

IMAX[®] and OMNIMAX[®] Theatre Design

By William C. Shaw and J. Creighton Douglas



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Theatre design for both IMAX® and OMNIMAX® presentations opens up a variety of new possibilities and presents a host of problems, some old, and many new. Many traditional concepts of theatre design, such as clear sight-lines to the bottom of the screen, are no longer justified, or even desirable. Conversely, because of the large included angles in the projection beam, projector light-ray clearances become critical at many points in the auditorium.

Audience movement and safety are important factors, and several unusual concepts are discussed. Since most IMAX® and OMNIMAX® theatres are in new construction, there are unique opportunities to optimize the audience environment, including picture, sound, and acoustics. Existing IMAX® theatres range in size from 120 to 980 seats, with 1400 seats projected. OMNIMAX® theatres range from 94 to 380, with larger theatres in the planning stage.

The IMAX® and OMNIMAX® Motion Picture Systems were first developed over 10 years ago to create motion picture images of superior quality and audience impact. These "high-fidelity" images, accompanied by high-fidelity multi-channel sound, involve the viewers with the motion picture and with each other in a way that puts everyone "in the picture." This strong sense of reality is achieved by reducing or eliminating the various "clues" which normally remind the audience that they are watching a picture. Improvement of the systems continues and a review of the present state of the art may be of interest.

Special Features

Significant features of the IMAX® and OMNIMAX® theatre and system are:

1. A screen/audience relationship which provides every viewer with a very wide field of view. The edges of the picture are not within the recognition field of view, and the rear seats in the theatre are very close to the screen by normal standards.

2. The bottom edge of the screen is placed so that the audience can look down as well as up and to the sides.

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through special attention to screen and illumination system design.

The IMAX® System presents motion pictures on a screen which is slightly curved or flat, and rectangular in shape. The image occupies a 60° to 120° lateral field of view and a 40° to 80° vertical field of view.

The OMNIMAX® System presents motion pictures on a dome screen (typically using about 80% of a hemisphere). In this type of theatre the image occupies a lateral field of view averaging 180°, and a vertical field of view averaging 125°.

IMAX® — General

IMAX® is a high-fidelity motion picture system: that means both high-fidelity pictures and high-fidelity sound. High-fidelity pictures are produced by using a large film image area (Fig. 1), moderate magnification, and with picture steadiness at least five times better than can be achieved by conventional systems.

The high-resolution picture is used in conjunction with a large screen and

This allows the horizon to be in a natural position for most viewers.

3. The film format is very large (ten times the 35-mm format area), to produce a grain-free, sharply defined image for all viewers.

4. The projector is especially designed to handle the large format with excellent image stability.

5. Picture contrast and brightness are maintained at a high standard

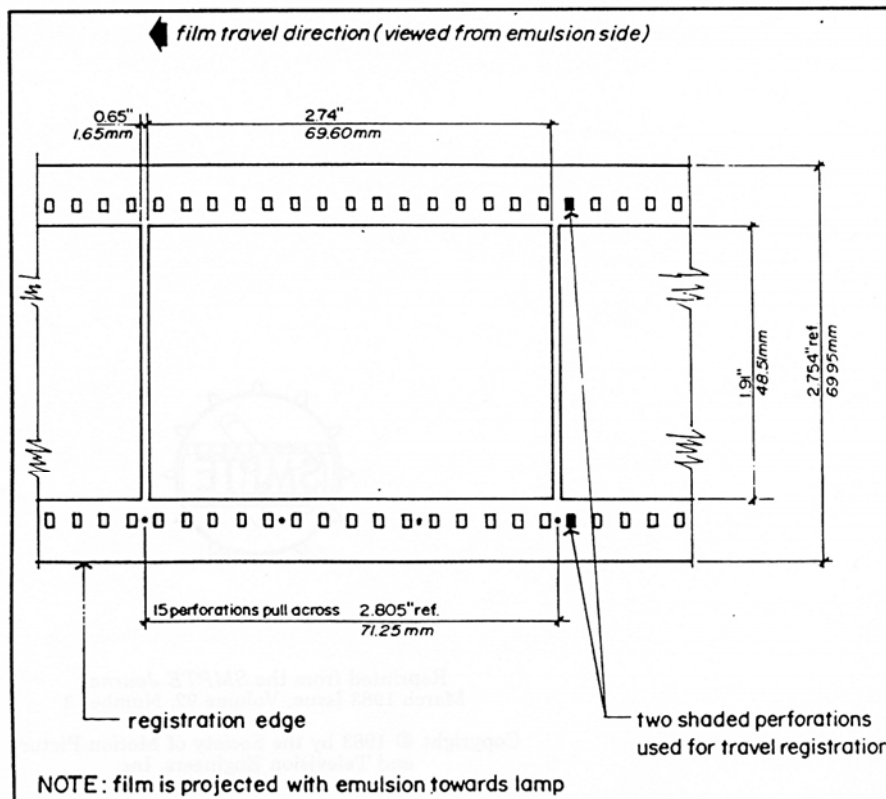


Figure 1. IMAX® projector film format.

