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Remembering the City: An Augmented Reality Reconstruction of Memory, Power, and Identity in Ho Chi Minh City through Cartography & Architecture

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Remembering the City: An Augmented Reality Reconstruction of Memory, Power, and Identity in Ho Chi Minh City through Cartography & Architecture

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Abstract

Cartography and architecture are official channels that facilitate remembrance in Ho Chi Minh City. Maps and buildings serve as sites for actors of memory to manipulate the city's narratives and shape its collective identity. Power enables the production of space and knowledge through sites of memory. The ruling regimes of Ho Chi Minh City have leveraged control over the natural environment and the local population to create new forms of materials that propagate their ideologies and ideals for the city. Alterations to the natural and built environments in the city legitimize the authorities' official narratives for its history and future developments. This project explores the context and subtext of urban memory and its formation, using critical augmented reality to visualize the sites of memory. The design of the supplementary augmented reality application takes into consideration the computational theory behind the technology and the development tools for digital historical narratives. In addition, as this study investigates the complicity of science in promoting colonialism, imperialism, nationalism and uninformed nostalgia within the urban setting, it also critiques the use of a new form of technology, augmented reality, in memory formation and other historical processes. Augmented reality offers unprecedented potentials for history and other disciplines thanks to its accessibility and performance; however, the pitfalls of technology require developers and users to remain aware of the implications and assumptions behind each design.

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During my time at the college, I was asked many times about how I would combine my Computer Science and History Independent Studies. I always said that I would like to use Computer Science to visualize History. It used to sound far-fetched, until this project.

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Introduction

1.1 Saigon in *Miền Ký Ức*

In 2019, Saigon Bitexco Financial Tower held the exhibition "Memory Museum: Once There Was Saigon," showcasing miniature replicas of old Saigon scenes (Figure 1.1).[1] The exhibition was the brainchild of the youth art group SG-Xưa (Old-SG), who makes profit by creating and selling handcrafted models of old symbols in Ho Chi Minh City. The commodification of memory in Ho Chi Minh City is not a new phenomenon. Recently in Vietnam, there has been a growing obsession with antiques and romanticized representations of the past in the forms of cafés, restaurants, bookstores, etc.[2] The sweeping trend has also caught on among writers, who have taken to call Ho Chi Minh City a place in "miền ký ức.""Miền ký ức"is a term often associated with remembering Saigon's past.[3] Saigon in "miền ký ức"is a realm (*miền*) of memory (*ký ức*) where life was simpler and societal morals had

[1] "'Bảo Tàng Ký Ức' Lần Đầu Tiên Của Người Sài Gòn," *Dân Trí*, accessed February 26, 2020, https://dantri.com.vn/van-hoa/bao-tang-ky-uc-lan-dau-tien-cua-nguoi-sai-gon-20190425180415510.htm.

[2] Má Lúm, "Trào Lưu Quán Cà Phê Bao Cấp Khắp Ba Miền," *VnExpress*, April 10, 2017, https://dulich.vnexpress.net/photo/am-thuc/trao-luu-quan-ca-phe-bao-cap-khap-ba-mien-3568152.html; Tâm An, "Uống cà phê, nhớ những tháng ngày xưa cũ ở Đà Nẵng," *Dân Trí*, November 3, 2017, https://dantri.com.vn/doi-song/uong-ca-phe-nho-nhung-thang-ngay-xua-cu-o-da-nang-20171103065604954.htm.

[3] Lam Phong, "Sài Gòn của một miền ký ức," *Tuổi Trẻ Online*, January 19, 2014, https://tuoitre.vn/news-590460.htm

been not corroded. This realm of memory elicits nostalgic recollections of values embedded in sites that are now thought of as lost or at risk from the current rate of urbanization.[4] Nostalgia for the so-called golden age of Saigon is often connected to notions of an ideal living environment, whether that is a Western metropolis or a close-knit Asian society. Much as they are romantic and idealistic, these projections can be contradictory, misleading, unfounded, and superficial, created out of economic, political, and aesthetic expediency. What they do indicate, nevertheless, is the contested processes that result in the formation of such memories.

Figure 1.1: A mini model of Bến Thành Market in SG-Xưa's exhibition (Photograph by SG Xưa. Facebook, February 21, 2020.[5])

A city is concrete, but its memory is abstract. What is the relationship between the memory of a city and the bricks and mortar used to construct it? In the case of Ho Chi Minh City, the parallels between its physical and mental conceptions are even more striking, considering its relatively short history.[6] Mythical tales of the city's

[4] Ngô Minh Hùng, "Ký Ức Sài Gòn - Chợ Lớn Xưa," *Tạp Chí Kiến Trúc*, 2017.

[5] SG Xưa, "Chợ Bến Thành," *Facebook*, February 21, 2020. https://www.facebook.com/mohinhsaigonxua/photos/pcb.566548354205522/566539340873090/?type=3&theater

[6] This 300-year periodization is only concerned with the city's recent history as a Vietnamese urban center. The history of this region began much earlier than the arrival of the Vietnamese.

miraculous development and fighting spirit through the wars have consolidated a notion of Ho Chi Minh City that appears to have characterized the region for the length of its history. However, considering its relatively short history, these characteristics did not define the city's pre-1600s history of non-Vietnamese cultures and the natural wilderness that abounded the land. From the myths of its origin, it is obvious that these histories must have also been crafted alongside the physical work of building this urban center. In light of the tumultuous events and drastic transformations that transpired in the last three centuries, it is remarkable that these narratives could prove so pervasive in solidifying the position of the city in memory.

Ho Chi Minh City's history is one of foreign expansion and control. The Vietnamese were not natives in this land. Systemic Vietnamese settlements in South Vietnam only appeared with the waves of conquests into the South by the Vietnamese ruling dynasties from the 16th century onwards. Before Vietnamese presence in the area, Baigaur/Prey Nokor (former names of Ho Chi Minh City) was part of Indianized principalities including Funan, Chenla, the Kingdom of Champa and other proto-Cambodian polities.[7] Saigon fell into the hands of the French colonizers after their attack in 1859 and remained under French control until their defeat in 1954, except for a brief stint of Japanese occupation during World War Two.[8] Following the division of Vietnam after the Geneva Conference in 1954, Ngô Đình Diệm established the South Vietnamese government with the support of the United States.[9] Communist forces retook Saigon and gained control of the entire country in April 30, 1975, marking the end of the 20-year war known as the War

[7] Philippe Peycamm, "Saigon, From the Origins to 1859," in *Saigon, Ba Thế Kỷ Phát Triển Và Xây Dựng [Three Centuries of Urban Development]*, ed. Quang Ninh Lê and Stéphane Dovert, 4th ed. (Ha Noi: Nhà xuất bản Hồng Đức, 2015), 28–29.

[8] Hữu Ngọc, Ca Van Thinh, and Ta Xuan Linh, "Old Saigon," in *From Saigon to Ho Chi Minh City: A Path of 300 Years*, ed. Nguyễn Khắc Viện (Ha Noi: Thế Giới Publishers, 1998), 144–45.

[9] Nghia M. Vo, *Saigon: A History* (Jefferson, N.C: McFarland, 2011), 126.

of Resistance against America in Vietnamese national discourse and as the Vietnam War internationally. The immediate aftermath of the war was could as the *bao cấp* (subsidy) period, during which the government aggressively nationalized private enterprises and properties and monopolized the distribution of goods and resources.[10] These restrictions had devastating effects on the postwar economy and were finally lifted in 1986 by a series of reforms called Đổi Mới (Renovation).[11] Today, Ho Chi Minh City (renamed from Saigon in 1976) is the industrial center of the hybrid semi-capitalist economy of Vietnam. It also has the highest population in the country with almost nine million people.[12]

Considering these past turbulences, it is unlikely that any simple narrative can uncover the true complexity of history. The city of Ho Chi Minh painted in the current light of progress and modernity is an elaborately constructed myth. Despite having all the designs of a modern metropolis, the area known as Ho Chi Minh City today was mostly devoid of human habitation for the larger part of history, an environment inhospitable to most except for mosquitos and crocodiles. The bifurcation between past and present also includes the change in demographics from mostly Cham, Khmer, and Chinese to predominantly Vietnamese. Power transitions from colonial to democratic and now socialist created conflicting memories, forcing ruling regimes to grapple with the tensions and contradictions. The rapid transformations of Ho Chi Minh City resulted a multilayered mesh of identities, warped to account for the changes to the city's environmental and social makeup. But these changes were far from smooth. After one century of colonization, three major wars, and four regime changes, all initiated by foreigners to this land, the city's history has ended as a contested ground for defining and legitimizing these sometimes

[10] Hy V. Luong, *Postwar Vietnam: Dynamics of a Transforming Society*, Asian Voices (Singapore: Rowman & Littlefield, 2003), 2–8.

