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Polish Science and Technology in Relation to the Invention of the Cinematograph and the Formation of Modern Film

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Władysław Starewicz

Abstract
In his research, Jewsiewicki was interested in the relations between technology, science, and art. In the following text, the author looks for the origins of film inventions that grew out of the eternal human desire to capture life in moving images. Jewsiewicki reaches back to the 13th century and focuses on the optical devices of that time paying particular attention to the traces of inventions in Poland. He recalls Vitello (a Silesian monk, physicist, philosopher, researching optical and light phenomena in the context of visual illusions and the psychology of vision) as well as Nicolaus Copernicus. Jewsiewicki also mentions, among others, Jan Heweliusz and Christopher Scheiner, the astronomer associated with the city of Nysa, as well as Aleksy Sylvius – a designer of astronomical devices. Jewsiewicki writes about magic lanterns and Chinese shadows, as well as cameras for creating moving photographs. However, the article chiefly focuses on Kazimierz Prószyński, Jan Szczepanik and Władysław Starewicz, who, in Jewsiewicki's opinion, significantly influenced the technical development of cinema. **(Non-reviewed material; originally published in *Kwartalnik Filmowy* 1960, no. 40, pp. 59-71).**

General perspective

It is well known that before the first Lumière brothers' cinema presentation in Paris in 1895, scientists and designers put a lot of energy and effort into establishing the principles of perception of moving images and constructing an adequate cinematographic apparatus. The development of shows based on optical illusions progressed in parallel with scientists' research. The interaction of both factors eventually led to the invention of film.

A basic and important factor in the creation of the cinematograph is undoubtedly the film technique. Owing to it, and in organic connection with the spectacle, it was possible not only to create a film spectacle and organise the industry but also to shape contemporary film art. Being a synthesis of prior arts, it has found its language which speaks to the masses with irresistible force and conviction.

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The first ideas of the cinematographic apparatus can already be seen in the works of European scientists of the 13th century. Also, the first works of Polish scholars in the field of film prehistory can be located in this period.

Research on optical illusions in Europe was initiated by two scientists: Roger Bacon (a Franciscan philosopher, versatile researcher as well as professor at Oxford) and Vitello (a Polish optics researcher). Bacon's work entitled *The Greater, Lesser, and Third Work* was written between 1267 and 1268.[1] Vitello's work, *Perspectiva*, was written between 1270 and 1278.[2] From now on, we will observe continuous progress in research on the optical darkroom and the magic lantern.

Vitello was born in Poland, studied in Paris, and then, after a short stay in Poland, he went to Italy in the 1350s. There, he became interested in optical phenomena, especially refraction. In *Perspectiva*, Vitello addressed the issues in geometrical, physical, and physiological optics. Still, in the Middle Ages, the term 'perspective' applied to all optics. Vitello was a theoretician, and probably that is why there is no record of his attempts at the practical construction of an optical darkroom, just like in the case of Bacon's work.[3]

Further work on the development of the optical darkroom is carried out in Italy, especially by Leonardo da Vinci,[4] who carefully analysed the conclusions contained in Vitello's work.

Yet, in Poland, the issue of constructing and using the optical darkroom has not ceased to interest scientists. The *camera obscura* as an instrument for scientific astronomical research was of great interest to Nicolaus Copernicus. Contemporary studies on the history of Polish optical illusions conducted by Tadeusz Przypkowski have demonstrated that Copernicus (with his student Jerzy Joachim Retyk) observed a solar eclipse using pinhole projection. This research method of the Polish astronomer, with which he measured the percentage of the solar eclipse (on 28 March 1530, 18 June 1536, 6 April 1540, and 20 August 1541), was generally recognised at that time as a revelation by the scientific circles. Retyk introduced this method to professors in Wittenberg.

As for the use of the optical darkroom as a device improved by the use of a lens, its history also has its origins in research conducted in Poland. Krzysztof

Scheiner, the superior of the Jesuit monastery in Nysa Śląska, constructed an astronomical telescope based on the idea of the German astronomer Johann Kepler (1610). Using a pinhole projection system, Scheiner discovered sunspots in 1611.

A few years later, similar observations were initiated in Kalisz by the local Jesuits. Aleksy Sylvius, on the initiative of Kalisz scholars, constructs the first properly assembled projection apparatus for astronomical observations. Due to the use of an astronomical telescope, it is an improved method of Copernicus's pinhole projection. These cameras are already a prototype of the magic lantern. The construction date of the first three models falls in 1614. Their analysis demonstrates that Sylvius, recognised in scientific circles as an excellent constructor and inventor, managed to build these devices on his own, using old patterns and improving them for practical purposes.

Between 1630 and 1650, Stanisław Pudłowski and Jan Brożek – two professors from Kraków who had little contact with the Jesuits – carried out projection observations of the sun using instruments similar to those used by the Jesuits in Kalisz.

In 1646, Athanasius Kircher, a Jesuit then commonly considered to be the inventor of the magic lantern, publishes in Rome his great work *Ars Magna Lucis et Umbrae*, where he describes the operating principles of the magic lantern. However, according to Tadeusz Przypkowski, the lantern has probably already been used for several years for entertainment purposes in Western European cities.[5]

In Gdańsk, a year after Kircher (1647), Polish astronomer Jan Heweliusz publishes a work entitled *Selenography, or A Description of The Moon*, in which he describes a precisely designed projection apparatus, applicable not only to observing sunspots but also the lunar surface.[6]

Magical practices using a projection apparatus were probably also known in Poland, especially in the times of King Stanisław August in the second half of the 18th century, when, following the example of Paris, Chinese shadows were combined with a magic lantern. Also frequent were magic lantern presentations organised by Jesuit colleges during school performances.

