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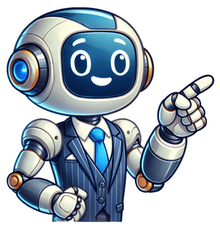

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Draw the details according to the Atari and it’s done. When drawing a female character, make the outline of the face rounded. Be sure the angle of the jawbone isn’t too sharp. I drew this character with wing-like hair that flows away from her face, a hairstyle that emphasizes her openness and innocence. A warm hair color also shows her friendliness and warmth. The sunflower design on the bag is also a symbol for her virtuous character. As you can see, this is a drawing of a girl who’s happy after eating some dessert! I recommend you draw any expression by imagining the situation and emotion the character is experiencing. A helpful tip to achieve this is to draw the position of the hands and the angle of the face. These details and body movements help you convincingly express the character’s happiness. The curvy letters and bubble-like shapes in the background also help convey her emotions. By drawing a character who’s sizing someone up by staring at them, you can convey suspicion and doubt. This expression is often used when a character is trying to find out another character’s true intentions. Frowning is also a sign of distrust. Crossed arms are also used when a character is thinking hard. The background effect helps to represent this suspicious thought process. This expression represents the moment that a character who’s been crying is caught off guard by another character’s actions or words. Almost missing what the other character said, the main character here is left confused and curious while tr...CoverTitleContentsIntroductionDrawing & Coloring EssentialsAnime & Manga Characters: Faces, Expressions & ChibisAbout the AuthorIndexCopyright 50%(4)50% found this document useful (4 votes)2K viewsThis document provides a tutorial on how to draw 8 different female anime character archetypes. 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Outside Japan and in English, anime refers specifically to animation produced in Japan.[1] However, anime, in Japan and in Japanese, describes all animated works, regardless of style or origin. Many works of animation with a similar style to Japanese animation are also produced outside Japan. Video games sometimes also feature themes and art styles that are sometimes labelled as anime. The earliest commercial Japanese animation dates to 1917. A characteristic art style emerged in the 1960s with the works of cartoonist Osamu Tezuka and spread in the following decades, developing a large domestic audience. Anime is distributed theatrically, through television broadcasts, directly to home media, and over the Internet. In addition to original works, anime are often adaptations of Japanese comics (manga), light novels, or video games. It is classified into numerous genres targeting various broad and niche audiences.[2] Anime is a diverse medium with distinctive production methods that have adapted in response to emergent technologies. It combines graphic art, characterization, cinematography, and other forms of imaginative and individualistic techniques.[3] Compared to Western animation, anime production generally focuses less on movement, and more on the detail of settings and use of "camera effects", such as panning, zooming, and angle shots.[3] Diverse art styles are used, and character proportions and features can be quite varied, with a common characteristic feature being large and emotive eyes.[4] The anime industry consists of over 430 production companies, including major studios such as Studio Ghibli, Kyoto Animation, Sunrise, Bones, Ufotable, MAPPA, Wit Studio, CoMix Wave Films, Madhouse, Inc., TMS Entertainment, Pierrot, Production I.G, Nippon Animation and Toei Animation. Since the 1980s, the medium has also seen widespread international success with the rise of foreign dubbed, subtitled programming, and since the 2010s due to the rise of streaming services and a widening demographic embrace of anime culture, both within Japan and worldwide.[5][6] As of 2016,[update] Japanese animation accounted for 60% of the world's animated television shows.[7] As a type of animation, anime is an art form that comprises many genres found in other mediums; it is sometimes mistakenly classified as a genre itself.[8] In Japanese, the term anime is used to refer to all animated works, regardless of style or origin.[9] English-language dictionaries typically define anime (/ˈænɪmeɪ/)[10] as "a style of Japanese animation"[11] or as "a style of animation originating in Japan".[12] Other definitions are based on origin, making production in Japan a requisite for a work to be considered "anime".[13] The etymology of the term anime is disputed. The English word "animation" is written in Japanese katakana as アニメーション (animēshon) and as アニメ (anime, pronounced [a.ɲi.me]) in its shortened form.[13] Some sources claim that the term is derived from the French term for animation dessin animé ("cartoon", literally 'animated drawing'),[14] but others believe this to be a myth derived from the popularity of anime in France in the late 1970s and 1980s.[13] In English, anime—when used as a common noun—normally functions as a mass noun. (For example: "Do you watch anime?" or "How much anime have you watched?")[15][16] As with a few other Japanese words, such as saké and Pokémon, English texts sometimes spell anime as animé (as in French), with an acute accent over the final e, to cue the reader to pronounce the letter, not to leave it silent as English orthography may suggest. Prior to the widespread use of anime, the term Japanimation, a portmanteau of Japan and animation, was prevalent throughout the 1970s and 1980s. In the mid-1980s, the term anime began to supplant Japanimation;[17] in general, the latter term now only appears in period works where it is used to distinguish and identify Japanese animation.[18] Main article: History of anime Emakimono and shadow plays (kage-e) are considered precursors of Japanese animation.[19] Emakimono was common in the eleventh century. Traveling storytellers narrated legends and anecdotes while the emakimono was unrolled from the right to left in chronological order, as a moving panorama.[19] Kage-e was popular during the Edo period and originated from the shadow plays of China.[19] Magic lanterns from the Netherlands were also popular in the eighteenth century.[19] The paper play called kamishibai surged in the twelfth century and remained popular in the street theater until the 1930s.[19] Puppets of the Bunraku theater and ukiyo-e prints are considered ancestors of characters of most Japanese animation.[19] Finally, manga were a heavy inspiration for anime. Cartoonists Kitzawa Rakuten and Okamoto Ippei used film elements in their strips.[19] Namakura Gatana (1917), the oldest surviving Japanese animated short film made for cinemas Animation in Japan began in the early 20th century, when filmmakers started to experiment with techniques pioneered in France, Germany, the United States, and Russia.[20] A claim for the earliest Japanese animation is Katsudō Shashin (c. 1907),[21] a private work by an unknown creator.[22] In 1917, the first professional and publicly displayed works began to appear; animators such as Ōten Shimokawa, Seitarō Kitayama, and Jun'ichi Kōuchi (considered the "fathers of anime") produced numerous films, the oldest surviving of which is Kōuchi's Namakura Gatana.[23] Many early works were lost with the destruction of Shimokawa's warehouse in the 1923 Great Kantō earthquake.[24] By the mid-1930s, animation was well-established in Japan as an alternative format to the live-action industry. It suffered competition from foreign producers, such as Disney, and many animators, including Noburō Ōfuji and Yasuji Murata, continued to work with cheaper cutout animation rather than cel animation.[25] Other creators, including Kenzō Masaoka and Mitsuyo Seo, nevertheless made great strides in technique, benefiting from the patronage of the government, which employed animators to produce educational shorts and propaganda.[26] In 1940, the government dissolved several artists' organizations to form the Shin Nippon Mangaka Kyōkai.[b][27] The first talkie anime was Chikara to Onna no Yo no Naka (1933), a short film produced by Masaoka.[28][29] The first feature-length anime film was Momotaro: Sacred Sailors (1945), produced by Seo with a sponsorship from the Imperial Japanese Navy.[30] The 1950s saw a proliferation of short, animated advertisements created for television.[31] Frame from the opening sequence of Tezuka's 1963 TV series Astro Boy In the 1960s, manga artist and animator Osamu Tezuka adapted and simplified Disney animation techniques to reduce costs and limit frame counts in his productions.[32] Originally intended as temporary measures to allow him to produce material on a tight schedule with inexperienced staff, many of his limited animation practices came to define the medium's style.[33] Three Tales (1960) was the first anime film broadcast on television;[34] the first anime television series was Instant History (1961–64).[35] An early and influential success was Astro Boy (1963–66), a television series directed by Tezuka based on his manga of the same name. Many animators at Tezuka's Mushi Production later established major anime studios (including Madhouse, Sunrise, and Pierrot). The 1970s saw growth in the popularity of manga, many of which were later animated. Tezuka's work—and that of other pioneers in the field—inspired characteristics and genres that remain fundamental elements of anime today. The giant robot genre (also known as "mecha"), for instance, took shape under Tezuka, developed into the super robot genre under Go Nagai and others, and was revolutionized at the end of the decade by Yoshiyuki Tomino, who developed the real robot genre.[36] Robot anime series such as Gundam and Super Dimension Fortress Macross became instant classics in the 1980s, and the genre remained one of the most popular in the following decades.[37] The bubble economy of the 1980s spurred a new era of high-budget and experimental anime films, including Nausicaä of the Valley of the Wind (1984), Royal Space Force: The Wings of Honnêamise (1987), and Akira (1988).[38] Neon Genesis Evangelion (1995), a television series produced by Gainax and directed by Hideaki Anno, began another era of experimental anime titles, such as Ghost in the Shell (1995) and Cowboy Bebop (1998). In the 1990s, anime also began attracting greater interest in Western countries; major international successes include Sailor Moon and Dragon Ball Z, both of which were dubbed into more than a dozen languages worldwide. In 2003, Spirited Away, a Studio Ghibli feature film directed by Hayao Miyazaki, won the Academy Award for Best Animated Feature at the 75th Academy Awards. It later became the highest-grossing anime film,[c] earning more than $355 million. Since the 2000s, an increased number of anime works have been adaptations of light novels and visual novels; successful examples include The Melancholy of Haruhi Suzumiya and Fate/stay night (both 2006). Demon Slayer: Kimetsu no Yaiba the Movie: Mugen Train became the highest-grossing Japanese film and one of the world's highest-grossing films of 2020.[39][40] It also became the fastest grossing film in Japanese cinema, because in 10 days it made 10 billion yen ($95.3m; £72m).[40] It beat the previous record of Spirited Away which took 25 days.[40][41][42][43][44] In 2021, the anime adaptations of Jujutsu Kaisen, Demon Slayer: Kimetsu no Yaiba and Tokyo Revengers were among the top 10 most discussed TV shows worldwide on Twitter.[45][46] In 2022, Attack on Titan won the award of "Most In-Demand TV Series in the World 2021" in the Global TV Demand Awards. Attack on Titan became the first ever non-English language series to earn the title of World's Most In-Demand TV Show, previously held by only The Walking Dead and Game of Thrones.[47] In 2024, Jujutsu Kaisen broke the Guinness World Record for the "Most in-demand animated TV show" with a global demand rating 71.2 times than that of the average TV show, previously held by Attack on Titan.[48][49] Anime artists employ many distinct visual styles.Clockwise from the top left: Dead Leaves, Flag, Serial Experiments Lain, Monster, Mind Game, Lucky Star, Cat Soup, and Gurren Lagann. Anime differs from other forms of animation by its art styles, methods of animation, its production, and its process. Visually, anime works exhibit a wide variety of art styles, differing between creators, artists, and studios.[50] While no single art style predominates anime as a whole, they do share some similar attributes in terms of animation technique and character design. Anime is fundamentally characterized by the use of limited animation, flat expression, the suspension of time, its thematic range, the presence of historical figures, its complex narrative line and, above all, a peculiar drawing style, with characters characterized by large and oval eyes, with very defined lines, bright colors and reduced movement of the lips.[51][52] Modern anime follows a typical animation production process, involving storyboarding, voice acting, character design, and cel production. Since the 1990s, animators have increasingly used computer animation to improve the efficiency of the production process. Early anime works were experimental, and consisted of images drawn on blackboards, stop motion animation of paper cutouts, and silhouette animation.[53][54] Cel animation grew in popularity until it came to dominate the medium. In the 21st century, the use of other animation techniques is mostly limited to independent short films,[55] including the stop motion puppet animation work produced by Tadahito Mochinaga, Kihachirō Kawamoto and Tomoyasu Murata.[56][57] Computers were integrated into the animation process in the 1990s, with works such as Ghost in the Shell and Princess Mononoke mixing cel animation with computer-generated images.[58] Fuji Film, a major cel production company, announced it would stop cel production, producing an industry panic to procure cel imports and hastening the switch to digital processes.[58] Prior to the digital era, anime was produced with traditional animation methods using a pose to pose approach.[53] The majority of mainstream anime uses fewer expressive key frames and more in-between animation.[59] Japanese animation studios were pioneers of many limited animation techniques, and have given anime a distinct set of conventions. Unlike Disney animation, where the emphasis is on the movement, anime emphasizes the art quality and let limited animation techniques make up for the lack of time spent on movement. Such techniques are often used not only to meet deadlines but also as artistic devices.[60] Anime scenes place emphasis on achieving three-dimensional views, and backgrounds are instrumental in creating the atmosphere of the work.[20] The backgrounds are not always invented and are occasionally based on real locations, as exemplified in Howl's Moving Castle and The Melancholy of Haruhi Suzumiya.[61] [better source needed] Oppliger stated that anime is one of the rare mediums where putting together an all-star cast usually comes out looking "tremendously impressive".[62] The cinematic effects of anime differentiates itself from the stage plays found in American animation. Anime is cinematically shot as if by camera, including panning, zooming, distance and angle shots to more complex dynamic shots that would be difficult to produce in reality.[63][64][65] In anime, the animation is produced before the voice acting, contrary to American animation which does the voice acting first.[66] Anime character design is diverse, but often incorporates common elements depending on the target demographic and era. These are representative samples. Clockwise from the top left: Ashita no Joe (1970), Macross: Do You Remember Love? (1984), Ghost in the Shell (1995), K-On! (2009), Your Name (2016), The Hidden Dungeon Only I Can Enter (2021), Fruits Basket (2001), and Rurouni Kenshin (1996). The body proportions of human anime characters tend to accurately reflect the proportions of the human body in reality. The height of the head is considered by the artist as the base unit of proportion. Head to height ratios vary drastically by art style, with most anime characters falling between 5 and 8 heads tall. Anime artists occasionally make deliberate modifications to body proportions to produce chibi characters that feature a disproportionately small body compared to the head; many chibi characters are two to four heads tall. Some anime works like Crayon Shin-chan completely disregard these proportions, in such a way that they resemble caricatured Western cartoons. A common anime character design convention is exaggerated eye size. The animation of characters with large eyes in anime can be traced back to Osamu Tezuka, who was deeply influenced by such early animation characters as Betty Boop, who was drawn with disproportionately large eyes.[67] Tezuka is a central figure in anime and manga history, whose iconic art style and character designs allowed for the entire range of human emotions to be depicted solely through the eyes.[68] The artist adds variable color shading to the eyes and particularly to the cornea to give them greater depth. Generally, a mixture of a light shade, the tone color, and a dark shade is used.[69][70] However, not all anime characters have large eyes. For example, the works of Hayao Miyazaki are known for having realistically proportioned eyes, as well as realistic hair colors on their characters.[71] Hair in anime is often unnaturally lively and colorful or uniquely styled. The movement of hair in anime is exaggerated and "hair actions" is used to emphasize the action and emotions of characters for added visual effect.[72] Gilles Poitras traces hairstyle color to cover illustrations on manga, where eye-catching artwork and colorful tones are attractive for children's manga.