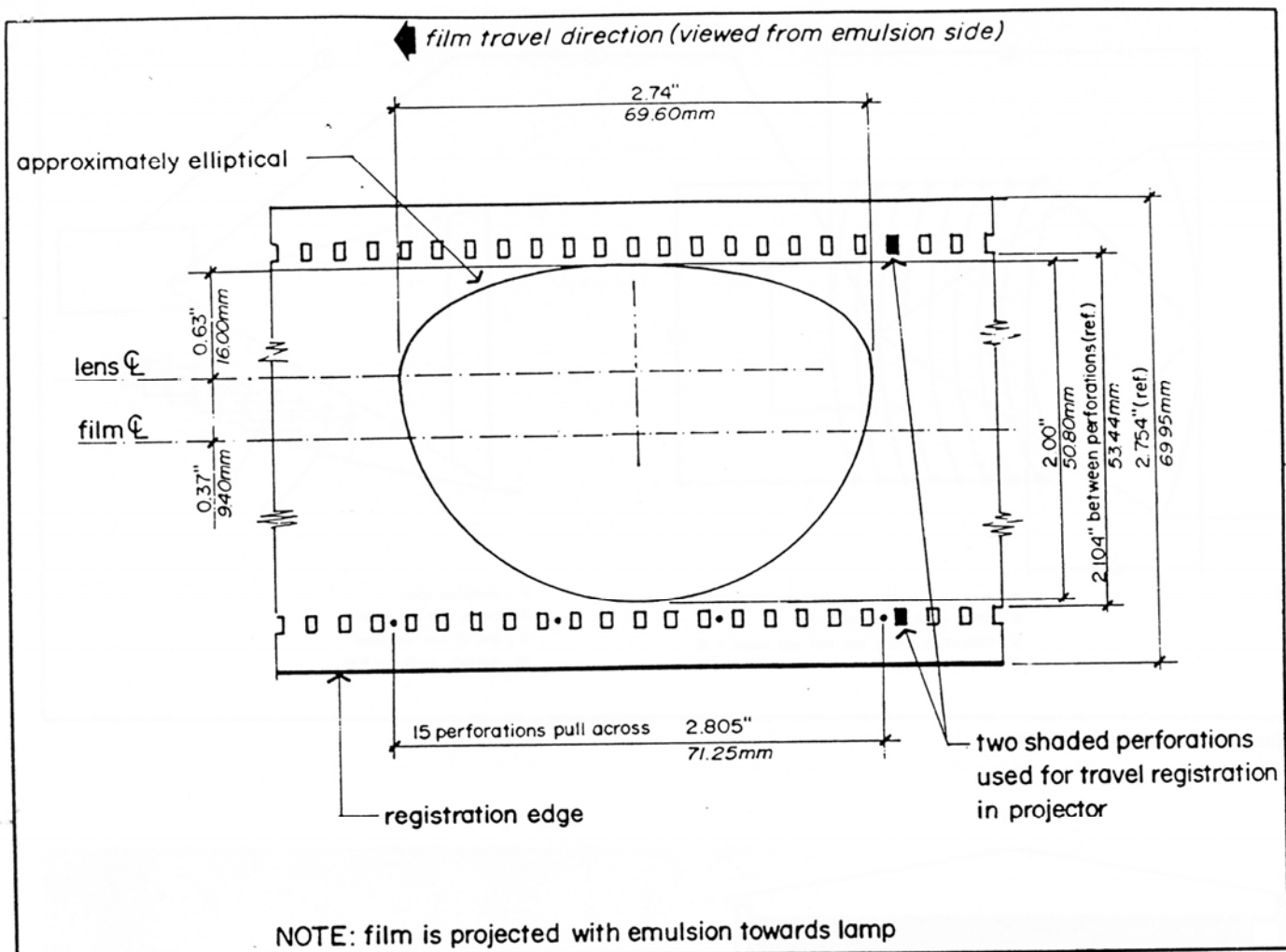


Figure 2. OMNIMAX® projector film format.

carefully organized audience seating to ensure that minimum and maximum viewing angles lie between 60° to 120° horizontally and 40° to 80° vertically for the farthest and nearest spectators respectively. The intent is to create an illusion of "being there," rather than to present a "normal" motion picture through a well-defined window. Theatre sizes thus far range from a "small" screen of 21.3 ft × 32.7 ft, with 120 seats, to the largest IMAX® system presently operating using a 70.5-ft × 96-ft screen with 988 seats. Larger screens, up to 75 ft × 100 ft, are presently in the planning stage.

Most important, in our view, is to strive for audience viewing angles which approach those encountered in reality; that is, horizontal and vertical angles which extend well into the area of peripheral vision and which require eye/head movement to take in the entire picture. The feeling of a large window on reality is found to be enhanced if the screen appears to fill the entire front of the theatre, wall-to-wall and floor-to-ceiling.

OMNIMAX® — General

The traditional planetarium has a flat floor, an elevated centrally-located star projector, a concentrically-seated audience surrounding the star projector, and a horizon suggesting an earthbound environment. OMNIMAX® was developed to break away from these constraints and provide a "Space Theatre." The first of these was opened in San Diego in 1973, and has subsequently been duplicated in a number of other locations.

An OMNIMAX® Theatre is characterized by:

- a tilted dome typically in the range of 25° to 30°
- steeply raked one-directional seating
- star projector and other projection equipment positioned to avoid sight-line interference
- a strong sense of "space"
- enhanced motion-picture capability (OMNIMAX®) to provide much wider program possibilities, including underwater, terrestrial, and space travel.

The OMNIMAX® system uses a fish-eye lens with an included beam angle slightly in excess of 180°. When the physical limitations of the picture format (Fig. 2) on the film are taken into account, the result (in a typical tilted dome) is a picture which extends a total of 180° laterally, and 20° below and 110° above the horizon for the central viewers.

Theatre Design

Experience with the IMAX® system has altered many earlier concepts of theatre design. Minimum viewing distance, "single row vision," maximum horizontal and vertical viewing angles, and maximum viewing distance are but a few of the items which are affected as we gain experience in designing large-screen theatres for IMAX® format films.