Photography was the next element that contributed to the creation of the cinematographic apparatus. As we know, the invention of photography took place in France in 1839. Photography, with its original name 'daguerreotype,' found many supporters in European and American countries. We note the very early cultivation of daguerreotypes in Poland, exemplified by the works of engineer Maksymilian Strasz in Kielce,[7] and its rapid development and achievement of high artistic values, especially in the works of Karol Bayer[8] and his students in Warsaw.[9] Polish camera designs were also known, be it Konrad Brandel's 'photo-revolver,' which introduced a new system of snapshot photography,[10] or the works of engineer Piotr Lebiedziński on the quality of the substrate for obtaining the image, etc. Adam Prażmowski, a professor at the Warsaw Medical Academy and an emigrant after 1863, was also among the pioneering camera designers. He became famous in Paris as an optician and designer. He combined, among others, lenses for the camera of Pierre Janssen, who photographed the passage of the planet Venus through the face of the sun in 1874.[11]

The construction of cameras to 'animate' moving photography in the 1880s and 1890s became quite a common phenomenon. It was the last stage before the

creation of the cinematograph. Étienne-Jules Marey and Georges Demenÿ in France, William Friese-Greene and Robert W. Paul in England, Max and Emil Skladanowsky and Oskar Messier[12] in Germany, Diubuk[13] in Russia, as well as Eadweard Muybridge, Louis Aimé Augustin Leprince,[14] and Thomas Alva Edison in the United States – here is a modest list of the best-known constructors of pre-film cameras in the period before the invention of the cinematograph.

In Poland, among the constructors of pre-film cameras, we should mention Piotr Lebiedziński, Jan and Józef Popławski, as well as J. Janowski.[15] Their attempts to solve the specific construction of cinematographic apparatus did not bring satisfactory results.

The invention of the 'cinematograph' by the Lumiére brothers in France in 1895 soon revealed that cinematographic cameras were also built in many other countries. Therefore, immediately after the Paris cinema premiere in December, new cinematograph design solutions were announced in several countries (England, Germany, France, USA, Russia).

Attempts to construct a cinematograph in Poland resulted in the triumph of a Polish technician, Kazimierz Prószyński. His apparatus – the 'Pleograph' – from the end of 1894 met the scientific requirements: it had a jumping mechanism for even movement of the perforated tape.

Prószyński's invention put Polish designers among the first ranks of cinema creators, especially since our inventor shot films himself using his own camera. His documentary, entertainment, and genre scenes were well known in Warsaw: *Ulica Franciszkańska* [*Franciszkańska Street*], *Aleja Ujazdowska* [*Ujazdowska Avenue*], *Przed pomnikiem Mickiewicza* [*In front of the Mickiewicz Monument*], *Mazur kostiumowy* [*Costume Mazurka*], *Pan Twardowski*, *Powrót birbanta* [*The Return of the Roisterer*], and others.

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The achievements of Polish engineering in the development of the cinematograph can be observed in several fundamental areas of film technology: 1) in the development of the vision of moving film images and the related designs of cinematographic devices and apparatuses, 2) in the development of sound recording and reproduction systems in cinematography, 3) in the development of colour film systems, 4) in the development of the animation technique of puppet film.

Let us discuss each issue in turn.

Between 1895 and 1902, from the moment of the complete construction of the cinematograph to the moment of learning about its potential possibilities, is the period when primarily photographic technology developed. It was at that time that photographic tricks came about, to which Georges Méliès added theatrical, chemical, illusionistic, pyrotechnic, and others, thus creating theatre on the screen and initiating the staging of a film show. This is how the fundamental elements of photographic technique in cinema were born.

Since 1900, scientists and technicians have been working both in the field of sound recording and reproduction in cinema and in the development of film colour systems. Ernst Ruhmer and André Blondel established foundations for

practical recording of sound on film, but it was still a long way to sound film. The experimental work of the inventors allowed the producers to introduce speech into cinema. These were attempts to synchronise the image with singing recorded on gramophone records and called *portrait parlant*.

In the field of colour film, the first attempts to obtain a colour image using filters were recorded as early as 1898. But neither the work of Claude Friese-Green and George Adam Smith nor that of Frederick Marshal Lee and Edward Raymond Turner brought any positive results.

The years 1895-1902 were a period in which the projection of black and white images still left much to be desired. The annoying flashing of the image on the screen while showing films did not allow the film spectacle to develop. This problem was tackled by many technicians and designers.

After this brief summary of the history of the general development of cinema in the first years of its existence, it is possible to get an idea of the main problems of technical progress which will continue to occupy the minds of scholars and inventors alike.

The construction of cinematographic instruments and apparatuses

Kazimierz Prószyński was the best representative of Polish designers in this field. He was the son of Konrad Prószyński, known as "Promyk" ["Ray"] – a well-known educator in the Kingdom of Poland. The matter of removing image flashes from the screen during film presentation was taken up by Prószyński in 1898. In his 'Pleograph' camera, he introduced two positive tapes from which images were projected alternately to eliminate vibrations while screening the film. The inventor did not receive any positive results from these experiments. He called his new stationary apparatus a 'Bio-Pleograph' (1898).[16]

In the history of cinematography between 1903 and 1909, we can observe the development and full use of the potential capabilities of the film camera. This, of course, had an impact on the organisational and economic aspects of cinema, as well as on the development of expressive means. Technology is slowly expanding the scope of the film spectacle and its range of influence. Industrialisation of the film spectacle takes place, and thus a change in the modus of film production, distribution, and presentation. The film industry switches from the previous cottage industry methods of operation to factory methods.

However, a major obstacle hindering the production of feature films was the unbearable and tiresome flickering of the images on the screen. The average length of the films made at that time was between 200 and 300 meters. In the course of his research on this problem, Kazimierz Prószyński built in 1906 a new camera and a projector with a very original gripper (greifer).[17] Still, despite the inventor's great hopes, flickering during the projection, although insignificant, remained.

