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Layout Characteristics and Design Principles of Atrium Integrated Space

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With the development of China's cruise tourism industry, it is necessary to study the design and construction of cruise ships, especially the central atrium, which is an important part of public area design and represents the quality and characteristics of the entire ship's design. However, compared with Europe, China's research foundation for large-scale cruise ship design is still lacking. Therefore, studying the spatial layout characteristics of the central atrium is of great significance for improving China's cruise industry. This article focuses on the design principles and characteristics of integrated space layout in the central atrium of cruise ships. By applying basic theories from architecture, shipbuilding engineering, aesthetics, international maritime safety conventions and technology to analyzing representative central atria from 25 typical domestic and foreign cruise brands through data collection and research methods including mathematical statistics methodology, clustering methodology and cases research methodology. Through comparison and generalization of the cases, the study eventually summarizes six overall principles and four structural principles for designing integrated space in the central atrium of a cruise ship. The six overall principles include safety, rationality, applicability, artistry, coordination and technique-economics. The four structural principles include clear space circulation, natural spatial connection, theme coordination & unification and prominent key levels. This study provides insights into designing integrated space in the central atriums of cruise ships that hopefully can be applied in improving China's cruise design work while also supporting guidance for future related fields.

Keywords: *central atrium of cruise ship, integrated space, design principles, functional layout, decoration style*

Introduction

Research Background

In recent years, the development of cruise tourism in China has attracted more and more attention. Europe has now developed into the world's leading cruise design and production base (Huang 2018, Qian 2021). However, Asia is still in a backward state. In particular, compared with Europe, China's cruise design lacks the research foundation for large-scale cruise design. China's cruise industry still

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has many deficiencies in industrial planning, cruise design, cruise service system, cruise consumption concept and other aspects (Wang 2019).

The design and construction of cruise ships is the crystallization of cooperation between cruise ship design and architectural art design. The traffic area of the cruise is an important part of the public area design, which directly reflects the quality and characteristics of the whole ship design and the characteristics of traffic space layout are the basis of traffic area design. As an important node of traffic space, the atrium is highly integrated in many aspects such as working function, interior assembly and theme representation. Therefore, it is of great significance to study its spatial layout characteristics.

Research Content

This paper studies the cruise ship atrium. Cruise ships originally refer to large passenger ships with fixed routes and regular voyages at sea. At present, cruise ships in academia and industry refer to luxury ships that are mainly sailing at sea, equipped with relatively complete living and entertainment facilities, and specially used for tourism, leisure and vacation. For tourists, the cruise itself is one of the tourist destinations, and enjoying various facilities and services on the cruise is a major part of marine tourism (China Classification Society 2017).

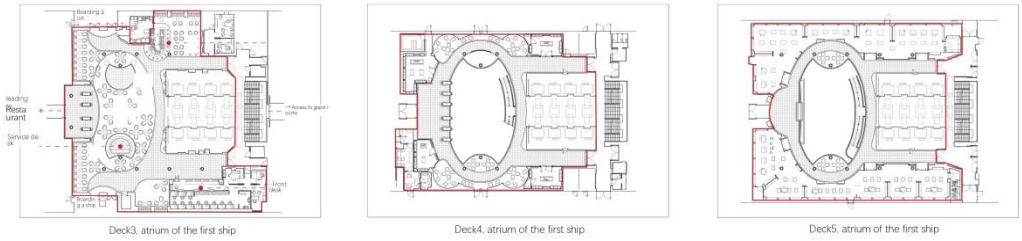
Today, cruise ships have gradually transformed from traditional postal and transportation functions into movable waterborne buildings with tourism and entertainment as the main content, which have the basic characteristics of buildings. However, due to the particularity of ships, cruise ships, compared with onshore buildings, have their unique artistic features and design specifications (Coufer and Oil, E. I. C. E. Inter-Governmental Maritime Consultative Organization 1974).

The traffic area is an important part of the key technology of cruise public space, and the design of the traffic area also directly reflects the quality and characteristics of the whole ship design, which is an important part of the public area design. As a landmark node in the public space and a hub node in the traffic space of the cruise ship, the cruise atrium naturally has integrated spatial characteristics. The cruise atrium is the node space of the traffic space. On the one hand, the cruise atrium creates a first impression for tourists to perceive the cruise ship and is an important place for tourists to experience the identifiability of the cruise ship; On the other hand, the cruise atrium is the core area presenting the cruise theme culture, and the design of the cruise atrium directly affects the comprehensive competitiveness of the cruise and the satisfaction of tourists.

Specifically, the cruise atrium refers to the public area connecting the main corridor, stairs, elevators and other spaces inside the cruise ship. The reason why it is called the atrium integrated space is that it meets the demands of the integration of multiple functions, comprehensive transportation and various information; Functions include lobby, rest, reception, registration, business, exhibition, assembly, social shopping, performance and other functions. The traffic involves vertical flow of people (elevators), horizontal flow of people (walkways, ring corridors), indoor and outdoor flow of people (external decks and indoor gatherings). For example, the atrium of the first large-scale cruise ship in China has multiple

functions such as boarding reception, front desk service, shopping, catering, social entertainment, and rest. The atrium is close to the bow elevator hall, connects the restaurant and guest room area, and connects the indoor space and outdoor deck. It is an important public space for tourists' entertainment, leisure, and consumption experience, and also a transportation hub to meet the demand for evacuation, assembly, and other distribution functions of passenger flow (Figure 1).

Figure 1. *Research Scope*



Source: Author.

Atrium is an ancient architectural space form. According to the Oxford Dictionary, it refers to the central courtyard in Roman times, usually with a covered cloister, mainly located in the front of the church entrance.

According to the Royal Geographical Society, the atrium refers to a roofed courtyard within or between buildings, usually with several levels, which serves as the central point of arrival and circulation (Saxon 1983).

