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Multiple-use performing arts halls

Sale widowiskowe o wielofunkcyjnym charakterze

Abstract

Performing arts halls are increasingly becoming multi-purpose halls. Purpose-built venues that serve purely as concert halls or opera houses are rather rare today. Multi-purpose halls, conversely, can be used for different types of stage presentations inside a single building, under one roof with proportionally lower costs; furthermore, they can also be used for activities which are not related to the performing arts. The paper discusses functional and spatial adaptability and flexibility in multiple-use halls, and presents possible forms and arrangements of the stage and the auditorium as well as their spatial interrelations. Attention is focused upon acoustics and their impact on the functioning of multi-purpose performance spaces. The paper also presents multi-use and multi-format facilities. The author attempts to determine the best possible conditions for various types of theatre arrangement.

Keywords: performing arts halls, functional adaptability, multiple-use

Streszczenie

Obiekty widowiskowe w coraz większym stopniu stają się ośrodkami wielofunkcyjnymi. Obiekty przeznaczone tylko dla jednego rodzaju prezentacji, takie jak sale koncertowe lub gmachy operowe nie są współcześnie bardzo liczne. Sale wielofunkcyjne z kolei mogą służyć różnym rodzajom prezentacji scenicznych, a także innym widowiskom, wewnątrz jednej przestrzeni, w jednym budynku, przy proporcjonalnie niższych kosztach. Niniejszy artykuł rozważa funkcjonalne i przestrzenne możliwości przekształceń sal wielofunkcyjnych oraz przedstawia możliwe wzajemne konfiguracje sceny i widowni wraz z ich powiązaniem przestrzennym. W opracowaniu autor uwzględnia również problematykę akustyki i jej wpływu na przestrzenie wielofunkcyjne. Bada on poszczególne formy i rodzaje aranżacji sceny i widowni pod względem ich optymalnego funkcjonowania.

Słowa kluczowe: obiekty widowiskowe, zmienność funkcjonalna, wielofunkcyjność

1. Introduction

Single purpose halls have the advantage of being able to provide optimum acoustics and artistic environments for each form of stage presentation; however, only large and wealthy institutions are able to afford them. Today, buildings for the performing arts with a single, dominant function are being increasingly replaced by structures combining many forms of stage presentation in a single building. Multi-purpose halls are intended to respond to changing situations in their use. In this paper, the author does not discuss all forms and functions of performance spaces; he wishes only to indicate how spaces in such structures can become functionally adaptable. Contemporary buildings for the performing arts are primarily distinguished by the functional adaptability of the auditorium, the stage and support facilities (public spaces). In many cases, they may have flexible auditoria and stage arrangements and also multi-purpose public spaces. Multiple-use of such buildings is associated with the adequate design of those facilities and also with such solutions which can enable the appropriate conditions for different types of productions. Each of the alternative uses requires specific provisions to be made in its design and equipment. Multiple-use auditorium design must involve aspects relating to their profitable functioning. This may be limited to architectural factors, technical issues and acoustics, but it may also lead to the wide range of potential uses of the building [1]. This paper explores the types and characteristics of multi-purpose buildings and presents the possible applications of elements of functional adaptability in performance spaces.

2. Types of Buildings for the Performing Arts

Performance spaces are very diverse. The differences lie not only in the types of stage presentation they are suitable for but also in the arrangement of the auditorium, the stage and areas for the audience members (public spaces) and their adaptability. The main types of buildings for the performing arts are defined by the types of stage presentations for which they are designed; these include: drama theatres, concert halls, opera halls, halls intended for dance performances (ballet and others) and multi-purpose halls, e.g. combining various forms of presentation in one space. ***Drama theatres*** can be divided into categories with regard to the types of stage and seating arrangements in the auditorium: *theatre in the round* - a central stage surrounded by audience from all sides; *thrust stage theatre* - a theatre in which the stage is extended so that the audience surrounds it on three sides, characteristic of Shakespearian performances; *traverse stage* halls with the audience on two opposite sides; *open stage theatre* and its variants (e.g. *end stage theatre*); *proscenium stage theatre* – the most popular type; *flexible theatre* with a variable structure of the stage and of the auditorium (e.g. *black box theatre, studio theatre, courtyard theatre, promenade theatre*)[1]. Drama theatres can be further

[1] One example that combines drama theatres of different sizes and forms is the National Theatre in London. The large theatre (Olivier Theatre) has an open stage and houses 1,160 seats. The medium-size theatre (Lyttelton

classified with regard to: character of the presentations (formal or informal); the methods of financing the theatre institutions (public theatre, commercial theatre, etc.). With regard to their plans, drama theatres can assume various forms from square and rectangle formats through to polygon and fan shapes.

Opera theatres are distinguished by both their greater dimensions than drama theatres and also by their smaller diversity of forms. A prevailing solution for a 'playing space' in such buildings is a proscenium stage equipped with a fly tower, a stage basement and side stages. In fact, every opera has an orchestra pit. The auditorium layout in buildings of this type mostly repeats the historical solutions with a horse shoe form[2], a semicircle or fan shape.

Concert halls also vary in size and the ways in which the auditorium and the stage platform are arranged. They include very small recital halls and also large halls with capacities as high as 2,500 seats in the auditorium. With regard to the auditorium and stage layout, one may distinguish among concert halls: *single direction relationship* - popular arrangements based on a rectangular plan, with an auditorium situated opposite the stage (*shoebox format*; *rectangular box*); *vineyard formats*, with an auditorium surrounding the stage; arrangements of polygonal shape, fan shape and even an elliptical shape, with an auditorium surrounding either the entire stage or a part of it.

Multi-purpose halls are characterised by their large diversity, both with regard to size and the manner of arranging the auditorium and the stage. There is an emergence of halls with a fixed configuration of the auditorium and variability only within the stage and forestage, and there are also halls with a completely variable space, adjusted to various types of presentations, both onstage and offstage.

3. Historical Development of Multi-Purpose Theatres

Until the beginning of the 20th century, cultural facilities usually had a single, specific function: an opera house was for opera and a cinema was used almost exclusively to show films. The multi-use of buildings for the performing arts originates from the concept of the 'synthesis of the arts', which appeared around the end of the nineteenth century or, more precisely, which re-emerged around that time[3]. The primary promoter of the 'synthesis of the arts' at that time was Richard Wagner, who wanted to create a musical drama combining poetry, music, dance, architecture, painting and sculpture to form the *Gesamtkunstwerk* – the total work of art. The

Theatre) with the proscenium stage offers 890 seats in the auditorium. The smallest theatre is a studio theatre (Dorfman Theatre, formerly Cottesloe Theatre) with a variable space and a maximum capacity of 400 seats. The smallest theatre is also an example of a courtyard theatre.