At that time, cinema was already fulfilling a specific service function, and one could even talk about its social, educational, and interventional role. The film's subject matter was becoming mature enough that the formerly limited film length could no longer suffice for the artist to express himself. From 1907 to 1908,

the subject matter of films produced changed radically, especially in France. Instead of films dealing with social issues set in a proletarian environment, there was a shift towards historical dramas, sentimental stories, and adaptations of literary classics. The repertoire of cinemas in large cities adapted to the tastes of the theatre-goers. Improving cinema projection is becoming urgent since films dealing with new topics require much greater length to fulfil new objectives.

In such circumstances, Prószyński crowned his 11-year-long efforts by finally removing the flickering of the image during the projection. On 7 June 1909, at a meeting of the French Academy of Sciences, the eminent physicist Albert Dastre[18] reported on Prószyński's scientific discovery,[19] the practical expression of which was the introduction of an additional three-blade diaphragm (obturator) to projection cameras. Thanks to the use of an additional diaphragm in the projector, the rotation frequency increased to 44 times per second so that the interruption of light during the film projection was several times faster, which, in turn, eliminated the vibrations of images on the screen.

Prószyński's scientific insight enriched our knowledge about the laws governing the perception of moving film images. One should point out that a few years ago, Prószyński was awarded an honorary silver medal for the theoretical development of the motion of a film reel during projection by the Society for the Promotion of National Industry at the French Ministry of Industry in Paris.[20]

The invention of the 'obturator' is the ultimate development of proper cinema projection while simultaneously providing a constructive solution for synthesizing movement on the screen.

Thanks to the introduction of Prószyński's invention into the projection apparatus, the production of feature films (from 1,500-3,000 m) became possible. Only then began the full-scale production of historical dramas and adaptations of novels in France, Italy, Russia, Denmark, as well as in the USA.

Between 1909 and 1914, there was a period of further exploration in the field of deepening the reproduction values of film. The rapid development of film art placed great demands on the technique. The result of this demand was a hand-held 'Aeroscope' film camera constructed by Kazimierz Prószyński in 1910.[21]

Cameras on tripods have been used so far. Since the introduction of the 'Aeroscope,' hand-held shots have been taken in all kinds of circumstances. An appropriate device used in the camera eliminated the vibrations caused by a shaking hand while filming. The tape load for the 'Aeroscope' was 120 meters, enough for 10-15 minutes of continuous shooting. This small and light film camera, shaped like a small oblong box, revolutionised the production of short films. The development of social life and the accumulation of political events in the years 1910-1914, resulting from rapidly growing contradictions between the imperialist states in Europe, demanded from cinema a 'live newspaper.' A heavy camera on a tripod could still be tolerated in the production of a feature film. However, in a short film, especially in reportage, it could no longer keep up with the fast-paced events of the day. That is why Prószyński's hand-held camera quickly came into use as a reporting camera and a recording instrument in the hands of journalists, scientists, and landscape filmmakers.

The French Academy of Sciences has approved the Pole's invention. The referent of the case was Professor Gabriel Lippmann – an eminent specialist in colour photography and the winner of the Nobel Prize in 1908.[22]

The popularisation of Prószyński's 'Aeroscope' was initiated by Cherry Kearton – an English traveller and scholar. He tried out this camera on numerous scientific journeys in various parts of the world and later described it in his two books: *Wild Life Across the World* (1913) and *Trough Central Africa from East to West* (1915). Prószyński's camera was used for filming on the front during the Balkan War in 1912 and World War I, with many cameramen expressing their positive opinions. Between 1913 and 1915, the Gaumont Graphic and other newsreel companies used the 'Aeroscope' to shoot the footage.[23]

It should also be emphasised that at the International Cinematographic Exhibition in London in 1913, Prószyński's camera received a special award.[24]

Kazimierz Prószyński built a practical amateur camera in 1912. This time it was an extremely original, light camera for the so-called 'sequential' film: 12 cm wide, with 15 frames in a horizontal row of 5x7 mm. This film was shown successively from left to right and then from right to left. The original features of the new camera were the dimensions of the film strip, its arrangement, and the method of traction. When one watches this camera work during the projection, one gets the impression of 'reading' the images. The load of film tape for the camera was 1 m and replaced 150 metres of regular 35mm tape. The entire apparatus, a film camera, turned into a projector after adding a projection bulb and changing the lens. This amateur camera with dimensions of 27x19x11 cm, later called the 'Eye,' was demonstrated by Prószyński for the first time in Warsaw in 1912.[25] The projection bulb that Prószyński installed in his amateur camera was equally original. It was a technical revelation. The minimum power of this bulb was 50W, while the light power was practically equal to 450W thanks to the use of filaments of a special chemical composition. These filaments were bent backward towards the wall of the bulb facing the light-reflecting mirror.[26]

The first foreign demonstration of the amateur 'Eye' camera took place in London on 20 January 1914, at a meeting of the Royal Photographic Society of which Prószyński was a member.[27] The demonstration was very successful.

