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Architecture-Oriented Design Method For Digital Cultural Relics Collection Service System With History Timeline

Shuh-Ping Sun
Department of Digital Media Design
I-Shou University
Kaohsiung, Taiwan

***Abstract*—This study utilizes the Structure-Behavior Coalescence (SBC) architecture as a design approach for a digital collection service system of cultural relics with a history timeline. The SBC architecture design method employs Architecture Description Language (ADL) to formally design both the essence and the specific details of the architecture for the digital collection of cultural relics service system with a history timeline. During the design phase, the framework diagram (FD)-ADL, architecture hierarchy diagram (AHD)-ADL, and interaction flow diagram (IFD)-ADL are employed. The SBC architecture design method facilitates the integration of different historical timelines within the same digital collection of cultural relics service system, allowing the unfolding of the chronological track of cultural relics history. Users can utilize the structure, behavior, functionality, and data of the digital collection service system for cultural relics with a history timeline to explore the historical context of cultural relics and discover specific scenarios related to cultural relics history using the digital collection service system for advanced research.**

Keywords—Digital Cultural Relics Collection; Service System; History Timeline; Architecture Description Language; Structure-Behavior Coalescence Architecture

I. INTRODUCTION

The incorporation of a historical timeline into the design of a digital cultural relics collection service system holds significant scientific and cultural importance as it reflects the unique lifestyle of each location. Generally, the design method for a digital cultural relics collection service system with a history timeline is highly complex, encompassing multiple perspectives such as structure, behavior, function, and data views (Thornton, 2012; Gilbert, 2011). To address this complexity, there are two approaches employed in the system modeling of digital cultural relics collection service systems with a history timeline.

The first approach is the non-architecture-oriented method, which involves selecting a separate model for each view (Kendall, 2010; IACOB, 2014; Maier, 2009). On the other hand, the architecture-oriented method, as described by Qiu et al. (2016) and Bass (2003), focuses on utilizing a single coalescence model instead of multiple unrelated models. This architecture-oriented approach provides a more integrated and comprehensive perspective.

In an architecture-oriented design method for digital cultural relics collection service systems with a history timeline, the structure-behavior coalescence (SBC) architecture is adopted as the systems model (Chao, 2013; Chao, 2014; Chao, 2016). By employing the SBC architecture, the design process effectively addresses the structure, behavior, function, and data aspects of the digital cultural relics collection service system with a history timeline, mitigating uncertainties and risks associated with non-architecture-oriented design methods. Overall, the SBC architecture design method facilitates the integration of various stakeholders' efforts and provides a solid foundation for the design of digital cultural relics collection service systems with a history timeline.

The design outcomes of the SBC architecture-oriented digital cultural relics collection service system serve as valuable schemes for enhancing the acceptance and effectiveness of the development of such systems with a history timeline. By utilizing the SBC architecture, the digital cultural relics collection service system design method with a history timeline can be improved to deliver a more cohesive and efficient solution.

II. MATERIALS AND METHODS

The design of a digital cultural relics collection service system with a history timeline involves the consideration of multiple views, including the structure view, behavior view, function view, and data view, as illustrated in Figure 1. The systems model employs two different methods for designing the digital cultural relics collection service system with history timeline multiple views: the non-architecture-oriented method and the architecture-oriented method.

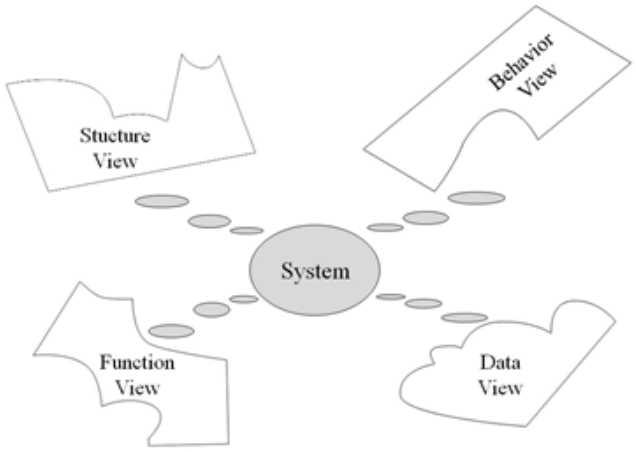

Figure 1 Multiple Views of a System

In the non-architecture-oriented method, each view is assigned a separate model, as depicted in Figure 2. The structure view is represented by the structure model, the behavior view is represented by the behavior model, the function view is represented by the function model, and the data view is represented by the data model. These individual models are heterogeneous and unrelated to each other, making it challenging to integrate them into a unified and coherent model (Clements, 2013; Dennis, 2008).