2 A horse shoe form of an auditorium was a solution characteristic of historic opera houses; however, it did not always meet the requirement of good visibility in the horizontal plane. Such a construction of an auditorium (concave wall surfaces, theatre boxes and balconies) also affected the uneven distribution of the acoustic field in the theatres of this type.

3 This is because the concept of the synthesis of the arts dates back as far as ancient Greece, particularly to the archaic period, when art was syncretic. It was referred to as *triune choreia*, and it was a combination of sound (music), words (poetry) and movement (dance).

first modern buildings with functionally adaptable auditoriums were constructed around the end of the nineteenth century and beginning of the twentieth century. Examples of theatres and concert halls with adaptable auditoria and stage areas include the Auditorium Theatre in Chicago, erected in 1889 and Grosses Schauspielhaus in Berlin of 1919. In 1926, a German theatre reformer and director, Erwin Piscator, together with the architect Walter Gropius, proposed a solution for the theatre space that was referred to as 'Total Theatre'. Their project, which never came to life, involved a revolving auditorium and stage (proscenium stage with the auditorium located opposite the stage and an open stage with the auditorium located on three sides and also a central stage with a surrounding auditorium), and it was supposed to combine architectural functionalism with elements of other arts. Piscator required the elimination of the proscenium in order to bring the actors and the audience closer together and in addition 'convertibility, flexibility and anonymity' in the drama theatre design. The aim of Gropius and his 'Total Theatre' design was to draw the spectator into the drama. He wrote about his design: "I have tried to create an instrument so flexible that a director can employ any one of the three stage forms by the use of simple, ingenious mechanisms. The expenditures for such an interchangeable stage mechanism would be fully compensated for by the diversity of purposes to which such a building would lend itself: for the presentation of drama, opera, film and dance; for choral or instrumental music, for sports events or assemblies" [11]. The building was designed to be a really multiple-use venue.

Avant-garde concepts for theatre reform also appeared in Poland in the interwar period, challenging the dominant solutions used in opera and theatre buildings in the eighteenth and nineteenth centuries. The domination of the proscenium stage was abandoned and replaced by bold solutions concerning the area of the stage and the auditorium. The Stefan Żeromski Theatre in Warsaw (1932-33, designed by Sz. Syrkus) was equipped with changeable units, a system of portable platforms with a size of 2.0 x 0.9 m, which could be rearranged to fit the needs of a particular stage presentation. Consequently, it was the first theatre hall with a completely adaptable space in Poland and, most likely, in the entire world [4]. In the design of another structure, the Simultaneous Theatre, also referred to as the 'Theatre of the Future' (1928–29), the designers, Sz. Syrkus and A. Pronaszko, replaced the proscenium stage with a circular (ring) moving stage, which was designed to consist of two revolving circles with lifts and small revolving stages[4].

The designs of experimental theatres that appeared in the nineteen-twenties and nineteen-thirties revolutionised buildings for the performing arts. The proscenium stage and the auditorium located opposite no longer constituted the only possible spatial arrangement for theatre performances. Efforts were made to come up with solutions that would alter the audience member's perception of the performance, transforming it into an aesthetic and spiritual experience. Most cultural centres and other multi-purpose buildings in the twentieth century were of local significance only. This was also the case in France, where the first cultural centre projects were created. Over a dozen cultural centres were built in France in 1961-1971 [6], and the idea of multi-purpose buildings re-emerged in that country in later years (despite the partial failure of cultural centre financing), as demonstrated by the Pompidou Centre in

[4] The designers modified the Gropius design and Oskar Strandt's concept of the 'circular stage'.

Paris. It should be noted that multi-purpose structures had already existed in ancient times; buildings constructed in that period – odeons – also included stage facilities designed for various musical, theatrical and oratorical presentations.

4. The Multiple-Use Theatre Design

'Multi-purpose' is a very broad term that can be interpreted in several different ways. In buildings for the performing arts, functional adaptability primarily relates to transformations on the stage and in the seating areas that enable the presentation of different stage forms in a single space. A concert hall has a different interior layout and different acoustics to a drama theatre hall. Most multi-purpose halls can be characterised by such arrangements that are, on the one hand, typical for concert halls (with regard to the auditorium form and the seating layout), and on the other, for drama theatres and opera houses (with regard to the form of the stage area). Functional adaptability is usually found in structures with a proscenium stage which can be transformed within the proscenium zone (e.g. through the use of an adaptable orchestra pit with lifts) and also in the area of the main stage (adjustable height and width of the proscenium opening, lifts and bridges, acoustic shells or suspending reflectors, revolving platform, etc.), Fig. 1.

A forestage area can be adapted for multiple activities. A permanent orchestra pit can hinder the relationship between the audience and the performance by increasing the distance between the two. Therefore, it is a common practice to cover over the orchestra pit and use it as a forestage. This can be done manually by assembling panels and framework, but the upraised hydraulic lift can also form an apron stage [7, p.56], Fig. 2.a. A lift or lifts can be lowered to the seating area for extra seating rows, Fig. 2.b. A lift in the lowest position forms the orchestra pit, Fig. 2.c. Open or apron stages can also be retractable or comprised of moveable platforms [10, p. 143]. Lifts and bridges within the stage area can be used not only for scenic devices, but also as platforms for musicians and the choir, Fig. 2.e. Sometimes, lifts and bridges can be used for additional audience seating, Fig. 2.d. A wide proscenium opening is usually used for musical performances, especially for orchestral concerts, Fig. 3.a, b, c. A reduced width of the proscenium opening can be applied for drama theatre productions [2, p. 156], Fig. 3.d.