[11] Vo, *Saigon*, 198–210.

[12] Thông tấn xã Việt Nam, "Dân Số TPHCM Gần 9 Triệu Người, Đông Nhất Cả Nước," *Báo Sài Gòn Đầu Tư Tài Chính*, October 12, 2019, https://saigondautu.com.vn/content/NjcxMDQ=.html.

violent alterations. Memory has become such a central concept to the building and governing of the city. With this in mind, how can understanding the way strands of memory get embedded in the physical components of urban construction help unravel the identity meshes woven by foreign and Vietnamese powers in the city? This research seeks to deconstruct the connections between memory, power, and identity, centered around the theme of environment, which can be natural, built, or symbolic. Past and present authorities of Ho Chi Minh City have harnessed their power to shape these environments of the city to create memory, solidify their legitimacy and justify future augmentations to the city.

1.2 Memory, Vietnam, and Ho Chi Minh City

The framework for understanding memory, according to scholars such as Maurice Halbwachs and Pierre Nora, is based on the premise that memory is fallible, malleable, and as a result, subject to distortion.[13] Psychologists like Daniel Schacter suggest that every time the human brain recollects an event from the past, it alters the memory to account for the feelings, beliefs and knowledge acquired after the experience.[14] Because of this impressionable nature, memory changes over time, making the influencing of recollections, or the process of memory, a historical process with context, agency, and implications. Memory can be social and collective.[15] It can be constructed through the use of *lieux de memoir*, the term Nora uses for the sites where images or narratives are embedded to evoke a particular reconstruction

[13] For more on memory, see Maurice Halbwachs, *The Collective Memory*, 1st ed (New York: Harper & Row, 1980); Pierre Nora, *Rethinking France: Les Lieux de Mémoire*, trans. Mary Trouille, vol. 1 (Chicago: University of Chicago Press, 2001); Paul Ricœur, *Memory, History, Forgetting* (Chicago: University of Chicago Press, 2004); Alexandre Dessingué and J. M. Winter, eds., *Beyond Memory: Silence and the Aesthetics of Remembrance*, Routledge Approaches to History 13 (New York: Routledge, 2015); Daniel L. Schacter, *The Seven Sins of Memory: How the Mind Forgets and Remembers* (Boston: Houghton Mifflin, 2001); Jeffrey K. Olick, *The Politics of Regret: On Collective Memory and Historical Responsibility* (New York: Routledge, 2007).

[14] Schacter, *The Seven Sins of Memory*.

[15] Halbwachs, *The Collective Memory*, 50–87.

of the past.[16] Sites of memory can be physical, immaterial or both. A physical site of memory is meant to trigger a mental response; public sites of memory are tools for constructing national narratives.[17] Within this broader framework, there are other micro-processes concerned with specific lenses through which memories are framed, such as through commemoration, nostalgia, or suppression.[18]

The existing body of scholarship on remembrance in Vietnam builds upon the same framework for studying memory, which is mostly Eurocentric. Some of the most important memory scholarship on Vietnam is by Hue-Tam Ho Tai, whose research is concerned with the commemorative mode of reimagining the past in the public sphere through mediums such as memoirs, paintings, tourism, cinematography, or in spaces like war monuments, cemeteries, shrines, and museums.[19] The American War of Resistance, internationally known as the Vietnam War, is a significant moment in Vietnam's collective and personal memory. New modes of remembrance emerge as a result of the war's disruptive nature, allowing for reconciliation and rebuilding, whether in celebration or in grief.[20] Authors like Viet Thanh Nguyen and Scott Laderman write about narratives that have materialized in the struggle to make sense of the war, mostly from a top-down approach through

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[16] Nora, *Rethinking France*.

[17] J. M. Winter, *Sites of Memory, Sites of Mourning: The Great War in European Cultural History*, Canto Classics edition, Canto Classics (Cambridge: Cambridge University Press, 2014).

[18] Henry Rousso, *The Vichy Syndrome: History and Memory in France since 1944* (Cambridge, Mass: Harvard University Press, 1991).

[19] For more on historical memory studies on Vietnam, see Hue-Tam Ho Tai and John Bodnar, *Country of Memory: Remaking the Past in Late Socialist Vietnam* (Berkeley: University of California Press, 2001); Long T. Bui, "The Debts of Memory: Historical Amnesia and Refugee Knowledge in The Reeducation of Cherry Truong," *Journal of Asian American Studies* 18, no. 1 (February 25, 2015): 73–97; David G. Marr, "History and Memory in Vietnam Today: The Journal 'Xưa & Nay,'" *Journal of Southeast Asian Studies* 31, no. 1 (2000): 1–25; Nathalie Huynh Chau Nguyen, *Memory Is Another Country: Women of the Vietnamese Diaspora* (Santa Barbara: Praeger, 2009); Christina Schwenkel, "Recombinant History: Transnational Practices of Memory and Knowledge Production in Contemporary Vietnam," *Cultural Anthropology* 21, no. 1 (2006): 3–30.

[20] Nathalie Huynh Chau Nguyen, *South Vietnamese Soldiers: Memories of the Vietnam War and After* (Santa Barbara: Praege, 2016); Karen Turner-Gottschang and Thanh Hao Phan, *Even the Women Must Fight: Memories of War from North Vietnam* (New York: Wiley, 1998).

examining the national historical discourse.[21] Research on remembrance at the community level is limited to Vietnamese in the diaspora due to state suppression, but recently, especially after Đổi Mới (1986), alternative modes to commemoration have become more common as Vietnamese learn to navigate various layers of bureaucracy and censorship to inject revolutionary beliefs into the collective, state-sanctioned public memory.[22]

On the topic of Ho Chi Minh City specifically, one sees a curious case with Vietnamese-language texts written about the past, where remembrance is lively but this popularity is at the expense of critical memory works. This genre of historical writings about Ho Chi Minh City is called*tản văn*. These are expressive and descriptive vignettes on a particular subject, usually without a central argument.[23] The most accomplished writer of this genre on South Vietnam, Sơn Nam, produced compilations of accounts about the city's history centered around themes such as nature, bureaucrats, and land reclamation.[24] The growing fascination with Ho Chi Minh City's past has also encouraged the rise in popularity of works such as *Sài Gòn Những Biểu Tượng (Saigon's Icons)* and *Vọng Sài Gòn (Saigon Echoes [of Memory])*.[25] These books share similar themes that evoke nostalgia and pride in the city, which sometimes borders on exceptionalism.[26] There are very few instances where these memories of Ho Chi Minh City are questioned, and often they are done

[21] Viet Thanh Nguyen, *Nothing Ever Dies: Vietnam and the Memory of War* (Cambridge: Harvard University Press, 2016); Scott Laderman, *Tours of Vietnam: War, Travel Guides, and Memory*, American Encounters/Global Interactions (Durham: Duke University Press, 2009).

[22] Rivka Syd Eisner, "Performing Prospective Memory," *Cultural Studies* 25, no. 6 (November 2011): 892–916.

[23] Hoài Nam, "Tản Văn, Từ Một Cái Nhìn Lướt," *Báo Công an Nhân Dân Điện Tử*, January 30, 2015, http://antgct.cand.com.vn/Nhan-dam/Tan-van-tu-mot-cai-nhin-luot-340089/.

[24] Sơn Nam, *Đất Gia Định - Bến Nghé Xưa & Người Sài Gòn* (Ho Chi Minh: Nhà xuất bản Trẻ, 2016).

[25] Du Tử Lê et al., *Sài Gòn Những Biểu Tượng* (Ho Chi Minh: Nhà Xuất Bản Văn Hóa - Văn Nghệ, 2018); Trác Thúy Miêu, *Vọng Sài Gòn* (Ha Noi: Nhà Xuất Bản Hội Nhà Văn, 2019).