[72] Some anime will depict non-Japanese characters with specific ethnic features, such as a pronounced nose and jutting jaw for European characters.[73] In other cases, anime feature characters whose race or nationality is not always defined, and this is often a deliberate decision, such as in the Pokémon animated series.[74] Anime and manga artists often draw from a common canon of iconic facial expression illustrations to denote particular moods and thoughts.[75] These techniques are often different in form than their counterparts in Western animation, and they include a fixed iconography that is used as shorthand for certain emotions and moods.[76] For example, a male character may develop a nosebleed when aroused.[76] A variety of visual symbols are employed, including sweat drops to depict nervousness, visible blushing for embarrassment, or glowing eyes for an intense glare.[77] Another recurring sight gag is the use of chibi (deformed, simplified character designs) figures to comedically punctuate emotions like confusion or embarrassment.[76] See also: Anime composer and Anime song An example of a 2022 anime video with music The opening and credits sequences of most anime television series are accompanied by J-pop or J-rock songs, often by reputed bands—as written with the series in mind—but are also aimed at the general music market, therefore they often allude only vaguely or not at all, to the thematic settings or plot of the series. Also, they are often used as incidental music ("insert songs") in an episode, in order to highlight particularly important scenes.[78][better source needed] Future funk, a musical microgenre that evolved in the early 2010s from Vaporwave with a French house Euro disco influence, heavily uses anime visuals and samples along with Japanese City pop to build an aesthetic.[79] Since the 2020s anime songs have experienced a rapid growth in global online popularity due to their widened availability on music streaming services like Spotify and promotion by fans and artists on social media.[80] In 2023, the opening theme "Idol" by Yoasobi of the anime series Oshi no Ko topped the Billboard Global 200 Excl. U.S. charts with 45.7 million streams and 24,000 copies sold outside the U.S. "Idol" has become the first Japanese song and anime song to top the Billboard Global chart as well as taking the first spot on the Apple Music's Top 100: Global chart.[81][82] Anime are often classified by target demographic, including children's (子供, kodomo), girls' (少女, shōjo), boys' (少年, shōnen), young men (青年, Seinen), young women (女性, josei) and a diverse range of genres targeting an adult audience. Shōjo and shōnen anime sometimes contain elements popular with children of all genders in an attempt to gain crossover appeal. Adult anime may feature a slower pace or greater plot complexity that younger audiences may typically find unappealing, as well as adult themes and situations.[83] A subset of adult anime works featuring pornographic elements are labeled "R18" in Japan, and are internationally known as hentai (originating from pervert (変態, hentai)). By contrast, some anime subgenres incorporate ecchi, sexual themes or undertones without depictions of sexual intercourse, as typified in the comedic or harem genres; due to its popularity among adolescent and adult anime enthusiasts, the inclusion of such elements is considered a form of fan service.[84][85] Some genres explore homosexual romances, such as yaoi (male homosexuality) and yuri (female homosexuality). While often used in a pornographic context, the terms yaoi and yuri can also be used broadly in a wider context to describe or focus on the themes or the development of the relationships themselves.[86] Anime's genre classification differs from other types of animation and does not lend itself to simple classification.[87] Gilles Poitras compared the labeling of Gundam 0080 and its complex depiction of war as a "giant robot" anime akin to simply labeling War and Peace a "war novel".[87] Science fiction is a major anime genre and includes important historical works like Tezuka's Astro Boy and Yokoyama's Tetsujin 28-go. A major subgenre of science fiction is mecha, with the Gundam metaseries being iconic.[88] The diverse fantasy genre includes works based on Asian and Western traditions and folklore; examples include the Japanese feudal fairytale InuYasha, and the depiction of Scandinavian goddesses who move to Japan to maintain a computer called Yggdrasil in Ah! My Goddess.[89] Genre crossing in anime is also prevalent, such as the blend of fantasy and comedy in Dragon Half, and the incorporation of slapstick humor in the crime anime film Castle of Cagliostro.[90] Other subgenres found in anime include magical girl, harem, sports, martial arts, literary adaptations, medievalism,[91] and war.[92] Early anime works were made for theatrical viewing, and required played musical components before sound and vocal components were added to the production. In 1958, Nippon Television aired Mogura no Abanchūru ("Mole's Adventure"), both the first televised and first color anime to debut.[93] It was not until the 1960s when the first televised series were broadcast and it has remained a popular medium since.[94] Works released in a direct-to-video format are called "original video animation" (OVA) or "original animation video" (OAV); and are typically not released theatrically or televised prior to home media release.[95][96][better source needed] The emergence of the Internet has led some animators to distribute works online in a format called "original net animation" (ONA).[97][better source needed] The home distribution of anime releases was popularized in the 1980s with the VHS and LaserDisc formats.[95] The VHS NTSC video format used in both Japan and the United States is credited with aiding the rising popularity of anime in the 1990s.[95] The LaserDisc and VHS formats were transcended by the DVD format which offered the unique advantages; including multiple subtitling and dubbing tracks on the same disc.[98] The DVD format also has its drawbacks in its usage of region coding; adopted by the industry to solve licensing, piracy and export problems and restricted region indicated on the DVD player.[98] The Video CD (VCD) format was popular in Hong Kong and Taiwan, but became only a minor format in the United States that was closely associated with bootleg copies.[98] A key characteristic of many anime television shows is serialization, where a continuous story arc stretches over multiple episodes or seasons. Traditional American television had an episodic format, with each episode typically consisting of a self-contained story. In contrast, anime shows such as Dragon Ball Z had a serialization format, where continuous story arcs stretch over multiple episodes or seasons, which distinguished them from traditional American television shows; serialization has since also become a common characteristic of American streaming television shows during the "Peak TV" era.[99] See also: List of anime companies and List of Japanese animation studios Akihabara district of Tokyo is popular with anime and manga fans as well as otaku subculture in Japan. The animation industry consists of more than 430 production companies with some of the major studios including Toei Animation, Madhouse, Gonzo, Sunrise, Bones, TMS Entertainment, Nippon Animation, P.A.Works, Studio Pierrot, Production I.G, Ufotable and Studio Ghibli.[100] Many of the studios are organized into a trade association, The Association of Japanese Animations. There is also a labor union for workers in the industry, the Japanese Animation Creators Association. Studios will often work together to produce more complex and costly projects, as done with Studio Ghibli's Spirited Away.[100] An anime episode can cost between US$100,000 and US$300,000 to produce.[101] In 2001, animation accounted for 7% of the Japanese film market, above the 4.6% market share for live-action works.[100] The popularity and success of anime is seen through the profitability of the DVD market, contributing nearly 70% of total sales.[100] According to a 2016 article on Nikkei Asian Review, Japanese television stations have bought over ¥60 billion worth of anime from production companies "over the past few years", compared with under ¥20 billion from overseas.[102] There has been a rise in sales of shows to television stations in Japan, caused by late night anime with adults as the target demographic.[102] This type of anime is less popular outside Japan, being considered "more of a niche product".[102] Spirited Away (2001) was the all-time highest-grossing film in Japan until overtaken by Demon Slayer: Kimetsu no Yaiba – The Movie: Mugen Train in 2020.[103][104][105] It was also the highest-grossing anime film worldwide until it was overtaken by Makoto Shinkai's 2016 film Your Name.[106] Anime films represent a large part of the highest-grossing Japanese films yearly in Japan, with 6 out of the top 10 in 2014, 2015 and also in 2016. Anime has to be licensed by companies in other countries in order to be legally released. While anime has been licensed by its Japanese owners for use outside Japan since at least the 1960s, the practice became well-established in the United States in the late 1970s to early 1980s, when such TV series as Gatchaman and Captain Harlock were licensed from their Japanese parent companies for distribution in the US market. The trend towards American distribution of anime continued into the 1980s with the licensing of titles such as Voltron and the 'creation' of new series such as Robotech through the use of source material from several original series.[107] In the early 1990s, several companies began to experiment with the licensing of less child-oriented material. Some, such as A.D. Vision, and Central Park Media and its imprints, achieved fairly substantial commercial success and went on to become major players in the now very lucrative American anime market. Others, such as AnimEigo, achieved limited success. Many companies created directly by Japanese parent companies did not do as well, most releasing only one or two titles before completing their American operations. Licenses are expensive, often hundreds of thousands of dollars for one series and tens of thousands for one movie.[108] The prices vary widely; for example, Jinki: Extend cost only $91,000 to license while Kurau Phantom Memory cost $960,000.[108] Simulcast Internet streaming rights can be cheaper, with prices around $1,000–2,000 an episode,[109] but can also be more expensive, with some series costing more than US$200,000 per episode.[110] The anime market for the United States was worth approximately $2.74 billion in 2009.[111] Dubbed animation began airing in the United States in 2000 on networks like The WB and Cartoon Network's Adult Swim.[112] In 2005, this resulted in five of the top ten anime titles having previously aired on Cartoon Network.[112] As a part of localization, some editing of cultural references may occur to better follow the references of the non-Japanese culture.[113] The cost of English localization averages US$10,000 per episode.[114] The industry has been subject to both praise and condemnation for fansubs, the addition of unlicensed and unauthorized subtitled translations of anime series or films.[115] Fansubs, which were originally distributed on VHS bootlegged cassettes in the 1980s, have been freely available and disseminated online since the 1990s.[115] Since this practice raises concerns for copyright and piracy issues, fansubbers tend to adhere to an unwritten moral code to destroy or no longer distribute an anime once an official translated or subtitled version becomes licensed. They also try to encourage viewers to buy an official copy of the release once it comes out in English, although fansubs typically continue to circulate through file-sharing networks.[116] Even so, the laid back regulations of the Japanese animation industry tend to overlook these issues, allowing it to grow underground and thus increasing its popularity until there is a demand for official high-quality releases for animation companies. This has led to an increase in global popularity of Japanese animation, reaching $40 million in sales in 2004.[117] Fansub practices have rapidly declined since the early-2010s due to the advent of legal streaming services which simulcast new anime series often within a few hours of their domestic release.[118] Since the 2010s, anime has become a global multibillion industry setting a sales record in 2017 of ¥2.15 trillion ($19.8 billion), driven largely by demand from overseas audiences.[119] In 2019, Japan's anime industry was valued at $24 billion a year with 48% of that revenue coming from overseas (which is now its largest industry sector).[120] By 2025 the anime industry is expected to reach a value of $30 billion with over 60% of that revenue coming from overseas.[121] Japan External Trade Organization (JETRO) valued the domestic anime market in Japan at ¥2.4 trillion ($24 billion), including ¥2 trillion from licensed products, in 2005.[122] JETRO reported sales of overseas anime exports in 2004 to be ¥2 trillion ($18 billion).[123] JETRO valued the anime market in the United States at ¥520 billion ($5.2 billion),[122] including $500 million in home video sales and over $4 billion from licensed products, in 2005.[124] JETRO projected in 2005 that the worldwide anime market, including sales of licensed products, would grow to ¥10 trillion ($100 billion).[122][124] The anime market in China was valued at $21 billion in 2017,[125] and is projected to reach $31 billion by 2020.[126] In Europe the anime merchandising market was valued at about $950 million with the figurine segment accounting for most of the share and is expected to reach a value of over $2 billion by 2030.[127] The global anime market size was valued at $26.055 billion in 2021 with 29% of the revenue coming from merchandise. It is expected that the global anime market will reach a value of $47.14 billion by 2028.[128][129] In 2023 the anime industry generated a $19.8 billion in total global revenue, including $5.5 billion from streaming and $14.3 billion from merchandising sales. North America and Asia contributed a combined $14.3 billion in total revenue, accounting for over 72% of anime's global impact.[130][131] By 2030 the global anime market is expected to reach a value of $48.3 Billion with the largest contributors to this growth being North America, Europe, Asia–Pacific and The Middle East.[132] The global anime market size was valued at $25.8 Billion in 2022 and is expected to have a market size of $62.7 Billion by 2032 with a CAGR of 9.4%.[133][134][135] In 2019, the annual overseas exports of Japanese animation exceeded $10 billion for the first time in history.[136] The anime industry has several annual awards that honor the year's best works. Major annual awards in Japan include the Ōfuji Noburō Award, the Mainichi Film Award for Best Animation Film, the Animation Kobe Awards, the Japan Media Arts Festival animation awards, the Seiyu Awards for voice actors, the Tokyo Anime Award and the Japan Academy Prize for Animation of the Year. Internationally, anime TV series and films compete shows such as the Crunchyroll Anime Awards and The Astra Awards. There were also the American Anime Awards, which were designed to recognize excellence in anime titles nominated by the industry, and were held only once in 2006.[137] Anime productions have also been nominated and won awards not exclusively for anime, like the Academy Award for Best Animated Feature or the Golden Bear. In recent years, the anime industry has been accused by both Japanese and foreign media of underpaying and overworking its animators.[138][139][140] In response the Japanese Prime Minister Fumio Kishida promised to improve the working conditions and salary of all animators and creators working in the industry.[141] A few anime studios such as MAPPA have taken actions to improve the working conditions of their employees.[142] There has also been a slight increase in production costs and animator pays during the COVID-19 pandemic.[143] Throughout 2020 and 2021 the American streaming service Netflix announced that it will greatly invest and fund the anime industry as well as support training programs for new animators.[144][145][146] On April 27, 2023, Nippon Anime Film Culture Association (NAFCA) was officially founded. The association aims to solve problems in the industry, including the improvement of conditions of the workers.[147][148] The Japanese government is actively working to improve the working conditions within the anime industry as part of its broader initiative to support and further expand the sector in order to sustain its growing global demand.[149] See also: Japanese pop culture in the United States, History of anime in the United States, List of anime theatrically released in the United States, List of anime distributed in India, Japanese influence on Chinese culture, Japanese influence on Korean culture, Anime in hip hop, and List of highest-grossing anime films Anime Expo in Los Angeles, California, United States – one of the largest fan conventions in the Western world.[150] Anime has become commercially profitable in the Western world,[151][152][153] as demonstrated by early commercially successful Western adaptations of anime, such as Astro Boy and Speed Racer. Early American adaptions in the 1960s made Japan expand into the continental European market, first with productions aimed at European and Japanese children, such as Heidi, Vicky the Viking and Barbapapa, which aired in various countries. Italy, Spain, and France[154][155] grew a particular interest in Japan's output, due to its cheap selling price and productive output. As of 2014, Italy imported the most anime outside Japan.