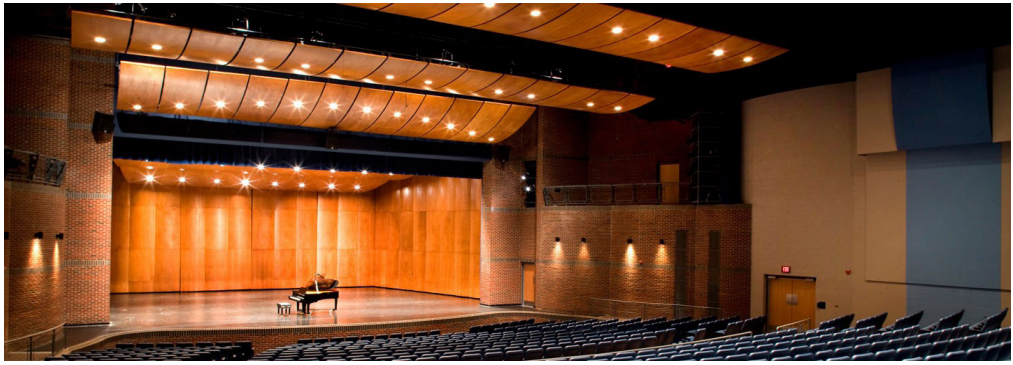

Fig. 1. A multi-use proscenium stage with acoustical shell and ceiling panels (reflectors) (source: [12])

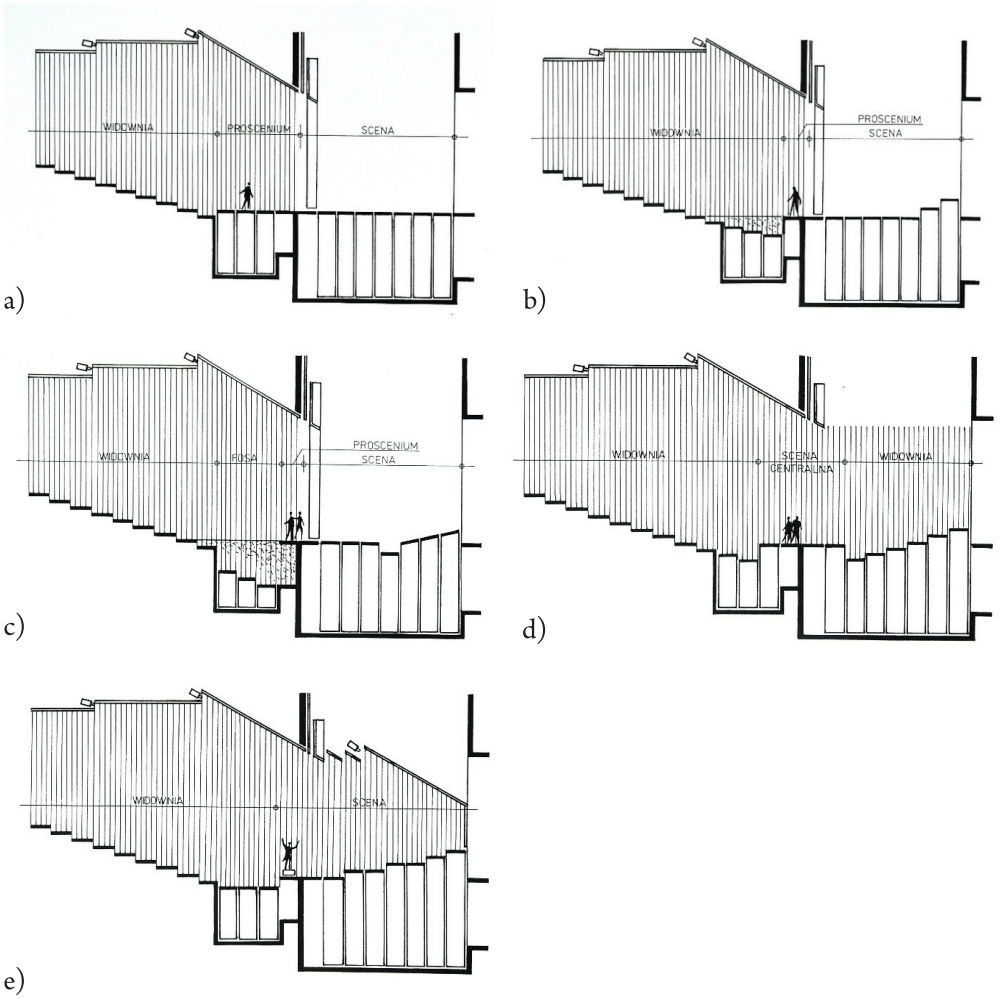

Fig. 2. A multi-use proscenium stage with a fly tower and a flexible proscenium zone – lifts and bridges within the stage and a forestage area: a) drama theatre arrangement with the forestage in position over orchestra pit; b) drama theatre configuration with additional seating rows – orchestra pit lifts are lowered to the auditorium level; c) opera and musical arrangement – lifts at the lowest position form an orchestra pit; d) central stage with additional seating for the audience on the main stage; e) concert hall configuration with platforms and an acoustic shell
(prepared by: A. Grudziński, P. Amałowicz)

In addition to having different options with the stage and the forestage area, the auditorium can also be adaptable, both in terms of layout (folding or movable seat rows or rotating such rows using platforms) and the division of the space through movable partitions to create separate areas. Another possibility is the adaptation of the auditorium size and cubic volume of the hall to meet the requirements of current stage presentations. Some performances are suitable for smaller audiences than the full capacity of the house, and it is therefore useful to be able to reduce the size of the auditorium in the best possible way– this is very difficult to achieve in