During the war years, Prószyński also constructed the world's first aerial camera for the Royal [?] War Office in England.[28] There are documented opinions on this invention by people who used this camera in their professional work, such as the English cinematographer Gordon,[29] the American cinematographer Leslie Wyand,[30] British Army Lieutenant Geoffrey Malins, and British Army Major [Harold Henry?] Blake.[31]

The first attempts at aerial photography with Prószyński's camera, according to the memoirs of James Anderson, a former colleague of Cherry Kearton, were taken in 1912 or 1913. They were photos of Kearton taken from the Spencer brothers' balloon in London.[32]

After the end of the war, Prószyński returned to Poland. In Warsaw, a joint-stock company was established in 1922 for the production and maintenance of the 'Eye' amateur camera. In 1925, the company managed to produce one hundred promotional units of the 'Eye' cameras and then liquidated without starting mass production.[33]

Becky Sharp, dir. Rouben Mamoulian (1935)

The Grasshopper and the Ant, dir. Władysław Starewicz (1911)

The Beautiful Leukanida, dir. Władysław Starewicz (1912)

The Cameraman's Revenge, dir. Władysław Starewicz (1912)

The work and constructions of other Polish technicians were not original enough to influence the development of world film technology, so we will not be discussing these otherwise interesting achievements here.

Sound recording and playback

The development of the cinematic spectacle and the diversification of the film subject matter inspired film engineers to try to solve arising technical problems, including those connected with film sound. The most well-known inventions in this field from 1907 are attributed to Eugène Augustin Lauste and Lee de Forest.

These early experiments leading to the invention of the sound film also involved Poles. The first of them, the already-introduced inventor Kazimierz Prószyński, patented his original system of synchronising the image on film tape with sound registered on gramophone records in Berlin (1907) and London (1908).[34] Prószyński's use of pneumatic compression for the synchronisation of sound and image resonated among professionals at that time, leading to the development of many other inventions in the field of sound technology based on this operating principle.

At this stage, insufficient technological progress in the field of electric current amplifiers made it impossible to implement inventions in sound films. Therefore, attempts to make sound films using Prószyński's invention, the 'Kinofon,' were unsuccessful. Two sound films shot by Prószyński together with the Warwick Trading Co. studio in 1913 in London were not appreciated by film industrialists.[35]

New attempts at inventions in the field of sound recording and reproduction in cinema took place in the last years before World War I. The first patents for recording sound on film using a light-sensitive method synchronously with the image appeared in 1912. The patents of Edward H. Amet and Lauste are particularly well known. Poles achieved comparable results in the same year. A pioneering achievement in the field of photographic recording of sound on film tape was Jan Gizy's density recording method,[36] as well as the use of a special device for recording and reproducing sound on film tape, similar to the string galvanometer introduced by Eustachy Białoborski.[37]

Jan Szczepanik, a famous inventor of colour photography and film, patented his own device for recording and reproducing sound using an oscillographic tube of a special design in 1914.[38] He brought a number of new inspirations to the history of the development of sound technology with his construction. During the war years, Józef Krawiecki worked on the invention of the sound film. He was the first to present a remarkably original sound recording method using a double mirror galvanometer in 1918. Although developed only theoretically, this method significantly contributed to the knowledge of the sound technique in cinema.[39]

The achievements of Edmund Łasiński are also valuable. While working on the proposed projection device with a video amplifier, he constructed an improved and highly original selenium cell (1917).[40] Marceli Rohoziński is the author of probably the first idea for a very interesting combined photo and sound

camera using magnetic recording on steel tape – a forward-looking invention patented in 1921.[41]

Polish inventions played the part of a 'construction sequence' and, alongside other inventions from all over the world, are the basis for the development of sound technology in film.

One more innovation should be added to the number of Polish inventions in the field of sound, perhaps a bit out of the way of proper sound technology: Jakub Karol's (Caroll) idea of 'dubbing.' Submitted and used in 1930 in Hollywood, it later came into use in many countries with highly developed film industries.[42]

Colour photography and colour film

The popularity of cinema forced producers to look for new ways to make the film spectacle more attractive. In the wake of sound technology, attempts to produce colour films were made as early as 1902. However, the poor substitute for colour quickly discouraged the audiences, and insufficient knowledge about dyes hindered the invention of colour film. Despite all this, intensive research was carried out in science laboratories and workshops to develop methods for colour photography and film.

From among Polish technicians, who have devoted themselves to this problem, one should mention Jan Szczepanik. The son of a poor woman worker from the Krosno area, he was a brilliant, self-taught technician, creator of many inventions in various areas of technology, such as television, bulletproof armour, the photosculptor, the automatic thrust regulator, the spark telegraph, and sound film.

Having graduated from the teacher training college in Kraków, Jan Szczepanik became a teacher in the district of Krosno, where he developed his first invention, which brought him fame, recognition, and wealth. It was an invention in the field of weaving that was applied to the production of silk tapestries by the photographic-electric method on an automatic basis. Szczepanik's weaving invention[43] was based on a reproduction technique which he remained faithful to in all his works in the fields of photography and film.

Jan Szczepanik began researching colour photography and cinema well before 1898. The first invention in this field was a camera designed for photos and projections in 'natural' colours according to the additive method.[44] It made it possible to take three photographs simultaneously through three filters in primary colours. The photographs obtained in this way were developed and copied in the usual way since they were black and white. Szczepanik's prints copied on glass or film tape could be displayed in colour on the screen using a camera similar to that used for photos and equipped with an appropriate lighting device.

In 1899, Szczepanik patented the small-format colour film system[45] that was subsequently used and developed for 16mm film as Codacolor[46] in 1928 and Agfacolor in 1932. Szczepanik's original system was based on pressing cylindrical lenses on the side of the film tape facing the object lens provided with a filter composed of three strips: blue, red, and green. The film was, likewise, developed in black and white.

At the time, it was impossible to put Szczepanik's and other researchers' inventions to practical use due to poor knowledge of dyes and no known methods for permanent copying.

Jan Szczepanik has been conducting persistent research to obtain photos and prints in colour since 1902. This problem had absorbed the inventor's mind almost until the outbreak of World War I. Between 1902 and 1912, he patented a number of inventions in the field of colour photography resulting from laborious theoretical investigations.[47] They concern several procedures and various improvements in the method of copying coloured slides and the production of special paper for colour prints.