Because of the amount of information on the large format, we aim for a minimum eye-to-screen distance of .35 times geometry screen-width and a maximum distance to the last row equal section to the screen-width (Fig. 3). Center-seat eye horizon is set in the

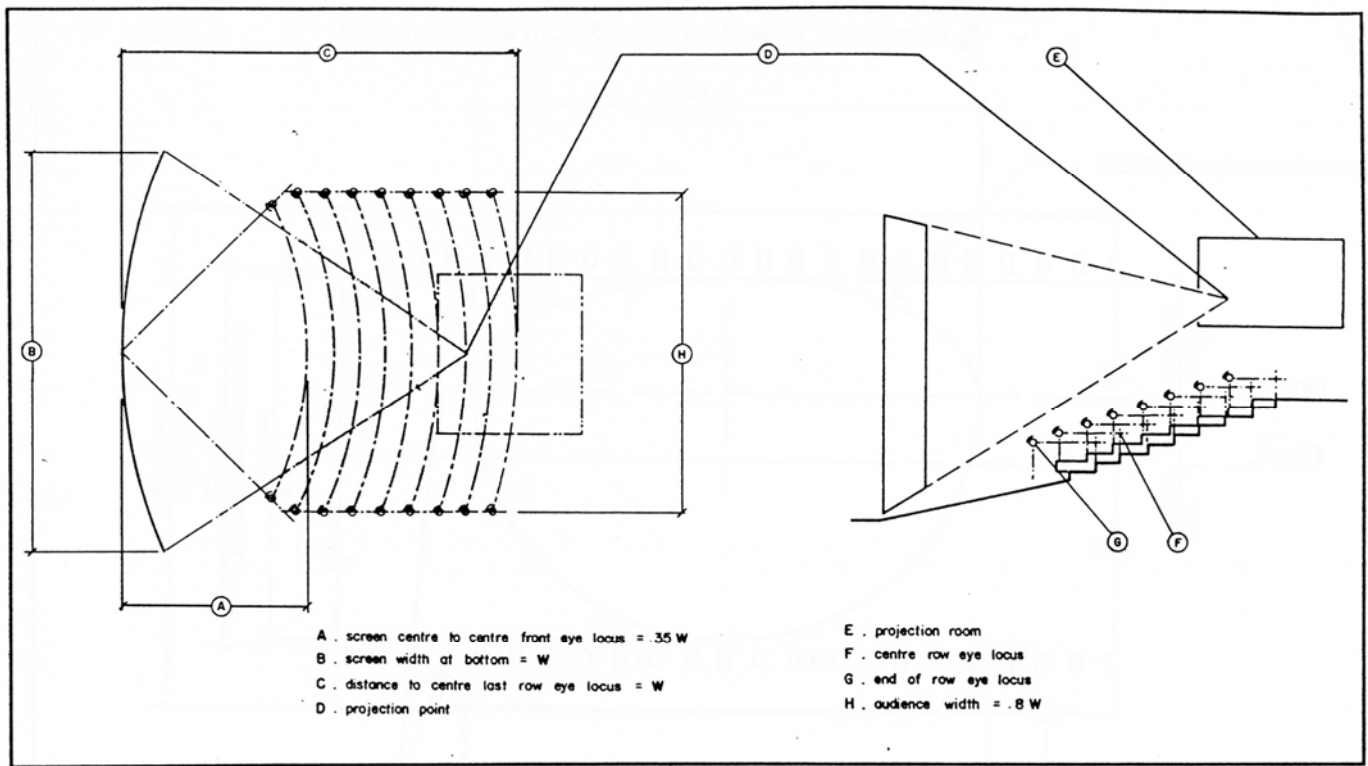


Figure 3. IMAX® theatre geometry.