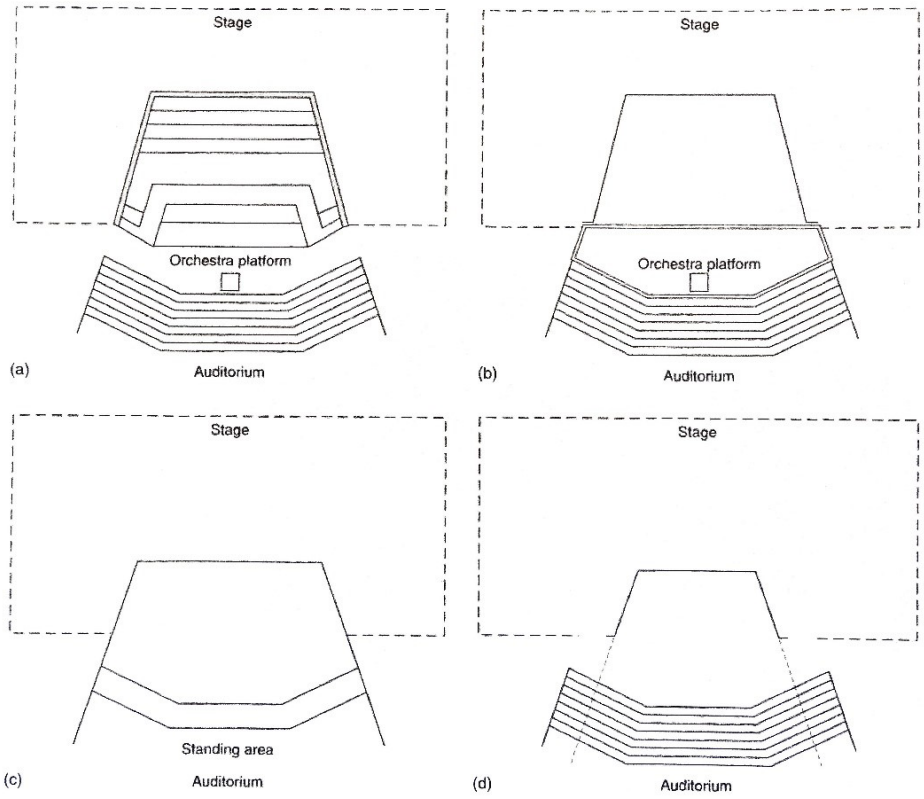

Fig. 3. Possible layouts of a multi-use proscenium stage with a changeable proscenium zone: a) concert hall configuration with an acoustic shell and the widest proscenium opening; b) opera and musical arrangement with an orchestra pit and a wide proscenium opening; c) pop/rock music layout with a forestage in position over the orchestra pit; d) drama theatre arrangement with a forestage in position and reduced width of proscenium opening (source: [2, p. 156])

a single-tier auditorium [7, p.19]. Moving walls or curtaining off the rear of the auditorium is not very satisfactory because the audience usually have to approach through the curtained-off area. With a multi-tier auditorium, on the other hand, it is relatively easy to close off the balcony level, but a more sophisticated development is to lower the auditorium ceiling to rest on the front of the balcony [7, p.19]. Acoustic elements that adjust the cubic volume in functionally adaptable halls are important to ensure suitable reverberation time for particular events [3]. This is usually accomplished with movable ceilings, which can be lowered or raised as necessary, Fig. 4. Acoustic panels can also be placed at suitable angles to correctly direct the sound (acoustic wave). The walls may also have variable acoustic properties, e.g. they may be covered with an sound-absorbing material (curtains) to shorten the reverberation time where necessary.

The most popular plan arrangement for multi-purpose halls is a rectangular form. The adaptable auditorium forms include polygonal shapes, square and fan configurations. For practical reasons, rectangular halls with a flat floor (and retractable or removable seating) with a ratio of width to length 1:2 can be easily divided into two or three parts. In this case,

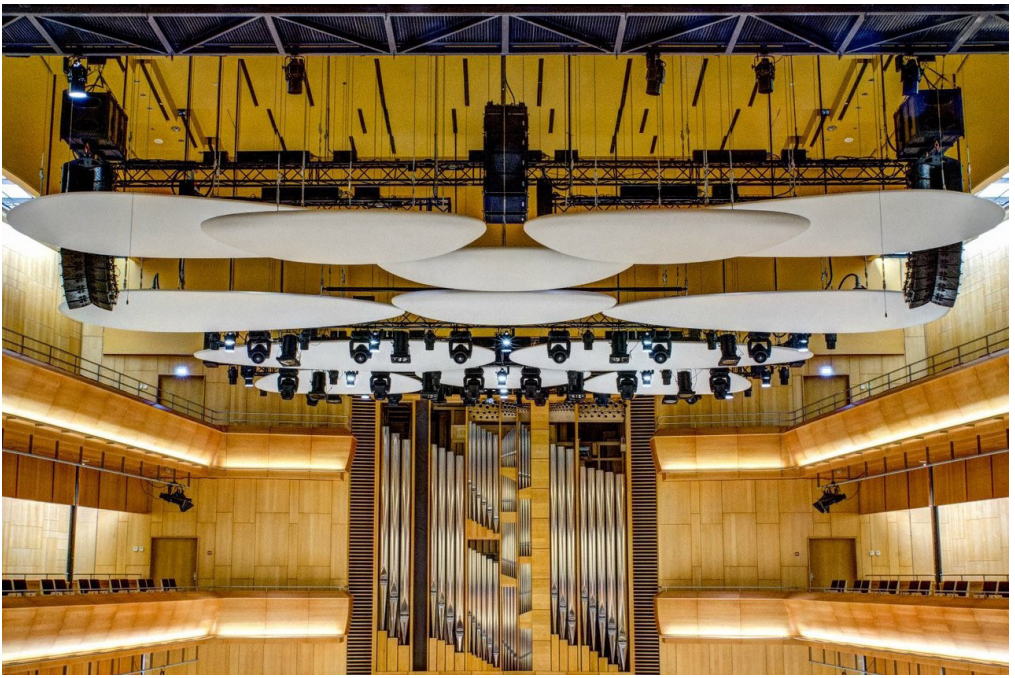

Fig. 4. Movable acoustic ceiling elements in Stavanger Concert Hall (source: [13])

each part of the hall can serve different purposes. If the room is divided into three parts, the middle part is often used as a sound buffer. Rectangular forms are used for orchestral music and drama theatre plan arrangements, especially when the audience is placed in front of the platform – this is a single-direction relationship between the audience and the performers. Straight rows of seats and also straight rows with side blocks of seats angled and focused towards the platform/stage are used in such configurations.

For some concert hall configurations and also for drama theatre arrangements, the audience is located on three sides of the platform/stage. In this case, the auditorium forms include a rectangle, a polygon and a fan. The audience can also surround the stage. The performance area may be placed in the centre of the seating or along the long axis. The audience can surround the stage through the use of galleries or by sub-division into terraces [2, p. 106]. For such configurations, the auditorium formats include rectangular, polygonal, elliptical (oval) and circular shapes and the seating geometry can provide curved and angular rows. Distinct blocks of seating focused towards the platform/stage can also be used.

Multi-purpose halls can be subdivided into the following categories:

1. 1. Halls with adaptable stage and auditorium areas, designed for a single form of stage presentation;
2. 2. Halls with adaptable stage, proscenium areas and front parts of the auditorium, designed for various types of production;
3. 3. Halls with adaptable stage, proscenium and auditorium areas, designed for various types of production;

4. 4. Multi-use halls, used not only for stage presentations but also for other functions, such as conferences, lectures or sports [2, p. 110].