According to the ancient Chinese literature, the atrium is the middle part of the front steps of the ancient temple, where officials stand when the court meets or confers nobility. In Guanzi · Zhongkuang, it is recorded that: "Guan Zhong returned and leaned against the screen, and the king refused to talk; Then Guan Zhong took a few steps into the atrium, and the king still refused to talk." It is also recorded that the atrium is the central space of the hall, or the open courtyard in the center of the building. In Shanglin Fu written by Xiangru Sima in Han Dynasty, it is recorded that "Sweet water springs out in the tiny room, and free streams flow through the yard."

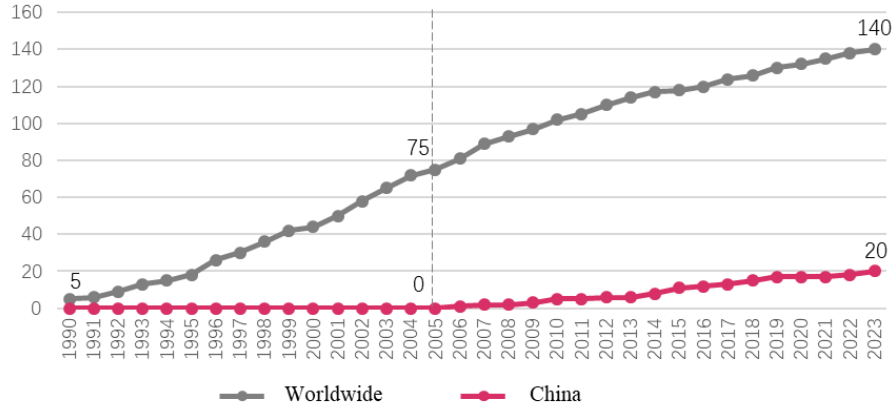
In nowadays, the atrium is endowed with more functional values. It is widely used in public buildings such as hotels on land and cruise ships on the sea. It is a large hall with lobby, rest, reception, registration, business and other functions (Psarra 2021). The function of the atrium space includes: sharing the space of the external environment for the internal environment of the building; Experiencing natural light - "outdoor space" in the interior; Providing space for sense of direction and helping users overcome negative psychological reactions.

Literature Review

Up to now, the existing research of cruise ship atrium is still quite lacking at home and abroad. According to WOS and Google Scholar, in the latest 30 years there are only 32 literatures on the subject of “cruise ship atrium” published in

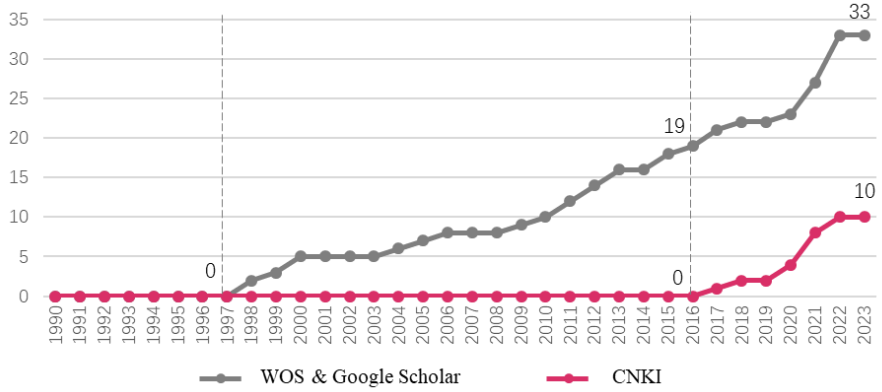
total worldwide, while at the same time over 140 new cruise ships have been put into service. The research in similar fields in China just starts and devotes 10 related literatures (Figures 2-3).

Figure 2. *Total Amount of New Cruise Ship since 1990*



Source: Author.

Figure 3. *Total Amount of Literature on the Subject of 'Cruise Ship Atrium'*



Source: Author

The existing researches have explored many valuable methods for cruise atrium design from the perspective of different professional fields, but there are some limitations at the same time. For one thing, the existing research on cruise ship atrium mainly focuses on construction practical technique (Wieslaw 2012) and influence on Business Models & Revenue (Kulhanek 2012), while there are few studies analyzing the atriums` interior assembly and influence on activities. On the other hand, the existing research from the perspective of architectural & interior design mainly analyzes directly based on certain specific element like enclosure of atriums (Xi and Chen 2022), but few studies provide a preliminary systematic composition structure of cruise ship atriums to obtain an overall understanding. Therefore, a systematic analysis framework of cruise ship atrium based on spatial features and scientific principles for the spatial layout design are the two key points to be solved in the research field of cruise ship atrium.

The purpose of this research is to collect, analyze and summarize the cases of the typical cruise ship atrium space at home and abroad, sort out the development context and rules of the cruise ship atrium space layout at home and abroad, reveal and summarize the evolution rules, design principles and strategies of the cruise ship atrium space design, so as to fill the gap in the research on the cruise ship atrium space layout in domestic academia. The research further provides basic data and theoretical methods for the optimization scheme of cruise ship atrium space, and provides theoretical support and technical guidance for the independent design and construction of the first domestic cruise ship.

Methodology

This research uses data from multiple authoritative data sources, including the database of Shanghai Waigaoqiao Group, the official website of dozens of well-known cruise brand companies around the world, the official website of the famous international cruise industry organization - International Cruise Association, and combines Wikipedia data to conduct a comprehensive data collection and research on the cruise atrium space of representative cruise lines at home and abroad.

The study then uses mathematical statistics methodology, clustering methodology, case research methodology and other methods to study the spatial layout characteristics of the atrium as a node integrated space in the cruise traffic space. With the first ship as the key research object, the study analyzes the three main elements of spatial form (components), structure and functional layout, sorting out the characteristics and evolution mechanism of modern cruise ship atrium integrated space layout in the past 30 years. Then the study focuses on the core issues of the traffic area-visibility and accessibility-for analysis and optimization.