[156] Anime and manga were introduced to France in the late 1970s and became massively popular in spite of a moral panic led by French politicians in the 1980s and 1990s.[157] These mass imports influenced anime popularity in East Asian,[158][159][160] Southeast Asian,[161] South Asian,[162] Latin American,[163][164] Arabic[165] and German markets.[166] The beginning of 1980 saw the introduction of Japanese anime series into the American culture.[167] In the 1990s, Japanese animation slowly gained popularity in America. Media companies such as Viz and Mixx began publishing and releasing animation into the American market.[168] The 1988 film Akira is largely credited with popularizing anime in the Western world during the early 1990s, before anime was further popularized by television shows such as Pokémon and Dragon Ball Z in the late 1990s.[169][170] By 1997, Japanese anime was the fastest-growing genre in the American video industry.[171] The growth of the Internet later provided international audiences with an easy way to access Japanese content.[117] Early on, online piracy played a major role in this, through over time legal alternatives appeared which significantly reduced illegal practices.[172] Since the 2010s streaming services have become increasingly involved in the production, licensing and distribution of anime for the international markets.[173][174] This is especially the case with net services such as Netflix, Crunchyroll and others which have large catalogs in many countries, although until 2020 anime fans in multiple developing countries, such as India[175] and the Philippines, had fewer options for obtaining access to legal content, and therefore would still turn to online piracy.[176][177] However beginning with the 2020s anime has been experiencing yet another boom in global popularity and demand due to the COVID-19 pandemic and streaming services like Netflix, Amazon Prime Video, HBO Max, Disney+, Hulu and anime-only services like Crunchyroll and Hidive, increasing the international availability of the amount of new licensed anime shows as well as the size of their catalogs.[178][179][180][181][182] Netflix reported that, between October 2019 and September 2020, more than 100 million member households worldwide had watched at least one anime title on the platform. Anime titles appeared on the streaming platform's top-ten lists in almost 100 countries within the one-year period.[183] As of 2021, anime series are the most demanded foreign-language television shows in the United States accounting for 30.5% of the market share. (In comparison, Spanish-language and Korean-language shows account for 21% and 11% of the market share, respectively.)[184] In 2021 more than half of Netflix's global members watched anime.[185][186] In 2022, the anime series Attack on Titan won the award of "Most In-Demand TV Series in the World 2021" in the Global TV Demand Awards. Attack on Titan became the first ever non-English language series to earn the title of "World's Most In-Demand TV Show", previously held by only The Walking Dead and Game of Thrones.[47][187] In 2024, the anime series Jujutsu Kaisen won the award of "Most In-Demand TV Series in the World 2023" in the Global TV Demand Awards.[188] Rising interest in anime as well as Japanese video games has led to an increase of university students in the United Kingdom wanting to get a degree in the Japanese language.[189] The word anime alongside other Japanese pop cultural terms like shonen, shojo and isekai have been added to the Oxford English Dictionary.[190][191] Various anime and manga series have influenced Hollywood in the making of numerous famous movies and characters.[192] Hollywood itself has produced live-action adaptations of various anime series such as Ghost in the Shell, Death Note, Dragon Ball Evolution and Cowboy Bebop. However most of these adaptations have been reviewed negatively by both the critics and the audience and have become box-office flops. The main reasons for the unsuccessfulness of Hollywood's adaptions of anime being the often change of plot and characters from the original source material and the limited capabilities a live-action movie or series can do in comparison to an animated counterpart.[193][194] One of the few particular exceptions to this includes Alita: Battle Angel, which has become a moderate commercial success, receiving generally positive reviews from both the critics and the audience for its visual effects and following the source material. The movie grossed $404 million worldwide, making it director Robert Rodriguez's highest-grossing film.[195][196] Anime and manga alongside many other imports of Japanese pop culture have helped Japan to gain a positive worldwide image and improve its relations with other countries.[197][198][199] In 2015, during remarks welcoming Japanese Prime Minister Shinzo Abe to the White House, President Barack Obama thanked Japan for its cultural contributions to the United States by saying: This visit is a celebration of the ties of friendship and family that bind our peoples. I first felt it when I was 6 years old when my mother took me to Japan. I felt it growing up in Hawaii, like communities across our country, home to so many proud Japanese Americans... Today is also a chance for Americans, especially our young people, to say thank you for all the things we love from Japan. Like karate and karaoke. Manga and anime. And, of course, emojis.[200] In July 2020, after the approval of a Chilean government project in which citizens of Chile would be allowed to withdraw up to 10% of their privately held retirement savings, journalist Pamela Jiles celebrated by running through Congress with her arms spread out behind her, imitating the move of many characters of the anime and manga series Naruto.[201][202] In April 2021, Peruvian politicians Jorge Hugo Romero of the PPC and Milagros Juárez of the UPP cosplayed as anime characters to get the otaku vote.[203] On October 28, 2024, The Vatican unveiled its own anime-styled mascot, "Luce", in order to connect with Catholic youth through pop culture.[204] In April 2023, the Japan Business Federation laid out a proposal aiming to spur the economic growth of Japan by further promoting the contents industry abroad, primarily anime, manga and video games, for measures to invite industry experts from abroad to come to Japan to work, and to link with the tourism sector to help foreign fans of manga and anime visit sites across the country associated with particular manga stories. The federation seeks on quadrupling the sales of Japanese content in overseas markets within the upcoming 10 years.[205][206] A 2018 survey conducted in 20 countries and territories using a sample consisting of 6,600 respondents held by Dentsu revealed that 34% of all surveyed people found excellency in anime and manga more than other Japanese cultural or technological aspects, which makes this mass Japanese media the third most-liked "Japanese thing", below Japanese cuisine (34.6%) and Japanese robotics (35.1%). The advertisement company views anime as a profitable tool for marketing campaigns in foreign countries due to its popularity and high reception.[207] Anime plays a role in driving tourism to Japan. In surveys held by Statista between 2019 and 2020, 24.2% of tourists from the United States, 7.7% of tourists from China and 6.1% of tourists from South Korea said they were motivated to visit Japan because of Japanese popular culture.[208] In a 2021 survey held by Crunchyroll market research, 94% of Gen-Z's and 73% of the general population said that they are familiar with anime.[209][210] See also: Anime and manga fandom, Anime and manga fandom in Poland, ACG (subculture), and List of anime conventions Cosplay of Madoka Kaname and Kyubey from Puella Magi Madoka Magica during Tracon 2013 event at the Tampere Hall in Tampere, Finland Anime clubs gave rise to anime conventions in the 1990s with the "anime boom", a period marked by anime's increased global popularity.[211] These conventions are dedicated to anime and manga and include elements like cosplay contests and industry talk panels.[212] Cosplay, a portmanteau of "costume play", is not unique to anime and has become popular in contests and masquerades at anime conventions.[213] Japanese culture and words have entered English usage through the popularity of the medium, including otaku, an unflattering Japanese term commonly used in English to denote an obsessive fan of anime or manga.[214] Another word that has arisen describing obsessive fans in the United States is wapanese meaning 'white individuals who want to be Japanese, or later known as weeaboo or weeb, individuals who demonstrate an obsession with Japanese anime subculture, a term that originated from abusive content posted on the website 4chan.org.[215] While originally derogatory, the terms "Otaku" and "Weeb" have been reappropriated by the anime fandom overtime and today are used by some fans to refer to themselves in a comedic and more positive way.[216] Anime enthusiasts have produced fan fiction and fan art, including computer wallpapers, and anime music videos (AMVs).[217] Many fans visit sites depicted in anime, games, manga and other forms of otaku culture. This behavior is known as "Anime pilgrimage".[218] As of the 2020s, many anime fans and followers use social media platforms and other sites like YouTube, Bilibili, Twitch,[219] Fandom,[220] Facebook, Instagram, Reddit, Discord,[221] Tumblr,[222] 4chan, TikTok and Twitter[46] with online communities and databases such as IMDb, MyAnimeList to discuss anime, manga and track their progress watching respective series as well as using news outlets such as Anime News Network.[223][224] According to Crunchyroll's research data from 2023 to 2024 provided by its President Rahul Parini, revealed that there are approximately 800 million people globally (outside of China and Japan) who are either highly aware of anime, show interest in anime or currently watch anime and identify as fans.[225][226][227] According to a 2024 survey conducted on anime fans by Polygon, 65% of the surveyed anime fans said that they find anime more emotionally compelling than other forms of media and more than 3 in 4 of Millennial and Gen-Z fans use the medium as a form of escapism. Almost two-thirds of the anime-watching Gen Z audience said they emotionally connect better with anime than they do with traditional media. Over 50% of surveyed Gen-Z anime fans said that anime influences their identity, fashion and social understanding.[228] Due to anime's increased popularity in recent years, a large number of celebrities such as Elon Musk, BTS and Ariana Grande have come out as anime fans.[229] Main article: Anime-influenced animation One of the key points that differentiated anime from a handful of Western cartoons is the potential for visceral content. Once the expectation that the aspects of visual intrigue or animation are just for children is put aside, the audience can realize that themes involving violence, suffering, sexuality, pain, and death can all be storytelling elements utilized in anime just as much as other media.[230] "Japanese animation is so different from what airs here. It's far edgier, more adult and violent." Mike Lazzo of the American Cartoon Network[231] However, as anime itself became increasingly popular, its styling has been inevitably the subject of both satire and serious creative productions.[13] South Park's "Chinpokomon" and "Good Times with Weapons" episodes, Adult Swim's Perfect Hair Forever, and Nickelodeon's Kappa Mikey are examples of Western satirical depictions of Japanese culture and anime, but anime tropes have also been satirized by some anime such as KonoSuba. Traditionally only Japanese works have been considered anime, but some works have sparked debate about blurring the lines between anime and cartoons, such as the American anime-style productions Avatar: The Last Airbender and Avatar: The Legend of Korra.[232] These anime-styled works have become defined as anime-influenced animation, in an attempt to classify all anime styled works of non-Japanese origin.[233] Some creators of these works cite anime as a source of inspiration, for example the French production team for Ōban Star-Racers that moved to Tokyo to collaborate with a Japanese production team.[234][235][236] When anime is defined as a "style" rather than as a national product, it leaves open the possibility of anime being produced in other countries,[232] but this has been contentious amongst fans, with John Oppliger stating, "The insistence on referring to original American art as Japanese "anime" or "manga" robs the work of its cultural identity."[13][237] While some anime will depict non-Japanese characters with specific ethnic features, such as a pronounced nose and jutting jaw for European characters,[73] there are some styles that deliberately forgo any identification of its characters with real-world ethnicities or nationalities, termed in criticism as mukokuseki (statelessness). Mukokuseki characters can significantly impact the reception of a property outside of Japan.[238][239] A U.A.E.-Filipino produced TV series called Torkaizer is dubbed as the "Middle East's First Anime Show", and is currently in production[240] and looking for funding.[241][needs update] Netflix has produced multiple anime series in collaboration with Japanese animation studios,[242] and in doing so, has offered a more accessible channel for distribution to Western markets.[243] Similar initiatives have been enacted by the US-based streaming service Crunchyroll,[244] producing titles such as High Guardian Spice and an adaptation of Tower of God. The web-based series RWBY, produced by Texas-based company Rooster Teeth, is produced using an anime art style, and the series has been described as "anime" by multiple sources. For example, Adweek, in the headline to one of its articles, described the series as "American-made anime",[245] and in another headline, The Huffington Post described it as simply "anime", without referencing its country of origin.[246] In 2013, Monty Oum, the creator of RWBY, said "Some believe just like Scotch needs to be made in Scotland, an American company can't make anime. I think that's a narrow way of seeing it. Anime is an art form, and to say only one country can make this art is wrong."[247] RWBY has been released in Japan with a Japanese language dub;[248] the CEO of Rooster Teeth, Matt Hullum, commented "This is the first time any American-made anime has been marketed to Japan. It definitely usually works the other way around, and we're really pleased about that."[245] Further information: Media mix and List of highest-grossing media franchises Pokémon Center at Jewel Changi Airport in Singapore In Japanese culture and entertainment, media mix is a strategy to disperse content across multiple representations: different broadcast media, gaming technologies, cell phones, toys, amusement parks, and other methods.[249] It is the Japanese term for a transmedia franchise.[250][251] The term gained its circulation in late 1980s, but the origins of the strategy can be traced back to the 1960s with the proliferation of anime, with its interconnection of media and commodity goods.[252] A number of anime and manga media franchises such as Demon Slayer: Kimetsu no Yaiba, Dragon Ball, Fate/stay night, Yu-Gi-Oh!, Neon Genesis Evangelion and Gundam have gained considerable global popularity, and are among the world's highest-grossing media franchises. Pokémon in particular is estimated to be the highest-grossing media franchise of all time.[253] Cool Japan Hentai History of anime Japanese popular culture Japanophilia Lists of anime La nouvelle manga Manfra Mechademia OEL manga Otaku Soft power § Japan Television in Japan Video games in Japan Voice acting in Japan Vtuber ^