The first category includes, for example, drama theatre halls, which can be adapted for different types of dramatic productions. It is a multi-format with a single production type. A stage can be changed from a proscenium format, with a proscenium arch and a fly tower to an open stage form or a thrust stage form. A theatre in the round could be also arranged (with a central stage). The Gdańsk Shakespeare Theatre, opened in 2014, is a perfect example of such a facility. It is a functionally flexible theatre, which enables different variants of stage and auditorium configuration for the purpose of theatrical and extra-theatrical presentations. There are two main arrangements in the GST hall. The first is the Italian configuration with a traditional proscenium stage, Fig. 5. The stage movement technology located in the base below the floor slab enables transformation of the stage into the Elizabethan configuration, Fig. 6. It is a mobile stage. The roof above this stage is retractable. The ground floor seating is also changeable and the flat floor can be arranged for standing audience members, in addition to the fixed three storeys of wooden galleries in the perimeter areas for 680 people. In this configuration, the Shakespeare stage is surrounded on three sides by the seating. The other possible arrangements are: experimental configuration with a central stage, ceremony configuration with a flat floor and a fencing arrangement with a fencing strip. The Yard at Chicago Shakespeare is an even more flexible theatre example. The design features nine mobile audience 'towers' that can be arranged in a wide variety of ways (twelve different configurations). Compressed air skid technology lifts each of the 16 tonne towers off the ground on a bed of air, allowing them to be moved by a three persons. The capacity of the hall ranges from 150 to 850.

The second category could be described as a single format with flexibility [2] – a space which accommodates more than one type of production and requires physical adaptation, e.g. a concert hall arrangement with an acoustic shell, an opera and dance arrangement with an

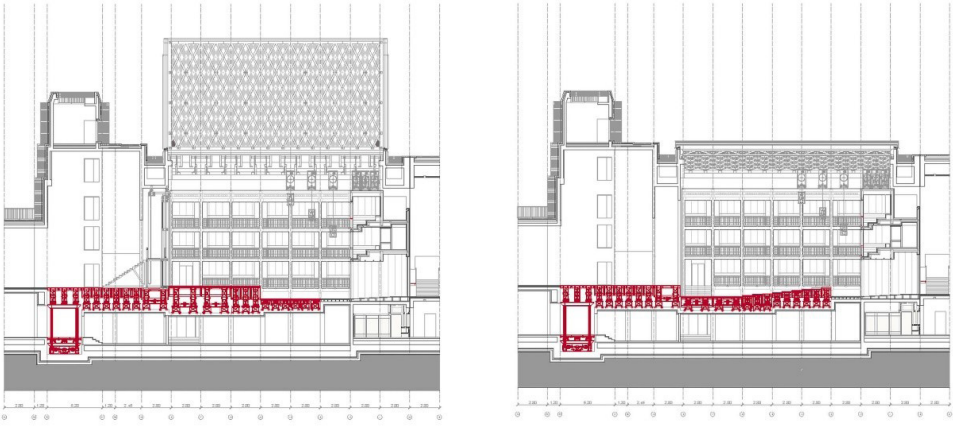

Fig. 5. 6. The Gdańsk Shakespeare Theatre, the main hall: sections of the Italian configuration (left) and the Elizabethan configuration (right) (source: [14])

orchestra pit and a proscenium frame, and a drama theatre arrangement with a forestage – all in one space. A recent example of this type is the functionally adaptable hall of the Podlasie Opera and Philharmonic in Białystok, Poland, designed under the guidance of the architect Marek Budzyński. It is an opera house, a concert hall and a drama theatre, all in one space. The stage is a multi-use proscenium form with a large proscenium opening – 16.0 x 16.5 m. The height of the opening can be reduced to 11 m, especially for opera and drama theatre productions. For concert purposes, the acoustic shell must be placed on the stage to enhance acoustics in the stage house and the auditorium. The seating layout is different for different types of production. The basic size of the auditorium is 824 seats, but it can be reduced to 652 seats or even 570 seats for small scale productions or increased to 1016 seats (with additional seating onstage). Special curtains are used to separate and isolate balconies, if necessary. Acoustic properties are also adjustable within this auditorium. Reflective panels suspended above the audience seating can be raised or lowered to increase or reduce reverberation time,