This study uses inductive and deductive methods to summarize the basic principles and techniques of cruise atrium integrated space design, sort out the basic laws, and then summarize the design principles and strategies of cruise atrium integrated space as a traffic node.

Results

Atrium Integrated Space and its Constituent Elements

As a central organization space for passenger service with wide adaptability, strong accessibility and high relevance in cruise ships, the atrium is an important space for daily and random communication of tourists in the cruise public space, and also a critical node in the transportation space of large cruise ships, and has the characteristics of integration and economy (Guan 2015).

The integrated space of cruise atrium includes three main elements: spatial form, interior assembly and functional layout.

Among them, spatial form is the existence form of space as a matter, which is mainly reflected by the scale, proportion, shape, division, enclosure and other

elements of space (Deforge and Cullars 1990). The cruise ship atrium is composed of deck, bulkhead, canopy, furniture, etc. Its spatial form is mainly reflected in the distribution type, location distribution, planar form, interface form, spatial scale, etc. (Barry 2006).

The interior assembly refers to the interrelationship and distribution characteristics between the various parts of the space inside the atrium. Different types of interior assembly will shape different images of the atrium and bring different spatial experiences to tourists. The interior assembly design of the cruise ship atrium needs to consider the particularity of different spaces and the regularity, coordination, combination and other elements of multiple spatial associations, as well as the primary and secondary relationship of tourists' experience paths and spaces. The layout combination, people organization evacuation and circulation design of the cruise ship atrium are supposed to be conducted to meet the needs of the cruise theme and transportation hub, and achieve the goal of intensification (Sun et al. 2016).

The functional layout includes the planning and combination design of functional activities for the cruise ship atrium, which is an important design factor for the atrium as a node of public space (Tan et al. 2016). The functions undertaken by the atrium usually include the lobby, rest, reception, registration and business. The atrium space is closely connected with other surrounding spaces, including corridors, elevators, shopping spaces, restaurants and other public spaces. In the design of functional layout, it is essential to focus on the relationship of division and combination among various parts, and solve various contradictions one by one to achieve a reasonable and perfect functional relationship, a reasonable function arrangement, a vivid layout and a clear circulation. In addition, the functional layout should be combined with the spatial form and interior assembly of the atrium to meet the spiritual needs of tourists in the limited space and enrich the navigation life (Bruce 2006).

The research report will study the characteristics of integrated space layout of the cruise ship atrium, which is the most important public transport space node in cruise ships, based on the three elements of spatial form, interior assembly and functional layout described above, from the perspective of the scientific ship aesthetics. This research is also based on the comprehensive application of basic theories in architecture, shipbuilding and aesthetics, and the International Convention and Technology for the Safety of Life at Sea.

Spatial Form Characteristics of Atrium

The study compares the typical atriums of 15 typical cruise brands at home and abroad according to 5 different factors including distribution type, location distribution, plane shape, interface form, and spatial scale, and obtains the characteristics of the typical atriums of different cruise brands at home and abroad.

Spatial Form Characteristics of Atrium of Foreign Cruise Brands

(1) Distribution type

The distribution type of most cruise ship atriums abroad is centralized. The centralized distribution type atrium means that the atrium has become a large indoor shared space in cruise ships. The atrium integrates many functions, such as front desk service, business center, luggage service, tour consultation, bar catering, large gatherings, etc., creating a place full of life and humanity, just like an indoor city square. This is also the mainstream atrium distribution form adopted by foreign cruise companies such as Carnival Cruise Lines, Costa Cruise Lines, Princess Cruise Lines, Disney Cruise Lines, etc.

Decentralized distribution type atrium refers to that there is more than one atrium space on a ship, and different atriums have different spatial forms, decoration styles, functional themes, and play different roles. The distribution type of decentralized atriums in foreign cruise ships began in 2000. There are three types of atriums in Royal Caribbean International Cruise Lines, namely Royal Avenue, Central Park, and 270° landscape atrium, which are distributed in the middle and tail areas of the deck layer. The atrium design has its own characteristics. Royal Avenue belongs to the "linear atrium" form of Long Corridor Street. It is located in a ship with five decks and is more than four decks high, with a large spatial scale. The first and second floors of the atrium are public facilities such as shop, coffee and catering, front desk service, etc. The upper floor is the cabin space, and the top is glass and or art decoration. At the end of the Royal Avenue, a small atrium is usually set as the atrium for traffic and crowd flow. Central Park is the open comprehensive leisure area at the core of the whole cruise ship. It is rectangular in shape, generally located in the middle of the eighth deck, with six decks height, and has a large spatial scale. The bottom floor of the atrium is public entertainment facilities such as shopping, coffee and catering, and the upper five floors are the cabin space. The 270 ° landscape atrium, which has appeared since 2014, is semi elliptical in shape and is generally located at the stern of the fifth deck. It is enclosed by a huge floor glass wall spanning three decks. The enclosed interface is curved and inclined. It is a scientific and technological atrium integrating sightseeing, modern performance, rest and dining. In addition, the appearance of arcades in Mediterranean Cruise Lines since 2016 is also a decentralized atrium.

(2) Location distribution

The atriums of foreign cruise ships are distributed in various locations, from the first floor to the ninth floor. Before 1998, most of the atriums of foreign cruise ships were mainly distributed on the higher deck above the seventh floor. From 1995 to 2014, the distribution of the atrium began to move down to the lower deck, mainly concentrated on the third to fifth floor. From 1995 to 2013, the distribution of the atrium began to move up to the middle layer of the cruise ship, which is mostly the fifth or sixth layer. From the perspective of development trend, the distribution of atriums of foreign cruise ships in the future may be more concentrated in the middle layer (5-6 layers) of cruise ships.