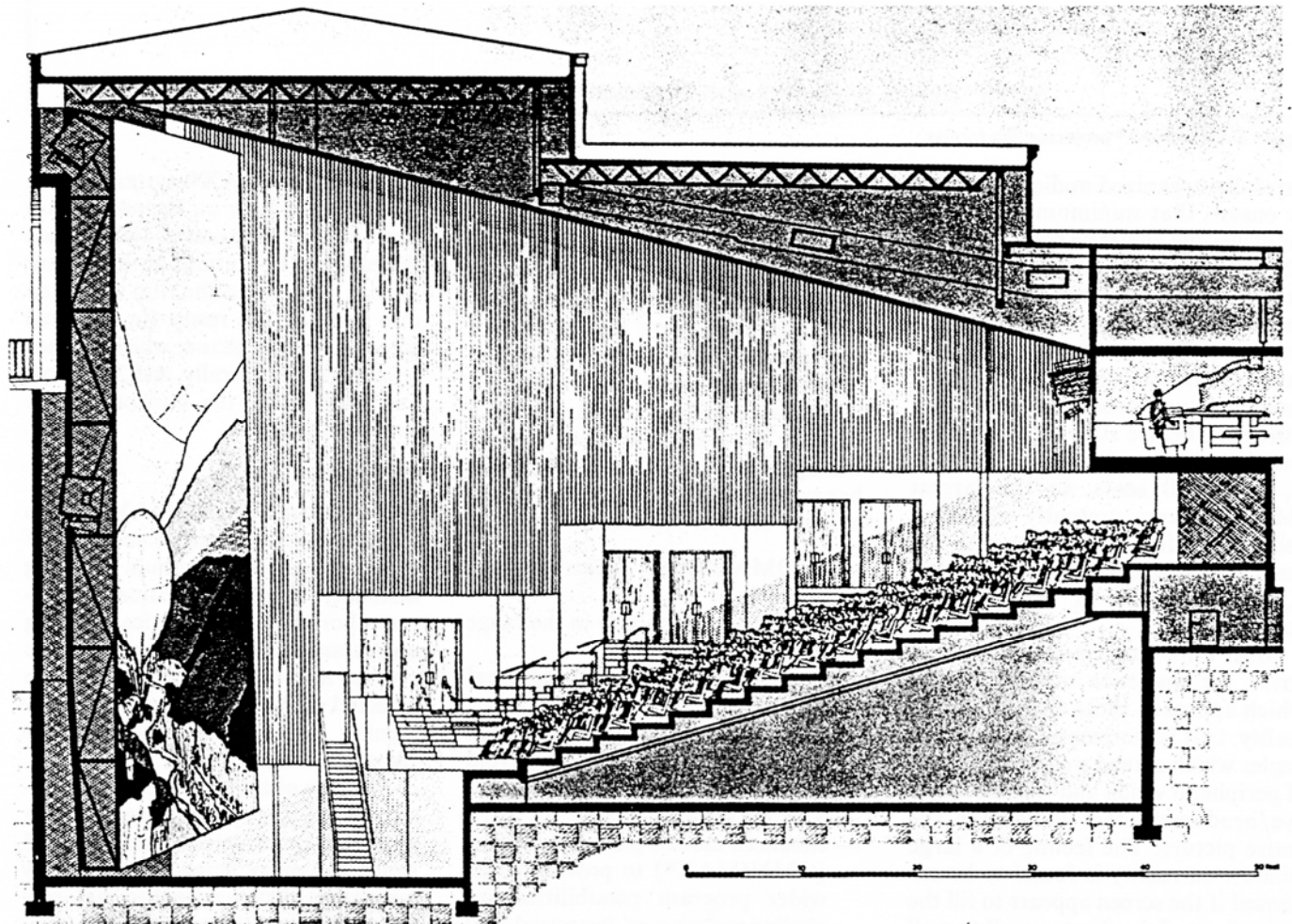


Figure 4. Typical IMAX® theatre.

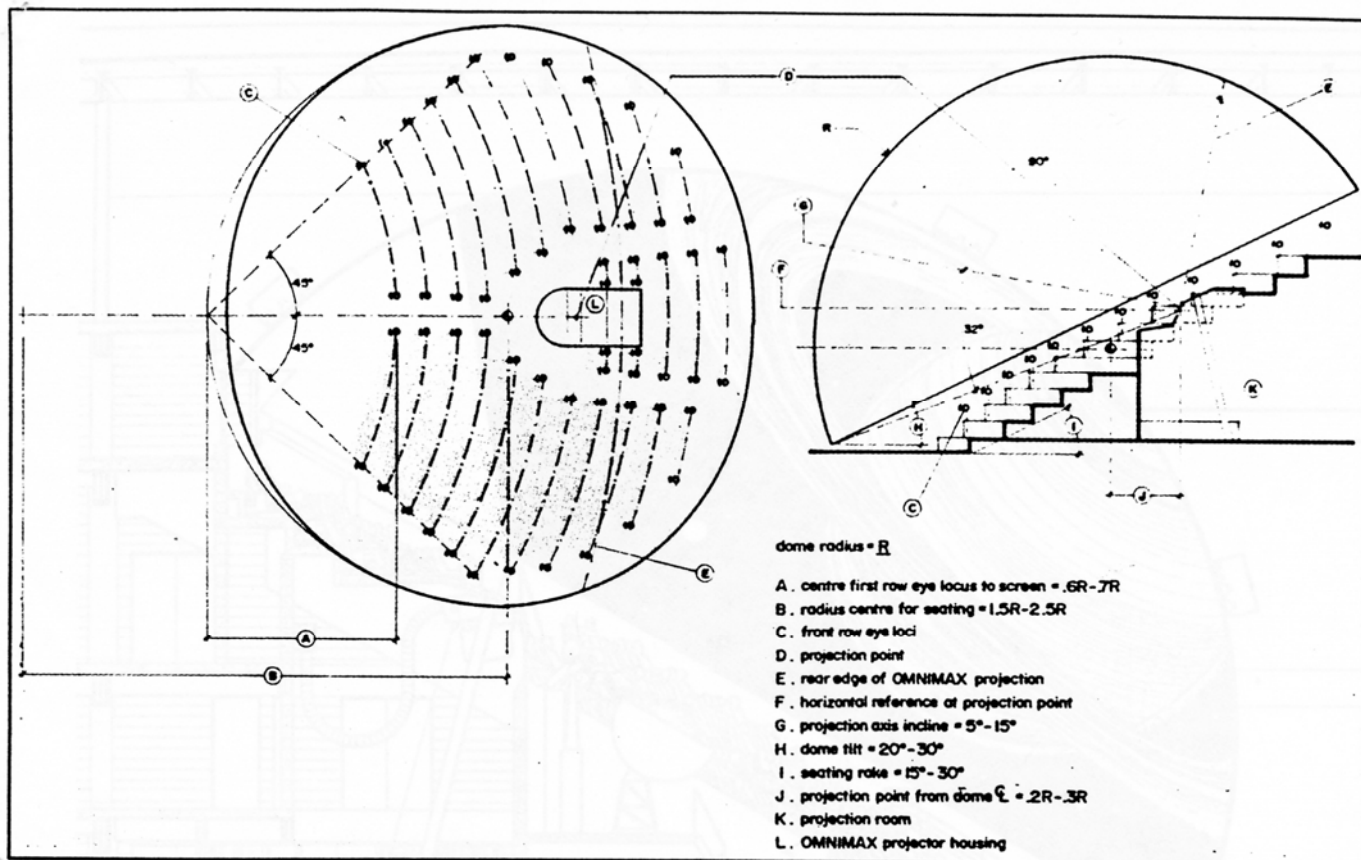


Figure 5. OMNIMAX® theatre geometry.

range of .28 to .33 of screen height, corresponding to the usual horizon height in IMAX® picture material. This results in the front row eye level being considerably above the bottom of the screen and the rear row eye level being at roughly half the height of the screen. Seating is curved so that outermost straight-ahead eye positions are aimed at the 0.25 W and 0.75 W points respectively. This geometry results in the heads of people in the row in front blocking the view of the bottom of the screen, but we consider this to be a "normal" condition for the viewing of nature, a condition we all accept in group viewing experiences.