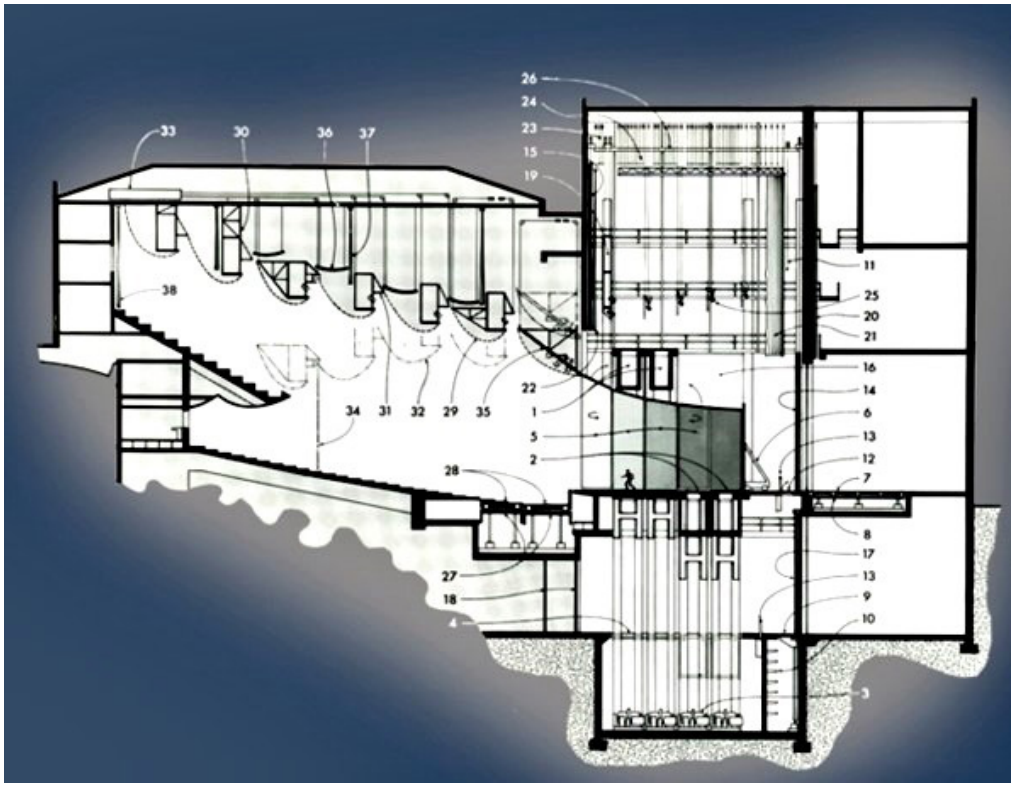

Fig. 7. A multi-purpose theatre project by Olaf Soot Design for Maracaibo, Venezuela – the longitudinal section shows possible conversion from concert hall with 2,100 seats to an opera house (1,740 seats) or a drama theatre (750 seats). The main adjustable elements are: an orchestra shell (5) in position onstage – panels of the shell are a part of downstage lifts for quick conversion from a theatre to a concert hall; a movable ceiling located at a high (29) or low (32) position; auditorium partition curtain (34); orchestra pit lift (27) with seating wagons (28); ceiling acoustical absorptive curtains (37) and wall acoustical curtains (38). (source: [15])

and their rake angle is also variable. The reverberation time should be longer for orchestral and choral music performances, slightly shorter for opera and much shorter for dramatic and electroacoustic performances; therefore, the volume of the auditorium must be changed. The acoustic properties of internal walls can also be transformed from reflective to absorptive when plush curtains are dropped.

The third category refers to multi-form halls, where various productions take place within the same enclosure. It is similar to the second category, but the seating layout and the capacity can also be modified, Fig. 7.

The last category combines a provision for performing arts productions with other activities, e.g. indoor sports facilities, conferences and lectures. Usually, the auditorium in such buildings can be reconfigured into different seating arrangements to change the performer – audience relationship. By moving large architectural elements, one form of the theatre can be transformed into another. In this case, the halls frequently have a flat floor used to place movable inclined seating. Such seating can be retractable, telescopic, moved on trolleys (wheeled units), removable or hydraulically raised and retracted[5] [10, pp. 142-143], Figs. 8 & 9. The Derngate Auditorium in Northampton, England, is a good example of this category[6]. Another example, however, not a perfect example, is the Schaubuhne in Berlin; this is a building with a vast central nave – an open space in which the position of the acting area is not predetermined. The convertible space can be adapted to each production by combining or adding mobile facilities located on the walls, floor and ceiling. The space can be divided into three auditoriums that can be used together or separately[7] [5, p. 64].

Fixed seating in multi-use halls is usually located in stepped perimeter areas and the central part of the auditorium is often flat and equipped with movable chairs. Rectangular and square box forms are often used in this category, both with fixed perimeter seating and removable central seating, and also with fixed rear seating and removable front seating on a flat floor. Adaptability from one format to another is sometimes simple, when the level of adaptation is relatively small, such as the formation of the forestage over an orchestra pit, and when it does not interfere with sightlines. Sometimes, however, adaptability means alterations of seating and staging, Fig. 10. On a small scale, such changes can be achieved manually or mechanically without serious problems, but on a large scale, the problems become more challenging, both technically and economically, if all formats are to perform satisfactorily [2, p. 124, 125].

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5 In retractable or telescoping seating, each row retracts into the row behind until the stored unit is one rear row deep. Complete inclined units on wheels can also be easily moved into storage areas. In some cases, removable seats are placed on a units built up on a set of boxes. Hydraulic lifts are also used to form a stepped floor [2, p. 127].

6 The Derngate Theatre in Northampton is a multiple-use building. the auditorium and stage space of which can be changed and shaped in accordance with the need of theatrical, opera, musical and dance performances, and even sporting events.

7 The Schaubuhne in Berlin was refurbished in 1981 and a flexible space was built. The machinery was sufficiently variable to enable a wide variety of configurations. The building was filled with lifts, mobile units, winches and acoustic movable curtains but this was not without other constraints. Three auditoriums, each of a different size, could be combined together with a total capacity of 2,000 seats.

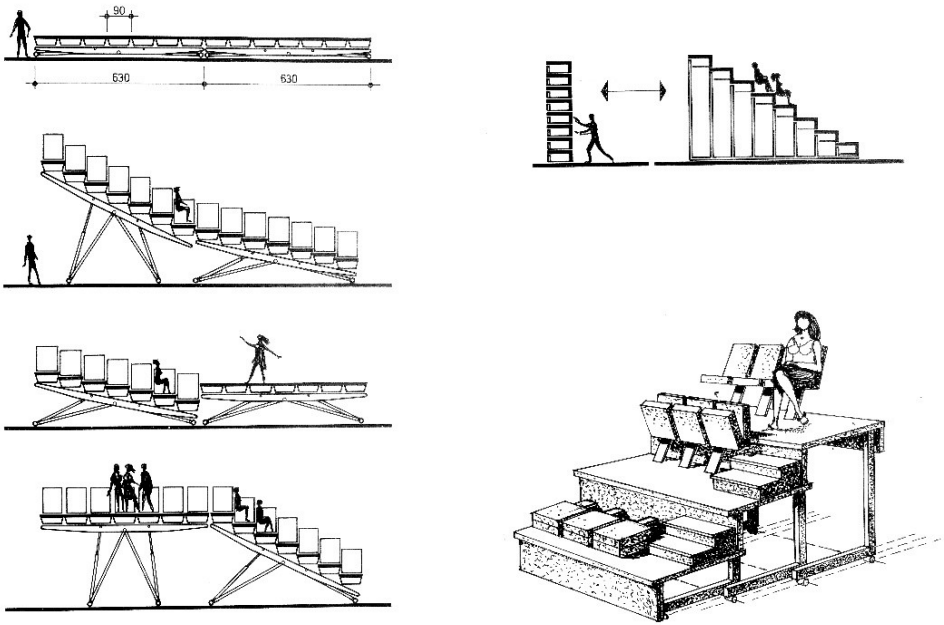

Fig. 8. 9. Movable seating and stage platforms (left), retractable seating (right) (prepared by: A. Grudziński)

