to decay. This phenomenon also affects films from later times printed on cellulose butyrate, cellulose propionate, and, from 1949, on cellulose triacetate base. The principal traits of this sort of decay are described by technicians in graphic yet effective terms:

- vinegar syndrome, so called because of the strong acidic odour given out by the deteriorating film;

- rancid butter syndrome, produced by the butyric acid which develops in the acetate stock;
- pisces syndrome (or rotten fish syndrome), believed to be the effect of the decay in the photographic gelatin.

In many of the above cases the film becomes fragile and tends to curl up. At this stage it should not be unrolled because, if we attempted this, we would find ourselves holding a handful of semitransparent shavings. Decay can be retarded but not stopped (this is why film archivists fight to prolong the life of nitrate film until it becomes possible to duplicate it onto another carrier). Unfortunately, this is also true for cellulose acetate films, whose long-term survival is connected to the rigorous control of temperature and humidity in the premises where they are kept. Archivists are hoping that polyester, whose lifespan as well as physical and chemical compatibility with the photographic emulsion are now undergoing laboratory trials, may offer a viable alternative. Contrary to common belief, digital technology is not necessarily the solution to our problem. We shall return to this point in Chapter 3.

Reproduction

Because they are rare and extremely fragile, original prints should not – with few exceptions – be projected at all. These prints first must survive as long as possible if archives are to be able to restore these films, to duplicate them onto more durable and accessible material, or to preserve them until such time as the techniques of transferring the endangered images to another carrier have improved.

Archives affiliated to the Fédération Internationale des Archives du Film (FIAF) share the opinion that a restored film should be seen in a form as close as possible to the original. An increasing number of institutions provide scholars with reproductions of the most requested films on electronic media, since the wear and tear of a 35mm viewing print may necessitate re-use of the archive negative, at the cost of money that would be better spent on restoring endangered films. (The technological and moral implications of this policy are further discussed in Chapter 7.) Nevertheless, a silent film viewed in an appropriate archival or museum site is still a 35mm or, at least, a 16mm copy. This copy is the result of a preservation process involving print duplication. The main phases of this process will be examined in Chapter 3. In the meantime, it is important to bear in mind that a viewing copy obtained through preservation work may be affected by optical flaws or manipulations that reflect not the 'original' itself but the way it was handled and then duplicated:

- a 'double frame' line: the image is crossed horizontally by an opaque line, most often next to the upper or lower edge of the frame (see photo overleaf);
- stretching: this procedure allows a silent film to be shown at 24 frames per second (or faster for television). The method, now rejected by most major film archives, consists of reprinting some frames two or more times, at regular intervals. Copies made with this system are recognisable by the dreamlike or irregular pace of moving figures;
- cropped frame: the reproduction of each image obtained by eliminating the peripheral areas of the original frame in order to insert a soundtrack (on the left side of the image on screen) or to adapt the frame ratio to the mask fitted on modern projectors;
- the reproduction in black and white of films originally made in colour;
- alteration in contrast, due to careless reprinting or deliberately done in order to 'improve' the grading of the original print, to compensate for the absence of colour in the duplicate, or to adapt the contrast range to current taste;
- a soundtrack may have been added long after the copy was initially distributed and commercially exploited as a silent film;
- the editing may have been altered by zealous 'preservationists' and archivists (we are not including here the alterations made before the print entered the archive);

A 16mm acetate print of *The Navigator* (Donald Crisp and Buster Keaton, 1924) showing printed-in 'double' frame line – next to the upper edge of the frame (George Eastman House).

- freeze frames may have been added corresponding to shots or intertitles which were damaged or which survived only as fragments, and which are reprinted several times in order to make them visible;
- apocryphal intertitles may have been inserted by the archive because the originals are missing or severely damaged;
- production stills, explanatory titles or other images may have been inserted in the film to plug gaps in the narrative.

The above list is far from being exhaustive. (We shall return to some of its points in Chapters 3 and 6 when dealing, respectively, with film preservation and the viewing practice.) It does, however, serve the purpose of introducing a key concept in silent film studies: there is a huge difference between the moving image we are allowed to see today and what audiences saw at the time of its initial release. What this difference means, in silent cinema and beyond its chronological boundaries, is the question at the core of our inquiry.

Further Reading

Physical structure

See the bibliography at the end of Chapter 3. A short film produced by Metro-Goldwyn-Mayer, *The Romance of Celluloid* (1937), describes the process of manufacturing nitrate film stock.