From the vertical comparison between different foreign cruise lines, Carnival Cruise Lines and Costa Cruise Lines have various atrium locations, but the overall trend is downward; the atriums of Royal Caribbean International Cruise Lines are mainly located in the middle floor (4-5 floors) of the cruise ship. The atrium built in 2009 was located on the 8th floor because of the appearance of the central park atrium. Due to the nature of open space enclosure, its distribution position was on the upper floor. Other foreign cruise companies have relatively stable atrium locations, such as Princess Cruise Lines (4-5 floors), Mediterranean Cruise Lines (5-6 floors), Norwegian Cruise Lines (5-7 floors), Disney Cruise Lines (3 floors) and Cunard Cruise Lines (1-2 floors).

(3) Planar form

The planar form of most cruise ship atriums abroad is mostly circular and elliptical. From 1990 to 1998, the planar form of the atrium was mainly circular and elliptical; since 1998, the planar form of atrium has been rectangular, corridor shaped, and polygon, and has continued to this day. From 2010, the planar form of atrium began to appear irregular shape. From the perspective of development trend, the planar form of the atrium of foreign cruise ships in the future is more inclined to irregular free shape or the combination of multiple planar shapes.

From the perspective of comparison between different foreign cruise companies, those companies whose atriums' planar shapes are mainly circular (including ellipse and arc) include Princess Cruise Lines, Holland America Cruise Lines, Cunard Cruise Lines, Royal Caribbean International Cruise Lines before 1999, Norwegian Cruise Lines before 2007, and Mediterranean Cruise Lines before 2010. Cruise companies whose atriums' planar shapes are mainly rectangular (including those with nested circles or squares) include Carnival Cruise Lines and Disney Cruise Lines. The cruise companies with the planar shape of the atrium dominated by polygons include Costa Cruises. Since 2000, Royal Caribbean Cruise Line has been mainly in the form of atrium with long corridor "Royal Avenue". Since 2010, Norwegian Cruise Lines and Mediterranean Cruise Lines have started to use irregular atrium planes.

(4) Interface form

The atrium interface of most foreign cruise ships is mainly circular, curved and vertical enclosure. Since 2009, Royal Caribbean International Cruise Lines has appeared a new interface form of open air and inclined enclosure. From the perspective of development trend, the atrium interface form of foreign cruise ships in the future will be more inclined in curvature and freer style.

From the perspective of comparison between different foreign cruise companies, cruise companies that mainly adopt the form of vertical interface are: Carnival Cruise Lines and Disney Cruise Lines. Cruise companies that mainly adopt the form of round (including curve) interface include: Princess Cruise Lines, Mediterranean Cruise Lines, Norwegian Cruise Lines, Cunard Cruise Lines, Holland American Cruise Lines. Cruise companies that adopt a variety of encirclement methods

include Costa Cruise Lines and Royal Caribbean International Cruise Lines.

(5) Spatial scale

The space scale of the atrium of foreign cruise ships is diversified, ranging from a small scale of one floor in height to a super scale of over seven floors in height, but mainly is at a moderate scale of 2-3 floors in height. Before 2004, there were mainly two kinds of atriums in most foreign cruise ships: 7-storey high large-scale atriums and 3-storey moderate scale atriums. After 2004, the atrium scales are mainly at a moderate level of 3-4 floors in height. Since 2017, the sizes of atriums have become larger.

From the horizontal comparison between different foreign cruise companies, the atrium spatial scale law of most foreign cruise ships is basically consistent with the above. It is worth mentioning that the atrium space scale of Royal Caribbean International Cruise Lines is generally large, especially the atrium of the Brilliance of the Seas in 2002 is 7-storey high. In addition, the "Central Park" outdoor atrium space scale of the brand since 2009 is also large, spanning 6 stories.

Spatial Form Characteristics of Atrium of Domestic Cruise Brands

(1) Distribution type

The distribution type of atriums of all domestic cruise brands is basically centralized.

(2) Location distribution

The atriums of domestic cruise ships are mainly distributed at the fifth to the seventh floors. From 1988 to 1999, the atriums were mainly located in the upper layers of the cruise ship (over the seventh layer). From 2000 to 2017, the distribution of the atriums moved down to the middle of the cruise ship (at the fifth and sixth floors).

(3) Planar form

The planar form of domestic cruise ship atrium is mostly rectangular, and irregular planar form has appeared since 2010. Among them, the planar form of the atrium of Hong Kong Star Cruises is mainly rectangular and round (semicircle). Atriums of domestic cruise lines in China are mainly rectangular and irregular in shape.

(4) Interface form

The atrium interfaces of most domestic cruise ships are mainly vertical enclosure type. Since 2012, interfaces of cruise lines in mainland China have appeared in the form of curve interface.

(5) Spatial scale

The atrium space scale of domestic cruise lines is diversified and the annual distribution is relatively average, ranging from a small scale of one-floor height to a large scale spanning over 5 floors.

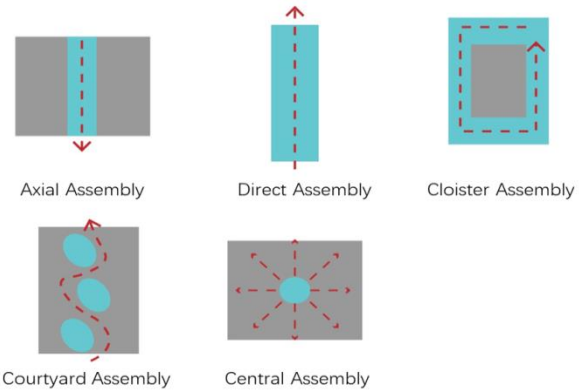
Interior Assembly Characteristics of Atrium

The spatial assembly characteristics of cruise ship atriums are closely linked to both the theme positioning of the ship and the spatial form of the atrium. This study, through the collection and pattern analysis of representative atrium decoration styles both domestically and internationally, has identified the typical characteristics of cruise ship atrium spatial assembly types (Figure 4).