Since the eye appears to integrate the total brightness of large fields of view, brightnesses of the order of 5-7 fL at the center and 50% of this at the corners are adequate for IMAX® screens instead of the usual theatre standard of 10 to 16 fL.

The relatively high seating area means that projection ray clearances over the heads of the seated audience, particularly in the front rows, are very tight, and clearances over railings, etc., at the front of the theatre are usually minimal (Fig. 4).

OMNIMAX® theatres, usually with the complications of a central star projector and control console and the intrusion of the OMNIMAX® pro-

jector doghouse into what would otherwise be the best seats in the theatre, present another level of complication (Fig. 5). Front seats require that the audience lean back at rather steep angles in reclining seats, the angle of which varies from the front to the back of the theatre. Persons seated too close to the edge of the dome will see excessively distorted images and will interfere with projection "rays"; if they are placed too near the "starball pit" wall, then the wall interferes excessively with their view of the screen. The smaller the segment of a hemisphere occupied by the screen, the easier the design. 165° is the upper limit of practicality, but the smaller the angle, the less impressive the environment.

A significant problem in dome theatres is cross-reflection and consequent loss of contrast. To minimize this, it is necessary to use screen gains considerably less than unity. The improvement can be easily demonstrated down to a gain as low as 0.25, and screen gains in the range of 0.3 to 0.4 represent a good compromise. Both motion pictures and star projection benefit from the improved contrast, but projectors must obviously provide sufficient light output to operate with such low-gain screens (Fig. 6).

Now, a few comments about audience flow and seating. Because of the

rake of the theatre floor, established for IMAX® by the center seat eye height horizon and other criteria (generally in the range of 30% of screen height), and in OMNIMAX® by the dome tilt (generally 25° to 30°), risers and steps become problems. In other words, there often does not appear to be sufficient horizontal space for the required number of steps with the correct heights and tread widths. We further complicate matters by insisting in the interests of safety that the rise be consistent within the theatre, even though this may not be legally required.

At one time, we believed that for IMAX® theatres the best audience movement pattern was cross-flow — people entering at many levels on one side of the theatre, moving across to their seats, and then across to exit at the opposite side. This avoids the need for most climbing or descending of stairs, and is a good technique in World's Fair-type situations, where audiences are conditioned to being regimented. However, where there is more freedom, people who have been standing at the head of a queue feel entitled to choose the "best seats," in the center of the theatre, and will seat themselves in the center rather than move through the row as intended. It is very difficult to alter this pattern