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For 2D motion pictures created using 3D modeling software, see Computer-generated imagery. For motion pictures created using stereophotogrammetry, see Volumetric video. 3D films are motion pictures made to give an illusion of three-dimensional solidity, usually with the help of special glasses worn by viewers. 3D films were prominently featured in the 1950s in American cinema and later experienced a worldwide resurgence in the 1980s and 1990s driven by IMAX high-end theaters and Disney-themed venues. 3D films became increasingly successful throughout the 2000s, peaking with the success of 3D presentations of Avatar in December 2009, after which 3D films again decreased in popularity.[1] Certain directors have also taken more experimental approaches to 3D filmmaking, most notably celebrated auteur Jean-Luc Godard in his film Goodbye to Language. This section needs additional citations for verification. Please help improve this article by adding citations to reliable sources in this section. Unsourced material may be challenged and removed. (December 2009) (Learn how and when to remove this message) The basic components of 3D film were introduced separately between 1833 and 1839. Stroboscopic animation was developed by Joseph Plateau in 1832 and published in 1833 in the form of a stroboscopic disc,[2] which he later called the fantascope and became better known as the phénakisticope. Around the very same time (1832/1833), Charles Wheatstone developed the stereoscope, but he did not really make it public before June 1838.[3] The first practical forms of photography were introduced in January 1839 by Louis Daguerre and Henry Fox Talbot. A combination of these elements into animated stereoscopic photography may have been conceived early on, but for decades it did not become possible to capture motion in real-time photographic recordings due to the long exposure times necessary for the light-sensitive emulsions that were used. Charles Wheatstone got inventor Henry Fox Talbot to produce some calotype pairs for the stereoscope and received the first results in October 1840.[3] Only a few more experimental stereoscopic photographs were made before David Brewster introduced his stereoscope with lenses in 1849. Wheatstone also approached Joseph Plateau with the suggestion to combine the stereoscope with the fantascope. In 1849, Plateau published about this concept in an article about several improvements made to his fantascope and suggested a stop-motion technique that would involve a series of photographs of purpose-made plaster statuettes in different poses.[4] The idea reached Jules Duboscq, an instrument maker who already marketed Plateau's Fantascope as well as the stereoscopes of Wheatstone and Brewster. In November 1852, Duboscq added the concept of his "Stéréoscope-fantascope, ou Bïoscope" to his stereoscope patent. Production of images proved very difficult, since the photographic sequence had to be carefully constructed from separate still images. The bioscope was no success, and the only extant disc, without apparatus, is found in the Joseph Plateau collection of the University of Ghent. The disc contains 12 albumen image pairs of a machine in motion.[5] Most of the other early attempts to create motion pictures also aimed to include the stereoscopic effect. In November 1851, Antoine Claudet claimed to have created a stereoscope that showed people in motion.[6] The device initially only showed two phases, but during the next two years, Claudet worked on a camera that would record stereoscopic pairs for four different poses (patented in 1853).[7] Claudet found that the stereoscopic effect did not work properly in this device, but believed the illusion of motion was successful.[8] In 1855, Johann Nepomuk Czermak published an article about his Stereophoroskop. His first idea to create 3D animation involved sticking pins in a stroboscopic disc to create a sequence that would show one pin moving further into the cardboard and back. He also designed a device that would feed the image pairs from two stroboscopic discs into one lenticular stereoscope and a vertical predecessor of the zoetrope.[9] On February 27, 1860, Peter Hubert Desvignes received British patent no. 537 for 28 monocular and stereoscopic variations of cylindrical stroboscopic devices. This included a version that used an endless band of pictures running between two spools that was intermittently lit by an electric spark.[10] Desvignes' Mimoscope, received an Honourable Mention "for ingenuity of construction" at the 1862 International Exhibition in London.[11] It could "exhibit drawings, models, single or stereoscopic photographs, so as to animate animal movements, or that of machinery, showing various other illusions."[12] Desvignes "employed models, insects and other objects, instead of pictures, with perfect success." The horizontal slits (like in Czermak's Stereophoroskop) allowed a much improved view, with both eyes, of the opposite pictures.[13] In 1861, American engineer Coleman Sellers II received US patent No. 35,317 for the kinematoscope, a device that exhibited "stereoscopic pictures as to make them represent objects in motion". In his application he stated: "This has frequently been done with plane pictures but has never been, with stereoscopic pictures". He used three sets of stereoscopic photographs in a sequence with some duplicates to regulate the flow of a simple repetitive motion, but also described a system for very large series of pictures of complicated motion.[14][15] On August 11, 1877, the Daily Alta newspaper announced a project by Eadward Muybridge and Leland Stanford to produce sequences of photographs of a running horse with 12 stereoscopic cameras. Muybridge had much experience with stereo photography and had already made instantaneous pictures of Stanford's horse Occident running at full speed. He eventually managed to shoot the proposed sequences of running horses in June 1878 with stereoscopic cameras. The published result and animated versions for his zoopraxiscope were not stereoscopic, but in 1898 Muybridge claimed that he had (privately) viewed the pictures in two synchronized zoetropes with Wheatstone's reflecting stereoscope as a "very satisfactory reproduction of an apparently solid miniature horse trotting and of another galloping".[16] Thomas Edison demonstrated his phonograph on November 29, 1877, after previous announcements of the device for recording and replaying sound had been published earlier in the year. An article in Scientific American concluded, "It is already possible, by ingenious optical contrivances, to throw stereoscopic photographs of people on screens in full view of an audience. Add the talking phonograph to counterfeit their voices, and it would be difficult to carry the illusion of real presence much further". Wordsworth Donisthorpe announced in the January 24, 1878, edition of Nature that he would advance that conception: "By combining the phonograph with the kinesigraph, I will undertake not only to produce a talking picture of Mr. Gladstone, which, with motionless lips and unchanged expression, shall positively recite his latest anti-Turkish speech in his own voice and tone. Not only this, but the life size photograph itself shall move and gesticulate precisely as he did when making the speech, the words and gestures corresponding as in real life."[17] Dr. Phipson, a correspondent for British news in a French photography magazine, relayed the concept but renamed the device "Kinétiscope" to reflect the viewing purpose rather than the recording option. This was picked up in the United States and discussed in an interview with Edison later in the year.[18] Neither Donisthorpe's or Edison's later moving picture results were stereoscopic. In the late 1890s, British film pioneer William Friese-Greene filed a patent for a 3D film process. In his patent, two films were projected side by side on screen. The viewer looked through a stereoscope to converge the two images. Because of the obtrusive mechanics behind this method, theatrical use was not practical.[19] Frederic Eugene Ives patented his stereo camera rig in 1900. The camera had two lenses coupled together 1+3⁄4 inches (4.45 centimeters) apart.[20] On June 10, 1915, Edwin S. Porter and William E. Waddell presented tests to an audience at the Astor Theater in New York City.[21] In red-green anaglyph, the audience was presented three reels of tests, which included rural scenes, test shots of Marie Doro, a segment of John Mason playing a number of passages from Jim the Penman (a film released by Famous Players–Lasky that year, but not in 3D), Oriental dancers, and a reel of footage of Niagara Falls.[22] However, according to Adolph Zukor in his 1953 autobiography The Public Is Never Wrong: My 50 Years in the Motion Picture Industry, nothing was produced in this process after these tests. By 1909, the German film market suffered much from overproduction and too much competition. German film tycoon Oskar Messter had initially gained much financial success with the Tonbild synchronized sound films of his Biophon system since 1903, but the films were losing money by the end of the decade and Messter would stop Tonbild production in 1913. Producers and exhibitors were looking into new film attractions and invested for instance in colorful imagery. The development of stereoscopic cinema seemed a logical step to lure visitors back into the movie theatres. In 1909, German civil engineer August Engelsmann patented a process that projected filmed performances within a physical decor on an actual stage. Soon after, Messter obtained patents for a very similar process, probably by agreement with Engelsmann, and started marketing it as "Alabastra". Performers were brightly dressed and brightly lit while filmed against a black background, mostly miming their singing or musical skills or dancing to the circa four-minute pre-recorded phonographs. The film recordings would be projected from below, to appear as circa 30 inch figures on a glass pane in front of a small stage, in a setup very similar to the Pepper's ghost illusion that offered a popular stage trick technique since the 1860s. The glass pane was not visible to the audience and the projected figures seemed able to move around freely across the stage in their virtual tangible and lifelike appearance. The brightness of the figures was necessary to avoid see-through spots and made them resemble alabaster sculptures. To adapt to this appearance, several films featured Pierrot or other white clowns, while some films were probably hand-coloured. Although Alabastra was well received by the press, Messter produced few titles, hardly promoted them and abandoned it altogether a few years later. He believed the system to be uneconomical due to its need for special theatres instead of the widely available movie screens, and he did not like that it seemed only suitable for stage productions and not for "natural" films. Nonetheless, there were numerous imitators in Germany and Messter and Engelsmann still teamed with American businessman Frank Joseph Godsol (Goldsoll) set up a short-lived variant named "Fantomo" in 1914.[23] Rather in agreement with Messter or not, Karl Juhasz and Franz Haushofer opened a Kinoplastikon theatre in Vienna in 1911. Their patented system was very similar to Alabaster, but projected life-size figures from the wings of the stage. With much higher ticket prices than standard cinema, it was targeted at middle-class audiences to fill the gap between low-brow films and high-class theatre. Audiences reacted enthusiastically and by 1913 there reportedly were 250 theatres outside Austria, in France, Italy, United Kingdom, Russia and North America. However, the first Kinoplastikon in Paris started in January 1914 and the premiere in New York took place in the Hippodrome in March 1915. In 1913, Walter R. Booth directed 10 films for the U.K. Kinoplastikon, presumably in collaboration with Cecil Hepworth. Theodore Brown, the licensee in the U.K. also patented a variant with front and back projection and reflected decor, and Goldsoll applied for a very similar patent only 10 days later.[23] Further development and exploitation was probably haltered by World War I. Alabastra and Kinoplastikon were often advertised as stereoscopic and screenless. Although in reality the effect was heavily dependent on glass screen projection and the films were not stereoscopic, the shows seemed truly three-dimensional as the figures were clearly separate from the background and virtually appeared inside the real, three-dimensional stage area without any visible screen. Eventually, longer (multi-reel) films with story arcs proved to be the way out of the crisis in the movie market and supplanted the previously popular short films that mostly aimed to amuse people with tricks, gags or other brief variety and novelty attractions. Sound film, stereoscopic film and other novel techniques were relatively cumbersome to combine with multiple reels and were abandoned for a while. Fairall in 1922 Fairall's 3D camera Audience wearing special glasses watch a 3D "stereoscopic film" at the Telekinema on the South Bank in London during the Festival of Britain 1951. The earliest confirmed 3D film shown to an out-of-house audience was The Power of Love, which premiered at the Ambassador Hotel Theater in Los Angeles on September 27, 1922.[24][25][26] The camera rig was a product of the film's producer, Harry K. Fairall, and cinematographer Robert F. Elder.[19] It was filmed dual-strip in black and white, and single strip color anaglyphic release prints were produced using a color film invented and patented by Harry K. Fairall. A single projector could be used to display the movie but anaglyph glasses were used for viewing. The camera system and special color release print film all received U.S Patent No. 1,784,515 on December 9, 1930.[27][28] After a preview for exhibitors and press in New York City, the film dropped out of sight, apparently not booked by exhibitors, and is now considered lost. Early in December 1922, William Van Doren Kelley, inventor of the Prizma color system, cashed in on the growing interest in 3D films started by Fairall's demonstration and shot footage with a camera system of his own design. Kelley then struck a deal with Samuel "Roxy" Rothafel to premiere the first in his series of "Plasticon" shorts entitled Movies of the Future at the Rivoli Theater in New York City. Also in December 1922, Laurens Hammond (later inventor of the Hammond organ) premiered his Teleview system, which had been shown to the trade and press in October. Teleview was the first alternating-frame 3D system seen by the public. Using left-eye and right-eye prints and two interlocked projectors, left and right frames were alternately projected, each pair being shown three times to suppress flicker. Viewing devices attached to the armrests of the theater seats had rotary shutters that operated synchronously with the projector shutters, producing a clean and clear stereoscopic result. The only theater known to have installed Teleview was the Selwyn Theater in New York City, and only one show was ever presented with it: a group of short films, an exhibition of live 3D shadows, and M.A.R.S., the only Teleview feature. The show ran for several weeks, apparently doing good business as a novelty (M.A.R.S. itself got poor reviews), but Teleview was never seen again.[29] In 1922, Frederic Eugene Ives and Jacob Leventhal began releasing their first stereoscopic shorts made over a three-year period. The first film, entitled Plastigrams, was distributed nationally by Educational Pictures in the red-and-blue anaglyph format. Ives and Leventhal then went on to produce the following stereoscopic shorts in the "Stereoscopiks Series" released by Pathé Films in 1925: Zowie (April 10), Luna-cy! (May 18), The Run-Away Taxi (December 17) and Ouch (December 17).[30] On September 22, 1924, Luna-cy! was re-released in the De Forest Phonofilm sound-on-film system.[31] The late 1920s to early 1930s saw little interest in stereoscopic pictures. In Paris, Louis Lumiere shot footage with his stereoscopic camera in September 1933. The following March he exhibited a remake of his 1895 short film L'Arrivée du Train, this time in anaglyphic 3D, at a meeting of the French Academy of Science.[26] In 1936, Leventhal and John Norling were hired based on their test footage to film MGM's Audioscopiks series. The prints were by Technicolor in the red-and-green anaglyph format, and were narrated by Pete Smith. The first film, Audioscopiks, premiered January 11, 1936, and The New Audioscopiks premiered January 15, 1938. Audioscopiks was nominated for the Academy Award in the category Best Short Subject, Novelty in 1936. With the success of the two Audioscopiks films, MGM produced one more short in anaglyph 3D, another Pete Smith Specialty called Third Dimensional Murder (1941). Unlike its predecessors, this short was shot with a studio-built camera rig. Prints were by Technicolor in red-and-blue anaglyph. The short is notable for being one of the few live-action appearances of the Frankenstein Monster as conceived by Jack Pierce for Universal Studios outside of their company. While many of these films were printed by color systems, none of them was actually in color, and the use of the color printing was only to achieve an anaglyph effect.[32] While attending Harvard University, Edwin H. Land conceived the idea of reducing glare by polarizing light. He took a leave of absence from Harvard to set up a lab and by 1929 had invented and patented a polarizing sheet.[33] In 1932, he introduced Polaroid J Sheet as a commercial product.[34] While his original intention was to create a filter for reducing glare from car headlights, Land did not underestimate the utility of his newly dubbed Polaroid filters in stereoscopic presentations. In February 1936, Land gave the first public demonstration of Polaroid filters in conjunction with 3D photography at the Waldorf-Astoria Hotel.[35] The reaction was enthusiastic, and he followed it up with an installation at the New York Museum of Science.[26] It is unknown what film was run for audiences at this exhibition. Using Polaroid filters meant an entirely new form of projection, however. Two prints, each carrying either the right or left eye view, had to be synced up in projection using an external selsyn motor. Furthermore, polarized light would be largely depolarized by a matte white screen, and only a silver screen or screen made of other reflective material would correctly reflect the separate images. Later that year, the feature, Nozze Vagabonde appeared in Italy, followed in Germany by Zum Greifen nah (You Can Nearly Touch It), and again in 1939 with Germany's Sechs Mädel rollen ins Wochenend (Six Girls Drive Into the Weekend). The Italian film was made with the Gualtierotti camera; the two German productions with the Zeiss camera and the Vierling shooting system. All of these films were the first exhibited using Polaroid filters. The Zeiss Company in Germany manufactured glasses on a commercial basis commencing in 1936; they were also independently made around the same time in Germany by E. Käsemann and by J. Mahler.[36] In 1939, John Norling shot In Tune With Tomorrow, the first commercial 3D film using Polaroid in the US[citation needed]. This short premiered at the 1939 New York World's Fair and was created specifically for the Chrysler Motors Pavilion. In it, a full 1939 Chrysler Plymouth is magically put together, set to music. Originally in black and white, the film was so popular that it was re-shot in color for the following year at the fair, under the title New Dimensions.[citation needed] In 1953, it was reissued by RKO as Motor Rhythm. Another early short that utilized the Polaroid 3D process was 1940's Magic Movies: Thrills For You produced by the Pennsylvania Railroad Co. for the Golden Gate International Exposition.