The challenge of sound restoration from 1927 to digital

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Preface

At the time of the first projection of The Jazz Singer, no one was in a position to imagine how cinematic sound would one day evolve. Who today can retrace its past?

Only seventy years separate us from the beginnings of sound cinema, and within this short period the extraordinary evolution of analogue sound processing, more amazing even than the digital sound that followed, has unfolded. The real history of sound in cinema begins with the first dialogue films that mark the fundamental transformation of filmic language. A new form of cinematic narrative was born with The Jazz Singer, and in an even more significant manner with works like The Blue Angel or Lights of New York.

There are two major directions to take under consideration. The most important seems to me to be the aesthetic of sound, but that is not my topic here. The other direction is that of technological evolution and its implications for the film industry, that of the evolution of standards which necessarily followed, and finally (and for our greatest satisfaction now), the consequences of these inventions, these sound systems, on the notion of film presentation, the presentation which it is our duty to conserve in its original form.

In its primitive form, as introduced by Vitaphone, sound, without qualifying technical parameters, was considered sufficient in itself. One could compare the phenomenon of the earliest sound tests with the first flickering projections of the Lumière brothers, unbearable in our day, which the spectators of the time accepted uncomplaining for lack of other standards of reference.

A considerable part of this study is principally based on this notion of reference to our memory which permits us to express a qualitative and quantitative opinion about all that surrounds us. Concerning sound, we always refer to two types of sources: comparing one recording with another, and comparing recorded sound with 'live'. These seem to me to be the principal distinctions, but they have the sense of sine qua non only under one condition: each recording must be heard with a sound system that respects the standards active at the time. Today, for example, we hear the sound of The Jazz Singer with a modern installation, the same that will serve two hours hence to present Citizen Kane and two hours after that Raiders of the Lost Ark! The sound quality will inevitably be very different, but the notion of reference will be totally falsified since the recordings won’t have been reproduced with equipment respective to their period. To listen today to the sound of the film

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The Jazz Singer with a Western Electric type 16-A loudspeaker coupled to a 555 driver exactly as in 1927 reveals to us a ‘sound’ that is almost meaningless compared to one heard with modern amplification and loudspeakers. The recordings of 1927 were linear, and loudspeaker characteristics did not permit the reproduction of low and high frequencies. Today’s sound systems have a precision Academy filter and high performance amplifiers and speakers. In 1927, the sound of The Jazz Singer was free from rumble and hiss, and the intermediary band that came through was linear from 400 to 5000 Hz; tonal equilibrium was thus perfectly respected since the films of that period were mixed with speakers identical to those in the projection rooms. Today, the sound will be reproduced with noisy low and high frequencies and the hiss reproduced across the curve of the Academy filter, and therefore out of equilibrium with the tonal balance of the recording. It is important to know that recording systems are provided with particular, standardized filters, which were modified several times over the course of history and that this means that the recordings of one period must necessarily be read with the reproduction characteristics of that same period. This is only one small detail in terms of the numerous systems that map the history of cinematic sound.

The situation during the first period
Before film screening became ‘film presentation’ and settled in form, many image formats were proposed. The formation and commercialization of cinema was in large part due to the standardization of projection systems. The commercial might of the Bell & Howell company originates from a required standardization of image to perforations that remained unchanged until the beginning of dialogue films. During all this time, presentation evolved within the 4:3 format, which no invention modified during this period.

Second period (1927–52)
Multiple inventions that permitted sound recording and reproduction in large rooms decisively marked the second period of presentation history. The advent of dialogue was at the root of a fundamental change in all that was previously attained, not only concerning filmic language, but equally in the technical equipment of the entire industry. A new dimension was added to performance: ‘the sound’, with optical sound and its qualitative limits belonging to the Academy norm as a second constraint for the director.

The situation during this second period
The passage from silence to dialogue sound with its multiple systems and the introduction at the same time of several processes for wide screens mark the beginning of this period, which is considerably more important for the study of technical evolution. Inventions and procedures of all sorts were introduced into the industry. Producers and major production companies restrained their enthusiasm, however, and the economic crisis at the time was not propitious to the development of new wide screen processes. No invention modified the image format during this period and only monophonic sound, which is qualitatively very limited, was added to film presentation. The evolution of technologies as a consequence of World War II would overtake stereophonic processes developed earlier, such as Fantasound and Vitasound.