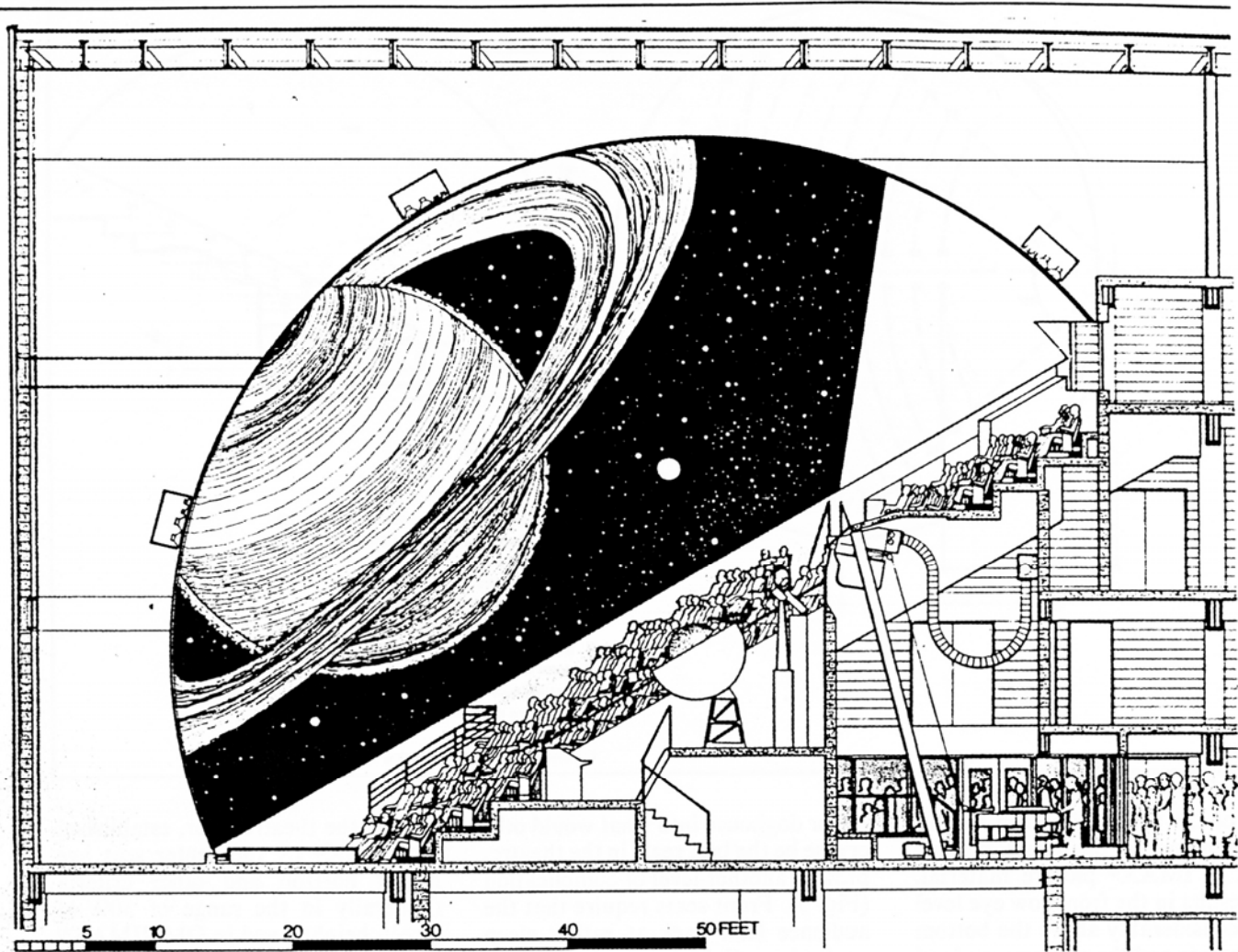


Figure 6. Typical OMNIMAX® theatre section.

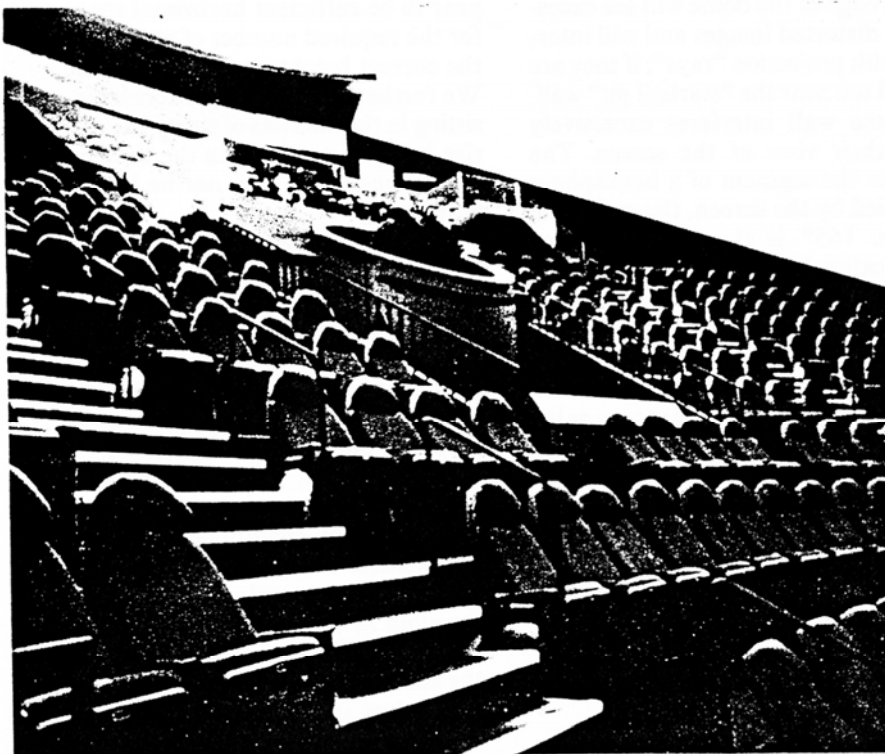


Figure 7. Interior of OMNIMAX® theatre.

without being downright unfriendly to the customers . . . something to be avoided if at all possible. Thus many of our designs now provide entry at both sides, feeding to the center.

Our design philosophy is strongly in favor of entry at the front (low) and exit at the rear (high). A 20° to 30° seating rake may not sound like much, but to an older person it does seem steep. Looking up and moving up from the front seems much less worrisome, and the danger of serious falls is minimized. White step-tread noses are a most important safety measure in space theatres where almost total darkness exists at times (Fig. 7).

Sound and Acoustics

The high-fidelity sound which accompanies IMAX® and OMNIMAX® presentations has been thus far achieved by a conservative approach: a dedicated double-system 6-track reproducer not subject to the vagaries of a projector intermittent mechanism, wide magnetic tracks on 35-mm full-

coat stock, large amplifiers (typically 100 to 400 W per channel, with at least 10 db of headroom above 95 dbA), and large high-quality speaker systems. There is often, but not always, a sub-bass system operating in the 20-80 Hz range to make low frequency elements truly earthshaking.

Since a relatively "dead" environment enhances intelligibility, as well as the ability to identify the location of the sound source, the reverberation time for IMAX® and OMNIMAX® theatres is specified in the range of 0.5 to 0.7 sec, which is quite short by most standards. Given the volume required for an IMAX® theatre, almost all available surfaces will require acoustical treatment to achieve the desired reverberation time.

Overview of IMAX® and OMNIMAX® Equipment

IMAX® projectors have 20,000-ft film platters for 1-hour film capacity, and 12,000-W xenon water-cooled lamps for very large screen illumination (Fig. 8).

OMNIMAX® projectors are similar, but are mounted on elevators so that they can rise into compact housings in the center of the space theatre, (Fig. 10).

A feature of most OMNIMAX® installations, which is also being added to IMAX® theatres when feasible, is the display of the projection room and equipment. In Fig. 9 "show biz" is brought to the projection room in the OMNIMAX® theatre in St. Paul; this projection room is in fact in the audience waiting room.

The IMAX® and OMNIMAX® cameras, of which there are now eight, are relatively compact for the format size they use (Fig. 11).

Underwater housings have been developed, as well as helicopter mounts, and even a Lear Jet nose mount which is just ready to fly. Work has just begun on a camera housing for the space shuttle.