Formats

Raife G. Tarkington, 'Early History of Amateur Motion-Picture Film', *Journal of the Society of Motion Picture and Television Engineers*, vol. 64 no. 3, March 1955, pp. 105–16; Brian Coe, *The History of Movie Photography* (Westfield, NJ: Eastview, 1981), pp. 162–9; John Belton, 'The Origins of 35mm Film as a Standard', *SMPTE Journal*, vol. 99 no. 8, August 1990, pp. 652–61; by the same author, *Widescreen Cinema* (Cambridge, MA: Harvard University Press, 1992), pp. 12–33; Paul C. Spehr, 'Unaltered to Date: Developing 35mm Film', in John Fullerton and Astrid Söderbergh-Widding (eds), *Moving Images: From Edison to the Webcam* (Sydney: John Libbey, 2000).

Sound

Historical sources (in chronological order)

E.A. Ahern, *What and How to Play for Pictures* (Twinfalls, ID: Newsprint, 1913); John S. Zamecnik (ed.), *Sam Fox Moving Picture Music* (Cleveland, OH: Sam Fox, 1913 [vols. 1 and 2], 1914 [vol. 3]); Giuseppe Becce, *Kinobibliothek* (Berlin: Schlesingersche Buch- und Musikhandlung Robert Lienau, 1919 ff.); Edith Lang and George West, *Musical Accompaniment of Moving Pictures* (Boston, MA: Boston Music, 1920; reprinted, New York: Arno Press, 1970); George W. Beynon, *Musical Presentation of Motion Pictures* (New York: G. Schirmer, 1921); P. Kevin Buckley, *The Orchestral and Cinema Organist* (London: Hawkes, 1923); Erno Rapee, *Motion Picture Moods for Pianists and Organists: A Rapid-Reference Collection of Selected Pieces* (New York: G. Schirmer, 1924; reprinted, New York: Arno Press, 1970) and, by the same author, *Encyclopedia of Music for Pictures* (New York: Belwin, 1925; reprinted, New York: Arno Press, 1970); *Cinema Music as a Profession* (Torquay: Educational Section, Screen Music Society, 1925); Hans Erdmann and Giuseppe Becce, *Allgemeines Handbuch der Film-Musik I & II* (Berlin-Leipzig: Schlesingersche Buch- und Musikhandlung Robert Lienau, 1927).

Critical and historical studies

A summary of experiments with sound cinema during the first thirty years of the 20th century can be found in Brian Coe, *The History of Movie Photography*, pp. 90–111. For an introduction to music in silent film see Gillian B. Anderson (ed.), *Music for Silent Films, 1894–1929. A Guide* (Washington, DC: Library of Congress, 1988); by the same author, 'The Presentation of Silent Films, or Music as Anaesthesia', *The Journal of Musicology* 5, 1987. pp. 257–95, and *Film Music Bibliography I* (Hollywood, CA: Society for the Preservation of Film Music, 1995); see also Charles Hofmann, *Sounds for Silents* (New York: Drama Book Specialists, 1970); Charles M. Berg, *An Investigation of the Motives for and Realization of Music to Accompany the American Silent Film, 1896–1927* (New York: Arno Press, 1976); Martin Marks, 'Film Music: The Material, Literature and Present State of Research', *The Quarterly Journal of the Music Library Association*, vol. 36 no. 2, 1979, pp. 282–325; Walther Seidler (ed.), *Stummfilmmusik gestern und heute* (Berlin: Volker Spiess Verlag, 1979); Hans-Jörg Pauli, *Filmmusik: Stummfilm* (Stuttgart: Klett-Cotta, 1981); Sergio Miceli, *La Musica nel film. Arte e artigianato* (Fiesole: Discanto Edizioni, 1982); David Robinson, *Musica delle ombre / Music of the Shadows: The Use of Musical Accompaniment with Silent Films, 1896–1936* (supplement to *Griffithiana*, vol. 13 nos 38–9, October 1990); Martin Marks, 'The First American Film Scores', *Harvard Library Bulletin*, vol. 2 no. 4, 1991, pp. 78–100; Emmanuelle Toulet and Christian Belaygue, *Musique d'écran, 1918–1995. L'accompagnement musical du cinéma muet en France, 1918–1995* (Paris: Editions des Musées Nationaux, 1994); Philip C. Carli, 'Musicology and the Presentation of Silent Film', *Film History*, vol. 7 no. 3, Autumn 1995. pp. 298–321. 'Global Experiments in Early Synchronous Sound', special Domitor issue of *Film History*, vol. 11 no. 4, 1999. A bibliography of over 800 titles, mostly from the silent period, can be found in Steven D. Wescott (ed.), *A Comprehensive Bibliography of Music for Film and Television* (Detroit, MI: Information Coordinators, Inc, 1985, Detroit Studies in Music Bibliography 54, pp. 25–67). Early films with synchronised phonograph recordings: Jan Olsson, *Från filmjud till ljudfilm* (Stockholm: Proprius Förlag, 1986), including an audio cassette containing 17 recordings from phonograph discs for silent films in the period 1903 to 1914. Mechanical instruments for film theatres: *Das Mechanische Musikinstrument enhält Die Drehorgel*, vol.