Third period (1952 to present)
The introduction into the marketing network of Cinerama, with its giant screen and high quality
stereophonic sound, marks a third significant period, featuring Cinemascope and a number of other analogous and compatible image formats. The whole film industry was upset once again, but for the first time directors were liberated from the constraints of image format and of lower quality monophonic sound, thus considerably enlarging their visual and sonic palette.

The situation during the third period

Cinerama, which was made commercially viable by the evolution of an ensemble of technologies, marks here a decisive jump in the development of film presentation. Introduced in the industry on 30 September 1952, its enlarged image and stereophonic sound sparked a resurgence of interest among the directors of the major studios. By 16 September 1953, 20th Century Fox had massively commercialized the newly invented CinemaScope process, setting up and installing it in theatres in its marketing network in under a year—a unique event in film history.

System has followed system to the present day, giving us an incredible variety of presentation styles, each inseparable from its film genre. Films are made in great numbers in all of these processes, and distributed throughout the world with their original process, unlike those produced during the two earlier periods. We can distinguish in this third period of history three major categories of presentation, following very distinct orientations adopted by the producers and studios:

1st category

Systems conceived exclusively for large theatres, such as Cinerama, MGM Camera 65, Ultra-Panavision, Todd AO, etc., and more recently Super Panavision 70.

2nd category

Systems conceived for average use, like CinemaScope for 4 magnetic tracks, Perspecta Sound, Dimensional Sound, Technirama, Vistavision, etc., and most recently Dolby Stereo, Ultra Stereo and various digital systems.

3rd category

Systems usable in all theatres, but mainly conceived for small halls, like CinemaScope with optical sound, Superscope, Techniscope and today the enlargements Super 16 and so forth.

Image and sound formats in the first category evolved simultaneously and were rarely standardized. Rapid standardization quickly stabilized and reduced the number of image formats in category 2, but sound systems continue to develop. Economic restraints in the third category have reduced the number of image formats and sound systems to the bare minimum. A preliminary study has permitted me to distinguish nearly a hundred systems where combinations of image and sound procedures produced more than 350 different types of presentation. Therefore, a single film may exist in several formats, depending on the year it was made, and its theatrical presentation may vary considerably from one theatre to another, depending on the technical projection capabilities of each theatre².

The development of sound in cinema

Since Vitaphone, the development of cinema sound was marked by the extraordinary success of synchronized sound and paradoxically by the defeat of the original Vitaphone system, which consisted of using a 16" (404 mm) diameter disk. Warners was quickly compelled to abandon the disk system in favour of optical sound, but kept the name Vitaphone for a while. After 1930 only optical sound (sound on film) was used for film production. A standardization of projection speeds and of the position and dimensions of the soundtrack after 1930 contributed greatly to world-wide film distribution.

Further technical advances and diversification soon posed problems, however. Western Electric, for example, the same company that introduced the celebrated 16A loudspeaker with the 555W driver in 1927 for Vitaphone, was touting 'the first three-way wide-range loudspeaker systems in theatres' by 1931⁴, and two years later the same company introduced the 'Mirrophonic' sound system which used multicellular horns⁵. RCA on its side brought out a two channel system for sound reproduction, but each of these companies recorded and treated the sounds by their own special method, which rapidly led to incompatible systems. The Western Electric recording not only had
to be read by Western Electric installations, but the later modifications had to be on contemporary systems in order to have the improved characteristics. In addition, playing an RCA recording on a Western Electric installation posed further problems. The situation actually became so critical that it was addressed by an SMPE committee in 1934.

Report of Sound Committee

In a communication addressed to the chairman of the committee by President Goldsmith, about the middle of March, the committee was asked ‘... to formulate standards of sound recording reproduction (audio-frequency characteristics) of such a type that the producing studios and the theatre circuits can all agree to accept them at a reasonably early date after the standards shall have been agreed upon. The present state of sound recording and reproducing indicates that the matter is definitely urgent. There is an unnecessary amount of deviation in releases from the various studios, and it is obvious that the full advantages of improved methods of reproduction can not be realized under the present conditions. Such standardization is the most important problem facing the Committee’.