New Developments

One interesting recent development is a "disappearing screen." On several occasions clients have wanted to install IMAX® systems in existing theatres. There is never enough height in the stage area behind the proscenium, where a screen would normally be located, and usually there is not enough height, period. Occasionally, a theatre (usually of an older design) will be

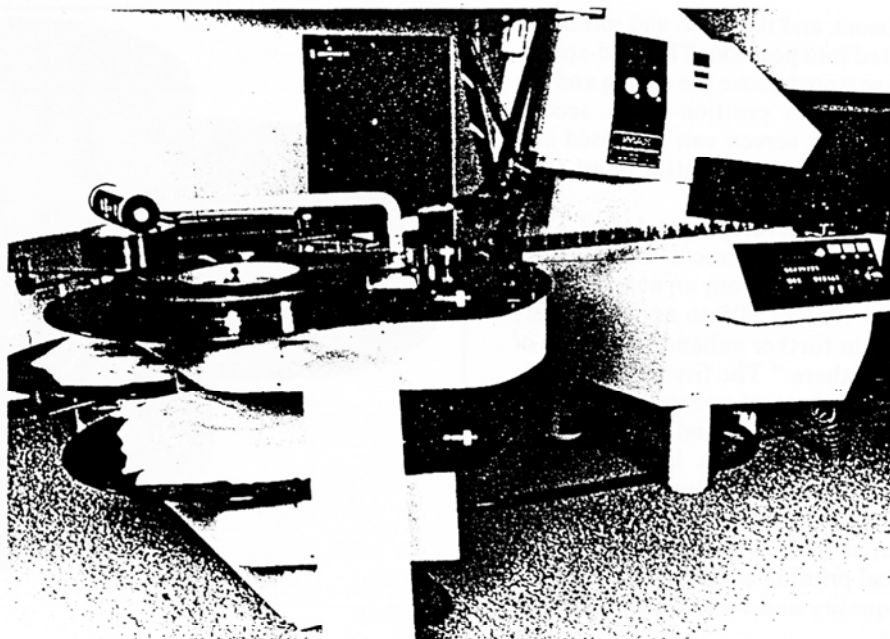


Figure 8. 12 kW water-cooled IMAX® projector.

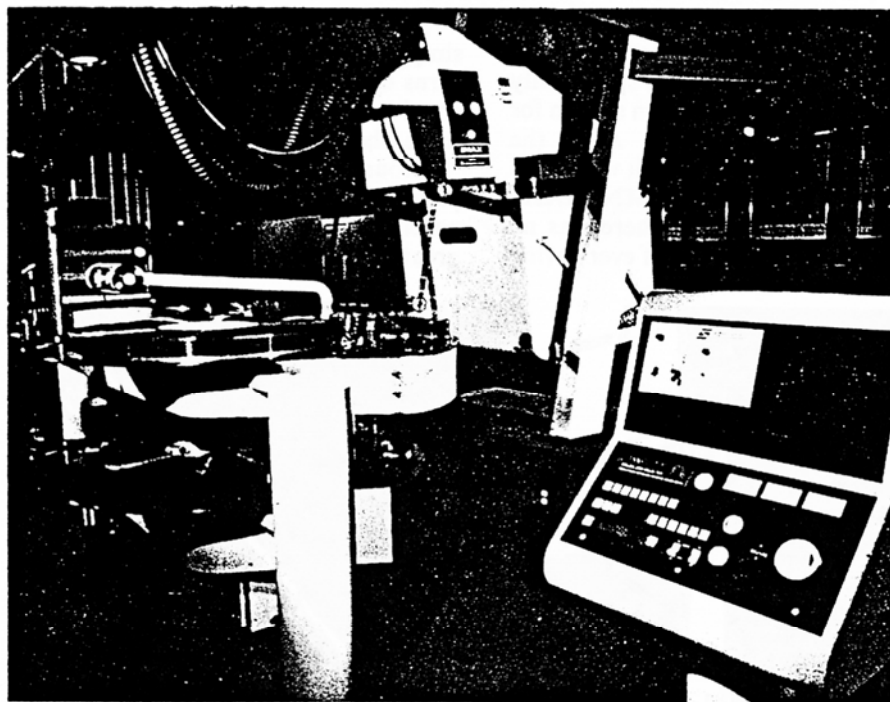


Figure 9. OMNIMAX® projector on elevator. View from audience waiting area.

found in which there is enough height in the area just in front of the proscenium. One of this type is at the American Museum of Natural History in New York City. The auditorium is a nice example of turn-of-the-century theatre architecture, and the Museum authorities wanted to retain the atmosphere of the existing theatre. They also wanted to continue to use the theatre for regular stage presentations and for standard 16-mm and 35-mm film presentations.

For IMAX® a screen 67 ft wide by 41 ft high was required, which could be

caused to "disappear," along with the loudspeakers behind it, all in a matter of a few minutes. This was achieved using a "foldable" vinyl screen, a support boom, a multi-cable winch, and a tensioning system on which IMAX® has patents pending. The screen is stored with its boom in a 2 ft × 4 ft "trough" a little longer than the width of the screen and built into the front of the stage. To convert to the IMAX® mode, the hatch covers over the trough are removed, and five winch cables are lowered from their "stored" positions above the ceiling, attached to

the boom, and the boom and screen are hoisted into position. The loud-speakers are stored above the ceiling and are lowered into position by a second winch. The screen can be raised and stretched taut in a little more than three minutes.

Another development during 1981 was the enlargement of IMAX® viewing angles from an average horizontal view of 90° to approximately 100°, to further enhance the sense of "being there." The first of these wide IMAX® theatres opened in Australia in December, 1981 and the second one in Shakopee, Minn. in May, 1982. Development is continuing on projectors, cameras, screens, and sound systems, as well as on a project to build optical printing equipment to enhance the quality and versatility of the systems.