Cruise ship interior assembly types can be categorized into linear assembly and focal point central assembly: Linear assemblies in cruise ship atriums often possess clearly defined linear sequences of movement and spatial guidance. Key spaces or primary paths form linear spatial cues, with secondary spaces arranged symmetrically, circumferentially, or dispersed freely around this main sequence. Depending on the relationship between these secondary spaces and the main traffic flow, linear assemblies can be further subdivided into axial assembly, direct assembly, corridor assembly, and courtyard assembly.

Focal point central assemblies in cruise ship atriums radiate outward from a unique central space, with other spaces distributed around this center. This center serves as a crucial node in design and the hub of tourist activities and experiences (Lu 2018).

Figure 4. *Interior Assembly Characteristics of Cruise Ship Atrium*

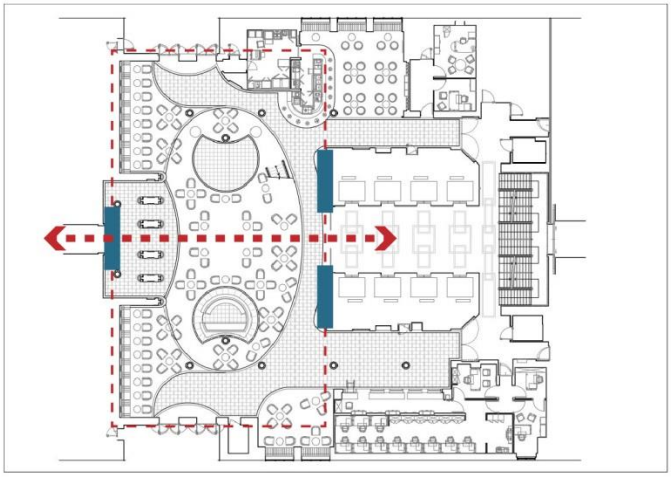


Source: Author.

Axial Assembly

In this type, key nodes or primary spaces within the cruise ship atrium form a distinct axis. The spaces and nodes on this axis also comprise the center of design, with other spaces symmetrically distributed around this axis. The atrium of the Adora Magic City serves as the representative example of this type of assembly (Figure 5).

Figure 5. *Interior Assembly of the Adora Magic City*

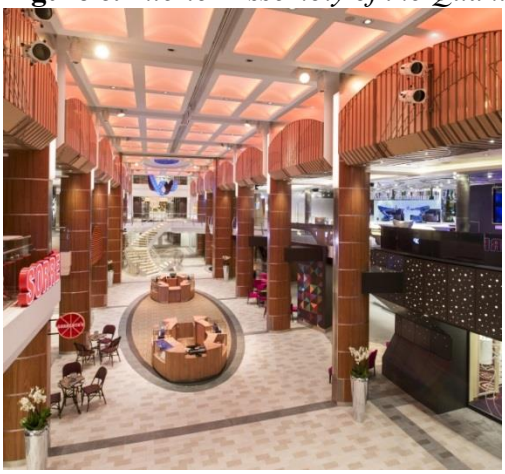


Source: Author.

Direct Assembly

This type means that all parts of the spaces in the atrium (the main platform, stairs, rest area, characteristic space, etc.) are arranged along a straight line, and the main circulation of tourists coincide with this. This type of atrium space is also dominated by the strip type, and the representative cruise ship atrium is the Quantum of the Seas' atrium "Royal Avenue", belonging to the Royal Caribbean International Cruise Lines (Figure 6).

Figure 6. *Interior Assembly of the Quantum of the Seas*



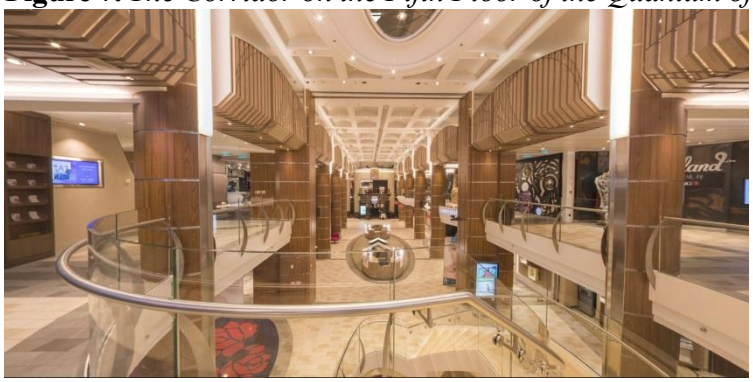
Source: https://oceanworldtravel.com/cruise-ship/.

Corridor Assembly

This type is characterized by the main spatial traffic flow of the atrium distributed in a corridor-like circular arrangement, commonly observed in the upper spaces of multi-story atriums, like the five-story space of the "Royal Promenade" atrium in the Royal Caribbean's Quantum of the Seas. The spaces around the corridor primarily focus on shopping and experiences and can also appreciate the

design of the atrium from an overlooking perspective (Figure 7).

Figure 7. *The Corridor on the Fifth Floor of the Quantum of the Seas' Atrium*



Source: https://oceanworldtravel.com/cruise-ship/.

Courtyard Assembly

In this format, the primary spaces within the atrium are organized in a relatively free manner within the constraints of linear boundaries, offering visitors a courtyard-like experience. The representative example of this type is the "Central Park" atrium of the Royal Caribbean's Wonder of the Seas. The boundaries of "Central Park" adhere to a regular rectangle, but its main internal space is a garden filled with green plants. The visitor's traffic flow meanders through it, combined with transparent daylight from above, providing the experience of an outdoor courtyard (Figure 8).