Despite this communication, it took until 1937 for a project on the standardization of reproduction characteristics to be accepted. This first standardization, published in the SMPE Journal in January 1938, put an end to what we consider today to be the first great evolutionary period of sound cinema (1927–38). The technological evolution resulting from WWII would result in a modification of this standardization in 1948. These two standardizations only concern the characteristics of the bandwidth, but other standards, like control of the relative sound level, or push-pull systems, were rapidly adopted.

All this concerns only electric recordings termed ‘Academy recording’, but an examination of sound systems from this second period of cinema history shows that numerous attempts at stereophonic processes also appeared. The most important included the sound perspective of Abel Gance, the stereo system of Blumlein, the ‘surround’ system of the Magnoscopic projections, Warners’ Vitasound, or again RCA’s Fantasound.

The development of sound in cinema during the third period of cinema history that we term ‘the era of wide screen and stereo’, is one of great complexity. The introduction of magnetic sound in the industry and the many possible combinations offered by multitrack systems like the four tracks of CinemaScope, the six tracks of Todd-AO, the two-tape systems of Cinerama or Warnerphonic sound would require a full-scale study for anything approaching a summary. We will describe, by way of an introduction to a long series of processes, the Dimensional Sound system, a variant of the Perspecta Sound system that was used for the Alfred Hitchcock film The Man Who Knew Too Much in 1956.

Discovered by the Cinévolution Center in Belgium, supported by the Bologna Cinémathèque since the FIAF International Congress in 1994, the presentation of this work in its original sound system proves how important it is to conserve not only the films but also the image and sound systems, which must be considered an integral part of the work. Among the major European archives, the Bologna Cinémathèque and the J. Paul Getty Jr. Conservation Centre at Berkhamsted are the first to have become aware of this fact.

A brief history of Perspecta Sound

The premiere of the first Cinerama film in September 1952 overturned the entire cinema industry and opened the era of wide-screen and stereo. Only a year after the introduction of Cinerama, however, 20th Century Fox commercially introduced its own wide-screen system of shooting and projection and also provided a stereo sound process. Indeed, Cinerama was not solely responsible for Fox’s initiative. The arrival of television in private homes and its consequences in lowering box office receipts made it imperative to reconquer part of the public by giving a new dimension to film presentation. After experimenting with several systems, Fox settled upon a process invented by Henri Chrétien, which consisted of shooting a very wide image, still using a conventional 35 mm film. A system of lateral compression of the image permitted, with the help of an anamorphoser, com-
pression of this in a ratio of 1:2. In projection, this image would be decompressed in the same ratio to its original proportions. The frame of the image thus produced was 2.55:1 for the system with magnetic recording, and 2.35:1 for the system with optical sound. Unlike Cinerama, this process, which Fox named CinemaScope, was conceived for the entire industry, and most of the majors adopted it. Today, the CinemaScope process, adapted to projection prints with optical sound recording introduced at the beginning of 1954, remains, with a few variations, the same.

Before CinemaScope, the stereophonic systems employed by the Cinerama company, Warner Bros. and other majors used a 35 mm magnetic tape synchronized with the image. 20th Century Fox opted for the more economical and practical solution of running four magnetic tracks directly on the projection prints, not on a second tape. The exceptional quality of magnetic recording allowed the engineers of 20th Century-Fox to abandon their old 3-track optical system, known under the name of ERPI Stereophonic Movietone.

20th Century-Fox premiered its first film in the new process, Henry Koster's *The Robe*, on 16 November 1953. MGM later premiered Richard Thorpe's *The Knights of the Round Table*, and a few months after that Warner Bros. released George Cukor's version of *A Star Is Born*. At first the magnetic four-track system was an integral part of the CinemaScope process. Its prohibitive cost, due to the special equipment needed for theatrical preamplification and realization of the sound, rapidly became an obstacle for the diffusion of films made by the process. MGM was the first of the majors to react to this economic problem and quickly proposed an alternate stereophonic sound system that was compatible with optical sound reproduction systems already installed in theatres; this was called 'Perspecta Stereophonic Sound'.