Beginning in 1903, we note some interesting endeavours on the colour photography method carried out by another Polish technician, engineer Karol Juliusz Drac, a native of Warsaw and a graduate of the St. Petersburg Institute of Technology. Drac also relied on the principle of three-colour photography but chose a different approach: he received three negatives simultaneously with one exposure, completely abandoning the use of filters. The 'Chromograph,' the camera constructed by Drac, was equipped with carefully calculated prisms positioned at the front of the camera. As a result, the inventor simultaneously exposed three panchromatic plates arranged in three wings of the camera with one exposure. After the demonstration of the 'Chromograph' in 1906 in London and Warsaw, Karol Juliusz Drac died tragically that year without completing the invention.[48]

Between 1909 and 1914, the work on colour photography and cinematography has progressed significantly. However, experimental colour films of that period screened for commercial purposes could not satisfy cinema audiences. The problem of colour photography and film still could not be solved optically and photochemically.

Jan Szczepanik generally does not stop the research on colour photography he started in 1902. He worked on improving his own methods of producing paper and plates for colour photography until World War I, patenting their more and more important aspects. The inventor's main works concerned the so-called method of 'fading' ('creeping'). The phenomenon of colour fading as a result of various coloured objects' long-term exposure to light is known from everyday life. The objects lose their colour and fade while photochemical reactions occur. Jan Szczepanik, taking advantage of this phenomenon, developed colour-sensitive photographic paper, which, due to the very expensive production process, was of rather theoretical importance. The method developed by Szczepanik has been widely recognised and is known in professional literature as *Ausbleichverfahren*.[49] After long discussions in scientific circles, especially in Germany, Jan Szczepanik was finally granted precedence in developing this method.

Simultaneously, Szczepanik developed a method for making a three-colour raster that became the basis of colour raster plates for photography produced in Dresden between 1906 and 1907 under the name 'Veracolor.'[50] He also developed a method for measuring colour using an instrument of his own design, the 'Colorimeter,' which enabled determining the quality and intensity of the tested colour in numbers.[51] These inventions are Jan Szczepanik's further contributions to the theoretical knowledge of colours and their use.

Colour film was not invented during World War I, although it was then that fundamental inventions came about, such as 'Codachrome'[52] and 'Technicolor.' Among the Polish technicians and their achievements in the field of colour film at the time, Jan Szczepanik, already an outstanding theoretician and practitioner of colour photography, should again be placed in the first position. The inventor still bases his work on the three-colour additive method.

In Germany, in 1925, and later in Switzerland, an association was established to utilise Jan Szczepanik's invention of the colour film system. This system constituted major competition for American inventions. Well-known German company Busch A.-G. Rathenov began producing the cameras.

Jan Szczepanik constructed a special apparatus with optical equalisation for photos and film projection in colour. The camera had 18 lenses placed on an endless tape like a caterpillar tank tread. They moved in the operational field of a large object lens, with which they constituted an optical unit, producing images projected from the film, even though the film tape was moving continuously with these 18 lenses. Three images could be exposed simultaneously, each one through one of the filters: red, green, or blue.[53] Therefore, due to the very long exposure time, it was possible to take three photos (colour extracts) from the image at the same time and obtain a reproduction through the so-called additive method. The results provided fullness of (natural) colours unattainable in other systems available at the time.

The disadvantage of Szczepanik's invention, from a practical perspective, was the necessity to use special cameras for taking the photos, as well as for projection. This could not withstand competition with more practical and less expensive colour film systems.

Jan Szczepanik did not have time to bring his invention to the stage of practical use. He died in 1926 in Tarnów at the age of 54, in full creative strength. Thanks to his outstanding achievements in the field of colour cognition theory and its practical application,[54] his name has been permanently recorded in the history of the struggle for colour photography and colour film as the most prominent representative of the additive method in colour systems.

Jan Szczepanik's sons, alongside Franciszek Ożga, resumed the inventor's work in 1932. At the beginning of 1934, in the premiere cinemas[55] Atlantyk and Stylowy in Warsaw, short films in 'natural' colours produced by Szczepanik-Film were being shown well before the colour film was released to the general public on an industrial scale. Zbigniew, the inventor's son, adapted the apparatus for film in 'natural' colours according to Jan Szczepanik's system, constructing a special attachment for a regular projector.[56]

The 1935 USA premiere of the colour film *Becky Sharp* (dir. Rouben Mamoulian) in the 'Technicolor' system based on the subtractive method marked the beginning of colour film production on a mass scale. 'Technicolor' did not require any modifications [to the projector] during the screening and therefore gained universal recognition despite its inferior quality of colours to Jan Szczepanik's system.

Puppet film animation technique

In this field, one Pole has achieved outstanding successes recorded in cinema history. Władysław Starewicz, the son of a participant of the 1863 January Uprising, born in 1882 in Moscow and brought up in Kaunas, pioneered this film genre.

The animated cartoon, among other types of animated films, was created in the USA in 1906. Soon, the cartoon animation technique found its way to Europe. However, the puppet animation technique was developed uniquely by Władysław Starewicz at first in Kaunas and later in Moscow in Aleksandr Khanzhonkov's studio. Starewicz, a keen naturalist, made his first puppet films between 1910 and 1912 with insects as their central characters. These are: *The Beautiful Lukanida* (*Piękna Lukanida*, 1912), *The Grasshopper and the Ant* (*Konik polny i mrówka,* 1913), *The Cameraman's Revenge* (*Zemsta kino-operatora*, 1912), and others.[57] Starewicz introduced the first human puppet, Santa Claus, to the film *The Insects' Christmas* (*Gwiazdka u owadów*, 1911).

