The Invention of Motion Pictures : from Phenakistoscope to Hollywood

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Preface

This paper was written in order to examine the order of discovery of significant developments in the history of motion pictures. It is part of my efforts to put the study of social and cultural history and social change on a scientific basis capable of rational analysis and understanding. This has resulted in a hard copy book *How Change Happens: A Theory of Philosophy of History, Social Change and Cultural Evolution* and a website How Change Happens Rochelle Forrester's Social Change, Cultural Evolution and Philosophy of History website. There are also philosophy of history papers such as The Course of History, The Scientific Study of History, Guttman Scale Analysis and its use to explain Cultural Evolution and Social Change and Philosophy of History and papers on Academia.edu, Figshare, Humanities Commons, Mendeley, Open Science Framework, Orcid, Phil Papers, SocArXiv, Social Science Research Network, Vixra and Zenodo websites.

This paper is part of a series on the History of Science and Technology with each paper showing the order of discoveries leading to scientific and technological breakthroughs were necessary and inevitable. Other papers in the series are:

The Invention of Stone Tools Fire The Neolithic Revolution The Invention of Pottery History of Metallurgy The Domestication of Plants and Animals History of Writing The Invention of Glass History of Astronomy Invention of Microscopes and Telescopes History of Printing The Invention of the Steam Engine History of Electricity Electric Telegraph Telephone Radio Television Photography Motion Pictures Internal Combustion Engine Motor Car Aeroplanes The History of Medicine The Discovery of the Periodic Table The Discovery of the Subatomic Particles

Other papers by Rochelle Forrester include works on Epistemology and the Philosophy of Perception such as Sense Perception and Reality and on quantum mechanics such as the Quantum Measurement Problem and The Bohr and Einstein debate on the meaning of quantum physics. Rochelle Forrester's work is also published on Slideshare, Issuu and Scribd. Rochelle Forrester is a member of the International Network for Theory of History.

Abstract

The invention of motion pictures was only possible due to the prior discovery of the phenomenon of persistence of vision, the prior invention of photography and the ability to produce photographs with very brief exposure times. These discoveries were necessary before motion pictures could be invented, and given how human beings like to be entertained, it was also inevitable, that sooner or later in some society open to new ideas and technology, that motion pictures would be made to meet the human need for entertainment. Once motion pictures had been invented, sound and then color were added to create the motion pictures we are familiar with today. The order of discovery was inevitable and is an example of how social and cultural history has to follow a particular course determined by the structure of the world around us.

In 1824 the phenomena of persistence of vision was described by Dr Peter Roget. Human vision persists, for a second after a scene has disappeared, as a memory and Roget suggested that if successive pictures of a scene, with only slight differences between the pictures, were run before a person's eyes the memory of the previous picture will run over to the next picture and produce the appearance of continuous movement. Using Roget's idea, machines were invented that flashed pictures before an observer's eyes to create an impression of continuous motion. These machines such as the Phenakistoscope, the Zoetrope and the Thaumatrope relied upon rotating disks and drums, to which a succession of pictures were attached and continuous motion was produced when the disk or drum was turned. The first moving picture to be shown on a screen was achieved by combining a Phenakistoscope with a magic lantern but the results were not very satisfactory.

Photography in the early and mid-19th century could not be used for moving pictures as moving pictures required many pictures per second, while it took several seconds exposure to make a single photograph. Exposure times for making photographs declined throughout the 19th century and in the 1870's Eadweard Muybridge was able to set up a system using 12 to 24 cameras that enabled him to produce a moving picture of a horse at full gallop. Muybridge was later to take over a hundred thousand pictures of people and animals in motion and was able to show them as a moving picture on a kinetoscope, a machine invented by Edison Laboratories. The kinetoscope produced a good motion picture but could not project the pictures onto a screen. The kinetoscope contained a substantial part of the mechanism of a movie projector. It used 35mm celluloid film which ran at 46 frames per second for the duration of the film which was usually about 15 seconds.

Muybridge, in 1879, invented a projector called the Zoopraxiscope which enabled moving images to be projected onto a screen. He placed pictures onto a rotating glass disk which was connected to a slotted metal disk which was rotated in the opposite direction to create breaks between the pictures. A lantern using oxyhydrogen limelight was shone through the disks onto a screen to create a moving picture on the screen. Improved projection machines were invented by C. Francis Jenkins and Thomas Armat in America and Louis and Auguste Lumiere in France. Jenkins and Armat's projector known as a phantoscope used an electric motor to turn a sprocket around which the film was wound. The turning sprocket unwound the film into a beam of light which put the pictures on the film on to the movie screen. The Lumiere brothers using a similar machine opened the world's first public cinema in 1895.