MGM, at first, decided to play its CinemaScope productions on four magnetic tracks domestically, and in Perspecta Sound in foreign houses. *Knights of the Round Table* was the first film shown in Europe with the system. Paramount was interested in Perspecta and announced that it would be used for all of its VistaVision productions. Experience showed that Paramount's current standard-format productions would also benefit from the process. At Columbia the situation was very different, and only a few films were encoded with the system. Warner Bros. adopted the same strategy as MGM and all its important productions were distributed in both systems. The superior quality of magnetic recording gradually convinced the majors to review their position regarding systematic use of Perspecta Sound. Perspecta Stereophonic Sound disappeared from US productions by 1960 in the US, although it was used by the Japanese until 1965, and for the rest of the world information is seriously lacking. Only the examination of individual prints will allow the exact situation concerning the abandonment of the process to be known.

**A technical overview of Perspecta Sound**

Except for a few very rare cases, the Perspecta Stereophonic Sound system was used only for optical sound for 35 mm films. The principle of the Perspecta system consists in directing a monophonic recording to three volume amplifiers that feed three speakers situated behind the screen. The monophonic optical recording is directed by the frequency and amplitude of pilot signals, previously recorded in the mixing of the film. In projection, a device called an 'integrator' detects the frequency or frequencies and integrates them as one continuous composite which controls the gain in a variable gradient tube. Three frequencies were chosen, inaudible in the installations of the period: 30, 35 and 40 Hz.

After amplification as photoelectric current, the signal is directed to four circuits. The first circuit is composed of a high-pass filter that suppresses the pilot signals. The sound of the film, purified of the control signal, is then directed to three amplifiers each equipped with a variable gradient tube. Output from these amplifiers is controlled by a triple attenuator placed before the theatre's volume amplifier. The three remaining circuits are selective filters, each assigned to one of the pilot frequencies. The 30 Hz frequency commands the left channel, the 35 Hz the centre, and the 40 Hz the right channel. The frequency of the pilot signal thus determines the position of the sound source behind the screen and its amplitude determined the loudness of the sound in the hall. The output signal thus
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consists of only one pure frequency that is integrated as a continuous composite. This direct current controls the gain in the variable gradient tube and thus the output level in the hall. The studio sound mixer had the ability, using one or several frequencies at different levels, to direct monophonic sound toward any part of the screen. He could also, using all the frequencies at maximum level, give greater sound volume to the presentation.

Two examples will illustrate how this operates in practice. If dialogue occurs at the centre of the screen, the mixer would add the 35 Hz pilot signal to the sound on the film. During theatrical projection, the integrator captures that frequency and augments the output level in the central channel. Spectators would then hear the sound from the center of the screen no matter where they were in the hall. If a second actor situated at the right of the screen responds, the mixer reduces the 35 Hz frequency and progressively adds 40 Hz. The integrator then directs the sound from the film to the right channel and suppresses the centre. Now, if a symphony orchestra appears on the screen with all the instruments playing at the same time, the mixer would add all three frequencies to the track and the integrator would direct the sound to all three screen speakers at the same time. For this last example, it would evidently be impossible to localize the instruments in their respective places, so that Perspecta Sound is, in reality, a pseudo-stereophonic system.

The major studios evidently used Perspecta in different forms and under different names. Paramount called the process ‘Dimensional Sound’, and, since their productions at that time were all filmed in full-frame panoramic format from 1.66:1 to 1.96 or 2, the stereophonic effects were more modest than in CinemaScope productions. Perspecta, in this instance, functioned principally as noise reduction and gave a subjectively superior sound quality to Academy recording. In MGM or Columbia’s CinemaScope productions, however, the recordings were highly stereophonic and the sound followed the action on the screen, fully utilizing the Perspecta integrator as a stereophonic system as well as a subjective noise reducer. When correctly adjusted, the integrator brought the sound into extraordinarily nuanced relief, adding greater dimension to the film – a dimension whose loss is regrettable. The Cinévolution Center has three Perspecta systems as well as a collection of films recorded in the different systems. This material is available to researchers, historians and students who wish to study the history of film presentation [see Fig. 1].

‘Dimensional Sound’ in the work of Alfred Hitchcock: The Man Who Knew Too Much (1956)

An analytical study of the Perspecta/Dimensional Sound system in the works of Alfred Hitchcock is under way at Mons, Belgium, and a brief examination of The Man Who Knew Too Much
(1956) in the context of this paper may illustrate a preliminary approach to further research. It is important to note here that there is no question of undermining all the studies, and they are numerous, which have been done in the realm of Alfred Hitchcock's work. Dimensional Sound, an optional projection process, does not introduce significant elements with respect to film narrative—it must be considered a complementary, not an essential element to the form; the system, just like VistaVision, would only be appreciated by those who attached importance to film presentation, a subtle mixture of essence and form.