[26] Vo, Saigon, 54; Nguyễn Khắc Viện and Hữu Ngọc, eds., *From Saigon to Ho Chi Minh City: A Path of 300 Years* (Ha Noi: Thế Giới Publishers, 1998), 11–15.

through criticizing of French colonialism.[27] Critical memory studies that challenge the agency of the narratives around Ho Chi Minh City's creation and development outside the French colonization period are almost non-existent, in spite of the burgeoning memory business. The memorialization of some idealized, romanticized, and depoliticized versions of the past have taken precedence as the preferred mode of remembrance in Ho Chi Minh City.[28]

The interest in memory in an urban setting often stems from the fear of heritage loss in its fast-paced environment.[29] The past is a myth, and historic sites are "little more than the carcasses of former functions," as Mark Crinson aptly describes.[30] Jordan Sand's analysis on Tokyo's vernacular reveals that such concern is especially appropriate in places where there is little to preserve. The building stock of Tokyo was repeatedly destroyed and rebuilt, and in the place of the disappearing heritage, urban planners and residents have started to recreate spaces and objects to commemorate and preserve the past.[31] The materials of urban memory can be personal, in the form of literature, artwork, or public, in the case architecture and city plans. These tools of remembrance are political, and as Christine Boyer argues, engage with memory concepts such as "the public sphere" or "collective memory"

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[27] Đoàn Khắc Tình, "Cái Lý Của Nghệ Thuật Kiến Trúc Thuộc Địa," *Tạp Chí Kiến Trúc*, August 11, 2014, https://www.tapchikientruc.com.vn/chuyen-muc/ly-luan-phe-binh-kien-truc/cai-ly-cua-nghe-thuat-kien-truc-thuoc-dia.html.

[28] For more on Ho Chi Minh City, see Nguyễn Viết Ngoạn, *Di Sản Sài Gòn [Saigon Heritage]* (Ha Noi: Nhà xuất bản Thời đại, 2014); Nguyễn Thanh Lợi, *Sài Gòn Đất và Người* (Ho Chi Minh: Nhà xuất bản Tổng hợp Thành phố Hồ Chí Minh, 2015); Huỳnh Ngọc Trảng, *Sài Gòn - Gia Định xưa: tư liệu & hình ảnh* (Ho Chi Minh: Nhà xuất bản Thành phố Hồ Chí Minh, 1997).

[29] For more on urban memory, see Barbara E. Thornbury and Evelyn Schulz, eds., *Tokyo: Memory, Imagination, and the City* (Lanham, Maryland: Lexington Books, 2018); Steve Nash and Austin Wiliams, "The Historic City: False Urban Memory Syndrome," in *The Lure of the City: From Slums to Suburbs*, ed. Austin Williams and Alastair Donald (London: Pluto Press, 2011), 98–116; Teresa Stoppani, *Unorthodox Ways to Think the City: Representations, Constructions, Dynamics* (New York: Routledge, 2019).

[30] Mark Crinson, ed., *Urban Memory: History and Amnesia in the Modern City* (London: Routledge, 2005), xi.

[31] Jordan Sand, *Tokyo Vernacular: Common Spaces, Local Histories, Found Objects* (Berkeley: University of California Press, 2013), 1–5.

in an attempt to master and dominate urban spaces and the recollections they accommodate.[32] The memory phenomenon in Ho Chi Minh City is manifested in voracious consumption of historic imagery and ideals engendered in the materials of urban memory. Studying their connections to the city's history is integral to understanding citizens' experiences and responses to efforts by the state and other players to shape the urban memory environment.

This project considers the question of memory and city building from an ideological angle, by investigating physical sites of memory including maps and buildings. Both sources are connected to the manipulation of space to produce meaning. To examine how cartography and architecture have been employed by different governments or enterprises to create memory, this study investigates their use of symbology, design, structure, function, and technology to convey the builders' intentions for the city and and its memory. In addition to critiquing memory formation through the spatial mediums of maps and buildings, this research employs a digital spatial medium to visualize the process of memory in Ho Chi Minh City, in what could be described as an attempt at critical augmented reality.

1.3 An Augmented Urban History

Augmented reality (AR) describes a technology that allows computer-generated (or virtual) contents to be superimposed or projected on the environment around us using special interfaces such as digital glasses, phone screens, or holographic projectors. AR relies on computer vision techniques to generate a map of our surroundings, called the physical (or real) environment, and align virtual contents to this map.[33] It has applications in numerous fields including healthcare, education,

[32] M. Christine Boyer, *The City of Collective Memory: Its Historical Imagery and Architectural Entertainments* (Cambridge, MA: MIT Press, 1994), 3.

[33] H. Durrant-Whyte and T. Bailey, "Simultaneous Localization and Mapping: Part I," *IEEE Robotics Automation Magazine* 13, no. 2 (June 2006): 99–110.

entertainment, and history. Augmented reality has been used in the research phase of history for textual and image analysis and for sharing findings through AR-enabled public history projects.[34] Technologies like augmented reality and virtual reality are increasingly commonplace at sites of public memory such as museums and historic monuments. AR has grown to become a site of memory of its own, with the same characteristics as its traditional counterpart, and is implicated in agency, audience, and agenda.

The desire to control the surrounding environment and to "augment" it with interactive and maneuverable data is what motivates the various iterations of augmented reality. In 1968, Ivan Sutherland introduced the first augmented reality system, but the term "augmented reality" did not officially come about until 1992.[35] As the field of computer vision develops, scientists like Paul Milgram and Fumio Kishino have come up with different ways to describe the emerging technologies, such as the Reality-Virtuality Continuum (explained in Chapter 2).[36] Since then, AR contents have gone from simple wireframe drawings to complicated three-dimensional models; clunky hardware is gradually replaced by more portable and efficient processors and displays. Alongside hardware, AR software also benefits from the advances in detection and tracking algorithms. In 1991, Durrant-Whyte et al. made groundbreaking progress with the simultaneous localization and mapping problem, used extensively in augmented and virtual reality.[37] The increased portability and compactness of mobile devices have allowed for AR to be deployed more effectively with advanced features empowered by motion measuring components

[34] Kevin B. Kee and Timothy Compeau, eds., *Seeing the Past with Computers: Experiments with Augmented Reality and Computer Vision for History*, Digital Humanities (Ann Arbor: University of Michigan Press, 2019).

[35] Clemens Arth et al., "The History of Mobile Augmented Reality," *ArXiv*, no. 1505.01319 (November 10, 2015): 3, http://arxiv.org/abs/1505.01319.

[36] Arth et al., 5.

[37] Durrant-Whyte and Bailey, "Simultaneous Localization and Mapping."

in the devices' hardware. These developments help make AR accessible to many disciplines and industries without the technical overhead.

The parallels in space usage between the sites of memory of interest in this project (maps and buildings) and augmented reality can provide an illuminating case study on how effective these new computer vision techniques could help historians better understand processes of history and convey their understanding to the general public, especially to the communities whose lives these histories directly affect. In this example of Ho Chi Minh City, the introduction of an augmented reality component is an attempt to present a top-down perspective (government and ideology) to a grassroots audience. The critical part of project is delivered through a close examination of the back-end implementation of augmented reality as well as a critique of the ethics and implications of this technology, particularly in relation to memory and power.

Through close reading of maps and architectural structures of Ho Chi Minh City, this Independent Study argues that the ruling regimes of the city as well as private enterprises and local communities have fashioned these sites of memory into devices for mass-mediating the façade and function of urban spaces. The mobilization of cartography and monumental architecture to create memory is a form of control made permanent by wealth and power. These spaces are the manifestation of ideologies such as modernity and urbanism, conceptualized on plans and blueprints and realized with bricks and mortar. The augmented reality exhibit accompanying this project provides an opportunity for users to deconstruct these narratives by giving them a vantage point to view these historical processes, enabled by computer vision algorithms and techniques. Such an attempt also serves to demonstrate how perspectives are created with the assistance of power (AR technology) and that science is also a form of power capable of manufacturing memory. Cartography and

architecture are two examples of how science has participated in both the physical and mental construction of Ho Chi Minh City.

This independent study is made up of two main sections: the first part discusses the technical aspect of augmented reality and the process of designing an AR historical exhibit on the Vuforia platform, while the second part includes historical analysis of maps and sites from four major periods in Ho Chi Minh City's history. Although this organization creates a dichotomy between technology and history, each chapter considers both aspects within the context of each other. Chapter 2 offers a high-level overview of the technical underpinnings of augmented reality as well as an analysis of feature detection algorithms, while considering the implication of these methods from a humanities perspective. Chapter 3 describes the workflow of designing with Vuforia and the elements of digital storytelling for historical narratives. The contents for the AR applicationtare drawn from the analyses in chapters 4 and 5, which discuss cartography and architecture respectively and their relationship with memory. Each chapter concludes with a description of the augmented reality experience associated with each site of memory. Exhibit items include an augmented map and several 3D models of the buildings examined in chapter 5. The AR experiences are included in a mobile app available for both Android and Apple mobile devices.