Comparison of IMAX® and OMNIMAX®

It was mentioned earlier that OMNIMAX® was developed specifically to provide a film projection system for planetarium-type domes. After the system was demonstrated, it was found that some clients chose OMNIMAX® for installations where there was no need for and no thought of ever having

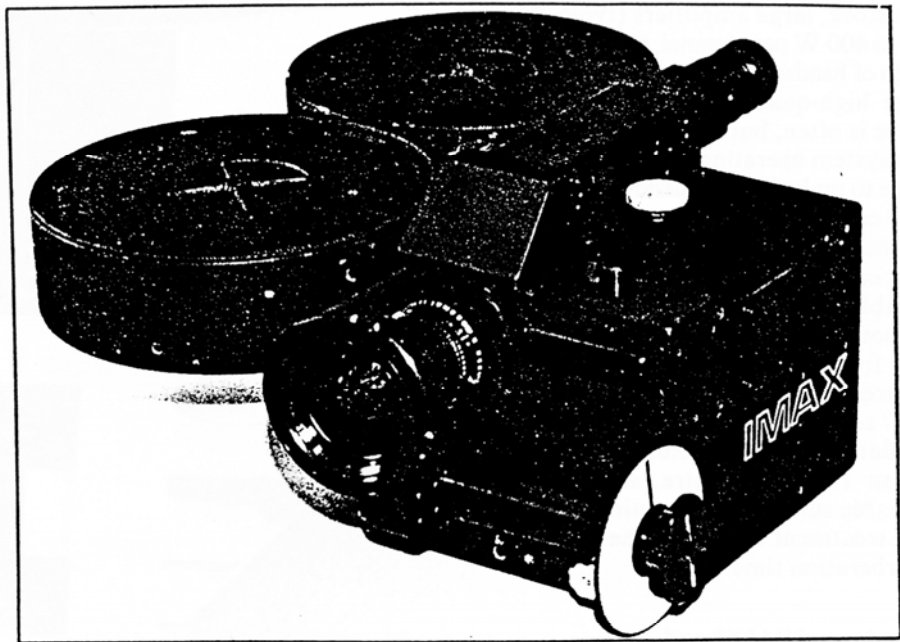


Figure 11. IMAX® camera with 1000-ft magazine.

a planetarium "star show." They simply liked the big, big picture. It turns out that people fall in roughly equal numbers, into one of two groups: those who prefer the sensation of being "surrounded" by the OMNIMAX® picture and (willingly) accept the apparently poorer resolution due to greater angular magnification, and

those who prefer the resolution and steadiness of the "large enough" IMAX® picture. Perhaps it is a distinction between the dreamers and the thinkers.

In any case, at present there are 15 IMAX® and 12 OMNIMAX® theatres in operation. Annual attendance at these theatres will exceed 14,000,000 people.

Acknowledgments

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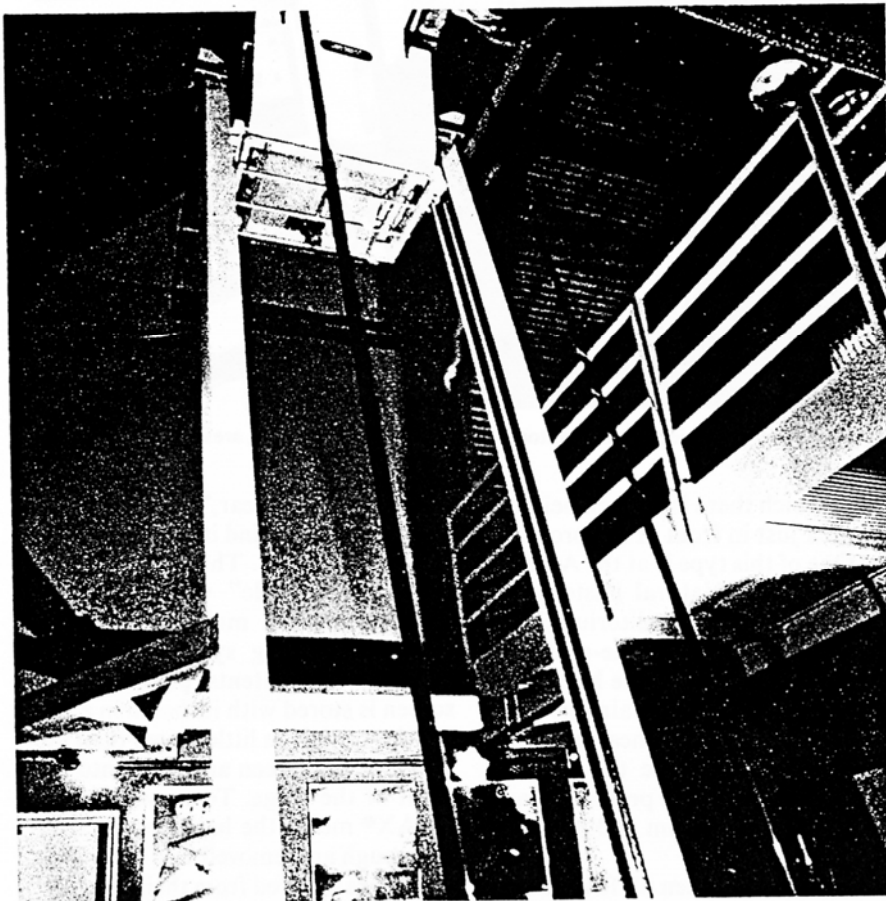


Figure 10. OMNIMAX® projector in raised position for projection.