In the mid 1950s, Paramount, like all the majors, wanted to impose its VistaVision wide-screen process, one of the best image processes, on directors of the time; and it was in VistaVision that Hitchcock's The Man Who Knew Too Much premiered. Hitchcock, an indefatigable perfectionist, mastered the VistaVision process in several of his works, where the quality and the composition of his images were all of the first order. VistaVision films were projected in a relatively wide format (1.96:1) approximating the CinemaScope system with optical sound (2.35:1). During the 1950s the sound, for such a wide image, had to be stereophonic. For the sound in The Man Who Knew Too Much, Paramount opted for its version of Perspecta, called Dimensional Sound—a complex process that had, as I have described earlier, only a short commercial life. Paramount took the option of Dimensional Sound for its VistaVision productions but never imposed the acquisition of the equipment on the projectionists in the commercial theatres. This means that a work directed at Paramount had to be conceived from the beginning so as to be projected either with or without the Dimensional Sound system.

Obviously, a similar situation existed regarding the image. Its composition, with respect to the film narrative, had to be established in a 1.96 or 2:1 format, but the composite format of the VistaVision system also permitted projection in multiple formats of which the smallest was about 1.5:1. Therefore, The Man Who Knew Too Much could either be presented on a small screen in the proportion 1.66:1 with monophonic sound, or on a large screen with a proportion of 1.96 or 2:1 and stereophonic sound. Though a mediocre presentation in the smaller format still allows a plot analysis of the film, in the VistaVision/Dimensional Sound version the work takes on its full value and the film presentation itself adds a real dimension to the intrigue.

As for the sound itself, Hitchcock employed Dimensional Sound in a discreet manner for two precise (and occasionally intermingled) purposes: we find the process used partly to accentuate the idea of space, and partly to attract the attention of the spectator when the sound of the film played a role in the intrigue. Dimensional Sound is used from the beginning of the film. The orchestra, conducted by Bernard Hermann, serves as background to the credits; a cymbal crash is heard, of which the audience does not yet know the importance within the plot. The sound on the film is at this point reproduced by all three speakers at a level that conventional photographic recording was not capable of reproducing. After the credits, the space in which the action occurs does not justify the use of particular sound effects, and the sound of the film comes from the central speaker [see Fig. 2]. An instance where Dimensional Sound is used to accentuate the idea of filmic space occurs shortly thereafter, during a dialogue scene set inside a bus. At first, the sound is reproduced from the centre. As the bus arrives in Marrakech at market time, the sound passes progressively through the three screen speakers. The opening of the sonic universe thus accentuates the idea of filmic and scenic space [see Fig. 3].

Where Dimensional Sound plays a significant role in the narrative is the point when the father of Hank (the young boy), having been locked in the chapel, attempts to escape through the bell tower. He uses the bell ropes to raise himself up to the tower and Dimensional Sound opens up the sound space. We are, like the neighbours who congregate, taken into this noisy sound universe, which makes us aware of the mob of onlookers curious about the outcome [see Figs. 4 & 5]. At the same time, Hank's mother finds herself in London's Royal Albert Hall, a notoriously sonorous space even more open than the preceding one. Dimensional Sound plunges us into the sound universe of large halls, where the accumulation of reverberations accentuates our impression of anguish, and accentuates also the isolation of the character, lost in this cacophonous world [see Fig. 6]. During the concert,
the amplitude of the sound would be proportional to the scene; the system reproduces the sound track of the film in all three speakers at a relatively high level [see Fig. 7]. Hank’s parents find themselves in the Albert Hall and converse; the amplitude of the sound is such that we cannot hear their dialogue. This sort of situation appears several times in the film and the process accentuates the realism. The sound dynamic follows subjective reality, which is one of the particularities of the process. If a scene demands a softer sound level, the sound of the film is automatically reduced, and the effect is much
more perceptible than it would be without the system [see Fig. 8].