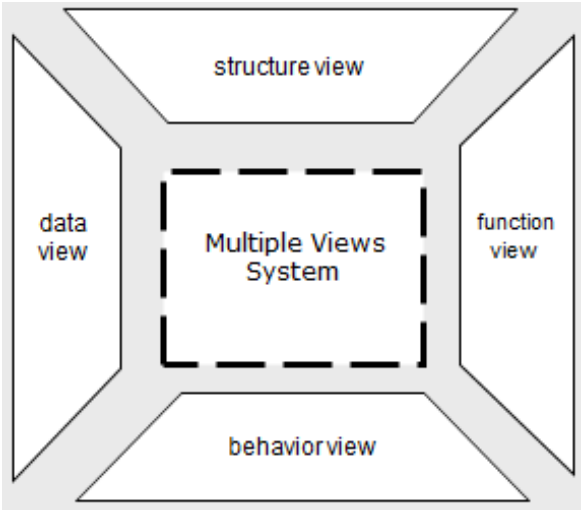

Figure 2 Non-Architecture-Oriented Method

In contrast, the architecture-oriented method takes a different approach by utilizing a single coalescence model, as illustrated in Figure 3. This model, known as the Multiple View Coalescence (MVC) systems model, integrates the structure, behavior, function, and data views into a cohesive framework (Qiu et al., 2016; Bass, 2003; Bernard, 2005; Chao et al., 2013; Chao, 2014, Chao, 2016; Johnson, 2014; Maier, 2009). By adopting the MVC systems model, the architecture-oriented method enables a more integrated and harmonious representation of the various views within the cultural relics digital collection service system design with a history timeline.

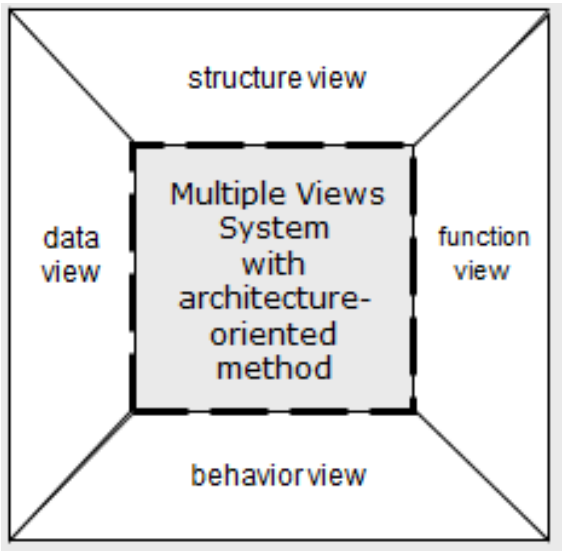

Figure 3 Architecture-Oriented Method

Comparing Figure 2 and Figure 3, it is evident that an integrated, holistic, united, coordinated, coherent, and coalescence model is more favorable than a collection of many heterogeneous and unrelated models. Since the structure and behavior views are the most prominent among the multiple views, integrating these two views is considered the optimal approach for integrating the various views of a system. This integration is achieved through the structure-behavior coalescence (SBC), as depicted in Figure 4 (Chao, 2013; Chao, 2014; Chao, 2016). Therefore, the authors assert that the SBC architecture serves as an architecture-oriented systems model.

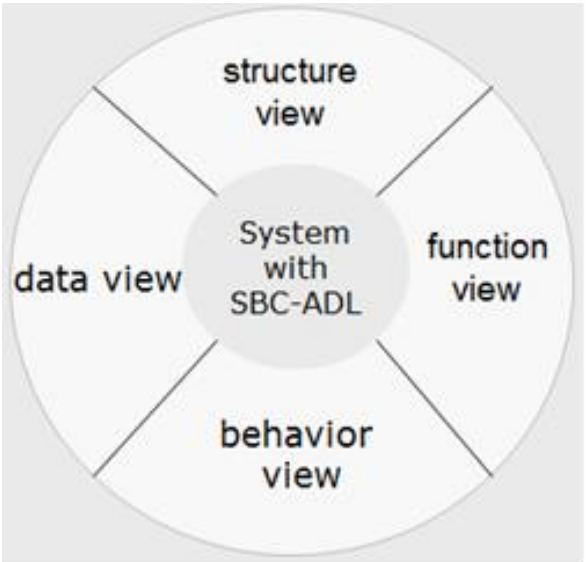

Figure 4 SBC-ADL Architecture-Oriented Method

III. RESULTS AND DISCUSSION

The SBC architecture design method for the digital cultural relics collection service system with a history timeline incorporates the SBC architecture as its systems model. The design process of the SBC architecture begins with the preparation phase and progresses through the planning, preliminary design,