Chapter 2

The Technicalities of Augmented Reality and Applications in Digital Humanities

In 2007, an Italian research group from the Polytechnic University of Marche collaborated with Huế College of Sciences to catologue "heritage cities"and architecture and produced a 3D model of the city of Huế.[1] The project emphasized the need for Asian countries to codify and analyze their heritage and illustrated how technologies such as virtual reality can assist in this process. In this case study, the former imperial city of Huế was chosen as a site for experimenting with spatial computing to reconstruct the urban environment and survey the transformations of its historic monuments. One of the motivations for this effort was the fear of culture and identity loss, especially among younger generations, amidst current economic growth and social transformation. The underlying premise of heritage preservation using emerging technologies is that a virtual replication can preserve history. From a historical perspective, these virtual reproductions are what Pierre Nora and other historians of memory call "sites of memory."[2] The prevalence of spatial computing mediums such as virtual reality and augmented reality in fields

[1] Fausto Pugnaloni, Giovanni Issini, and Nam Dang Minh, "3D City Model of the Ancient Hue, Vietnam; Reconstruction of the City Environment for the Cultural Heritage Identity Conservation," in *Virtual Systems and Multimedia*, ed. Theodor G. Wyeld, Sarah Kenderdine, and Michael Docherty, Lecture Notes in Computer Science (Berlin, Heidelberg: Springer, 2008), 13–23.

[2] Pierre Nora, *Rethinking France: Les Lieux de Mémoire*, trans. Mary Trouille, vol. 1 (Chicago: University of Chicago Press, 2001).

such as museum studies and heritage preservation requires an understanding of how these technologies work and their historical implications when applied to historical projects. This section provides a brief overview of augmented reality, its algorithmic and software requirements, while also discussing the emergence of digital humanities and relevant considerations.

2.1 Spatial Computing

Augmented reality is an application of spatial computing. Spatial computing describes the digital technology that blends computer-generated contents with the real world, allowing users to interact with digital data in their physical space in real time.[3] What defines spatial computing is the type of interactions that it affords: natural gestures in three dimensions with the physical environment as the interface. Spatial hardware and software can calculate the device's relative position in the physical world and create meaningful interactions using their understanding of the surrounding space. Spatial computing is also often known as the integration of different realities. In 1994, Paul Milgram and Fumio Kishino defined the reality-virtuality continuum as a spectrum with the physical environment on one extreme and the virtual environment on the other (Figure 2.1).[4] In the middle of the spectrume Figure 2.1, augmented reality indicates the use of digital contents to add to (augment) the physical world, while augmented virtuality uses real-world elements to augment the virtual space. Other definitions continue to build on this understanding of the extent to which technology augments and evmodifies our view of the world. The emerging technologies that use spatial computing to create realities are commonly known as **Extended Reality** (XR), where X is a variable

[3] In this I.S., I will use the terms "physical environment/world/space"and "real environment/world/space"interchangeably. They refer to the actual lived-in environment that we occupy. Magic Leap, "What Is Spatial Computing?," Magic Leap Creator, March 29, 2019, https://creator.magicleap.com/learn/guides/design-spatial-computing.

[4] Jon Peddie, *Augmented Reality: Where We Will All Live* (Cham, Switzerland: Springer, 2017), 1–28.

for the different kinds of realities on the Reality-Virtuality Continuum. The term Extended Reality covers mediums such as **Augmented Reality**, **Mixed Reality** and **Virtual Reality**.[5]

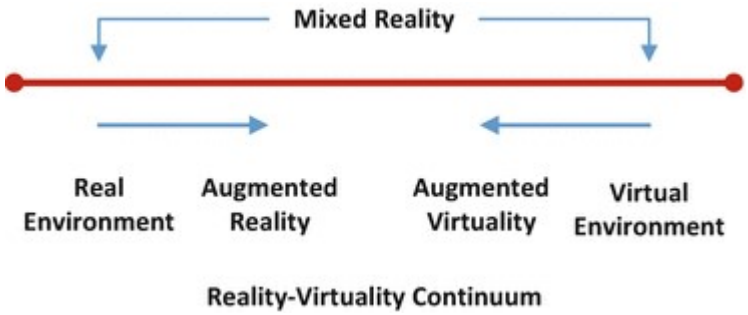


Figure 2.1: Milgram and Kishino's Reality-Virtuality Continuum (Illustration by Paul Milgram et al. In *Augmented Reality: Where We Will All Live*. By Jon Peddie.)

1. Augmented Reality (AR)

   Augmented Reality is the technology that uses spatial computing to overlay computer-generated contents onto the physical environment. Virtual data is projected onto the real world using mediums such as phone screens, heads-up displays, and wearable devices. An example of an augmented robot in front of a real couch is shown in Figure 2.2(a).

2. Mixed Reality (MR)

   Mixed Reality is an extended version of Augmented Reality. The main difference lies in the ability of virtual contents to interact with real-world elements following the laws and principles of physics. Virtual objects in MR respect the presence of objects in the physical environment. In the example in Figure 2.2(b), the robot's position is behind the couch. Therefore, part of its body is occluded. MR contents also react to real objects; for instance, when the robot encounters the couch, it walks around it.

[5] Alexandria Hexton, "The Revolution of Spatial Computing: Emerging Design Frontiers in VR/AR" (October 4, 2019), http://signage.showprg.com/ghc19/9d29dc65-3774-41bb-9d33-6c2d1d76a575-96117-Alexandria-Heston.pdf.

3. Virtual Reality (VR)

   Virtual Reality is a technology that creates an immersive experience by blocking the real world and presenting an alternative reality that simulates a real environment. The key in VR is convincing users that the virtual environment is real and suspending disbelief through three channels, sight, sound and touch. In Figure 2.2(c), the same robot is placed in a computer-generated 3D space. Virtual Reality is at the virtuality end of the Reality-Virtuality Continuum.

(a) AR (b) MR

(c) VR

Figure 2.2: Three XR mediums (Illustration by Alexandria Heston. Grace Hopper Celebration 2019, Orlando, October 4, 2019.)

2.2 AR Taxonomy

The taxonomy for emerging technologies such as augmented reality is constantly evolving to describe the ever-changing technological landscape. The standards for classification in AR are shifting with the introduction of new devices, methods of augmentation, and contents. As it is currently impossible to use a one-size-fits-all taxonomy for augmented reality, this section introduces some of the most common ways to categorize AR, by types of displays, types of devices, and types of tracking technology.

2.2.1 Types of Displays

To convince the human eye, AR displays have to conform to principles of human vision under the limitations of visual display technology. When discussing the requirements and characteristics of an AR visual system, Tobias Höllerer and Dieter Schmalstieg suggest that ideally an AR display is capable of creating 3D augmentations that occupy physical spaces.[6] Humans have a field of vision ranging from 200^o to 220^o, but the area with the highest clarity, or the fovea, is only from 1^o to 2^o.[7] The limited fovea is made up for by eye and head movements, so the actual fovea can cover up to 50^o. An AR display needs to ensure that its **field of view** and **resolution** accommodate human field of vision and range of fovea. Humans' ability to adjust to different lighting conditions through pupil dilation also means that AR lighting must be able to simulate all levels of hues and contrast and/or have agnostic contents (contents that are viewable in different lighting conditions).[8] Another important consideration in designing for the human eye

[6] Dieter Schmalstieg and Tobias Höllerer, "Displays," in *Augmented Reality: Principles and Practice* (Boston: Addison-Wesley, 2016).

[7] Schmalstieg and Höllerer.

[8] Bushra Mahmood, "A Quick Guide to Designing for Augmented Reality on Mobile (Part 3)," Medium, February 3, 2019, https://medium.com/@goatsandbacon/a-quick-guide-to-designing-for-augmented-reality-on-mobile-part-3-2380f253467a.

is monocular and binocular depth cues. The use of one eye (monocular field of vision) provides information such as size, height, occlusions (objects hidden behind others), shadows, and linear perspective (illusion of depth which makes further objects appear smaller). Perception of depth increases with the use of two eyes (binocular field of vision). The positional disparity between the image perceived by each eye is processed by the brain to create a sense of depth. This binocular depth cue is especially important for designing contents for AR eyeware. The different types of displays in AR must cater to different vision requirements to produce truly immersive experiences. This section introduces 3 types: see-through, spatial, and non-visual.