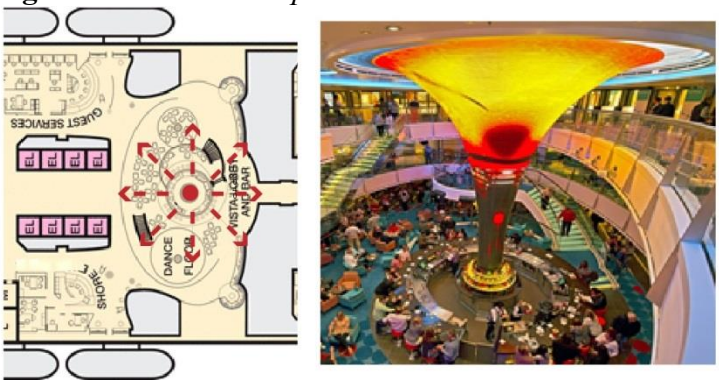
Figure 8. *Atrium Interior Assembly of Wonder of the Seas*

Source: https://oceanworldtravel.com/cruise-ship/.

Central Assembly

In this format, the primary spatial node of the atrium is the center of the atrium space, with the rest of the spaces, functions, and activities radiating divergently around this center. The representative example of this type is the atrium of the Carnival Vista (Figure 9).

Figure 9. *Carnival Prospect Atrium*



Source: https://oceanworldtravel.com/cruise-ship/.

Functional Layout Characteristics of Atrium

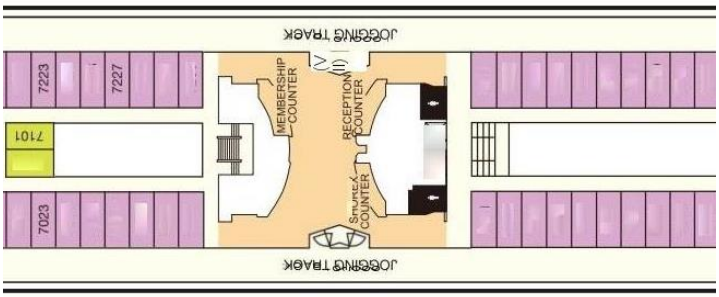
The study summarizes the laws and characteristics of the function layout of cruise ship atriums through research on the functional composition of the atrium itself and its adjacent area, and spatial layout of atriums from typical domestic and foreign cruise ship brands.

Research on Functional Layout of Cruise Ship Atrium

(1) Single-function type

This type refers to the atrium functions being limited to a single reception service and consultation office, without any entertainment functions. This type is less common in cruise ship atriums. The representative cruise ship of this type is the Aquarius Star belonging to Star Cruise Lines (Figure 10).

Figure 10. *Functional Layout of the Atrium of the Aquarius Star*



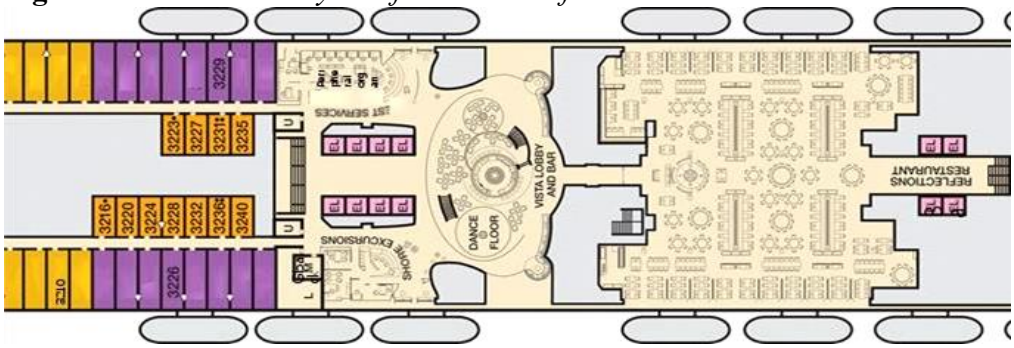
Source: Author.

(2) Multi-function Type

In this type, the atrium function group not only includes the reception service and consultation office but also includes dining, dances, and other entertainment functions. It can be further divided into three types: simple mixed type, comprehensive entertainment type, and spectator type. The simple mixed type refers to the atrium functions primarily serving as the reception and consultation

office, supplemented by functions such as bars, dining, and exhibitions. This type is more common in cruise ship atriums, represented by the Carnival Vista (Figure 11).

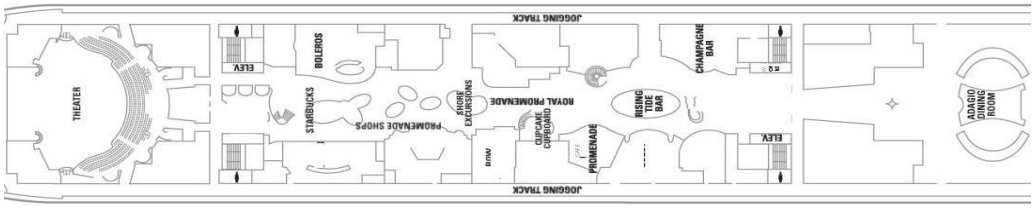
Figure 11. *Functional Layout of the Atrium of the Carnival Vista*



Source: Author.

The comprehensive entertainment type refers to the atrium serving as the core comprehensive leisure area of the entire cruise ship, with functions mainly based around entertainment, typically including bars, coffee, dining, shopping, performances, etc. This type primarily appears in the Royal Promenade atrium format of the Royal Caribbean International cruise ships, represented by the Harmony of the Seas (Figure 12).

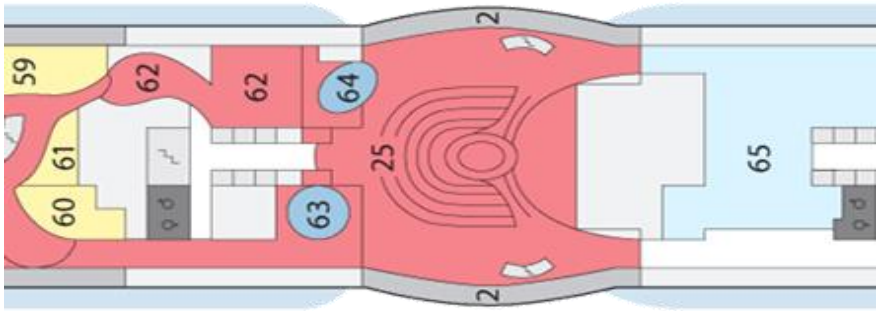
Figure 12. *Functional Layout of the Atrium of the Harmony of the Seas*



Source: https://oceanworldtravel.com/cruise-ship/.