and detailed design phases of SBC architecture construction. The aim of the SBC architecture is to ensure that the constructed digital cultural relics collection service system design method with a history timeline aligns with the users' requirements and preferences, as illustrated in Figure 5.

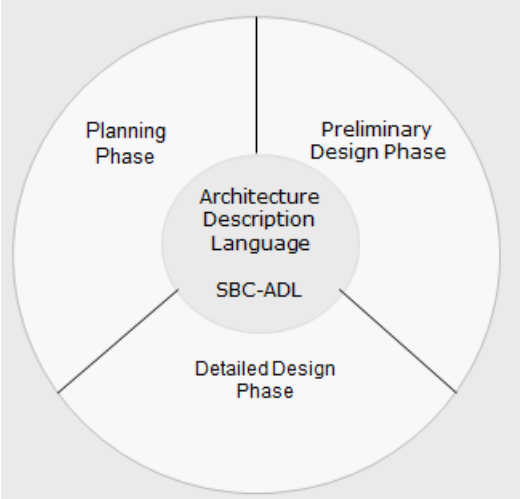

Figure 5 SBC architecture design method for digital cultural relics collection service system design method with history timeline

The SBC architecture design method employs the use of Architecture Description Language (ADL) to formally design both the essence and the specific details of the cultural relics digital collection service system design method with a history timeline. The planning phase utilizes the Framework Diagram (FD)-ADL, the preliminary design phase utilizes the Architecture Hierarchy Diagram (AHD)-ADL, and the detailed design phase employs the Interaction Flow Diagram (IFD)-ADL. These ADLs are utilized at different stages of the design process to ensure a comprehensive and structured approach to designing the cultural relics digital collection service system with a history timeline.

A. Planning Phase

The Framework Diagram (FD)-ADL is utilized to design the decomposition and composition of a cultural relics digital collection service system design method with a history timeline in a multi-layered manner. The FD-ADL specifically includes non-aggregated systems, showcasing their relationships and organization within the overall system. As an example, Figure 6 illustrates a FD-ADL of the cultural relics digital collection service system design method with a history timeline, demonstrating the hierarchical structure and composition of the system components.

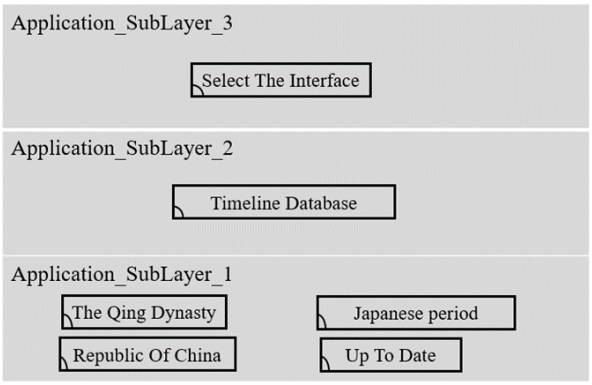

Figure 6: FD-ADL of the digital cultural relics collection service system design method with history timeline

B. Preliminary Design Phase

The Architecture Hierarchy Diagram (AHD) provides a visual representation of the decomposition and combination of a multi-level system, simplifying the understanding of complex systems by breaking them down into simpler components.

In the context of the SBC architecture system description language, the AHD is used to depict the hierarchical structure of the Digital Historical Time Axis Innovation Service System, as illustrated in Figure 7. The AHD diagram highlights the distinct components and clearly defines their interfaces within the architecture-oriented cultural relics digital collection service system design method with a history timeline. This visual representation aids in comprehending the system's organization and facilitates effective communication between different system elements.