Figure 2.3: Microsoft HoloLens 2 (Photograph by Microsoft.[9])

1. See-through Displays

   One of the challenges of augmented reality is how to combine the real and virtual environments into a seamless and believable world. The most intrinsic way to achieve this is to overlay a lens with virtual contents, through which

[9] "HoloLens 2—Pricing and Options," Microsoft, accessed December 5, 2019, https://img-prod-cms-rt-microsoft-com.akamaized.net/cms/api/am/imageFileData/RE2PHcl?ver=a890&q=100&m=6&h=291&w=517&b=%23FFFFFFFF&l=f&o=t.

users can view the environment. This method of augmentation is called a **see-through display**.[10] Consider camera filters in digital photography. These transparent pieces of colored glass correct white balance and filter out unwanted color while preserving the overall image. The idea of a see-through display is also to preserve the integrity of the real environment while enhancing it with other contents. Two types of see-through displays are **optical see-through display** and **video see-through display**. Optical see-through displays describe an optical element for the transmission and reflection of real and virtual imagery respectively.[11] Video see-through displays use a camera to capture images of the environment, on which computer-generated components are added on top. The final digitally enhanced imagery is rendered to a viewing screen.

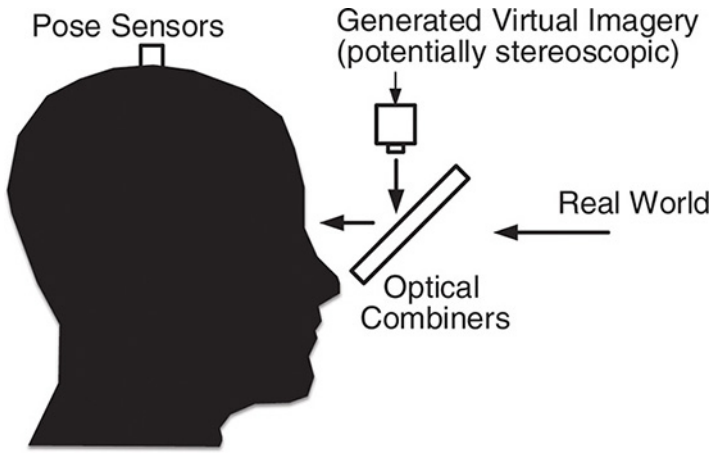


Figure 2.4: How real-world imagery is transmitted to the eye using an optical see-through display (Illustration by Schmalstieg and Höllerer. In *Augmented Reality: Principles and Practice*.)

Figure 2.4 describes the mechanism of an optical see-through display. The optical combiners transmit real-world images to the human eye while simultaneously reflecting virtual imagery. Both external light and the computer-generated image travel to the eye through the same optical device, creating the illusion of an enhanced reality. There are several ways for optical combiners

[10] Schmalstieg and Höllerer, "Displays."

[11] Schmalstieg and Höllerer.

to achieve this effect. The most common technique in the current wearable AR market is waveguide based, currently employed by the Microsoft Hololens (Figure 2.3) and Magic Leap One.[12] Waveguide displays combine virtual images and transport both external and virtual light through a tube so that the reflection out of the other end of the tube is completely preserved. Waveguide technology is popular for near-eye optical see-through displays because it allows imaging optics and display to be moved from the eye's field of vision to the temples or the forehead, creating a wider field of view.[13]

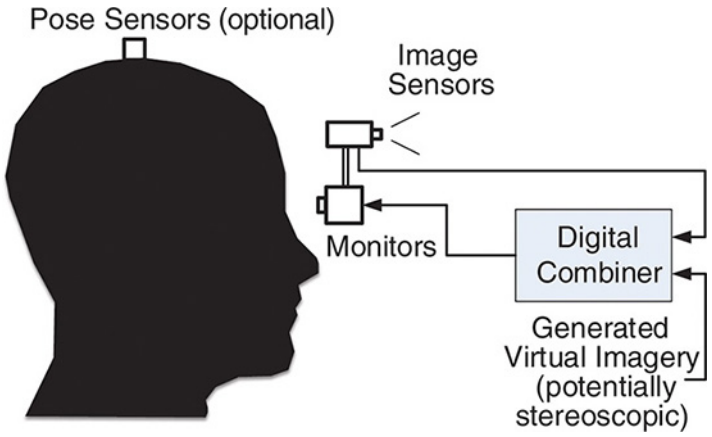


Figure 2.5: How real-world imagery is transmitted to the eye using a video see-through display (Illustration by Schmalstieg and Höllerer. In *Augmented Reality: Principles and Practice.*)

Handheld AR devices and some other head-mounted displays are video see-through. Video see-through displays block the real world from the users' view; the real environment is captured by a video camera and presented to the user on a screen. In Figure 2.5, the digital combiner combines the video signal of the external world and the video signal from the computer graphics system to produce augmented images that are displayed using a monitor.

For both types of see-through displays, the generated virtual content can be

[12] "HoloLens 2—Overview, Features, and Specs," Microsoft, accessed December 5, 2019, https://www.microsoft.com/en-us/hololens/hardware; Magic Leap, "Magic Leap One Creator Edition," Magic Leap, accessed December 5, 2019, https://www.magicleap.com/magic-leap-one.

[13] Lauren Bedal, "Designing for the Human Body in XR," Virtual Reality Pop, November 16, 2017, https://virtualrealitypop.com/designing-for-the-human-body-in-xr-e9ac88931e45.

monoscopic (single-eye content) or stereoscopic (creating illusion of depth using the same image with a slight angular difference for each eye). Mobile AR is usually monoscopic, as the content is viewed on a 2D screen. AR with head-mounted displays can be stereoscopic, with the display for each eye showing a different angle of the same scene to create a sense of depth.

2. Spatial Augmented Reality

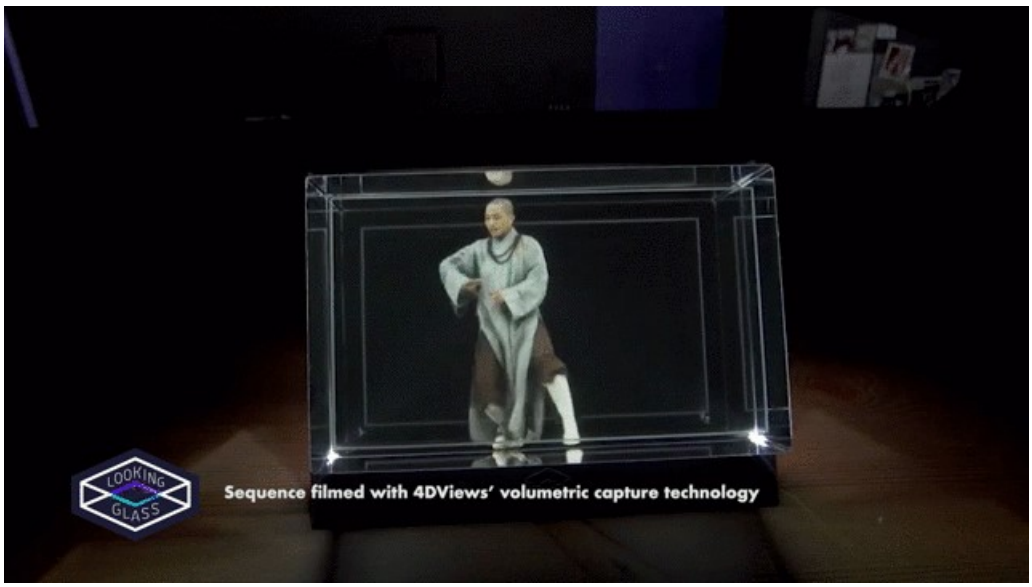


Figure 2.6: A volumetric video recording shown on the Looking Glass (Video sequence by Looking Glass Factory.[14])

Spatial AR, also known as projection-based AR, makes use of projection to display digitally created content. The AR system projects a special kind of light onto a projection surface, which could be real-world objects; the combination of virtual and real information, in this case, takes place in the physical world.[15] Holograms are examples of spatial AR displays. The Looking Glass in Figure 2.6 is an interactive light-field volumetric display showing a sequence of moves by a Tai Chi master. The Looking Glass optics 45

[14] Looking Class Factory, "Introducing The Looking Glass: A New, Interactive Holographic Display," *Looking Glass Factory Blog* (blog), July 24, 2018, https://blog.lookingglassfactory.com/content/images/2019/09/1_NYk5gfgwuA5ZJb3X1BB72g.gif

[15] Schmalstieg and Höllerer, "Displays."

unique views of the 3D content to create a superstereoscopic, full-color scene.[16] Head-up displays for cars (Figure 2.7) are some other successful applications of spatial AR.[17] The system projects vital information about the car onto the inside of the windshield, allowing the driver to view this information without requiring them to take their eyes off the road.