The spectator type appeared from 2008 in the new atrium function types of AIDA Cruises, which is a combination of the functions of a lobby and a theater. The representative cruise ship of this type is the AIDA Prima (Figure 13).

Figure 13. *Functional Layout of the Atrium of the AIDA Prima*



Source: Author.

Research on Functional Layout of Adjacent Areas of Cruise Ship Atrium

(1) Cabin Adjacent Type

This type refers to the atriums whose adjacent area is dominated by cabins, which can be further divided into four types: type of cabins on both sides represented by the Carnival Inspiration; type of dining area on one end represented by Princess Cruises' Island Princess; type of surrounding cabins on four sides represented by the Royal Caribbean's Oasis of the Seas; type of cabins on the front end without the rear end represented by the Skysea Cruise's Golden Era in China (Figure 14).

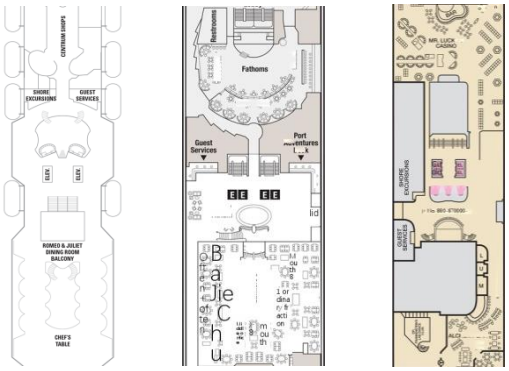
Figure 14. *Functional Layout of Atrium Adjacent Areas of the Carnival Inspiration (first from left), the Island Princess (second from left), the Oasis of the Seas (third from left), the Golden Era (first from right)*

Source: Author.

(2) Dining Adjacent Type

This category refers to the areas adjacent to the atrium, which are mainly composed of dining facilities, and can be subdivided into three types: The first is exemplified by the Royal Caribbean International's Legend of the Seas, featuring a front end with comprehensive functions (business center, shopping, theater, club, coffee, etc.) and a rear end designed for dining. The second type is represented by Disney Cruise Line's Magic, where both front and back ends are dedicated to dining. The third, epitomized by the Carnival Legend, has a dining-focused front end and an entertainment-focused rear end (Figure 15).

Figure 15. *Functional Layout of Atrium Adjacent Areas of Legend of the Seas (first from left), the Disney Magic (second from left) and the Carnival Legend (third from left)*

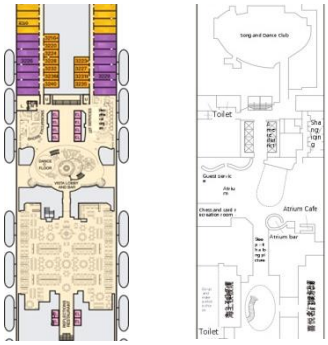


Source: Author.

(3) Mixed entertainment adjacent type

This type refers to the areas adjacent to the atrium, functioning as comprehensive zones, which can be further subdivided into those with promenade decks on both sides and those without. The atrium of the promenade deck type, represented by the Norwegian Cruise Line's Jewel, is located on the 7th floor near the stern of the ship, with promenade decks on both sides, a bar at the front end, and an exhibition space at the rear end (Figure 16).

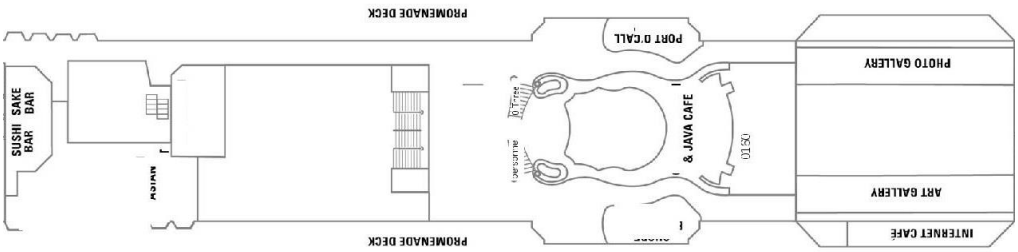
Figure 16. *Functional Layout of Atrium Adjacent Areas of the Norwegian Cruise's Jewel*



Source: https://oceanworldtravel.com/cruise-ship/.

The cruise ship without promenade decks on both sides is exemplified by the atrium of the MSC Meraviglia, where the atrium is situated on the 6th floor of the ship. This type does not feature promenade decks on either side of the atrium, with a theater at the front end and a bar and shopping area at the rear end (Figure 17).

Figure 17. *Functional Layout of Atrium Adjacent Areas of the MSC Meraviglia*

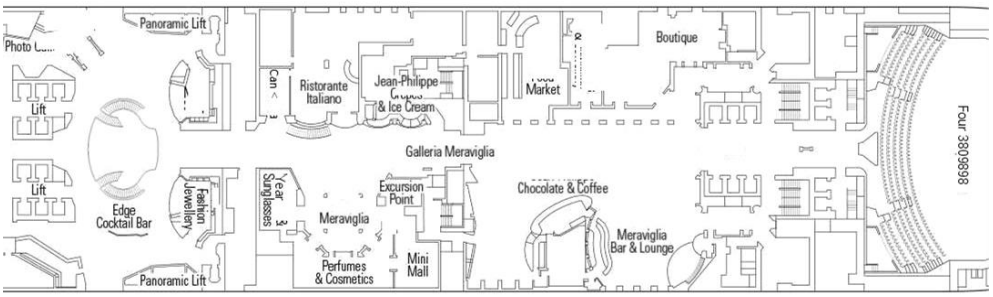


Source: https://oceanworldtravel.com/cruise-ship/.