11 no. 41, April 1987. The transition from silent to sound film: Scott Eyman, *The Speed of Sound: Hollywood and the Talkie Revolution, 1926–1930* (New York: Simon & Schuster, 1997); Martin Barnier, *Le Cinéphone et l'Idéal-Sonore, deux appareils sonores Gaumont des années 1920–1930, 1895*, no. 24, June 1998, pp. 37–53. A dissident, deliberately heretical view on the subject is brought by Rick Altman, who believes that 'silence was in fact a regular practice of silent film exhibition': 'The Silence of the Silents', *Musical Quarterly*, vol. 80 no. 4, 1997, pp. 648–718.

Projection

Given the fundamental role of the screen in the film experience, it is startling to see that so little, if anything, has been published on its history, a fascinating topic still awaiting proper attention. Even the history of film projection has so far been marginalised to specialised technical literature in periodicals such as the *SMTE* (later renamed *SMPTE*) *Journal*. No study on the subject should miss *The American Projectionist*, a journal published in New York between 1923 and 1931 by the American Projection Society. Useful readings on the topic are Raymond Fielding, *A Technological History of Motion Pictures and Television* (Berkeley: University of California Press, 1967); Laurent Mannoni, *Le Mouvement continué* (Milan-Paris: Mazzotta/Cinémathèque française/Musée du cinéma, 1996); John Hiller, 'Film History for the Public: the First National Movie Machine Collection', *Film History*, vol. 11 no. 3, 1999, pp. 371–86. The debate on projection speed is summarised in Kevin Brownlow, 'Silent Films. What Was the Right Speed?', *Sight and Sound*, Summer 1980, and *Classic Images*, June 1984; a heterodox viewpoint on the subject comes from James Card, 'Silent-Film Speed', *Image*, vol. 4 no. 7, October 1955, reproduced in Marshall Deutelbaum (ed.), *'Image' On the Art and Evolution of Film* (New York and Rochester, NY: Dover Publications Inc. and George Eastman House, 1979), pp. 145–6.

Production

The only production catalogues reprinted after the silent era have been published in the United States and United Kingdom: Stephen Herbert, Colin Harding, Simon Popple (eds), *Victorian Film Catalogues, A Facsimile Collection* (London: The Projection Box, 1996); Reese V. Jenkins (ed.), *The Thomas A. Edison Papers: A Guide to Motion Picture Catalogues by American Producers and Distributors, 1894–1908* (Frederick, MD: University Publications of America, 1985 [6 reels of 35mm microfilm]) is an invaluable source of information on the films produced in the United States during the early period. The microfilms are accompanied by a 50-page guide edited by Charles Musser. Bebe Bergsten (ed.), *Biograph Bulletins, 1896–1908* (Los Angeles: Locare Research Group, 1971); *Biograph Bulletins, 1908–1912* (New York: Octagon Books, s.d. [1973]). A partial exception is Henri Bousquet's chronology of the films produced by Pathé Frères in France (see the Filmographies section at the end of Chapter 5).

Distribution

Kristin Thompson, *Exporting Entertainment: America in the World Film Market, 1907–1934* (London: BFI, 1985); Richard Koszarski (ed.), *Exhibition*, special issue of *Film History*, vol. 6 no. 2, Summer 1994; Richard Abel, *The Red Rooster Scare. Making Cinema American, 1900–1910* (Berkeley: University of California Press, 1999); Robert C. Allen, 'Motion Picture Exhibition in Manhattan, 1906–1912: Beyond the Nickelodeon', *Cinema Journal* 18, Spring 1979, pp. 2–15; Ben Singer, 'Manhattan Nickelodeons: New Data on Audiences and Exhibitors', *Cinema Journal* 34, Spring 1995, pp. 5–35. The lively debate following the publication of Singer's essay, also documented in *Cinema Journal*, is well worth reading.