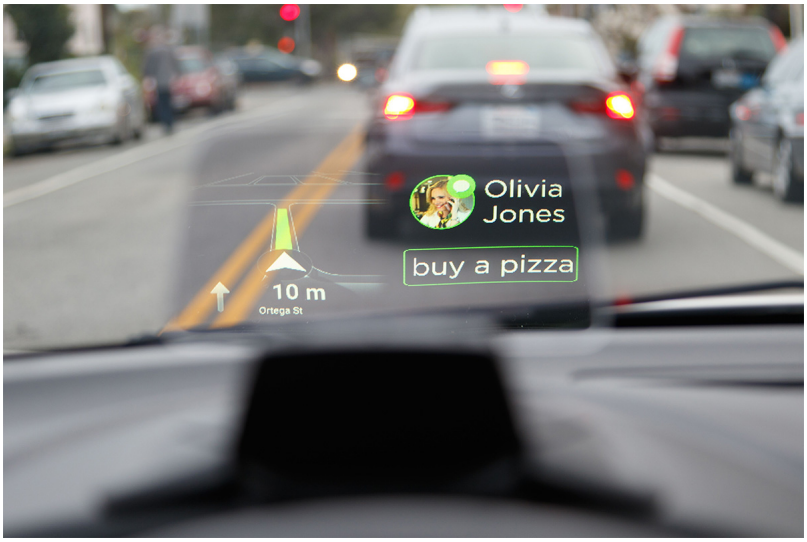


Figure 2.7: A map projected by the head-up display HUDWAY Drive on a car's windshield (Photograph by HUDWAY.[18])

3. Non-visual AR Displays

   AR displays do not have to be visual; displays that target other sensory modalities such as smell, sound, and taste to enhance an experience with virtual stimuli are also considered augmented reality.[19] Since humans perceive the environment through multiple senses, AR products should also be multimodal to cater to these different channels. Currently, audio AR is the most common display, but tangible, tactile, and haptic AR have also gained traction among

[16] Looking Class Factory

[17] "HUDWAY Drive," HUDWAY, accessed December 5, 2019, https://hudway.co/drive.

[18] "HUDWAY Drive," HUDWAY, accessed December 5, 2019, https://hudway.co/assets/images/tild3435-3265-4135-b866-383933393636__untitled-8.jpg

[19] Schmalstieg and Höllerer, "Displays."

researchers recently as more products seek to integrate these modes into the conventional visual display.

2.2.2 Types of Devices

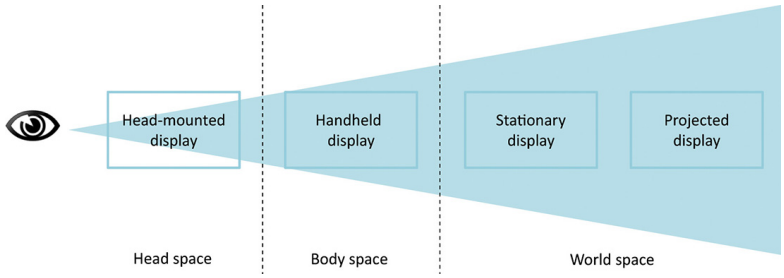


Figure 2.8: Classification of AR displays by distance from eye to display (Illustration by Schmalstieg and Höllerer. In *Augmented Reality: Principles and Practice*)

Augmented reality can also be classified by the type of devices. The previous section has briefly mentioned some of these devices: mobile handheld devices, head-mounted displays and heads-up displays. Devices can be broadly categorized into two classes: wearable and non-wearable. **Wearable devices** are usually glasses or headsets (head-mounted displays), but can also include helmets and contact lenses. **Non-wearable devices** for AR currently on the market feature mobile devices, stationary devices (desktops, televisions, etc.) and projected displays (holographic displays, heads-up displays). Another way to categorize AR devices is by order of distance from the eye. Figure 2.8 exemplifies the ranking of the aforementioned displays in terms of the space they occupy: head space, body space, or world space.[20]

2.2.3 Types of Tracking Technology

In addition to classifying AR by types of hardware (like displays and devices), augmented reality can also be differentiated by software implementation. In terms of tracking technologies, there are two main types of augmented reality:

[20] Schmalstieg and Höllerer.

marker-based AR and markerless AR. A key requirement of AR systems is real-time computer vision to perform instantaneous tracking and registration (alignment of objects in the device coordinate system). **Marker-based AR** relies on the use of predefined signs or images that are easily detectable with image processing, pattern recognition, and other computer vision techniques.[21] In marker-based tracking, the pose and scale of real-world objects are calculated relative to the position and orientation of the markers. An alternative to using artificial markers is markerless AR, which incorporates natural feature detection and other hybrid tracking methods (combining multiple techniques). Location-based AR is another branch of **markerless AR**. Markerless trackers remove the hindrance of markers and allow AR systems to make use of objects in the scene as tracking anchors. Natural feature detection is the most common method in markerless tracking. There is some overlap between marker-based AR and markerless AR when it comes to image detection. Markerless detection techniques implemented using natural feature identification algorithms share some similarities with marker-based tracking. The following sections include an in-depth discussion of natural feature tracking in image detection.

2.3 AR Pipeline

A simple augmented reality system typically requires three components: a camera, a computational unit and a display. The pipeline (in Figure 2.9) follows a process of capturing, tracking and rendering.[22] An AR system builds an understanding of the environment by capturing images and using mapping algorithms to generate topological maps of the physical space. The system tracks the device's position in the environment by determining the six degrees of freedom (6DOF) position

[21] Sanni Siltanen, *Theory and Applications of Marker-Based Augmented Reality* (Espoo, Finland: VTT, 2012), 39.

[22] Siltanen, 19–20.

of the camera, also known as the pose (see Figure 2.10). Using these positional and environmental data, developers can create virtual content that overlays and/or interacts with the physical space. Computer-generated elements are rendered to a display, which could be a see-through device or a digital screen. The following section only briefly discusses capturing and rendering and focuses mostly on tracking concepts and techniques.

Figure 2.9: Simple AR pipeline (Adapted from Siltanen, *Theory and Applications of Marker-Based Augmented Reality*, 20.)

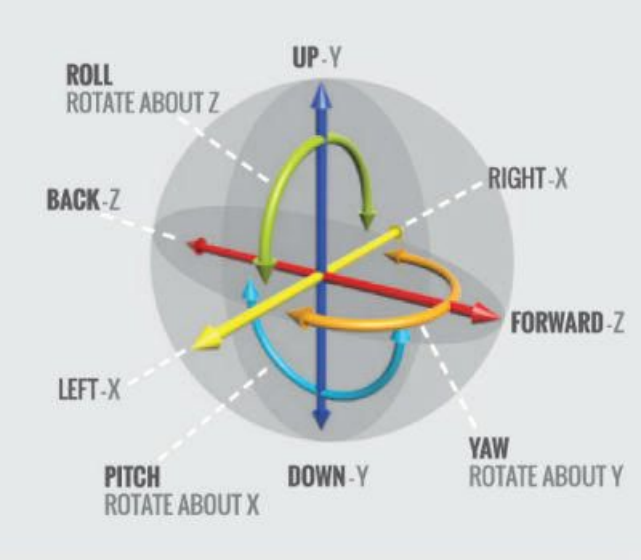


Figure 2.10: Six degrees of freedom refers to the freedom of movement by an object in 3D spaces (translation and rotation about the x, y, and z axes). (Illustration by Ola Podgórska. Pinterest.[23])

2.3.1 Tracking & Pose Determination

The first two steps in the AR pipeline, capturing and tracking, involve solving the problem of **simultaneous localization and mapping**. When a user turns on

[23] Ola Podgórska, "Six Degrees of Freedom," Pinterest. https://i.pinimg.com/236x/41/08/0b/41080b26d9f8cdcc69b830d719721534--degrees-of-freedom-octopus.jpg.

an AR device, the system has no prior (a priori) knowledge of the environment surrounding the device or its position in this environment. The AR system has to construct its internal version of the environment while at the same time estimate the device's pose in this internal map. This is known as simultaneous localization and mapping (SLAM). SLAM is the computational problem of building the map of the environment and simultaneously computing the device's pose in this map.[24] SLAM is solved using methods of mapping, sensing and modeling. Most AR software requires some sort of initial configuration. Initial scanning of the environment enables the system to map the physical space and deduce its position before any rendering happens. The next part describes the implementation of tracking and pose determination in SLAM.