Starewicz filmed frame by frame, gradually adjusting his puppets to the appropriate phases of movement. It required extraordinary patience, attention, and great precision in giving the puppets appropriate poses. The puppet animation technique emerged fully in 1911 in Kaunas when, in primitive conditions, Starewicz filmed a scene (intended for the film *Alkohol i jego konsekwencje /Alcohol and Its Consequences/*) in which the devil jumps out of a bottle.[58]

Starewicz was also the inventor of combined cinematography in feature film and a pioneer of many photographic techniques. In the aforementioned *The Grasshopper and the Ant*, Starewicz used double exposure. He introduced snow falling against a black velvet background. In the film *Terrible Vengeance* (*Straszliwa zemsta*, 1912), based on Gogol's novel, Starewicz went even further and introduced ten exposures for individual actors. To distinguish the otherworldly guests, he exposed the actors through a pre-lens diaphragm.[59] In *The Night before Christmas* (*Noc wigilijna*, 1913), also based on Gogol, Starewicz introduced a photographic enlargement of the actor Ivan Mozzhukhin, who played the role of the devil about to jump into the pocket of the blacksmith Vakula. Mozzhukhin acted until the jump, and then Starewicz replaced him with a life-size photograph of the actor, taking time-lapse photos and cropping the print after each phase of the movement. Starewicz introduced another innovation in this film, using fully artificial lighting for shooting in the studio.[60]

Starewicz emigrated from Russia and moved permanently to Paris in 1919, where he worked ever since.[61] He has perfected the technique of puppet film animation, as exemplified by the awards given to his films at international festivals.

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In this article, we presented the most important achievements of Polish scientists and technicians and their outstanding contributions to the invention of the cinematograph and the development of modern film. Many Polish achievements in various fields of film technology remain forgotten. Some are not mentioned

due to the fragmentary nature of the invention.[62] All Polish achievements have contributed their own unique values to the development of film technology, documenting our participation in the development of the world's technical civilization.

Transl. Artur Piskorz

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[1] Jewsiewicki refers here to three separate works: *Opus Majus* – Bacon's most important philosophical treatise containing his thoughts on theology, ethics, exact and natural sciences; *Opus Minus* – containing a summary of the most important theses of the previous work; *Opus Tertium* – being both an introduction and a supplement to the two previous works also revising some of the statements contained in them. [Editor's note]

[2] Full title: *Vitellionis Mathematici Doctissimi Peri Optikīs id est de natura, ratione et proiectione radiorum visus, luminum, colorum atque formarum quam vulgo Perspectivam vocant Libri X* [*Mathematical Scholar Witelon's on Optics, that is, on the Essence, Cause and Incidence of Rays of Sight, Colours and Shapes, which is Commonly Called Perspective, Ten Books*]. It is currently believed that the work, distributed under the shortened title *De Perspectiva* (*On Perspective*), was written in the years 1270-1273. [Editor's note]

[3] W. P. Zubov, "Leonardo da Vinci i Rabota Vitieło 'Perspiektiva'", *Trudy Instituta istorii jestestvoznanija i tekhniki*, vol. I, Moscow 1954, Izd-vo AN SSSR, pp. 219-248.

[4] W. Jewsiewicki, "Leonardo da Vinci – prekursor kinematografii" ["Leonardo da Vinci: The Precursor of Cinematography"], *Kwartalnik Filmowy* 1952, no. 5-6.

[5] T. Przypkowski, *Projekcja optyczna XVI-XVIII wieków* [*Optical Projection of the 16th-18th Centuries*], Jędrzejów 1958 (I use here the manuscript).

[6] T. Przypkowski, *Postęp techniczny między przyrządami astronomicznymi Kopernika, Brahego i Heweliusza*, [*Technical Progress between the Astronomical Instruments of Copernicus, Brahe and Heweliusz*], special print of *Postępy astronomii* [*Progress of Astronomy*], vol. III, Warszawa 1954, issue 1, p. 27.

[7] J. Kwietniewski, "Pierwociny fotografii w Warszawie" ["The Beginnings of Photography in Warsaw"], *Fotograf Polski* 1925, V, pp. 83-85.

[8] Incorrect spelling of the name of the photographer Karol Beyer (1818-1877). [Editor's note]

[9] A. Karoli, "Wspomnienie o ś.p. Karolu Bayerze" ["Remembering the Late Mr. Karol Bayer"], *Światło* 1899, no. 7. (Correction: A. Karoli, "Wspomnienie o ś.p. Karolu Beyerze" ["Remembering the Late Mr. Karol Beyer"] – Editor's note).

[10] L. Anders, "O swoim słów kilka" ["A Few Words about One's Own"], *Fotograf Warszawski* 1905, no. 10. Patent (priwilegija) 11515 for the "photo-revolver" issued by Diepartamient Torgowli i Manufaktur in 1889 in Moscow.

[11] W. Banaszkiewicz, "'Prehistoria filmu' W. Jewsiewickiego" ["W. Jewsiewicki's 'Prehistory of Film'"], *Kwartalnik Filmowy* 1954, no. 2.

[12] Incorrect spelling of the name of the German inventor Oskar Messter (1866-1943). [Editor's note]

[13] Person not identified conclusively. [Translator's note]

[14] Incorrect spelling of the name of the French inventor Louis Le Prince (1842-1890?) – one of the fathers of cinematography, currently considered the first filmmaker in the world. Le Prince, contrary to Jewsiewicki's statement, never worked in the United States and did not have the opportunity to present his invention there; in 1890, Le Prince disappeared in mysterious circumstances while traveling by train from Dijon to Paris, shortly before the planned New York demonstration of the camera he invented. [Editor's note]

[15] Person not identified conclusively. [Translator's note]

[16] A note about K. Prószyński's demonstration on 23 June 1899 at the Pracownia Chemiczna Szkoły Technicznej Wawelberga i Rotwanda w Warszawie [the Chemical Laboratory of the Wawelberg and Rotwand Technical College in Warsaw], *Światło*, Warszawa 1899, no. 8.