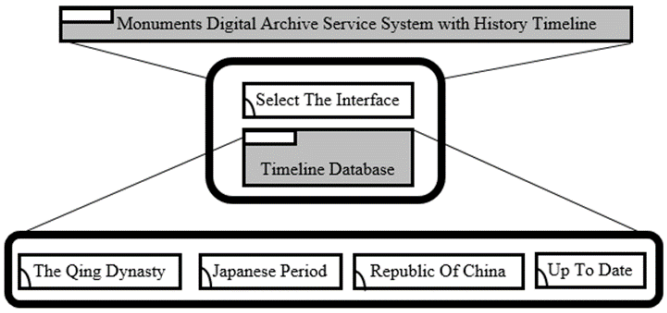

Figure 7: AHD-ADL of the digital cultural relics collection service system design method with history timeline

C. Detailed Design Phase

- In a cultural relics digital collection service system design method with a history timeline, interactions between components and external actors play a crucial role in determining the system's behavior. These interactions contribute to the coalescence of structures with behaviors within the design.

- The overall behavior of a system is the culmination of its individual behaviors, each of which operates independently and concurrently. Each individual behavior represents a distinct execution path, which can be defined using an Interaction Flow Diagram (IFD). The IFD captures the interactions and flow of actions within the system.
- Once the architecture construction is completed, the interaction flow diagrams depict the interactions among components and external actors. In the context of the Digital Collection Service System with History Timeline, the overall behavior encompasses four individual behaviors: Select "The Qing Dynasty Interface" Behavior, Select "Japanese period Interface" Behavior, Select "Republic Of China Interface" Behavior, and Select "Up To Date Interface" Behavior.

  Each individual behavior is represented by an execution path, which is defined using an IFD. The IFD enables the architecture-oriented design of the cultural relics digital collection service system with a history timeline, showcasing the significant impact of well-defined behaviors. Figure 8 illustrates an IFD of the Select "The Qing Dynasty Interface" Behavior, depicting the interactions between the User actor, the Timeline Database component, and the Qing Dynasty component through various operation calls.

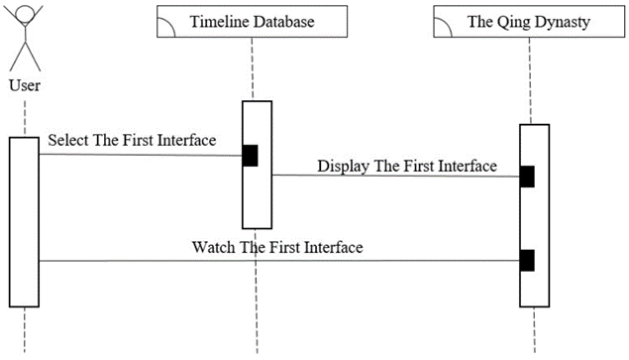

Figure 8: IFD of the Select「The Qing Dynasty Interface」Behavior

Figure 9 illustrates an Interaction Flow Diagram (IFD) showcasing the Select "Japanese period Interface" Behavior in the cultural relics digital collection service system with a history timeline. The IFD demonstrates the interactions involved in this behavior: The actor "User" initiates interaction with the "Timeline Database" component by calling the "Select The Second Interface" operation. The "Timeline Database" component communicates with the "Japanese period" component through the "Display The Second Interface" operation. Lastly, the actor "User" engages with the "Japanese period" component through the "Watch The Second Interface" operation. The IFD visually represents the sequence and flow of these interactions, providing a clear understanding of how the Select "Japanese period Interface" behavior unfolds within the system output parameter.

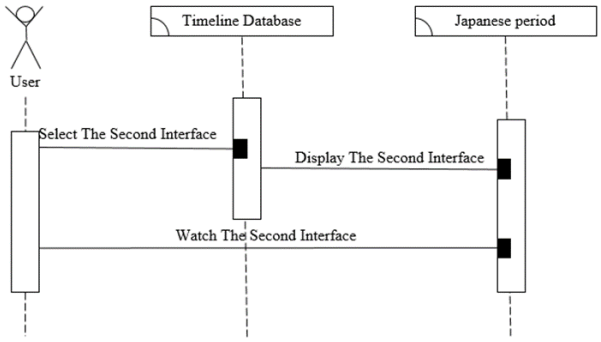

Figure 9: IFD of the Select「Japanese period Interface」Behavior

An Interaction Flow Diagram (IFD) representing the Select "Republic Of China Interface" Behavior in the cultural relics digital collection service system with a history timeline is shown in Figure 10. The IFD visualizes the interactions involved in this behavior: The actor "User" interacts with the "Timeline Database" component by initiating the "Select the Third Interface" operation call. The "Timeline Database" component communicates with the "Republic of China" component through the "Display the Third Interface" operation call. Finally, the actor "User" interacts with the "Republic Of China" component by performing the "Watch The Third Interface" operation call. Figure 10 effectively illustrates the flow and sequence of these interactions, providing a clear depiction of how the Select "Republic Of China Interface" behavior is executed within the system.