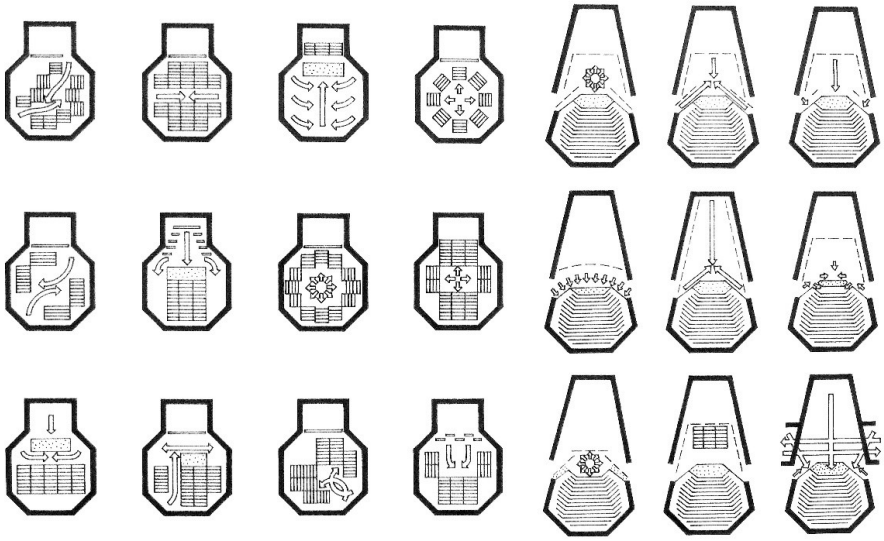

Fig. 9. Fig. 10. Adjustable auditorium plan arrangements – changeable seating and stage examples (left) and a multi-use stage with a flexible proscenium zone (right) (prepared by: A. Grudziński)

5. Acoustic Arrangements of Multiple-Use Auditoriums

Acoustic elements are crucial for multi-use halls. The ideal sound environment for performing arts halls depends on three variables: room acoustics, sound system and quietness. To achieve a quiet environment, enclose constructions must isolate external sounds and vibrations. Sometimes double or even triple walls are used to separate the main hall. Noise control within the hall is also important. Several conditions must be realised in the design of a multiple-use auditorium that is to have optimal room acoustics. Firstly, the hall must have the best possible shape and dimensions to provide the most favourable generation and distribution of sounds for both performers and the audience [9, p. 460]. Secondly, it should have the proper diffusion of reflected sound, so that the direct sound heard by the audience is enhanced by reflections of the sound, which flows to all listeners from all directions [9, p. 460]. The multiple-use auditorium must have provision for acoustic adjustability.

The main acoustic elements in multi-purpose halls are:

- acoustic enclosures (shells);
- reflective, diffusive and absorptive panels;
- movable, changeable ceilings which can adjust the cubic volume of the hall;
- adjustable acoustic properties of internal walls.

In most multi-purpose auditoriums, the stage area is separated from the seating by a proscenium opening. The proscenium stage used in drama and opera performances is not a sound reflector for orchestral and choral music performances. The fly tower is usually high and absorbs too much sound. Sound is absorbed by curtains, scenery and rigging systems. This space reduces the quality of sound, especially for concert arrangements. Therefore, ***acoustic shells*** must be used onstage. These should convert the theatrical stage to a concert hall platform that is acoustically coupled to the auditorium [9, p. 308]. These structures shield onstage sound absorption and acoustically connect the stage area to the auditorium. Acoustic enclosures enhance the ability of performers to hear each other (by providing early reflections), project sound toward the audience and increase sound intensity. Sound-reflective shell towers are placed on the stage floor, forming back and side walls that enclose the performers, and overhead panels are suspended above the stage using the rigging system. A full-stage acoustic shell is the ideal solution for musical performances on a proscenium stage, Fig. 11.

A high ceiling in the audience area could be also a sound trap (i.e. it can absorb too much sound). ***Reflective ceiling panels*** ('acoustic clouds') suspended above the audience seating area reflect sound down towards the audience, Fig. 12. The panels are spaced apart to enable sound to enter the volume above the panels. The later reflections from this volume enhance reverberation and create envelopment of the acoustic space.

Acoustic wall panels within the seating area are mainly diffusers and absorbers. The front one-third of the auditorium walls are usually diffuser panels. Aa combination of diffuser and absorber panels is generally placed on the middle third of the auditorium walls.. The rear sections of the side walls and the entire back wall are normally covered with absorber panels. The shapes of the reflective and diffusive panels include convex and pyramidal forms, and wavy patterns etc. Their construction materials are usually wood and gypsum boards (sometimes

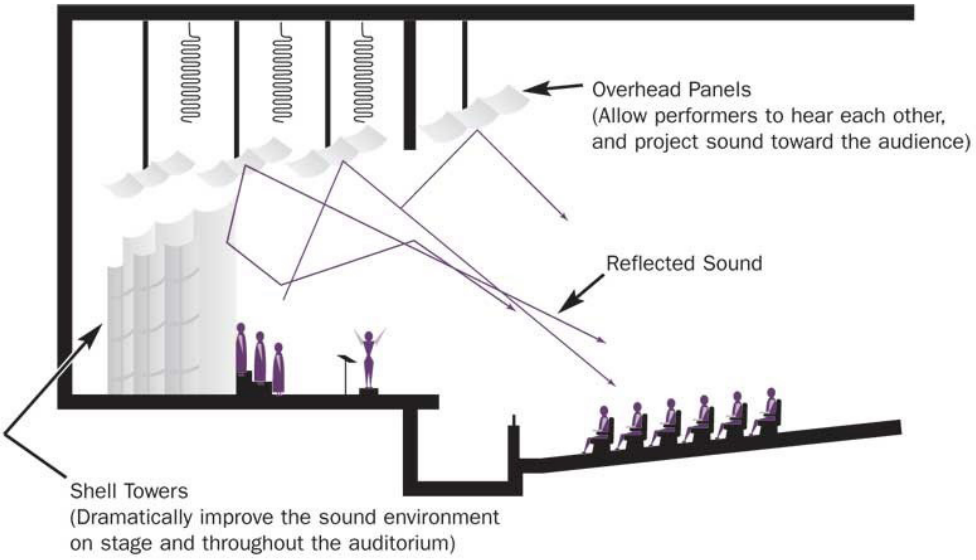

Fig. 11. Acoustic shell – sound-reflective shell towers and overhead panels surrounding the performers (source: [16])

