THE BEST REMAINING SEAT: A CASE STUDY.

B G L Vaupel and N V Jordan

Abstract: It is important that an auditorium be designed to have as many good seats as possible. We know from experience that all seats in an auditorium are not equally good. This is manifested in that the audience does not choose its seats randomly. Imagine an auditorium with open seating and imagine the audience entering the auditorium one at a time. People will in turn make a selection of what in their opinion is the best remaining seat. Where people prefer to sit is an indication of which seats in their opinion are better than others. The order in which the seats are chosen is an indicator of the rank order of the desirability of the individual seats. As the audience makes its seat selection, a geometric pattern of the occupied seats unfolds and reveals the boundary around the preferred seats. These perimeters describe equal desirability curves. By studying the order and the boundary of the selected seats, it is possible to determine which room geometry and lay-out will result in an auditorium with as many good seats as possible.

GATHERING AND RECORDING THE DATA. DEVELOPING THE MATHEMATICAL MODEL.

The audience choice of seat is recorded by time lapse photography. Data are gathered in the same auditorium a number of times to verify the audience choice of preferred seats. Different auditoria are studied to verify that the same geometrical pattern unfolds in different auditoria. It is from these data that the mathematical model is developed. Data collected from Odense Concert House are used to illustrate the study.

The study was done with the following constraints: Only auditoria with open seating were studied. Only auditoria for concert use and only shoe box auditoria were studied. Only the floor of the auditoria was considered.

The desirability of a seat is defined as how popular it is. The audience understands intuitively that the closer and the more straight on, the better it is. The potential desirability of a seat relates to the distance \( L \) and angle \( i \).

There exists one seat in an auditorium with the highest desirability. It is located on the center line and at the optimal distance \( L_{opt} \) from the center of the orchestra platform as shown in (1). This distance is approximately equal to the width of the orchestra platform \( w \). Moving away from this optimal location in any direction yields less desirable seats. The width of the orchestra platform creates an imaginary boundary beyond which the desirability of a seat falls off dramatically.

The optimal seat is defined as having a value of 1. Seats located more than 60 m from the measuring point are defined as having a value of 0. This is the maximum distance acceptable \( L_{max} \). The following equation was chosen because its resulting geometry resembles that of the empirical data and is meaningful. The resulting values are relative and not absolute. See figure 1.

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v = \cos^2(i) \cdot \frac{(L-L_{opt})}{(L_{max}-L_{opt})}, \text{ the desirability value of a seat location. For } v<0 \rightarrow v=0
\]

\[
V = \sum v, \text{ the overall desirability value of the auditorium.}
\]

Aisle seats are popular. So are seats in the first and the last row of a bank of seats. It can be deduced from studying the data, that the rank order and the approximate percentage increase in value of these seats are as follow:

Center Aisle: 20%  
Front Row: 15%  
Side Aisle: 10%  
Back Row: 5%.
MACRO ANALYSIS.

An auditorium plan has a potential desirability value inherent in its room geometry. Imagine an auditorium plan divided into unit areas. This is an auditorium with no aisles and no wasted space. The higher the overall potential desirability value, the better are the chances of designing a seating plan within that space with as high a desirability value as possible. The potential desirability value of an auditorium plan can be related to the average desirability value per unit area: \( V(2) = \sum v / A \), where \( A \) is the number of unit areas.

Changing the geometry of the auditorium plan will cause a change in the potential desirability value. The geometry that produces the maximum potential desirability is an auditorium plan which follows the geometry of the equal desirability curves. A Shoe Box auditorium could be long and narrow, square, or shallow and wide. We are able to calculate which Shoe Box geometry yields the highest potential desirability value. An auditorium with an area equal to that of Odense Concert House yields \( V(2) = 0.5993 \) in comparison with \( V(2) \) for Odense Concert House as built which equals \( 0.5975 \) desirability units. This is very close.

MICRO ANALYSIS.

Within the framework of an auditorium plan the seating can be arranged in a number of different ways. The auditorium must have aisles, and the seats will have to be of a certain size. The micro analysis evaluates the average desirability value per seat of the actual seating plan: \( V(3) = \sum v / S \), where \( S \) is the number of seats.

By using the above analysis the respective desirability values of the Conventional versus the Continental seating plan can be calculated. The Continental Seating Plan takes advantage of placing seats in that part of the auditorium which has the highest desirability value, namely along the center axis. The Conventional Seating Plan includes aisle seats which have a relative higher desirability. Adjusting for U.S. code regulations with respect to area allocated per seat, the two seating plans can be compared for desirability. Using Odense Concert House as a basis for the analysis, \( V(3) \) for the Continental Seating Plan amounts to \( 0.6911 \). \( V(3) \) for the Conventional Plan equals \( 0.6835 \). The increased area allocated per seat in the Continental Seating Plan will also result in potentially more comfortable seats. This will further increase the desirability value of the seats.

Each seat in an auditorium can be assigned a desirability value which in turn can be translated into a ticket price. This ticket price structure would be the most fair, but it would also be the most cumbersome. Alternately, the desirability curves can be used to outline seating blocks in the auditorium of approximately equal desirability. These blocks can be assigned a ticket price reflecting their relative desirability. Cf.(2)

ACOUSTICAL CONSIDERATIONS.

Acoustical qualities vary throughout an auditorium. Are the acoustical qualities of an auditorium reflected in the audience choice of seat? We are investigating whether the desirability of a seat also relates to the acoustical qualities and that whether when the audience chooses its seats it is conscious of the acoustical qualities.

The acoustical qualities that the audience is expected to perceive are Loudness, Early Decay Time and Clarity. (3) By using the acoustical simulation program 'Odeon' these acoustical qualities are calculated and mapped in a form similar to the contour maps of the desirability curves. Odense Concert House again forms the basis for the analysis.

The contour maps of the desirability curves and the contour maps of the acoustical qualities can be compared in order to determine which role the acoustics play in the audience seating preferences. Cf.(4).

Actual acoustical measurements in Odense Concert House will be recorded and mapped to verify the results generated by the computer simulation model. Actual seat preferences are then finally analyzed in the light of actual acoustical measurements. The acoustical simulation model is being validated for future work.

The floor of Odense Concert House has a seating capacity of 1200. The auditorium dimensions are 32 m wide by 49 m long. The volume is 14,000 m³.

REFERENCES.


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