Tracking is one of the most important stages in the augmented reality pipeline. **Tracking** refers to the dynamic capturing and measuring of the physical environment by AR systems using tracking devices and sensors.[25] Tracking enables the reconstruction of the real world, specifically by determining the pose of tracked objects. As discussed in Section 2.2.3, there are two main sets of tracking algorithms: marker-based and markerless. Marker-based tracking algorithms use the pose of the marker (relative to the viewer) to deduce the position and orientation of other objects in the environment. Some markerless methods also rely on the detection of natural markers to perform immediate registration of the scene, but other techniques can also be used to register the environment's layout.

The technology that enables pose determination in AR systems is **visual inertial odometry**. In computer vision and robotics, visual odometry is the process of determining the pose of the device by analyzing its camera images. Visual inertial

[24] H. Durrant-Whyte and T. Bailey, "Simultaneous Localization and Mapping: Part I," *IEEE Robotics Automation Magazine* 13, no. 2 (June 2006): 99–110.

[25] Dieter Schmalstieg and Tobias Höllerer, "Tracking," in *Augmented Reality: Principles and Practice* (Boston: Addison-Wesley, 2016).

odometry is a visual odometry system that applies camera image analysis and sensor fusion with inertial measurement units (IMU) to track acceleration and rotation. IMU sensors include the accelerometer (measures movements along the three axes) or the gyroscope (measures rotation about the three axes). These sensors enable the device to estimate the 6DOF pose of its camera. The measurement is taken using a mechanism called a proof mass. A proof mass changes from a neutral position under external influences such as acceleration or rotation This change is used to quantify movements or rotations made by the camera.[26] This information is used in conjunction with computer vision analysis of images captured by the device's camera to estimate its relative pose. Platforms like ARCore align the pose of the virtual camera and the device's camera to render virtual elements to their correct positions. The following section includes an in-depth discussion of marker detection algorithms and pose calculation based on these techniques.

2.4 AR Tracking System

2.4.1 Marker Detection

Every visual AR system requires at least one camera to perform marker detection. Images captured by the camera undergo a process of marker/feature detection to extract the pose of the camera. The process of image formation (to represent a 3D scene on a 2D image) requires switching from the world coordinate system to the image coordinate system, or in other words converting from a physical space to a flat image space. Computer graphics use the pinhole camera model to perform this translation. A pinhole camera is a box that has a hole on one side that only takes in a single ray of light, captured by a film placed on the other side of the box. The

[26] Steve Aukstakalnis, "Sensors for Tracking Position, Orientation, And Motion," in *Practical Augmented Reality: A Guide to the Technologies, Applications, and Human Factors for AR and VR* (Boston: Addison-Wesley Professional, 2016).

pinhole camera model is the ideal model for quickly calculating the 2D projection of a 3D object. However, digital cameras cannot fully simulate the pinhole model because of constraints with focal length, depth of field and field of view. Therefore, image formation by conventional cameras requires additional considerations.

The fluid nature of augmented reality requires AR systems to seamlessly switch between world space and image space, which means rapid mapping of world coordinates to image coordinates and vice versa. This requirement is true for both marker-based and markerless systems. In marker-based tracking, markers are objects or images that allow the AR system to quickly deduce the positions of the camera and other objects in the scene relative to the markers. Marker detection provides the image coordinates of the marker, which are then mapped back to their world coordinates (their actual position in the physical world). By acquiring the marker's position in both image and world coordinates, the system can then calculate the camera pose, which is applied to other objects in the image to find their positions in the real world. The matrix transformation M that maps the world coordinates of a point to image coordinates is called the **perspective projection** and is defined in Equation 2.1.[27]

$$M = K[R|t] \tag{2.1}$$

Matrix M is the result of the multiplication of the camera calibration matrix K and the concatenation of rotation matrix R and translation vector t. Matrix K contains information about the camera's focal length and other offsets that affect its image formation. Rotation matrix R and translation vector t describe the orientation and position of the camera respectively. The image coordinates x of an arbitrary

[27] Dieter Schmalstieg and Tobias Höllerer, "Computer Vision for Augmented Reality," in *Augmented Reality: Principles and Practice* (Boston: Addison-Wesley, 2016)

point with world coordinates X is calculated by Equation 2.2.[28]

$$x = MX \tag{2.2}$$

From Equation 2.1, it is clear that the position of the projected image of a point depends on both the internal geometric properties of a camera and its external positioning and orientation. Assuming that matrix K is constant for each camera, the perspective projection M needs to be updated every single frame to account for any external changes to the camera's pose. With Equation 2.2, M can easily be calculated when world coordinates X and image coordinates x are known. In marker-based systems, marker detection is necessary for finding image coordinates.

2.4.1.1 Artificial Marker Detection

Markers are essential for tracking because there is not enough information to deduce scale and pose at the beginning. Many AR systems depend on the use of markers to perform SLAM. **Artificial markers** are the most efficient and inexpensive solution to pose estimation. An artificial marker is a unique image that is easily detectable using computer vision and image processing techniques. Markers are often black and white because detection methods recognize differences in brightness better than differences in color, and black and white images provide the best contrast in brightness.[29] After the marker is detected, only four points from the marker are necessary for calculating the pose of the camera relative to the marker. The four-point rule is the reason why most markers, including QR codes, are in the shape of a square.

The AR marker system pipeline (Figure 2.11) has four main stages:

1. Capturing the image

[28] Siltanen, *Theory and Applications of Marker-Based Augmented Reality*, 49.

[29] Siltanen, 39.

2. Tracking

   (a) Detecting the marker

   (b) Calculating the pose of the camera

3. Rendering

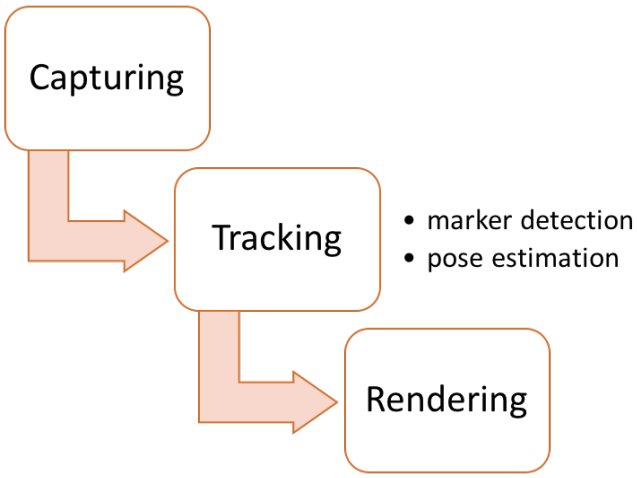


Figure 2.11: Marker-based system pipeline (Illustration adapted from Schmalstieg and Höllerer, "Tracking.")

After the system has successfully acquired an image from the camera feed, the processing function applies a threshold operation and performs edge detection and quadrilateral fitting on the resulting binary image.[30] Thresholded images only have two colors, black and white, separating the background from the objects. Each object is a closed contour. Scanline examination can be performed to detect the quadrilateral marker's edges; however to optimize performance, quadrilateral fitting is performed to check if an object is the marker. Figure 2.12 demonstrates the process of searching for furthest points from edges and diagonals to detect the square. The fitting algorithm first picks an arbitrary point a on the contour, then traces the entire contour to find a point with the greatest distance from a (labeled p_1). p_1 becomes the first corner of the quadrilateral. Next, the centroid m of the

[30] Siltanen, *Theory and Applications of Marker-Based Augmented Reality*, 41–43.

contour is calculated. It is clear that two of the remaining three corners must be on opposite sides of the diagonal through p_1 and m and are the furthest points from the diagonal from each side. These two corners are denoted as p_2 and p_3. Finally, the half plane formed by the line through p_2 and p_3 that does not contain p_1 has to contain p_4, which also turns out to be the furthest point from the p_2 and p_3 diagonal. This method of finding the furthest point from each edge is repeated to ensure that no new corners exist.