Finally, during the soirée at the embassy, Hank’s mother sings ‘Che sarà sarà’ very loudly, in the hope that her son, imprisoned in the same building, will hear [see Fig. 9]; he hears and responds with a whistle so as to let his mother know that he is indeed there [see Fig. 10]. The loud whistle could be heard by the parents beyond his room, up the staircase and in the reception room. During this whole scene, sonorous space plays an important role in the narrative and the use of
Dimensional Sound is a considerable asset. We effectively pass from the salon to the boy's room, passing the staircase where the camera shows a succession of levels as we approach the room, receding from the salon, then return to the salon [see Fig. 11].

This first examination of the use of Dimensional Sound shows us the technical possibilities the process could offer when exploited judiciously by a director like Hitchcock. A more precise study of the use of special processes, both visual and aural, in the work of Alfred Hitchcock will be
undertaken later by Paolo Cherchi Usai in collaboration with the Cinévolution Center¹.

The restoration of Perspecta

The restoration of Perspecta systems poses numerous problems, which are the object of an important programme put in motion by Cinévolution in collaboration with Berkhamsted and Bologna, the universities of Brussels and Los Angeles, and the Equipe studio in Brussels. Using period reproduction equipment is an extremely delicate business. Cinévolution has a collection of Perspecta integrators, and only equipment of a particular make is used. These devices are of such rarity that installing them at every archive is inconceivable, and only an equivalent transfer to a more current system is possible. One study has already shown that only digital systems will work. Restoration must not only take into account the decoding system of the optical sound track, but also the dynamic characteristics, which are not linear like the Academy filter in use at the time. Three important parameters must be taken into consideration:

Decoding

Currently, no analogue sound-on-film system will permit the transfer of Perspecta-style decoding. The system ultimately used must permit the recording of three distinct tracks, non-matricized, for the signals of the three channels are always in phase. A system of matricing and de-matricing like Dolby Tate DES, or even Ultra Stereo, will not work. Suppose we have as output from the integrator signals from the right and left, and nothing from the center. We will hear in the hall sound from the left and the right. If we pass these through a 4:2:4 mixer, the L and R signals, whose phase is identical, will be mixed and reproduced only in the centre. They are
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Fig. 13.

thus incompatible as much electrically as electro-acoustically.

**Dynamic characteristic**

The relative dynamic characteristic of Perspecta recordings is controlled by a circuit whose transfer characteristics are not linear. The proportion of relative compression can reach 1.5, and the time constant is on the order of about 0.3 seconds [see Fig. 13].

**Academy filter**

The Academy filter which must be applied to three volume amplifiers dates from 1948. Thus we are concerned with the second family of Academy filters which are nearly identical to those of today.

**Conclusion**

It has taken a century of film presentation history for us to take into serious consideration the more than sixty sound systems which were an integral and indissoluble part of cinematic works. Cinevolution owns more than thirty systems, and continues to direct its researches in that direction. The case of the Alfred Hitchcock film cited above brings the issue into high relief. To conserve and collect the special equipment pertaining to these processes is to conserve the heritage of evolving film presentation. A precise and trustworthy classification of these processes must come to join the numerous chapters already present in the history of cinema. The study I propose to write will revive technical history, which is, we must not forget, the pedestal on which the history of cinema art is built, born of technology and constrained immutably to follow its evolution.

Translated from the French by Philip and Alice Carli

**Notes**

1. The Cinevolution research and study centre has an equipment collection that allows analysis of the evolution of sound from Vitaphone disks through Dolby Stereo. Cinevolution, Belgian Mons.

2. This study is not yet published, but is available to researchers at Cinevolution.

4. The Altec Lansing Corporation, Heritage History form Altec Lansing, Industrial Professional Sound Products Catalogue 1993, p. 4 Altec Lansing, a Mark IV Company, P.O. Box 26105 Oklahoma City, OK, USA.

5. Idem 5.


12. Translator's note: M. Verscheure has noted earlier in this article that Paramount's version of Perspecta, which they called Dimensional Sound, differed in its effect from the way other studios employed the process, just as Paramount's VistaVision differed slightly from Fox's CinemaScope. As The Man Who Knew Too Much was released through Paramount, and M. Verscheure refers to VistaVision and Dimensional Sound in conjunction with the film, 'Dimensional Sound' will be used throughout this section in reference to the film's soundtrack.