[citation needed] Produced by John Norling, it was filmed by Jacob Leventhal using his own rig. It consisted of shots of various views that could be seen from the Pennsylvania Railroad's trains. In the 1940s, World War II prioritized military applications of stereoscopic photography and it once again went on the back burner in most producers' minds. What aficionados consider the "golden era" of 3D began in late 1952 with the release of the first color stereoscopic feature, Bwana Devil, produced, written and directed by Arch Oboler. The film was shot in "Natural Vision", a process that was co-created and controlled by M. L. Gunzberg. Gunzberg, who built the rig with his brother Julian, Friend Baker and Lothrop Worth, shopped it without success to various studios before Oboler used it for this feature, which went into production with the title, The Lions of Gulu.[37] The critically panned film was nevertheless highly successful with audiences due to the novelty of 3D, which increased Hollywood interest in 3D during a period that had seen declining box-office admissions.[38] As with practically all of the features made during this boom, Bwana Devil was projected dual-strip, with Polaroid filters. During the 1950s, the familiar disposable anaglyph glasses made of cardboard were mainly used for comic books, two shorts by exploitation specialist Dan Sonney, and three shorts produced by Lippert Productions. However, even the Lippert shorts were available in the dual-strip format alternatively. Because the features utilized two projectors, the capacity limit of film being loaded onto each projector (about 6,000 feet (1,800 m), or an hour's worth of film) meant that an intermission was necessary for every feature-length film. Quite often, intermission points were written into the script at a major plot point. During Christmas of 1952, producer Sol Lesser quickly premiered the dual-strip showcase called Stereo Techniques in Chicago.[39] Lesser acquired the rights to five dual-strip shorts. Two of them, Now is the Time (to Put On Your Glasses) and Around is Around, were directed by Norman McLaren in 1951 for the National Film Board of Canada. The other three films were produced in Britain for The Festival of Britain in 1951 by Raymond Spottiswoode. These were A Solid Explanation, Royal River, and The Black Swan. James Mage was also an early pioneer in the 3D craze. Using his 16 mm 3D Bolex system, he premiered his Triorama program on February 10, 1953, with his four shorts: Sunday In Stereo, Indian Summer, American Life, and This is Bolex Stereo.[40] This show is considered lost. Another early 3D film during the boom was the Lippert Productions short A Day in the Country, narrated by Joe Besser, which was composed mostly of test footage. Unlike all of the other Lippert shorts, which were available in both dual-strip and anaglyph, this production was released in anaglyph only. April 1953 saw two groundbreaking features in 3D: Columbia's Man in the Dark and Warner Bros.' House of Wax, the first 3D feature with stereophonic sound. House of Wax was (outside of Cinerama) the first time many American audiences heard recorded stereophonic sound; it was also the film that typecast Vincent Price as a horror star as well as the "King of 3-D" after he became the actor to star in the most 3D features (the others were The Mad Magician, Dangerous Mission, and Son of Sinbad). The success of these two films proved that major studios now had a method of getting filmgoers back into theaters and away from television sets, which were causing a steady decline in attendance. Universal-International released its first 3D feature, It Came from Outer Space, on May 27, 1953, with stereophonic sound. That was followed by Paramount's first 3D feature, Sangaree with Fernando Lamas and Arlene Dahl. The Walt Disney Studios entered 3D with its May 28, 1953, release of Melody, which accompanied the first 3D western, Columbia's Fort Ti at its Los Angeles opening. It was later shown at Disneyland's Fantasyland Theater in 1957 as part of a program with Disney's other short Working for Peanuts, entitled, 3-D Jamboree. The show was hosted by the Mousketeers and was in color. Columbia released several 3D westerns produced by Sam Katzman and directed by William Castle. Castle would later specialize in various technical in-theater gimmicks for such Columbia and Allied Artists features as 13 Ghosts, House on Haunted Hill, and The Tingler. Columbia also produced the only slapstick comedies conceived for 3D. The Three Stooges starred in Spooks and Pardon My Backfire; dialect comic Harry Mimmo starred in Down the Hatch. Producer Jules White was optimistic about the possibilities of 3D as applied to slapstick (with pies and other projectiles aimed at the audience), but only two of his stereoscopic shorts were shown in 3D. Down the Hatch was released as a conventional, "flat" motion picture. (Columbia has since printed Down the Hatch in 3D for film festivals.) John Ireland, Joanne Dru and Macdonald Carey starred in the Jack Broder color production Hannah Lee, which premiered on June 19, 1953. The film was directed by Ireland, who sued Broder for his salary. Broder counter-sued, claiming that Ireland went over production costs with the film.[citation needed] Another famous entry in the golden era of 3D was the 3 Dimensional Pictures production of Robot Monster. The film was allegedly scribed in an hour by screenwriter Wyott Ordung and filmed in a period of two weeks on a shoestring budget.[citation needed] Despite these shortcomings and the fact that the crew had no previous experience with the newly built camera rig, luck was on the cinematographer's side, as many find the 3D photography in the film is well shot and aligned. Robot Monster also has a notable score by then up-and-coming composer Elmer Bernstein. The film was released June 24, 1953, and went out with the short Stardust in Your Eyes, which starred nightclub comedian, Slick Slavin.[citation needed] 20th Century Fox produced its only 3D feature, Inferno, in 1953, starring Rhonda Fleming. Fleming, who also starred in Those Redheads From Seattle, and Jivaro, shares the spot for being the actress to appear in the most 3D features with Patricia Medina, who starred in Sangaree, Phantom of the Rue Morgue and Drums of Tahiti. Darryl F. Zanuck expressed little interest in stereoscopic systems, and at that point was preparing to premiere the new widescreen film system, CinemaScope. The first decline in the theatrical 3D craze started in August and September 1953. The factors causing this decline were: Two prints had to be projected simultaneously.[citation needed] The prints had to remain exactly alike after repair, or synchronization would be lost.[citation needed] It sometimes required two projectionists to keep sync working properly.[citation needed] When either prints or shutters became out of sync, even for a single frame, the picture became virtually unwatchable and accounted for headaches and eyestrain.[citation needed] The necessary silver projection screen was very directional and caused sideline seating to be unusable with both 3D and regular films, due to the angular darkening of these screens. Later films that opened in wider-seated venues often premiered flat for that reason (such as Kiss Me Kate at the Radio City Music Hall).[citation needed] A mandatory intermission was needed to properly prepare the theater's projectors for the showing of the second half of the film.[citation needed] Because projection booth operators were at many times careless, even at preview screenings of 3D films, trade and newspaper critics claimed that certain films were "hard on the eyes."[citation needed] Sol Lesser attempted to follow up Stereo Techniques with a new showcase, this time five shorts that he himself produced.[citation needed] The project was to be called The 3-D Follies and was to be distributed by RKO.[citation needed] Unfortunately, because of financial difficulties and the general loss of interest in 3D, Lesser canceled the project during the summer of 1953, making it the first 3D film to be aborted in production.[citation needed] Two of the three shorts were shot: Carmenesque, a burlesque number starring exotic dancer Lili St. Cyr, and Fun in the Sun, a sports short directed by famed set designer/director William Cameron Menzies, who also directed the 3D feature The Maze for Allied Artists. Although it was more expensive to install, the major competing realism process was wide-screen, but two-dimensional, anamorphic, first utilized by Fox with CinemaScope and its September premiere in The Robe. Anamorphic films needed only a single print, so synchronization was not an issue. Cinerama was also a competitor from the start and had better quality control than 3D because it was owned by one company that focused on quality control. However, most of the 3D features past the summer of 1953 were released in the flat widescreen formats ranging from 1.66:1 to 1.85:1. In early studio advertisements and articles about widescreen and 3D formats, widescreen systems were referred to as "3D", causing some confusion among scholars.[citation needed] There was no single instance of combining CinemaScope with 3D until 1960, with a film called September Storm, and even then, that was a blow-up from a non-anamorphic negative.[citation needed] September Storm also went out with the last dual-strip short, Space Attack, which was actually shot in 1954 under the title The Adventures of Sam Space. In December 1953, 3D made a comeback with the release of several important 3D films, including MGM's musical Kiss Me, Kate. Kate was the hill over which 3D had to pass to survive. MGM tested it in six theaters: three in 3D and three-flat.[citation needed] According to trade ads of the time, the 3D version was so well-received that the film quickly went into a wide stereoscopic release.[citation needed] However, most publications, including Kenneth Macgowan's classic film reference book Behind the Screen, state that the film did much better as a "regular" release. The film, adapted from the popular Cole Porter Broadway musical, starred the MGM songbird team of Howard Keel and Kathryn Grayson as the leads, supported by Ann Miller, Keenan Wynn, Bobby Van, James Whitmore, Kurt Kasznar and Tommy Rall. The film also prominently promoted its use of stereophonic sound. Several other features that helped put 3D back on the map that month were the John Wayne feature Hondo (distributed by Warner Bros.), Columbia's Miss Sadie Thompson with Rita Hayworth, and Paramount's Money From Home with Dean Martin and Jerry Lewis. Paramount also released the cartoon shorts Boo Moon with Casper, the Friendly Ghost and Popeye, Ace of Space with Popeye the Sailor. Paramount Pictures released a 3D Korean War film Cease Fire filmed on actual Korean locations in 1953.[41] Top Banana, based on the popular stage musical with Phil Silvers, was brought to the screen with the original cast. Although it was merely a filmed stage production, the idea was that every audience member would feel they would have the best seat in the house through color photography and 3D.[citation needed] Although the film was shot and edited in 3D, United Artists, the distributor, felt the production was uneconomical in stereoscopic form and released the film flat on January 27, 1954.[citation needed] It remains one of two "Golden era" 3D features, along with another United Artists feature, Southwest Passage (with John Ireland and Joanne Dru), that are currently considered lost (although flat versions survive). A string of successful films filmed in 3D followed the second wave, but many were widely or exclusively shown flat. Some highlights are: The French Line, starring Jane Russell and Gilbert Roland, a Howard Hughes/RKO production. The film became notorious for being released without an MPAA seal of approval after several suggestive lyrics were included, as well as one of Ms. Russell's particularly revealing costumes.[citation needed] Playing up her sex appeal, one tagline for the film was, "It'll knock both of your eyes out!" The film was later cut and approved by the MPAA for a general flat release, despite having a wide and profitable 3D release.[citation needed] Taza, Son of Cochise, a sequel to 1950s Broken Arrow, which starred Rock Hudson in the title role, Barbara Rush as the love interest, and Rex Reason (billed as Bart Roberts) as his renegade brother. Originally released flat through Universal-International. It was directed by the great stylist Douglas Sirk, and his striking visual sense made the film a huge success when it was "re-premiered" in 3D in 2006 at the Second 3D Expo in Hollywood. Two ape films: Phantom of the Rue Morgue, featuring Karl Malden and Patricia Medina, produced by Warner Bros. and based on Edgar Allan Poe's "The Murders in the Rue Morgue", and Gorilla at Large, a Panoramic Production starring Cameron Mitchell, distributed flat and 3D through Fox. Creature from the Black Lagoon,

starring Richard Carlson and Julie Adams, directed by Jack Arnold. Although arguably the most famous 3D film, it was typically seen in 3D only in large urban theaters and shown flat in the many smaller neighborhood theaters.[42] It was the only 3D feature that spawned a 3D sequel, Revenge of the Creature, which was in turn followed by The Creature Walks Among Us, shot flat. Dial M for Murder, directed by Alfred Hitchcock and starring Ray Milland, Robert Cummings, and Grace Kelly, is considered by aficionados of 3D to be one of the best examples of the process. Although available in 3D in 1954, there are no known playdates in 3D,[citation needed] since Warner Bros. had just instated a simultaneous 3D/2D release policy. The film's screening in 3D in February 1980 at the York Theater in San Francisco did so well that Warner Bros. re-released the film in 3D in February 1982. The film is now available on 3D Blu-ray, marking the first time it was released on home video in its 3D presentation. Gog, the last episode in Ivan Tors' Office of Scientific Investigation (OSI) trilogy dealing with realistic science fiction (following The Magnetic Monster and Riders to the Stars). Most theaters showed it flat. The Diamond (released in the United States as The Diamond Wizard), a 1954 British crime film starring Dennis O'Keefe. The only stereoscopic feature shot in Britain, released flat in both the UK and US. Irwin Allen's Dangerous Mission released by RKO in 1954 featuring Allen's trademarks of an all-star cast facing a disaster (a forest fire). Bosley Crowther's New York Times review mentions that it was shown flat. Son of Sinbad, another RKO/Howard Hughes production, starring Dale Robertson, Lili St. Cyr, and Vincent Price. The film was shelved after Hughes ran into difficulty with The French Line, and was not released until 1955, at which time it went out flat, converted to the SuperScope process. 3D's final decline was in the late spring of 1954, for the same reasons as the previous lull, as well as the further success of widescreen formats with theater operators. Even though Polaroid had created a well-designed "Tell-Tale Filter Kit" for the purpose of recognizing and adjusting out of sync and phase 3D,[43] exhibitors still felt uncomfortable with the system and turned their focus instead to processes such as CinemaScope. The last 3D feature to be released in that format during the "Golden era" was Revenge of the Creature, on February 23, 1955. Ironically, the film had a wide release in 3D and was well received at the box office.[44] Stereoscopic films largely remained dormant for the first part of the 1960s, with those that were released usually being anaglyph exploitation films. One film of notoriety was the Beaver-Champion/Warner Bros. production, The Mask (1961). The film was shot in 2-D, but to enhance the bizarre qualities of the dream-world that is induced when the main character puts on a cursed tribal mask, these scenes went to anaglyph 3D. These scenes were printed by Technicolor on their first run in red/green anaglyph. Although 3D films appeared sparsely during the early 1960s, the true second wave of 3D cinema was set into motion by Arch Oboler, the producer who had started the craze of the 1950s. Using a new technology called Space-Vision 3D. The origin of "Space-Vision 3D" goes back to Colonel Robert Vincent Bernier, a forgotten innovator in the history of stereoscopic motion pictures. His Trioptiscope Space-Vision lens was the gold standard for the production and exhibition of 3-D films for nearly 30 years.[45] "Space-Vision 3D" stereoscopic films were printed with two images, one above the other, in a single academy ratio frame, on a single strip, and needed only one projector fitted with a special lens. This so-called "over and under" technique eliminated the need for dual projector set-ups, and produced widescreen, but darker, less vivid, polarized 3D images. Unlike earlier dual system, it could stay in perfect synchronization, unless improperly spliced in repair. Arch Oboler once again had the vision for the system that no one else would touch, and put it to use on his film entitled The Bubble, which starred Michael Cole, Deborah Walley, and Johnny Desmond. As with Bwana Devil, the critics panned The Bubble, but audiences flocked to see it, and it became financially sound enough to promote the use of the system to other studios, particularly independents, who did not have the money for expensive dual-strip prints of their productions. In 1970, Stereovision, a new entity founded by director/inventor Allan Silliphant and optical designer Chris Condon, developed a different 35 mm single-strip format, which printed two images squeezed side by side and used an anamorphic lens to widen the pictures through Polaroid filters. Louis K. Sher (Sherpix) and Stereovision released the softcore sex comedy The Stewardesses (self-rated X, but later re-rated R by the MPAA). The film cost US$100,000 to produce, and ran for months in several markets.