Research on Functional Layout Form of Cruise Ship Atriums

The functional layout of typical cruise ship atriums can be divided into two types: axis sequence type and flexible layout type. The axis sequence type refers to the empty courtyards and their adjacent functional areas are distributed in a certain spatial sequence, and the layout form is basically axis symmetric. The typical atrium case is the Carnival Vista's atrium; the space sequence of the flexible layout refers to the space court and its adjacent functional areas is relatively free and flexible, and the typical atrium case is the atrium of the Norwegian Cruise's Joy (Figure 18).

Figure 18. *The Functional Layout of the Atrium of the Carnival Vista (left) and the Norwegian Cruise's Joy (right)*



Source: Author

Discussion

According to the spatial form characteristics analysis, the principles of integrated space design in cruise ship atriums are primarily applied in the conceptual and detailed schematic stages of the atrium's integrated design. By controlling specific elements of this design process, each component contributes to detailed interior design references and rules for the atrium, with the goal of providing theoretical references and technical guidance for the independent design of domestically built ships.

Six Overall Principles for Thematic Design and Interior Decor in Public Spaces aboard Cruise Ships

The overarching principles for integrated space design within a cruise ship atrium reflect considerations of safety, reasonableness, applicability, artistic quality, coordination, and technical economy (Massey 2020, Pile 2005).

Safety

Safety is an indispensable factor in the design of cruise ship atrium spaces. Pertinent safety issues in integrated atrium design encompass fire prevention, fall prevention, emergency evacuation, along with other factors related to the ship's performance, such as stability, buoyancy, and equipment usage.

Reasonableness

Reasonableness is fundamental to the design and construction of a cruise ship's atrium. It encompasses structurally sound designs, functional layout, appropriate spatial arrangement, suitable material use, and adherence to manufacturing standards.

Applicability

Applicability refers to satisfying the diverse needs of passengers from various nations, ethnicities, age groups, and educational backgrounds in the design and arrangement of atrium spaces, thereby maximizing the utility of the atrium as a communal and transitional space (Li and Wang 2013).

Artistry

Artistry lies at the core of aesthetic design and its ultimate goal. Within the framework of cruise ship aesthetics and guided by architectural aesthetics, the atrium space is designed in terms of spatial form, decorative style, and functional layout, aiming to create a vivid, unique public space that helps to craft a distinct brand identity and showcases its themes and operational characteristics (Deng and Deng 2010).

Coordination

The cruise ship atrium serves as an integration of functional, structural, and stylistic elements in a public space and acts as a hub of traffic and communal interaction. Coordination is thus a necessity in the arrangement of integrated atrium spaces. This includes harmonization with other spaces such as cabins, public corridors, other public activity spaces, and internal management spaces, as well as within the various functional areas and decorative elements of the atrium itself (Wu and Du 2018).

Technical Economy

The structure, function, and decorative design of an integrated atrium space are influenced by the level of craftsmanship and technical conditions. With the continual emergence and development of new materials and techniques, superior

and more flexible designs can be achieved through the application of novel visual elements, thereby enhancing the distinctiveness of different cruise ship brands.

Four Strategies for the Composition of Integrated Spaces in Cruise Ship Atriums

The design of integrated spaces within a cruise ship's atrium extends beyond individual areas such as the main service desk, bar, and landmark nodes, placing considerable emphasis on the combination and sequential arrangement of different functional spaces. Broadly speaking, the compositional principles of integrated space design in a cruise ship's atrium encompass clear spatial circulation, seamless spatial transitions, thematic harmony, and emphatic layering of focal points.

Clear Spatial Circulation

The spatial flow of a cruise ship's public spaces includes both planar and three-dimensional circulation, reflecting specific functional demands and spatial relationships. It also serves as a crucial basis for spatial composition. Organizing the sequence of various circulation activities and arranging spatial sequences play a significant role in the expression and experience of a cruise ship's public space theme.

Seamless Spatial Transition

The seamless transition of spatial sequences involves the designer strategically and flexibly organizing the beginning, continuity, transition, and culmination of public spaces on a cruise ship. The design's core principle is to emphasize the harmonious beauty in changing public spaces, promoting an organic sense of order. Every design arrangement of a spatial sequence must account for the theme, spatial form, decorative style, and functional layout of its constituent public spaces.

Unified Thematic Harmony

In the design and expression of a cruise ship's public space theme and interior decor, each element should be subordinate to the whole, maintaining unity amid variety. The atrium, corridors, and elevator spaces on a cruise ship should consider their mutual relations and interpenetration in terms of thematic orientation, spatial form, decorative style, and functional positioning. While ensuring harmony with the overall theme, individual characteristics should be highlighted and represented.

Emphasis on Hierarchical Focal Points

In the spatial combination and sequential arrangement of different public spaces on a cruise ship, one should account for the primary and secondary relationships among the various public spaces. The primary spaces should serve as the core, and the arrangement of secondary spaces should facilitate the functionality of primary spaces. Spaces with external links should be near traffic hubs, while internal use spaces should be relatively concealed. Spatial composition should ensure clear and complete contours of primary spaces, and the overall layout should emphasize balance and focus.

Conclusion

The key efforts of this study are as follows: Initially, comprehensive data collection and research were conducted on atrium spaces of representative cruise ship brands both domestically and internationally using methods such as internet big data research, literature review, and expert consultations. Subsequently, through data statistics, cluster analysis, case studies, and other methods, a detailed description and analysis of atrium spaces from the three main constituent elements - spatial form, decorative style, and functional layout - were conducted. This led to the clarification of the atrium's role as a traffic hub, its representational methods, and layout features, ultimately summarizing design principles and strategies.

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