Movie cameras were developed in the 1890's by Etienne Marey in France and William Friese Greene and J.A.R. Rudge in England. Marey invented a "photographic gun" which took a series of photographs using sensitised glass disks. The camera could take 12 photographs per second with exposures of around 1/720 of a second and could show the movements of a bird in flight. Marey improved the camera by replacing the revolving disk with roll film wound on spools and then later replaced the paper rolls with celluloid which had good transparency so as to make projection onto a large screen easier. Marey's chronophotographic movie camera could take 50 pictures a second with exposures of 1/1000 th of a second and was patented in 1890. Marey also invented a projector and discovered that if he took pictures of moving objects at 60 per second and then projected them at 10 per second he could see the pictures in slow motion.

Attempts were made to combine sound with moving pictures as soon as pictures began to be shown. The earliest attempts used Edison's phonograph on which recorded sound was played back in the cinema. It proved very difficult to synchronize the sound with the film, and without electrical amplification to produce enough sound to fill the cinema. *The Jazz Singer* was the first film to successfully combine sound and film in 1927. A much improved method of combining film and sound was developed by E.A. Lauste. This involved a photoelectric process in which the sound was recorded on the film as the picture was made. A microphone was used to capture the sound, which modulated a light signal, which fell on a strip on the edge of the film. When the film is shown, light goes through the strip onto a photoelectric cell causing a signal that activates a loudspeaker which produces the sound for the film. This process began to be used in the late 1920's and by 1930 only 5% of the major films produced were silent.

Color was added to the earliest films by coloring each frame by hand and later it was applied mechanically by using stencils. A process known as kinemacolor was invented by George Smith in 1909. This was a two color process in which black and white film was exposed at double the usual rate with red and green filters being used alternatively for succeeding frames. The film was projected through the same alternating filters. Kinemacolor was used for some years but had various problems in that special cameras and projectors were needed, good color requires three primary colors rather than two and moving objects usually had color fringes. The

big breakthrough came with the development of technicolor in the 1930's. It involved making three separate films in red, blue and green in a beam splitting camera. The three color negative films were used to produce three positive films and then the color was transferred to blank film. This enabled the production of a colored positive transparency able to be shown with ordinary projectors.

Motion pictures were to have a considerable effect on society. Their greatest effect was in the area of public entertainment, but they also played important roles in science, in education, in news delivery and in politics. Motion pictures were to become a vast industry dominated by Hollywood and making stars out of the actors appearing in the films. In the period after World War II before television became widespread 200 million people went to the movies every week. After television became common it became the principal form of public entertainment, the number of cinemas in England, Scotland and Wales declined from 4,600 in 1950 to 1,600 in 1979. In science, motion pictures were used to examine the movement of people and animals and of the effect of explosions and bullets in flight and generally of the results of many scientific experiments. Politically movies have been used to advance certain political movements such as Nazism in *The Triumph of the Will* and slightly more subtly the South's cause in the American Civil War in *The Birth of a Nation*. Many movies produced for public entertainment display subtle political values, in fact it is probably impossible to produce movies that do not display some political values. Public education was advanced by the making of documentaries on topics as diverse as wild life, history and science.

The development of motion pictures could not have taken place but for the existence of the phenomena of persistence of vision. If the persistence of vision did not exist all we would see was a series of individual pictures and there would have been no continuous motion. Motion pictures (of the type we are familiar with) were also dependent upon the prior development of photography. Little progress was made until the exposure times for photography fell so as to allow many pictures to be taken per second. Once this was achieved it was possible to invent a movie camera which could take the pictures capable of being used to create a motion picture. A means of projecting those pictures on to a screen was also needed and when that was achieved silent black and white motion pictures were able to be shown. The existence of persistence of vision and of the ability to invent photography, which depended on the camera obscura effect and of certain photosensitive chemicals allowed the production of motion pictures. This shows how the structure and laws of nature and the materials available in nature have a considerable effect in social and cultural history.

It was inevitable that silent black and white movies should appear before movies with sound and color. This is because the need for sound and color was not apparent until silent black and white movies had developed and what was needed to provide sound and color for motion pictures was not apparent until motion pictures had been developed. Only after black and white silent movies had been developed was it possible to work on how to add color and sound to those

movies. Eventually in the 1930's high quality sound and color was able to be added to motion pictures.

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