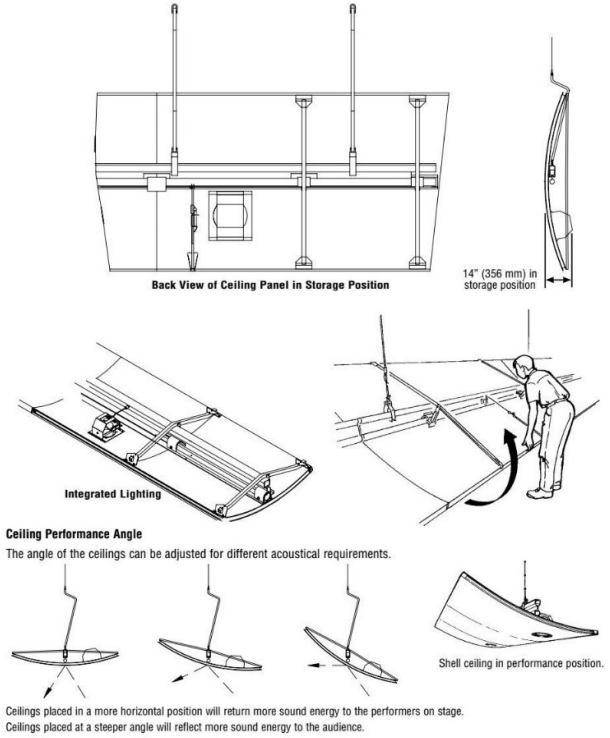

Fig. 12. Reflective ceiling panels (source: [17])

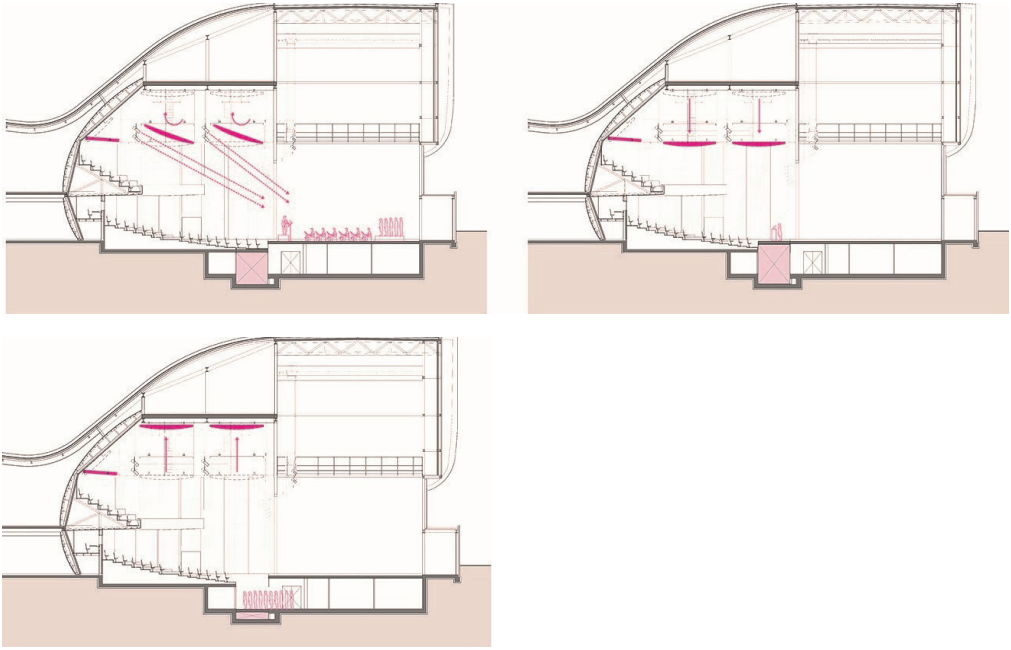

Fig. 13. Movable and retractable ceiling. Theatre de Stoep / UN Studio, the Netherlands(source: [18])

glass), which can be characterised as hard-surfaced. Absorptive panels, reversely, are made of soft and porous materials.

Reverberation time should be short for speech and long for music. Variations in volume and reverberation times typically cause difficulties when combined in a single auditorium. ***Movable ceilings*** can adjust the cubic volume of the auditorium for the given performance, Fig. 13. Mechanical, retractable elements can change the volume of the hall. Electronic devices like "assisted resonance" can also adjust reverberation time [2, p. 115]. Volume could be adjusted by dropping sound-absorbent banners or panels. Such an approach transforms the way in which ceilings and walls can be treated. It is also possible to curtain off a section(s) of the seating [2, p. 115], for example, balconies.

The requirements for some types of performance are akin to other types, whereas others can be vastly different. A concert hall has a different interior layout and different acoustics to drama theatre auditorium. A multiple-use hall must provide sufficient auditorium volume for use as a concert hall and means by which it can be reduced: by closing off balconies and other spaces of the auditorium to lower reverberation time and the seating capacity to an appropriate value for speech or by maintaining the volume constant and adding sufficient absorption to offset excessive volume [9, p. 308].

6. Summary and Conclusions

Multi-purpose performance spaces can be used for a variety of functions. The diversity of stage productions that can be presented in a single space is the main advantage of such facilities that can be configured and adapted to meet the needs of the current presentations. Another advantage they present is the diversity of support facilities for public. Buildings for the performing arts are often flexible in order to improve their functioning. However, it is necessary to consider all their main, changeable functions during the design work. It is also necessary to consider the balance between the costs and benefits of the flexibility. Venues that are multiple-use are associated with certain limitations. Too much machinery can generate very high costs and create other constraints. Acoustic arrangements can be quite complex, but they are also necessary when multi-form strategies are applied.

The multi-purpose idea has in some cases been the expression of the clients' unusual and unrealistic aims, not based on a reliable and comprehensive feasibility study. In attempting to cater for every use, even incompatible uses, designs of multiple-use buildings have occasionally failed. They have been too expensive and not suitable for any types of production that are very different from each other.

The optimum solution for multiple use seems to be such an approach to architectural design and construction that ensures maximum utilisation of the potential of buildings for the performing arts and their very high functionality. Therefore, the study of the design decisions that lead to flexible buildings is important. Features such as the incorporation of changeable elements and the creation of multi-purpose spaces must be examined. Flexibility of theatre buildings and the functional adaptability of the stage and auditorium area should be considered at an early stage of design work, and future spectators and the persons who manage the cultural institutions should be consulted. Design requirements are much more complicated for multiple use than for single use facilities, but a well-designed and efficiently operated multiple-use building for the performing arts offsets other more serious disadvantages, simply because of the increased use factor and the more stable income they are likely to provide [9, p. 306]. Multiple-use also broadens the range of services that can be provided by cultural institutions.

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