[17] Belgian patent no. 190 959 of 15 March 1906. British patent no. 12 072 of 23 May 1906.

[18] Albert Dastre (1844-1917) was a French physiologist, not a physicist. [Editor's note]

[19] "Problème de Vision cinématographique sans scintillements, Note de M. C. Prószyński, présentée par M. Dastre", *Comptes*

rendus hebdomadaires des séances de l'Académie des Sciences, tome CXLVIII N. 23 (7 Juin 1909), Paris 1909, pp. 1544-1546.

[20] W. Jewsiewicki, *Kazimierz Prószyński – polski wynalazca filmowy* [*Kazimierz Prószyński: A Polish Film Inventor*], Warszawa 1954, p. 21.

[21] British patents no. 6203 of 12 March 1910 and no. 9829 of 25 April 1912. The report on the demonstration of the 'Aeroscope', *The Bioscope*, London, 16 January 1913, vol. 18, no. 327.

[22] "Application du gyroscope et de l'air comprimé à la prize des vues cinématographiques, Note de M. C. de Prószyński, présentée par M. Lippmann", *Comptes rendus hebdomadaires des séances de l'Académie des Sciences*, tome 151, no. 26 (27 Décembre 1910), Paris 1910, pp. 1342-1344.

[23] *The Bioscope* of 5 June 1913, vol. 19, no. 347. A scientific interview with Mr. Gordon and Mr. Gregory conducted in London on 2 February 1956.

[24] *The Bioscope* of 26 June 1913, vol. 19, no. 350 and of 10 June 1913, vol. 19, no. 339.

[25] British patents no. 29 478 of 19 July 1912 and no. 29 417 of 20 December 1912.

[26] British Patent no. 17 795 of 2 August 1912.

[27] W. Czerniewski, "Polski Edison" ["The Polish Edison"], *Kino-Teatr i Sport*, Warszawa 1914, no. 2.

[28] The adjective 'Royal' is added by the author and is not a part of the official name of the department. [Translator's note]

[29] Person not identified conclusively. [Translator's note]

[30] Leslie Wyand (1890-1961) was a British cinematographer who worked with the American Pathé News newsreel from 1919 to 1928 as manager of the British branch in London and a local correspondent. [Editor's note]

[31] Person not identified conclusively. [Translator's note]

[32] A scientific interview with James Anderson conducted in London on 17 May 1956.

[33] Management Board Report of the "Eye" Joint Stock Company from its establishment in 1922 to the present (1925).

[34] German patent no. 207 366; British patent no. 22 415.

[35] K. Prószyński, "Ze wspomnień wynalazcy" ["From the Inventor's Memoires"], *Kino-świat*, Warszawa 1929, no. 7.

[36] Russian patent no. 27 649 of 1 June 1912.

[37] French patent no. 451 005 of 25 November 1912.

[38] Austrian patent no. 83 175 of 25 February 1914.

[39] German patent no. 322 506 of 3 July 1918; Austrian patent no. 80 728 of 25 May 1920.

[40] German patent no. 317 882 of 20 December 1917.

[41] Polish patent no. 3 755 of 1 October 1921.

[42] Polish historical achievements in the field of sound recording and reproduction in cinema were developed and analysed by Roman Wajdowicz and presented on 15 December 1959 at the Politechnika Warszawska [Warsaw University of Technology] in his doctoral dissertation on Polish achievements in the field of sound technology.

[43] German, Austrian, English, and American patents from 1896-1906 (a significant number).

[44] German, Austrian, English, and American patents from 1898-1904 (a significant number).

[45] British patent no. 7729 of 1899.

[46] Correction: Kodacolor. Lenticular colour film technology developed by Kodak (distinct from the later colour photography technology of the same name) was later discontinued after the introduction of Kodachrome colour film in 1935. [Editor's note]

[47] German patents no. 146 785 of 1902; no. 221 069 of 1906. Austrian patents no. 12 265 of 1902; no. 66 405 of 1915. British patents no. 10 813 of 1902; no. 3 196 of 1903.

[48] W. Jewsiewicki, "Karol Juliusz Drac – Dzieje polskiego wynalazku zdjęć kolorowych systemem optycznym (bez filtrów)" ["Karol Juliusz Drac: The History of the Polish Invention of Colour Photography Using an Optical System (with no Filters)"], *Kwartalnik Historii Nauki i Techniki Polskiej Akademii Nauk*, [*History of Science and Technology of the Polish Academy of Sciences Quarterly*], Warszawa 1956, no. 3; L. Polakow, "Analiza techniczna wynalazku Karola Juliusza Draca pod nazwą 'chromograf'" ["Technical Analysis of Karol Juliusz Drac's Invention Called 'Chromograph'"], Ibidem.

[49] German patent no. 149 627 of 1902 and a number of others.

[50] German patent no. 236 481 of 1906 and a number of others.

[51] German patent no. 191 738 of 1902; British patent no. 22 995 of 1907.

[52] Correction: Kodachrome. It refers to two-colour film technology invented by the photographer John Capstaff. It preceded the three-colour film developed in the 1930s and was introduced to the market under the same name (see note 46). [Editor's note]

[53] Austrian, German, American, British, and Polish patents in the years 1918-1926 (a significant number). N. N. Agokas, *Tsvetnoye kino*, Moscow 1936, Kinofotoizdat, pp. 56-59; J. S. Friedman, *History of Color Photography*, Boston 1947; A. B. L. Klein, *Colour Cinematography*, London 1936.