[citation needed] eventually earning $27 million in North America, alone ($140 million in constant-2010 dollars) in fewer than 800 theaters, becoming the most profitable 3-Dimensional film to date, and in purely relative terms, one of the most profitable films ever. It was later released in 70 mm 3D. Some 36 films worldwide were made with Stereovision over 25 years, using either a widescreen (above-below), anamorphic (side by side) or 70 mm 3D formats.[citation needed] In 2009 The Stewardesses was remastered by Chris Condon and director Ed Meyer, releasing it in XpanD 3D, RealD Cinema and Dolby 3D. The quality of the 1970s 3D films was not much more inventive, as many were either softcore and even hardcore adult films, horror films, or a combination of both. Paul Morrisey's Flesh For Frankenstein (aka Andy Warhol's Frankenstein) was a superlative example of such a combination. Between 1981 and 1983 there was a new Hollywood 3D craze started by the spaghetti western Comin' at Ya!. When Parasite was released it was billed as the first horror film to come out in 3D in over 20 years. Horror films and reissues of 1950s 3D classics (such as Hitchcock's Dial M for Murder) dominated the 3D releases that followed. The second sequel in the Friday the 13th series, Friday the 13th Part III, was released very successfully. Apparently saying "part 3 in 3D" was considered too cumbersome so it was shortened in the titles of Jaws 3-D and Amityville 3-D, which emphasized the screen effects to the point of being annoying at times, especially when flashlights were shone into the eyes of the audience. The science fiction film Spacehunter: Adventures in the Forbidden Zone was the most expensive 3D film made up to that point with production costs about the same as Star Wars but not nearly the same box office success, causing the craze to fade quickly through spring 1983. Other sci-fi/fantasy films were released as well including Metalstorm: The Destruction of Jared-Syn and Treasure of the Four Crowns, which was widely criticized for poor editing and plot holes, but did feature some truly spectacular closeups. 3D releases after the second craze included The Man Who Wasn't There (1983), Silent Madness and the 1985 animated film Starchaser: The Legend of Orin, whose plot seemed to borrow heavily from Star Wars. Only Comin' At Ya!, Parasite, and Friday the 13th Part III have been officially released on VHS and/or DVD in 3D in the United States (although Amityville 3D has seen a 3D DVD release in the United Kingdom). Most of the 1980s 3D films and some of the classic 1950s films such as House of Wax were released on the now defunct Video Disc (VHD) format in Japan as part of a system that used shutter glasses. Most of these have been unofficially transferred to DVD and are available on the grey market through sites such as eBay. Stereoscopic movies were also popular in other parts of the world, such as My Dear Kuttichathan, a Malayalam film which was shot with stereoscopic 3D and released in 1984. In the mid-1980s, IMAX began producing non-fiction films for its nascent 3D business, starting with We Are Born of Stars (Roman Kroitor, 1985). A key point was that this production, as with all subsequent IMAX productions, emphasized mathematical correctness of the 3D rendition and thus largely eliminated the eye fatigue and pain that resulted from the approximate geometries of previous 3D incarnations. In addition, and in contrast to previous 35mm-based 3D presentations, the very large field of view provided by IMAX allowed a much broader 3D "stage", arguably as important in 3D film as it is theatre. The Walt Disney Company also began more prominent use of 3D films in special venues to impress audiences with Magic Journeys (1982) and Captain EO (Francis Ford Coppola, 1986, starring Michael Jackson) being notable examples. In the same year, the National Film Board of Canada production Transitions (Colin Low), created for Expo 86 in Vancouver, was the first IMAX presentation using polarized glasses. Echoes of the Sun (Roman Kroitor, 1990) was the first IMAX film to be presented using alternate-eye shutterglass technology, a development required because the dome screen precluded the use of polarized technology. From 1990 onward, numerous films were produced by all three parties to satisfy the demands of their various high-profile special attractions and IMAX's expanding 3D network. Films of special note during this period include the extremely successful Into the Deep (Graeme Ferguson, 1995) and the first IMAX 3D fiction film Wings of Courage (1996), by director Jean-Jacques Annaud, about the pilot Henri Guillaumet. Other stereoscopic films produced in this period include: The Last Buffalo (Stephen Low, 1990) Jim Henson's Muppet*Vision 3D (Jim Henson, 1991) Imagine (John Weiley, 1993) Honey, I Shrunk the Audience (Daniel Rustuccio, 1994) Into the Deep (Graeme Ferguson, 1995) Across the Sea of Time (Stephen Low, 1995) Wings of Courage (Jean-Jacques Annaud, 1996) L5, First City in Space (Graeme Ferguson, 1996) T2 3-D: Battle Across Time (James Cameron, 1996) Paint Misbehavin (Roman Kroitor and Peter Stephenson, 1997) IMAX Nutcracker (1997) The Hidden Dimension (1997) T-Rex: Back to the Cretaceous (Brett Leonard, 1998) Mark Twain's America (Stephen Low, 1998) Siegfried & Roy: The Magic Box (Brett Leonard, 1999) Galapagos (Al Giddings and David Clark, 1999) Encounter in the Third Dimension (Ben Stassen, 1999) Alien Adventure (Ben Stassen, 1999) Ultimate G's (2000) Cyberworld (Hugh Murray, 2000) Cirque du Soleil: Journey of Man (Keith Melton, 2000) Haunted Castle (Ben Stassen, 2001) Panda Vision (Ben Stassen, 2001) Space Station 3D (Toni Myers, 2002) SOS Planet (Ben Stassen, 2002) Ocean Wonderland (2003) Falling in Love Again (Munro Ferguson, 2003) Misadventures in 3D (Ben Stassen, 2003) By 2004, 54% of IMAX theaters (133 of 248) were capable of showing 3D films.[46] Shortly thereafter, higher quality computer animation, competition from DVDs and other media, digital projection, digital video capture, and the use of sophisticated IMAX 70mm film projectors, created an opportunity for another wave of 3D films.[47][48] In 2003, Ghosts of the Abyss by James Cameron was released as the first full-length 3D IMAX feature filmed with the Reality Camera System. This camera system used the latest HD video cameras, not film, and was built for Cameron by Vince Pace, to his specifications. The same camera system was used to film Spy Kids 3-D: Game Over (2003), Aliens of the Deep IMAX (2005), and The Adventures of Sharkboy and Lavagirl in 3-D (2005). In 2004, Las Vegas Hilton released Star Trek: The Experience which included two films. One of the films, Borg Invasion 4-D (Ty Granoroli), was in 3D. In August of the same year, rap group Insane Clown Posse released their ninth studio album Hell's Pit. One of two versions of the album contained a DVD featuring a 3D short film for the track "Bowling Balls", shot in high-definition video.[49] Shooting of the film Hidden Universe 3D with IMAX camera.[50] In November 2004, The Polar Express was released as IMAX's first full-length, animated 3D feature. It was released in 3,584 theaters in 2D, and only 66 IMAX locations. The return from those few 3D theaters was about 25% of the total. The 3D version earned about 14 times as much per screen as the 2D version. This pattern continued and prompted a greatly intensified interest in 3D and 3D presentation of animated films. In June 2005, the Mann's Chinese 6 theatre in Hollywood became the first commercial film theatre to be equipped with the Digital 3D format. Both Singin' in the Rain and The Polar Express were tested in the Digital 3D format over the course of several months. In November 2005, Walt Disney Studio Entertainment released Chicken Little in digital 3D format. The Butler's in Love, a short film directed by David Arquette and starring Elizabeth Berkley and Thomas Jane[51] was released on June 23, 2008. The film was shot at the former Industrial Light & Magic studios using KernerFX's prototype Kernercam stereoscopic camera rig. Ben Walters suggested in 2009 that both filmmakers and film exhibitors regain interest in 3D film. There was more 3D exhibition equipment, and more dramatic films being shot in 3D format. One incentive is that the technology is more mature. Shooting in 3D format is less limited, and the result is more stable. Another incentive was the fact that while 2D ticket sales were in an overall state of decline, revenues from 3D tickets continued to grow at the time.[52] Through the entire history of 3D presentations, techniques to convert existing 2D images for 3D presentation have existed. Few have been effective or survived. The combination of digital and digitized source material with relatively cost-effective digital post-processing has spawned a new wave of conversion products. In June 2006, IMAX and Warner Bros. released Superman Returns including 20 minutes of 3D images converted from the 2D original digital footage. George Lucas announced that he would re-release his Star Wars films in 3D based on a conversion process from the company In-Three. Later on in 2011, it was announced that Lucas was working with the company Prime Focus on this conversion.[53] In late 2005, Steven Spielberg told the press he was involved in patenting a 3D cinema system that did not need glasses, based on plasma screens. A computer splits each film-frame, and then projects the two split images onto the screen at differing angles, to be picked up by tiny angled ridges on the screen.[citation needed] Animated films Open Season, and The Ant Bully, were released in analog 3D in 2006. Monster House and The Nightmare Before Christmas were released on XpanD 3D, RealD and Dolby 3D systems in 2006. On May 19, 2007 Scar3D opened at the Cannes Film Market. It was the first US-produced 3D full-length feature film to be completed in Real D 3D. It has been the #1 film at the box office in several countries around the world, including Russia where it opened in 3D on 295 screens. On January 19, 2008, U2 3D was released; it was the first live-action digital 3D film. In the same year others 3D films included Hannah Montana & Miley Cyrus: Best of Both Worlds Concert, Journey to the Center of the Earth, and Bolt. On January 16, 2009, Lionsgate released My Bloody Valentine 3D, the first horror film and first R-rated film to be projected in Real D 3D.[54] It was released to 1,033 3D screens, the most ever for this format, and 1,501 regular screens. Another R-rated film, The Final Destination, was released later that year in August on even more screens. It was the first of its series to be released in HD 3D. Major 3D films in 2009 included Coraline, Monsters vs. Aliens, Up, X Games 3D: The Movie, The Final Destination, Disney's A Christmas Carol, and Avatar.[55] Avatar has gone on to be one of the most expensive films of all time, with a budget at $237 million; it is also the highest-grossing film of all time. The main technologies used to exhibit these films, and many others released around the time and up to the present, are RealD 3D, Dolby 3D, XpanD 3D, MasterImage 3D, and IMAX 3D. The success of the film also led to electronics manufacturers releasing 3D televisions[56] and caused 3D films[57] to increase in popularity. March and April 2010 saw three major 3D releases clustered together, with Alice in Wonderland hitting US theaters on March 5, 2010, How to Train Your Dragon on March 26, 2010, and Clash of the Titans on April 2, 2010. On May 13 of the same year, China's first IMAX 3D film started shooting. The pre-production of the first 3D film shot in France, Derrière les murs, began in May 2010 and was released in mid-2011. On October 1, 2010 Scar3D was the first-ever stereoscopic 3D Video-on-demand film released through major cable broadcasters for 3D televisions in the United States. Released in the United States on May 21, 2010, Shrek Forever After by DreamWorks Animation (Paramount Pictures) used the Real D 3D system, also released in IMAX 3D. In September 2003, Sabucat Productions organized the first World 3-D Exposition, celebrating the 50th anniversary of the original craze. The Expo was held at Grauman's Egyptian Theatre. During the two-week festival, over 30 of the 50 "golden era" stereoscopic features (as well as shorts) were screened, many coming from the collection of film historian and archivist Robert Furmanek, who had spent the previous 15 years painstakingly tracking down and preserving each film to its original glory. In attendance were many stars from each film, respectively, and some were moved to tears by the sold-out seating with audiences of film buffs from all over the world who came to remember their previous glories. In May 2006, the second World 3-D Exposition was announced for September of that year, presented by the 3-D Film Preservation Fund. Along with the favorites of the previous exposition were newly discovered features and shorts, and like the previous Expo, guests from each film. Expo II was announced as being the locale for the world premiere of several films never before seen in 3D, including The Diamond Wizard and the Universal short, Hawaiian Nights with Mamie Van Doren and Pinky Lee. Other "re-premieres" of films not seen since their original release in stereoscopic form included Cease Fire!, Taza, Son of Cochise, Wings of the Hawk, and Those Redheads From Seattle. Also shown were the long-lost shorts Carmenesque and A Day in the Country (both 1953) and William Van Doren Kelley's two Plasticon shorts (1922 and 1923). In the wake of its initial popularity and corresponding increase in the number of screens, more films were being released in the 3D format, yet fewer people were choosing to see them in such a way. For instance, only 45% of the premiere weekend box office earnings of Kung Fu Panda 2 in 2011 came from 3D screenings as opposed to 60% for Shrek Forever After in 2010.[58] In addition, the premiere of Cars 2 opening weekend gross consisted of only 37% from 3D theatres.[59] Harry Potter and the Deathly Hallows – Part 2 and Captain America: The First Avenger were major releases that achieved similar percentages: 43% and 40% respectively.[60] In view of this trend, there has been box office analysis concluding the implementation of 3D presentation is apparently backfiring by discouraging people from going to film theatres at all. As Brandon Gray of Box Office Mojo notes, "In each case, 3D's more-money-from-fewer-people approach has simply led to less money from even fewer people."[61] Parallel, the number of televisions sold with support for 3D television has dropped, let alone those sold with actual 3D goggles. According to the Motion Picture Association of America, despite a record total of 47 3D films being released in 2011, the overall domestic box office receipts were down 18% to $1.8 billion from $2.2 billion in 2010.[62] Although revenues as a whole increased during 2012, the bulk has so far come from 2D presentations as exemplified by little over 50% of filmgoers opting to see the likes of The Avengers and 32% choosing Brave in their 3D versions. Conflicting reasons are respectively offered by studios and exhibitors: whereas the former blame more expensive 3D ticket prices, the latter argue that the quality of films in general is at fault. However, despite the perceived decline of 3D in the U.S. market, studio chiefs in 2012 were optimistic of better receipts internationally, where there still appeared to be a strong appetite for the format.[63][64][needs update] Studios are also using 3D to generate additional income from films that are already commercially successful. Such re-releases usually involve a conversion from 2D. For example, Disney has reissued both The Lion King and Beauty and the Beast, with plans to add some of its other well-known titles.[65] Titanic has also been modified for 3D,[66] and there are also plans to similarly present all six Star Wars films.[67] Jeffrey Katzenberg, a producer of 3D films and one of the leading proponents of the format, blames oversaturation of the market with inferior films, especially ones photographed conventionally and then digitally processed in post-production. He claims that such films have led audiences to conclude that the format is not worth the often much higher ticket price.[68] Daniel Engber, a columnist for Slate, comes to a similar conclusion: "What happened to 3-D? It may have died from a case of acute septicemia—too much crap in the system."[69] Film critic Mark Kermode, a noted detractor of 3D, has surmised that there is an emerging policy of distributors to limit the availability of 2D versions, thus "railroading" the 3D format into cinemas whether the paying filmgoer likes it or not. This was especially prevalent during the release of Prometheus in 2012, where only 30% of prints for theatrical exhibition (at least in the UK) were in 2D.[70] His suspicions were later reinforced by a substantial number of complaints about Dredd from those who wished to see it in 2D but were denied the opportunity.[71] In July 2017, IMAX announced that they would begin to focus on screening more Hollywood tentpole movies in 2D (even if there's a 3D version) and have fewer 3D screenings of movies in North America, citing that moviegoers in North America prefer 2D films over 3D films.[72] In 2024, 3D films in 4K HDR became available to home media for the first time, with the launch of the visionOS operating system offering two services to access movies in such formats: Apple TV and Disney+. Some films were also offered in high frame rate (48fps), such as Avatar: The Way of Water. Other 3D media shot in 8K with a 180-degree view was also made available under the moniker "Apple Immersive Video."[73][74] Further information: Stereoscopy Stereoscopic motion pictures can be produced through a variety of different methods. Over the years the popularity of systems being widely employed in film theaters has waxed and waned. Though anaglyph was sometimes used prior to 1948, during the early "Golden Era" of 3D cinematography of the 1950s the polarization system was used for every single feature-length film in the United States, and all but one short film.