Architecture

David Atwell, *Cathedrals of the Movies. A History of British Cinemas and their Audiences* (London: The Architectural Press, 1980); Ben M. Hall, *The Best Remaining Seats* (New York: Bramhall House, 1961). A useful bibliography on the subject appears in Joseph M. Valerio and Daniel Friedman, *Movie Palaces: Renaissance and Reuse* (New York: Educational Facilities Laboratories Division, Academy for Educational Development, 1982). The preservation of historical buildings dedicated to film exhibition is discussed by the periodical *Marquee*, published by the Theatre Historical Society of America (ISSN 0025–3928).

Reception

In the absence of a general history of film reception during the silent era, here's the best of the crop: Yuri Tsivian, *Historiceskaja recenija kino kinematograph v Rossii, 1896–1930* (Riga: Zinatne, 1991), translated into English and revised as *Early Cinema in Russia and Its Cultural Reception* (London and New York: Routledge, 1994). See also Gregg Bachmann, 'Still in the Dark: Silent Film Audiences', *Film History*, vol. 9 no. 1, 1997, pp. 23–48; Miriam Hansen, *Babel and Babylon: Spectatorship in American Silent Film* (Cambridge, MA: Harvard University Press, 1991); John Belton (ed.), *Audiences and Fans*, special issue of *Film History*, vol. 6 no. 4, Winter 1994); Janet Staiger, *Interpreting Films: Studies in the Historical Reception of American Cinema* (Princeton, NJ: Princeton University Press, 1992); Donald Crafton (ed.), special issue of *Iris*, no. 11, Summer 1990, on early cinema audiences.

Decay

(Roger Smither (ed.), *This Film is Dangerous: An Anthology in Celebration of Nitrate Film* (Brussels: FIAF, 2000); David Pierce, 'The Legion of the Condemned: Why American Silent Films Perished', *Film History*, vol. 9 no. 1, 1997: 5–22. A bibliography on film preservation is provided at the end of Chapter 3. Those who are curious to see what an actual fire of nitrate film looks like may enjoy watching the eerie short film, *Das Verhalten von brennendem Nitrofilm gegenüber löschmitteln* (Österreichisches Filmarchiv, Austria 1978, 19').

The poem by Christian Morgenstern 'Fisches Nachtgesang' (1905) is reproduced from *Über die galgenlieder* (Berlin: B. Cassirer, 1921).

2
The Way of All Flesh Tones

> I know that my colours are not yours. Two colours are never the same, even if they're from the same tube. Context changes the way we perceive them. I've usually used one word to describe a colour, so red remains red with lapses into vermilion or carmine. How could I be certain that the shade I wanted could be reproduced by the printer? I prefer that colours should float and take flight in your minds.
>
> Derek Jarman

The Heritage of Magic Lantern Slides: Hand-Colouring and Stencil

The first attempts to apply colour manually to the film emulsion derive from the methods normally used for magic lantern slides. Experiments in this direction were made in the United States and France almost as soon as the photographic moving image came into existence. Already in 1895 the Edison Kinetoscope Company had marketed *Annabelle's Dance* – the first of a vast repertory of single-shot views dedicated to the genre of the 'serpentine dance', which Loïe Fuller had made an international rage – in colour versions. Annabelle's white veils were tinted by hand by the wife of Edward Kuhn in the Edison Laboratories at Llewellyn Park, New Jersey, using half a dozen hues, in an attempt 'to simulate the effect of the coloured lights that were projected on the ballerina during her performance on stage'. Early attempts in this direction were also made by Lumière in France and by Robert William Paul in the United Kingdom.

The application of colour was later improved with the use of powerful enlarging lenses and extremely fine brushes. Georges Méliès, more than anyone else, took advantage of the limitations inherent in this practice (it was difficult to follow precisely the contours of people and objects) by producing some of the most fascinating colour films of the early period (Plate 45). *Le Palais des mille et une nuits* (1905) has ample strokes of brilliant dyes, sometimes with a dominant golden yellow, pervading the entire frame and creating an effect similar to tinting; more complex is the colour scheme in *Le Royaume des fées* (1903), in which the variety and density of the hues has no equal among surviving nitrate prints of the early period. The colours in this film have been compared to those of medieval miniatures, not only because of the minute detail and the clever articulation of delicately hued patterns within a tiny