[54] My monograph on Jan Szczepanik's inventive activity will be published at the end of this year. (W. Jewsiewicki, *Jan Szczepanik – wielki wynalazca* [*Jan Szczepanik: A Great Inventor*], Państwowe Wydawnictwa Techniczne, Warszawa 1961 – Editor's note).

[55] Premiere cinemas or 'zero-screen' cinemas were prestige cinemas that had priority in screening new films and hosting opening nights. [Editor's note]

[56] German patents no. 110 706, no. 110 707, no. 821 of 1933; no. 848 of 1934.

[57] W. Wiszniewskij, *Chudożestwiennyje filmy dorewolucijonnoj Rossiji*, Moscow 1945.

[58] *Pamiętnik Władysława Starewicza* [*Władysław Starewicz's Diary*] (in my collection, unpublished); L. Forestie, *Velikij niemoj*, Moscow 1945.

[59] M. Sieński, "Zagadnienie badań historycznych nad polską techniką zdjęciową" ["The Question of Historical Research into the Polish Photographic Technique"], *Kwartalnik Historii Nauki i Techniki Polskiej Akademii Nauk* [*History of Science and Technology of the Polish Academy of Sciences Quarterly*], Warszawa 1957, no. 1.

[60] *Pamiętnik Władysława Starewicza* [*Władysław Starewicz's Diary*]; S. Ginzburg, *Risowannyj i kukolnyj film*, Moscow 1957.

[61] Władysław Starewicz died in Fontenay-sous-Bois in France on 26 February 1965. [Editor's note]

[62] W. Jewsiewicki, "Problematyka badań historycznych nad polską techniką filmową" ["Aspects of Historical Research into Polish Film Technology"], *Studia i materiały z dziejów nauki polskiej Polskiej Akademii Nauk*, [*Studies and Materials from the History of Science of the Polish Academy of Sciences*], Warszawa 1955, issue 3.

Władysław Jewsiewicki

A pioneer of research into Polish film history, cinema and cinema technology, educator. Born in 1910 in Mitava (Jelgava) in Latvia and died in 2004 in Warsaw. He received a master's degree in philosophy at the Faculty of Humanities of Stefan Batory University in Vilnius, and graduated from the School of Political Science there in 1939. In March 1945, after being repatriated, he settled with his family in Łódź. At first, he was head of the technical office at the Film Polski State Enterprise, and from 1949 until his retirement, he lectured on the history of cinema at the Łódź Film School. In the first half of the 1950s, he served as vice-rector. Jewsiewicki defended his doctoral thesis *Przemysł filmowy w Polsce w okresie międzywojennym* [*Film Industry in Poland in the Interwar Period*] at the Faculty of Humanities at the University of Łódź in 1950. He obtained the title of full professor in 1982. Jewsiewicki is the author of numerous publications on film including: *Przemysł filmowy w Polsce w okresie międzywojennym (1919-1939)* [*Film Industry in Poland in the Interwar Period (1919-1939)*] (1951), *Materiały do dziejów filmu w Polsce (cz. I i II)* [*Materials for the History of Film in Poland (Parts I and II)*] (1952), *Prehistoria filmu* [*Prehistory of Film*] (1953), *Kazimierz Prószyński – polski wynalazca filmowy* [*Kazimierz Prószyński – Polish Film Inventor*]

(1954), *Historia powszechna kinematografii (cz. 1 i 2)* [*A General History of Cinematography (Parts 1 and 2)*] (1956), *Jan Szczepanik* (1961), *Polska kinematografia w okresie filmu niemego (1895–1929/30)* [*Polish Cinema in the Silent Film Period (1895–1929/30)*] (1966), *Polska kinematografia w okresie filmu dźwiękowego 1930–1939* [*Polish Cinema in the Sound Film Period 1930–1939*] (1967), *Kronika kinematografii światowej (1895–1964)* [*A Chronicle of World Cinema (1895–1964)*] (1967), *Polscy filmowcy na frontach drugiej wojny światowej*, [*Polish Filmmakers on the Fronts of World War II*] (1972), *Kazimierz Prószyński* (1974), *Ezop XX wieku. Władysław Starewicz, pionier filmu lalkowego i sztuki filmowej* [*Aesop of the 20th Century: Władysław Starewicz, Pioneer of Puppet Film and Film Art*] (1989).

Słowa kluczowe:
prehistoria kina;
archeologia kina;
latarnia magiczna;
Kazimierz Prószyński;
Jan Szczepanik;
Władysław Starewicz

Abstrakt

Władysław Jewsiewicki

Polska nauka i technika a wynalazek kinematografu i ukształtowanie współczesnego filmu

Autor w pracy badawczej interesował się relacjami techniki, nauki i sztuki. W tym tekście szuka korzeni wynalazków filmowych wyrosłych z odwiecznego ludzkiego dążenia do utrwalania życia w ruchomych obrazach. W swoich poszukiwaniach sięga do XIII w. i ówczesnych urządzeń optycznych. Szczególną uwagę kieruje na ślady wynalazków na terenach polskich. Przywołuje postać Witelona – śląskiego mnicha, fizyka, filozofa, badającego zjawiska optyczne i świetlne, w kontekście złudzeń wzrokowych i psychologii widzenia – a także Mikołaja Kopernika, związanego z Nysą astronoma Christophera Scheinera, konstruktora urządzeń astronomicznych Aleksego Sylwiusza, Jana Heweliusza i wielu innych. Pisze o latarniach magicznych i cieniach chińskich oraz aparatach do tworzenia ruchomych fotografii. Bohaterami jego artykułu są jednak przede wszystkim Kazimierz Prószyński, Jan Szczepanik i Władysław Starewicz, którzy jego zdaniem znacząco wpłynęli na techniczny rozwój kina. **(Materiał nierecenzowany; pierwodruk: „Kwartalnik Filmowy" 1960, nr 40, s. 59–71).**