[75] In the 21st century, polarization 3D systems have continued to dominate the scene, though during the 1960s and 1970s some classic films which were converted to anaglyph for theaters not equipped for polarization, and were even shown in 3D on television.[76] In the years following the mid-1980s, some films were made with short segments in anaglyph 3D. The following are some of the technical details and methodologies employed in some of the more notable 3D film systems that have been developed. Main article: Stereo photography techniques The standard for shooting live-action films in 3D involves using two cameras mounted so that their lenses are about as far apart from each other as the average pair of human eyes, recording two separate images for both the left eye and the right eye. In principle, two normal 2D cameras could be put side-to-side but this is problematic in many ways. The only real option is to invest in new stereoscopic cameras. Moreover, some cinematographic tricks that are simple with a 2D camera become impossible when filming in 3D. This means those otherwise cheap tricks need to be replaced by expensive CGI.[77] In 2008, Journey to the Center of the Earth became the first live-action feature film to be shot with the earliest Fusion Camera System released in Digital 3D and was later followed by several others. Avatar (2009) was shot in a 3D process that is based on how the human eye looks at an image. It was an improvement to the existing 3D camera system. Many 3D camera rigs still in use simply pair two cameras side by side, while newer rigs are paired with a beam splitter or both camera lenses built into one unit. While Digital Cinema cameras are not a requirement for 3D they are the predominant medium for most of what is photographed. Film options include IMAX 3D and Cine 160. In the 1930s and 1940s, the Fleischer Studios made several cartoons with extensive stereoscopic 3D backgrounds, including several Popeye the Sailor, Betty Boop, and Superman cartoons. In the early to mid-1950s, only half of the major Animation film studios operation experimented with creating traditional 3D animated short subjects. Walt Disney Studio produced two traditional animation short for stereoscopic 3D, for cinemas. Adventures in Music: Melody (1953), and the Donald Duck cartoon Working for Peanuts (1953). Warner Bros. only produced a single cartoon in 3D: Lumber Jack-Rabbit (1953) starring Bugs Bunny. Famous Studios produced two cartoons in 3D, the Popeye cartoon Popeye, the Ace of Space (1953), and the Casper the Friendly Ghost cartoon Boo Moon (1954). Walter Lantz Studio produced the Woody Woodpecker cartoon Hypnotic Hick (1953), which was distributed by Universal. From the late 1950s until the mid-2000s almost no animation was produced for 3D display in theaters. Although several films used 3D backgrounds. One exception is Starchaser: The Legend of Orin. CGI animated films can be rendered as stereoscopic 3D version by using two virtual cameras. Stop-motion animated 3D films are photographed with two cameras similar to live action 3D films. In 2004 The Polar Express was the first stereoscopic 3D CGI-animated feature film. The 3D version was solely released in IMAX theaters. In November 2005, Walt Disney Studio Entertainment released Chicken Little in digital 3D format, being Disney's first CGI-animated film in 3D. The film was converted from 2D into 3D in post production. nWave Pictures' Fly Me to the Moon (2008) was actually the first animated film created for 3D and released exclusively in 3D in digital theaters around the world. No other animation films have released solely in 3D since. The first 3D feature by DreamWorks Animation, Monsters vs Aliens, followed in 2009 and used a new digital rendering process called InTru3D, which was developed by Intel to create more realistic animated 3D images. InTru3D is not used to exhibit 3D films in theaters; they are shown in either RealD 3D or IMAX 3D. Main article: 2D to 3D conversion In the case of 2D CGI animated films that were generated from 3D models, it is possible to return to the models to generate a 3D version. For all other 2D films, different techniques must be employed. For example, for the 3D re-release of the 1993 film The Nightmare Before Christmas, Walt Disney Pictures scanned each original frame and manipulated them to produce left-eye and right-eye versions. Dozens of films have now been converted from 2D to 3D. There are several approaches used for 2D to 3D conversion, most notably depth-based methods.[78] However, conversion to 3D has problems. Information is unavailable as 2D does not have information for a perspective view. Some TVs have a 3D engine to convert 2D content to 3D. Usually, on high frame rate content (and on some slower processors even normal frame rate) the processor is not fast enough and lag is possible. This can lead to strange visual effects.[79] Further information: 3D television and 3D display Main article: Anaglyph 3D The traditional 3D glasses, with modern red and cyan color filters, similar to the red/green and red/blue lenses used to view early anaglyph films. Anaglyph images were the earliest method of presenting theatrical 3D, and the one most commonly associated with stereoscopy by the public at large, mostly because of non-theatrical 3D media such as comic books and 3D television broadcasts, where polarization is not practical. They were made popular because of the ease of their production and exhibition. The first anaglyph film was invented in 1915 by Edwin S Porter. Though the earliest theatrical presentations were done with this system, most 3D films from the 1950s and 1980s were originally shown polarized.[80] In an anaglyph, the two images are superimposed in an additive light setting through two filters, one red and one cyan. In a subtractive light setting, the two images are printed in the same complementary colors on white paper. Glasses with colored filters in each eye separate the appropriate images by canceling the filter color out and rendering the complementary color black. Anaglyph images are much easier to view than either parallel sighting or crossed eye stereograms, although the latter types offer bright and accurate color rendering, particularly in the red component, which is muted, or desaturated with even the best color anaglyphs. A compensating technique, commonly known as Anachrome, uses a slightly more transparent cyan filter in the patented glasses associated with the technique. Process reconfigures the typical anaglyph image to have less parallax. An alternative to the usual red and cyan filter system of anaglyph is ColorCode 3-D, a patented anaglyph system which was invented in order to present an anaglyph image in conjunction with the NTSC television standard, in which the red channel is often compromised. ColorCode uses the complementary colors of yellow and dark blue on-screen, and the colors of the glasses' lenses are amber and dark blue. The polarization 3D system has been the standard for theatrical presentations since it was used for Bwana Devil in 1952,[80] though early Imax presentations were done using the eclipse system and in the 1960s and 1970s classic 3D films were sometimes converted to anaglyph for special presentations. The polarization system has better color fidelity and less ghosting than the anaglyph system. In the post-'50s era, anaglyph has been used instead of polarization in feature presentations where only part of the film is in 3D such as in the 3D segment of Freddy's Dead: The Final Nightmare and the 3D segments of Spy Kids 3-D: Game Over. Anaglyph is also used in printed materials and in 3D television broadcasts where polarization is not practical. 3D polarized televisions and other displays only became available from several manufacturers in 2008; these generate polarization on the receiving end. cardboard 3D linear polarized glasses from the 1980s similar to those used in the 1950s. Though some were plain white, they often had the name of the theatre and/or graphics from the film Main article: Polarized 3D system To present a stereoscopic motion picture, two images are projected superimposed onto the same screen through different polarizing filters. The viewer wears low-cost glasses which also contain a pair of polarizing filters oriented differently (clockwise/counterclockwise with circular polarization or at 90 degree angles, usually 45 and 135 degrees,[81] with linear polarization). As each filter passes only that light which is similarly polarized and blocks the light polarized differently, each eye sees a different image. This is used to produce a three-dimensional effect by projecting the same scene into both eyes, but depicted from slightly different perspectives. Since no head tracking is involved, the entire audience can view the stereoscopic images at the same time. Resembling sunglasses, RealD circular polarized glasses are now the standard for theatrical releases and theme park attractions. Circular polarization has an advantage over linear polarization, in that the viewer does not need to have their head upright and aligned with the screen for the polarization to work properly. With linear polarization, turning the glasses sideways causes the filters to go out of alignment with the screen filters causing the image to fade and for each eye to see the opposite frame more easily. For circular polarization, the polarizing effect works regardless of how the viewer's head is aligned with the screen such as tilted sideways, or even upside down. The left eye will still only see the image intended for it, and vice versa, without fading or crosstalk. Nonetheless, 3D cinema films are made to be viewed without head tilt, and any significant head tilt will result in incorrect parallax and prevent binocular fusion. In the case of RealD a circularly polarizing liquid crystal filter which can switch polarity 144 times per second is placed in front of the projector lens. Only one projector is needed, as the left and right eye images are displayed alternately. Sony features a new system called RealD XLS, which shows both circular polarized images simultaneously: A single 4K projector (4096×2160 resolution) displays both 2K images (2048×1080 resolution) on top of each other at the same time, a special lens attachment polarizes and projects the images.[82] Optical attachments can be added to traditional 35mm projectors to adapt them for projecting film in the "over-and-under" format, in which each pair of images is stacked within one frame of film. The two images are projected through different polarizers and superimposed on the screen. This is a very cost-effective way to convert a theater for 3-D as all that is needed are the attachments and a non-depolarizing screen surface, rather than a conversion to digital 3-D projection. Thomson Technicolor currently produces an adapter of this type.[83] A metallic screen is necessary for these systems as reflection from non-metallic surfaces destroys the polarization of the light. Polarized stereoscopic pictures have been around since 1936, when Edwin H. Land first applied it to motion pictures. The so-called "3-D movie craze" in the years 1952 through 1955 was almost entirely offered in theaters using linear polarizing projection and glasses. Only a minute amount of the total 3D films shown in the period used the anaglyph color filter method. Linear polarization was likewise used with consumer level stereo projectors. Polarization was also used during the 3D revival of the 1980s. In the 2000s, computer animation, competition from DVDs and other media, digital projection, and the use of sophisticated IMAX 70mm film projectors, have created an opportunity for a new wave of polarized 3D films.[47][48] All types of polarization will result in a darkening of the displayed image and poorer contrast compared to non-3D images. Light from lamps is normally emitted as a random collection of polarizations, while a polarization filter only passes a fraction of the light. As a result, the screen image is darker. This darkening can be compensated by increasing the brightness of the projector light source. If the initial polarization filter is inserted between the lamp and the image generation element, the light intensity striking the image element is not any higher than normal without the polarizing filter, and overall image contrast transmitted to the screen is not affected. A pair of LCD shutter glasses used to view XpanD 3D films. The thick frames conceal the electronics and batteries. Main article: Active shutter 3D system In this technology, a mechanism is used to block light from each appropriate eye when the converse eye's image is projected on the screen. The technology originated with the Eclipse Method, in which the projector alternates between left and right images, and opens and closes the shutters in the glasses or viewer in synchronization with the images on the screen.[citation needed] This was the basis of the Teleview system which was used briefly in 1922.[29][84] A newer implementation of the Eclipse Method came with LCD shutter glasses. Glasses containing liquid crystal that will let light through in synchronization with the images on the cinema, television or computer screen, using the concept of alternate-frame sequencing. This is the method used by nVidia, XpanD 3D, and earlier IMAX systems. A drawback of this method is the need for each person viewing to wear expensive, electronic glasses that must be synchronized with the display system using a wireless signal or attached wire. The shutter-glasses are heavier than most polarized glasses, though lighter models are no heavier than some sunglasses or deluxe polarized glasses.[85] However these systems do not require a silver screen for projected images. Liquid crystal light valves work by rotating light between two polarizing filters. Due to these internal polarizers, LCD shutter-glasses darken the display image of any LCD, plasma, or projector image source, which has the result that images appear dimmer and contrast is lower than for normal non-3D viewing. This is not necessarily a usage problem; for some types of displays which are already very bright with poor grayish black levels, LCD shutter glasses may actually improve the image quality. Main article: Anaglyph 3D § Interference filter systems Dolby 3D uses specific wavelengths of red, green, and blue for the right eye, and different wavelengths of red, green, and blue for the left eye. Glasses which filter out the very specific wavelengths allow the wearer to see a 3D image. This technology eliminates the expensive silver screens required for polarized systems such as RealD, which is the most common 3D display system in theaters. It does, however, require much more expensive glasses than the polarized systems. It is also known as spectral comb filtering or wavelength multiplex visualization The recently introduced Omega 3D/Panavision 3D system also uses this technology, though with a wider spectrum and more "teeth" to the "comb" (5 for each eye in the Omega/Panavision system). The use of more spectral bands per eye eliminates the need to color process the image, required by the Dolby system. Evenly dividing the visible spectrum between the eyes gives the viewer a more relaxed "feel" as the light energy and color balance is nearly 50-50. Like the Dolby system, the Omega system can be used with white or silver screens. But it can be used with either film or digital projectors, unlike the Dolby filters that are only used on a digital system with a color correcting processor provided by Dolby. The Omega/Panavision system also claims that their glasses are cheaper to manufacture than those used by Dolby.[86] In June 2012 the Omega 3D/Panavision 3D system was discontinued by DPVO Theatrical, who marketed it on behalf of Panavision, citing "challenging global economic and 3D market conditions".[87] Although DPVO dissolved its business operations, Omega Optical continues promoting and selling 3D systems to non-theatrical markets. Omega Optical's 3D system contains projection filters and 3D glasses. In addition to the passive stereoscopic 3D system, Omega Optical has produced enhanced anaglyph 3D glasses. The Omega's red/cyan anaglyph glasses use complex metal oxide thin film coatings and high quality annealed glass optics. Main article: Autostereoscopy In this method, glasses are not necessary to see the stereoscopic image. Lenticular lens and parallax barrier technologies involve imposing two (or more) images on the same sheet, in narrow, alternating strips, and using a screen that either blocks one of the two images' strips (in the case of parallax barriers) or uses equally narrow lenses to bend the strips of image and make it appear to fill the entire image (in the case of lenticular prints). To produce the stereoscopic effect, the person must be positioned so that one eye sees one of the two images and the other sees the other. Both images are projected onto a high-gain, corrugated screen which reflects light at acute angles. In order to see the stereoscopic image, the viewer must sit within a very narrow angle that is nearly perpendicular to the screen, limiting the size of the audience. Lenticular was used for theatrical presentation of numerous shorts in Russia from 1940 to 1948[76] and in 1946 for the feature-length film Robinson Crusoe.[88] Though its use in theatrical presentations has been rather limited, lenticular has been widely used for a variety of novelty items and has even been used in amateur 3D photography.[89][90] Recent use includes the Fujifilm FinePix Real 3D with an autostereoscopic display that was released in 2009. Other examples for this technology include autostereoscopic LCD displays on monitors, notebooks, TVs, mobile phones and gaming devices, such as the Nintendo 3DS. Main article: Health effects of 3D Some viewers have complained of headaches and eyestrain after watching 3D films.