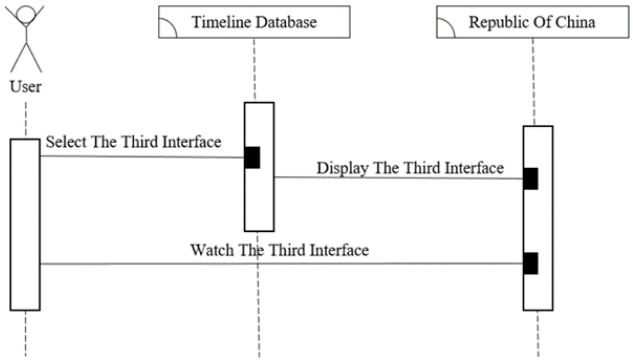

Figure 10: IFD of the Select「Republic Of China Interface」Behavior

Figure 11 illustrates an Interaction Flow Diagram (IFD) showcasing the Select "Up To Date Interface" Behavior in the cultural relics digital collection service system with a history timeline. The IFD demonstrates the interactions involved in this behavior: The actor "User" initiates interaction with the "Timeline Database" component by calling the "Select The Fourth Interface" operation. The "Timeline Database" component communicates with the "Up To Date" component through the "Display The Fourth Interface" operation. Finally,

the actor "User" engages with the "Up To Date" component through the "Watch The Fourth Interface" operation. The IFD visually represents the sequence and flow of these interactions,

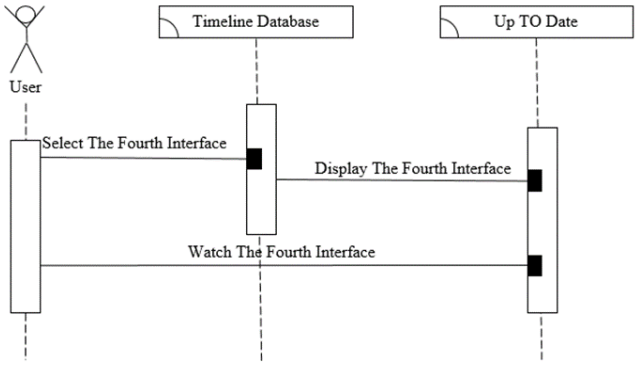

Figure 11: IFD of the Select「Up To Date Interface 」Behavior

Overall, the architecture-oriented design method for the digital collection of cultural relics service system with a history timeline offers a systematic and comprehensive approach, ensuring the alignment of structure, behavior, function, and data views. It serves as a valuable tool in improving the design and implementation of such systems, ultimately enhancing the preservation and accessibility of cultural relics.

IV. CONCLUSION AND FUTURE WORKS

A digital cultural relics collection service system design method with a history timeline involves multiple views, including structure, behavior, function, and data views. In non-architecture-oriented systems modeling, each view is addressed separately using different models. However, these models are heterogeneous and unrelated, making it challenging to integrate them into a cohesive model. On the other hand, architecture-oriented systems modeling utilizes a single coalescence model that integrates all views into a unified framework. The structure, behavior, function, and data views are seamlessly integrated in the architecture-oriented multiple view coalescence (MVC) systems model. This approach ensures a holistic representation of the cultural relics digital collection service system with a history timeline.

The SBC (Structure-Behavior Coalescence) architecture design method is adopted for the digital cultural relics collection service system design with a history timeline. This method leverages Architecture Description Language (ADL) to formally design the essential aspects of the system, including its architecture and detailed components. ADL enables designers to effectively capture and define the structure, behavior, function, and data elements of the digital cultural relics collection service system with a history timeline .By using ADL and the SBC architecture design method, designers can address uncertainties and mitigate risks associated with non-architecture-oriented design approaches. The resulting design schemes for the digital cultural relics collection service system with a history timeline also provide a basis for further adjustments and improvements, enhancing the overall effectiveness of the system design.

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