[91] Motion sickness, in addition to other health concerns,[92] are more easily induced by 3D presentations. One published study shows that of those who watch 3D films, nearly 55% experience varying levels of headaches, nausea and disorientation.[93] Glasses designed to eliminate eyestrain by converting 3D images back into 2D have been developed.[94] There are two primary effects of 3D film that are unnatural for human vision: crosstalk between the eyes, caused by imperfect image separation, and the mismatch between convergence and accommodation, caused by the difference between an object's perceived position in front of, or behind the screen and the real origin of that light on the screen. It is believed that approximately 12% of people are unable to properly see 3D images, due to a variety of medical conditions.[95][96] According to another experiment up to 30% of people have very weak stereoscopic vision preventing them from depth perception based on stereo disparity. This nullifies or greatly decreases immersion effects of digital stereo to them.[97] It has recently been discovered that each of the rods and cones in animal eyes can measure the distance to the point on the object that is in focus at the particular rod or cone. Each rod or cone can act as a passive LIDAR (Light Detection And Ranging). The lens selects the point on the object for each pixel to which the distance is measured; that is, humans can see in 3D separately with each eye.[98] If the brain uses this ability in addition to the stereoscopic effect and other cues no stereoscopic system can present a true 3D picture to the brain. The French National Research Agency (ANR) has sponsored multidisciplinary research in order to understand the effects of 3D film viewing, its grammar[clarification needed], and its acceptance.[99] After Toy Story, there were 10 really bad CG movies because everybody thought the success of that film was CG and not great characters that were beautifully designed and heartwarming. Now, you've got people quickly converting movies from 2D to 3D, which is not what we did. They're expecting the same result, when in fact they will probably work against the adoption of 3D because they'll be putting out an inferior product.—Avatar director James Cameron[100] Most of the cues required to provide humans with relative depth information are already present in traditional 2D films. For example, closer objects occlude further ones, distant objects are desaturated and hazy relative to near ones, and the brain subconsciously "knows" the distance of many objects when the height is known (e.g. a human figure subtending only a small amount of the screen is more likely to be 2 m tall and far away than 10 cm tall and close). In fact, only two of these depth cues are not already present in 2D films: stereopsis (or parallax) and the focus of the eyeball (accommodation). 3D film-making addresses accurate presentation of stereopsis but not of accommodation, and therefore is insufficient in providing a complete 3D illusion. However, promising results from research aimed at overcoming this shortcoming were presented at the 2010 Stereoscopic Displays and Applications conference in San Jose, U.S.[101] Film critic Mark Kermode[102] argued that 3D adds "not that much" value to a film, and said that, while he liked Avatar, the many impressive things he saw in the film had nothing to do with 3D. Kermode has been an outspoken critic of 3D film describing the effect as a "nonsense" and recommends using two right or left lenses from the 3D glasses to cut out the "pointy, pointy 3D stereoscopic vision", although this technique still does not improve the huge brightness loss from a 3D film.[103] Versions of these "2-D glasses" are being marketed.[104] As pointed out in the article "Virtual Space – the movies of the future"[105][failed verification] in real life the 3D effect, or stereoscopic vision, depends on the distance between the eyes, which is only about 2+1⁄2 inches. The depth perception this affords is only noticeable near to the head – at about arms length. It is only useful for such tasks as threading a needle. It follows that in films portraying real life, where nothing is ever shown so close to the camera, the 3D effect is not noticeable and is soon forgotten as the film proceeds. Director Christopher Nolan has criticised the notion that traditional film does not allow depth perception, saying "I think it's a misnomer to call it 3D versus 2D. The whole point of cinematic imagery is it's three dimensional... You know 95% of our depth cues come from occlusion, resolution, color and so forth, so the idea of calling a 2D movie a '2D movie' is a little misleading."[106] Nolan also criticised that shooting on the required digital video does not offer a high enough quality image[107] and that 3D cameras cannot be equipped with prime (non-zoom) lenses.[106] Late film critic Roger Ebert repeatedly criticized 3D film as being "too dim", sometimes distracting or even nausea-inducing, and argued that it is an expensive technology that adds nothing of value to the film-going experience (since 2-D films already provide a sufficient illusion of 3D).[108] While Ebert was "not opposed to 3-D as an option", he opposed it as a replacement for traditional film, and preferred 2-D technologies such as MaxiVision48 that improve image area/resolution and frames per second.[108] Most 3D systems will cut down the brightness of the picture considerably – the light loss can be as high as 88%. Some of this loss may be compensated by running the projector's bulb at higher power or using more powerful bulbs.[109] The 2D brightness cinema standard is 14 foot-lamberts (48 candela per square metre), as set by the SMPTE standard 196M. As of 2012[update], there is no official standard for 3D brightness. According to the industry de facto standard, however, the "acceptable brightness range" goes as low as 3.5 fL (12 cd/m2) – just 25% of the standard 2D brightness.[110] Among others, Christopher Nolan has criticized the huge brightness loss: "You're not that aware of it because once you're 'in that world,' your eye compensates, but having struggled for years to get theaters up to the proper brightness, we're not sticking polarized filters in everything."[111] In September 2012, the DCI standards body issued a "recommended practice" calling for a 3D projection brightness of 7 fL (24 cd/m2), with an acceptable range of 5–9 fL (17–31 cd/m2).[2] It is not known how many theaters actually achieve such light levels with current technology. Prototype laser projection systems have reached 14 fL (48 cd/m2) for 3D on a cinema screen.[3] Main article: 2D to 3D conversion Another major criticism is that many of the films in the 21st century to date were not filmed in 3D, but converted into 3-D after filming. Filmmakers who have criticized the quality of this process include James Cameron (whose film Avatar was created mostly in 3D from the ground up, with some portions of the film created in 2D,[112] and is largely credited with the revival of 3D) and Michael Bay.[100] However, Cameron has said that quality 2D to 3D conversions can be done if they take the time they need and the director is involved.[113] Cameron's Titanic was converted into 3D in 2012, taking 60 weeks and costing $18 million. In contrast, computer-animated films for which the original computer models are still available can be rendered in 3D easily, as the depth information is still available and does not need to be inferred or approximated. This has been done with Toy Story, among others.[114] Film portal Cinematography Digital cinema List of 3D films (1914–2004) List of 3D films (2005–present) 2D to 3D conversion Depth perception Stereoscopy Autostereoscopy 3D display 3D television 4D film Volumetric display 3-D Film Preservation Fund Motion capture Stereoscopic video game Surround sound Digital 3D Disney Digital 3-D RealD 3D Dolby 3D XpanD 3D MasterImage 3D IMAX 3D 4DX ^ Goldberg, Matt (April 6, 2018). "3D Is Dead (Again)". Collider. ^ "animation | History, Movies, Television, & Facts". Britannica. Retrieved April 18, 2022. ^ a b Mills, Virginia (August 13, 2018). "180 years of 3D". Royal Society. Retrieved January 16, 2023. ^ Bulletins de l'Académie Royale des Sciences, des Lettres et des Beaux-Arts de Belgique (in French). Hayez. 1849. ^ Pellerin, Denis (October 13, 2017). "The Quest for Stereoscopic Movement: Was the First Film ever in 3-D?". International Journal on Stereo & Immersive Media. 1 (1). 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Pictured here is a 4DX theater. 4D film is a presentation system combining motion pictures with synchronized physical effects that occur in the theater. Effects simulated in 4D films include motion, vibration, scent, rain, mist, bubbles, fog, smoke, wind, temperature changes, and strobe lights.[1][2] Seats in 4D venues vibrate and move. As of 2022, 4D films have been exhibited in more than 65 countries.[3] 4D motion pictures are also exhibited in theme parks.[4] The term "4D film" is an extension of 3D film, which gives the illusion of three-dimensional solidity.[5] Precursors of the modern 4D film presentation include Sensurround, which debuted in 1974 with the film Earthquake. Only a few films were presented in Sensurround, and it was supplanted by Dolby Stereo in 1977, which featured extended low frequencies and made subwoofers a common addition to cinema.[6] Other notable efforts at pushing the boundaries of the film viewing experience include Fantasound, the first use of stereo sound; Cinemiracle and Cinerama, both widescreen formats utilizing multiple projectors; and Smell-O-Vision. The Sensorium is regarded as the world's first commercial 4D film and was first screened in 1984 at Six Flags Power Plant in Baltimore. It was produced in partnership with Landmark Entertainment.[7] 4DX, D-Box Technologies, and Mediamation all currently integrate 4D technology in global stadium seating multiplexes.[8] The following is a list of 4D presentation systems developed for traditional film theatres. Overview of 4D providers Format Date Developer 3D format Motion seat Effects Remarks Notes 4DX CJ 4D Plex Stereoscopic 3D yes motion, vibration, scent/olfactory, water sprays, wind/air, snow, fog, strobes, lightning, bubbles Cineworld, Cinépolis D-Box D-Box Technologies Stereoscopic 3D yes motion, vibration Cinemark MX4D[9] MediaMation Stereoscopic 3D yes motion, vibration, scent/olfactory, water sprays, wind/air, snow, fog, strobes, lightning, bubbles Paramount, Showcase 4D E-Motion Lumma Stereoscopic 3D yes motion, vibration, scent/olfactory, water sprays, wind/air, snow, fog, strobes, lightning, bubbles (Not named by developer) Red Rover Stereoscopic 3D yes motion, water sprays, wind/air, scent/olfactory, fog, strobes, bubbles, Branded as Super 4D in Lotte Cinema installations. Title Year Release venue/Country Notes The Sensorium 1984 Six Flags Power Plant, Baltimore, MD The first 4D film Captain EO 1986 Epcot, Disneyland, Disneyland Paris and Tokyo Disneyland Closed in the mid-late 1990s and reopened in 2010 as a tribute to the late Michael Jackson. Muppet*Vision 3D 1991 Disney's Hollywood Studios Directed by Jim Henson Honey, I Shrunk the Audience 1994 Epcot, Disneyland, Disneyland Paris and Tokyo Disneyland Sponsored by Kodak, closed in all locations in May 2010 and was replaced with Captain EO. Terminator 2 3D: Battle Across Time 1996 Universal Studios Japan Directed by James Cameron Pirates 4D 1997 SeaWorld Ohio, Busch Gardens Williamsburg, Thorpe Park in the UK, Busch Gardens Tampa Bay Produced by Busch Entertainment, Directed by Keith Melton. PandaDroom 2002 The Efteling, Netherlands Same film released in other parks without 4D effects SpongeBob SquarePants 4-D 2002, 2006 Six Flags over Texas, Moody Gardens, Shedd Aquarium, Adventure Dome, Six Flags Great Adventure, Movie Park Germany, Adventure Aquarium, Kings Dominion, (formerly at Paramount Parks), Indianapolis Zoo, Carowinds, Camden Aquarium (Camden, NJ), Flamingo Land Theme Park and Zoo and other locations Mickey's PhilharMagic 2003 Magic Kingdom, Hong Kong Disneyland, Tokyo Disneyland, and Disney California Adventure. In collaboration with Walt Disney Feature Animation Haunted Lighthouse[a] 2003 Flamingo Land Theme Park and Zoo Shrek 4-D 2003 Universal Studios Florida, Universal Studios Japan, and Universal Studios Singapore Released in an anaglyph version as Shrek 3-D on DVD Borg Invasion 2004 Star Trek: The Experience, at Las Vegas Hilton, US Closed in 2008, to be reopened in Neonopolis, Las Vegas Fly Me to the Moon 2008 Six Flags over Texas Journey to the Center of the Earth 4-D Adventure 2008 Vibrant 5D, Raipur, India Stone Mountain Park, Dollywood, Warner Bros. Movie World Fly High: The Legend of Black Man 2017 India First Indian 4D film; directed by Rahul Rathish Kumar Avatar in 4D 2009 South Korea, Hong Kong In 4DX. James Cameron, Director London Eye 4D Experience 2009 London Eye Produced by Centre Screen Productions and Principal Large Format Beyond All Boundaries 2009 WWII Museum, New Orleans Produced by Tom Hanks ENERGIA The Spirit of the Earth 2009 Cité de l'énergie, Shawinigan (Quebec) Spectators are seated on a revolving platform. Features wind, snow, smoke, rain, vibration and lighting effects. "The Garden" 2010 USA pavilion at Expo 2010 The eight-minute film was projected upon five 10-meter-high screens. Marvel Super Heroes 4D 2010 Madame Tussauds London, Trans Studio Bandung[10] Rabid Rider 2010 Cincinnati Zoo Shalem 2011? Jerusalem Time Elevator, Jerusalem A 3000-year-old guide to Jerusalem's history at the Jerusalem Time Elevator, Jerusalem.[11] The Bourne Legacy 2012 Multinational In 4DX Tallgrass Prairie: Tides of Time 2012 Flint Hills Discovery Center, Manhattan, Kansas Features wind, snow, smoke, and lightning effects[12] Prometheus 2012 Cinepolis Galerias Guadalajara, Mexico In 4DX. Ridley Scott, Director Titanic 2012 Multinational 4DX re-release,[13] James Cameron, Director The Adventures of Tintin 2011 Nickelodeon Resorts, Paramount Parks, North Carolina Zoo, and Alton Towers 14-minute condensed version of the film. Iron Man 3 2013 Korona World Theatre Nagoya, Japan,[14] Seoul, South Korea Labeled as 4DX featuring strobe lights, tilting seats, blowing wind and fog, and odor effects. 47 Ronin 2014 Multinational In 4DX Fury 2014 Multinational In 4DX Interstellar 2014 Multinational In 4DX. Christopher Nolan, Director Rio 2014 San Diego Zoo, Kentucky Kingdom, North Carolina Zoo, Indianapolis Zoo, Cincinnati Zoo 12-minute condensed version of the film. Temple Run 7D 2014 India 9-minute ride to various Indian temples including Kedarnath, Badrinath, Gangotri, Rameshwaram, and Dwarka produced by Modern Techno Projects Private Ltd. Happy Feet Multinational [15] Star Wars: The Force Awakens 2015 Multinational In 4DX. J.J. Abrams, Director Ice Age: No Time for Nuts 4D 2015 United States 4D-remastered version of the 2006 short film of the same name. Rogue One 2016 Multinational In 4DX Batman v Superman: Dawn of Justice 2016 Seoul, Korea and New York City, New York Labeled as 4DX including fog, wind, motion, rain, lightning, vibrations and scents. Pixels 2016 Taguig, Philippines 4DX re-release including models, sprites, explosives, and bullets. Mass Effect: New Earth 4D 2016 California's Great America 4+1⁄2-minute film, 60-foot screen with 4K resolution, live performers, wind, water, leg pokers, neck ticklers, 80-channel surround sound LEGO Nexo Knights 4D: The Book of Creativity[16] 2016 Legoland parks and Legoland Discovery Centre parks worldwide 12+1⁄2-minute 4D film of LEGO Nexo Knights shown at Legoland, along with The LEGO Movie 4D Produced by Alexander Lentjes[17] for M2Film and Merlin Entertainments Gravity 2018 Multinational 4DX re-release,[18] Alfonso Cuarón, Director Life of Pi 2018 Multinational 4DX re-release,[19] Ang Lee, Director 1917 2019 Multinational In 4DX,[20] Sam Mendes, Director, Produced by Amblin Partners Star Wars: The Rise of Skywalker 2019 Multinational In 4DX. J.J. Abrams, Director Gemini Man 2019 Multinational In 4DX. Ang Lee, Director The Lion King 2019 Multinational In 4DX. Jon Favreau, Director Inception 2020 Multinational 4DX re-release,[21] Christopher Nolan, Director The Matrix Resurrections 2021 Multinational In 4DX. Lana Wachowski, Director Top Gun: Maverick 2022 Multinational In 4DX. Directed by Joseph Kosinski. The Super Mario Bros. Movie 2023 Multinational In 4DX. Aaron Horvath, Michael Jelenic Directors Tom and Jerry The Movie 2022 Multinational [22] SCOOB 2023 Multinational [23] DC League of Super Pets 2023 Multinational [24] Scrooge: A Christmas Carol 2023 Multinational [25] Oppenheimer 2023 Multinational In 4DX. Christopher Nolan, Director[26] Postcard from Earth 2023 Sphere at the Venetian Resort, Las Vegas Effects include wind, scents, and infrasound seat vibrations. Directed by Darren Aronofsky.[27] Godzilla Minus One 2023 Japan In 4DX. Directed by Takashi Yamazaki[28] 4DX Simulator ride ^ Also known as R. L. Stine's Haunted Lighthouse 4-D) ^ Archived atGhostarchive and the Wayback Machine: "4DX Cinemas Next Generation - Motion Seats, Wind, Fog, Lighting, Bubbles, Water & Scents". YouTube. ^ Archived at Ghostarchive and the Wayback Machine: "Smelly Screens & Moving Seats At The UK's First 4DX Cinema | Swipe". YouTube. ^ "4DX Continues to Dominate The 4D Marketplace by Inking Deal with Cineplex Germany". DCinemaToday. 2019-04-01. Retrieved 2022-03-27. ^ "Weekly Top 10: The World's Best Theme Park Movie Attractions". Theme Park Insider. Retrieved 2022-03-27. ^ "Watch: First 4D Theater Opens in the U.S." Time. June 24, 2014. Retrieved December 13, 2023. ^ Hauersley, Thomas (May 25, 2011). "...in Sensurround". In 70mm. Retrieved October 23, 2017. ^ Zone, Ray (2012). 3-D Revolution: The History of Modern Stereoscopic Cinema. The University Press of Kentucky. pp. 143–155. ISBN 978-0-8131-3611-0. Archived from the original on 2017-10-23. Retrieved 2017-10-23. ^ Maddox, Gary (October 7, 2011). 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