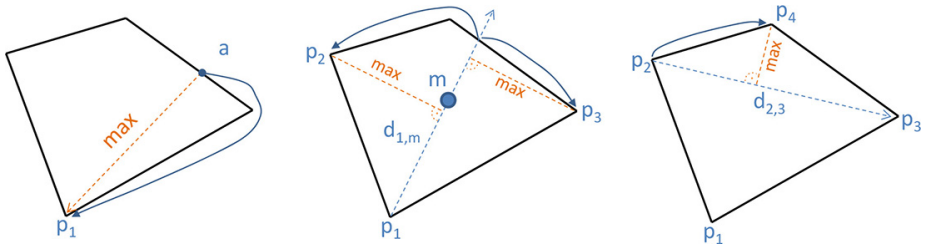


Figure 2.12: Quadrilateral fitting (Illustration by Schmalstieg and Höllerer. In *Augmented Reality: Principles and Practice*.)

After finding the image coordinates of the four corner points, the system can now calculate the linear transformation matrix M. Assume the world coordinates of these points are $(0,0,0)$, $(1,0,0)$, $(1,1,0)$, and $(0,1,0)$. Finding the matrix is to find the relationship between these coordinates and the image coordinates obtained from marker detection. To solve the relationship, AR systems commonly use **direct linear transformation** (Equation 2.3), a method used to solve the linear transformation A from known vectors x_k and y_k.[31]

$$x_k \propto A y_k \text{ for } k = 1, ..., N \tag{2.3}$$

$\propto$ denotes equality for an unknown scalar multiplication. To solve for M, replace x_k and y_k with the known image and world coordinates of the marker's corners. Recall from Equation 2.1 that M is the matrix product of the calibration matrix K and the pose matrix $[R|t]$. Since K is constant, the pose matrix, which provides the rotation

[31] Siltanen, 52; Schmalstieg and Höllerer, "Computer Vision for Augmented Reality."

and translation of the camera, can be recovered from M. Since point correspondence can be erroneous, further iterative error minimization is performed to refine the pose.[32]

2.4.1.2 Natural Feature Detection

Using a black and white square marker is efficient but its obstructive behavior is not always desirable. In terms of enhancing immersion, AR systems can be more intuitive if pose estimation can be performed on natural markers, markers that are part of the physical environment. One approach is to use **natural feature detection**. Natural feature tracking relies on sparse matching, the problem of finding the correspondences between a number of interest points in 2D images and their real 3D locations. The camera pose is recovered for every frame; in every single frame interest points are repeatedly detected and matched.[33] This behavior means that occlusions (caused by accidentally covering the camera or extreme changes in lighting) in previous frames do not affect tracking performance in later frames. Another advantage of interest point tracking is compactness since tracking models only have to match a select number of points and require no memory to store information from prior frames.

Figure 2.13 breaks down the steps in the tracking phase for markerless AR systems using natural feature detection.

Figure 2.13: Natural feature tracking pipeline (Illustration adapted from Schmalstieg and Höllerer, *Augmented Reality: Principles and Practice*.)

First the system detects interest points in the image from the camera feed and creates a descriptor to represent each detected point. These descriptors are matched

[32] Schmalstieg and Höllerer, "Computer Vision for Augmented Reality."

[33] Schmalstieg and Höllerer.

with predefined descriptors to determine if the points they describe are part of the target images. Lastly, the camera pose is estimated using the Perspective-n-Point algorithm.

An interest point (also known as feature point or key point) is a clearly defined area in an image that is visually distinct.[34] Interest points are well textured and exhibit considerable changes in intensity compared to their surroundings. Interest point selection algorithms must ensure constant performance across different lighting conditions and from various perspectives, or in other words, the algorithms must be able to select the same interest points every time regardless of external variables. Different methods can be used to select different kinds of features. Interest points can include edges, corners, blobs, and patches.[35] The following discussion considers two corner detection algorithms: Harris detector and Features from Accelerated Segment Test (FAST).

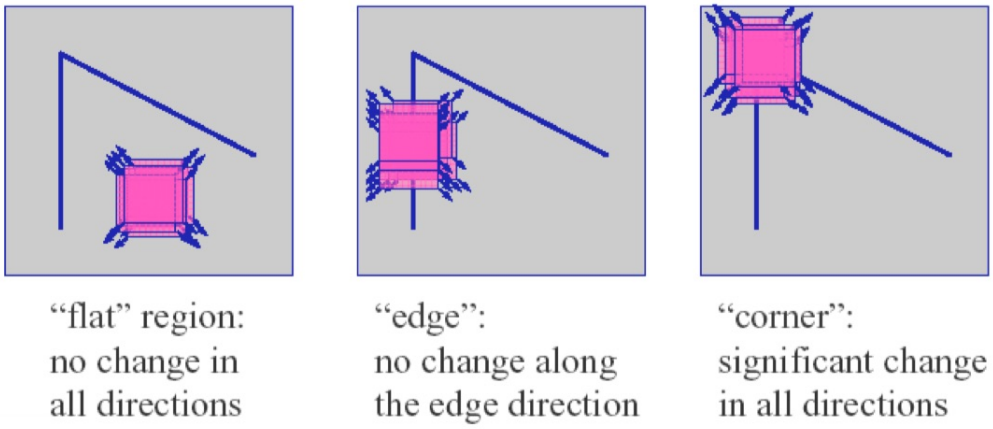


Figure 2.14: Different cases of changes in intensity in Harris corner detector (Illustration by Robert Collins. In "Lecture 06: Harris Corner Detector," 2007.[36])

Harris detector recognizes corners by analyzing changes in intensity. Figure 2.14 shows how autocorrelation can be used to detect interest points. This algorithm

[34] Schmalstieg and Höllerer; Siltanen, *Theory and Applications of Marker-Based Augmented Reality*, 94.

[35] Siltanen, *Theory and Applications of Marker-Based Augmented Reality*, 96.

[36] Robert Collins, "Lecture 06: Harris Corner Detector" (University Park, Pennsylvania, 2007), http://www.cse.psu.edu/~rtc12/CSE486/lecture06.pdf.

detects two types of interest points: corners and edges. Consider the pixel marked by the pink window. Let $I(a, b)$ be the function for measuring the intensity of pixel (x, y). In the first case, because the pixel's intensity does not change when the pink window is shifted in any direction, the bounded region is therefore flat and does not contain an interest point. In the second case, when the window contains an edge, moving the window along the edge's direction does not yield different intensities. Moving in any direction other than along the edge, however, produces changes. That is how the algorithm determines that an interest point is on an edge. In the last case, regardless of the direction, any movement would produce considerable changes in intensity. The sum of squared differences $E(u, v)$ of an image patch (x, y) in window W when shifting u units in the x-axis and v units in the y-axis is described by Equation 2.4.[37]

$$E(u, v) = \sum_{(x,y)\in W} [I(x + u, y + v) - I(x, y)]^2 \tag{2.4}$$

By calculating the sum of squared differences, the algorithm compares two patches of the image and assigns a dissimilarity score; the higher the score, the more dissimilar the two patches. Threshold values are specified for edges, corners, and flat regions. The values of $E(u, v)$ are large for corner points and approach 0 for flat regions.

Since the introduction of the first feature detection algorithms like the Harris detector, many other methods have emerged with improved robustness and computational efficiency. Performance is especially important for technologies such as AR, which require real-time video processing. The Features from Accelerated Segment Test (FAST) corner detector is among some of the more computationally efficient algorithms often used in processing real-time camera feed.The segment test detects

[37] Collins.

corners by determining if a specific pixel is an interest point by examining the pixels surrounding it. A pixel is deemed a corner if there are more than n (commonly $n = 12$) contiguous pixels surrounding it that are brighter or darker than the pixel considered. In Figure 2.15, a pixel is chosen for the segment test, labeled p. A Bresenham circle of 16 pixels is drawn around p using the midpoint circle algorithm. The intensity values of the pixels on the circle are tested against p's intensity. First p is compared to pixels 1, 5, 9, and 13. If at least three of these four intensity values are all greater or all less than p's value, the remaining pixels will be examined. If there is a strip of 12 continuous pixels that satisfy the criteria (all brighter or all darker than p), p is a corner pixel.[38] The range of intensity values is $[0, 255]$, where lower values indicate brighter intensities. The image is converted to grayscale to obtain its pixels' intensities (since the three RGB values of a grayscale pixel are the same).

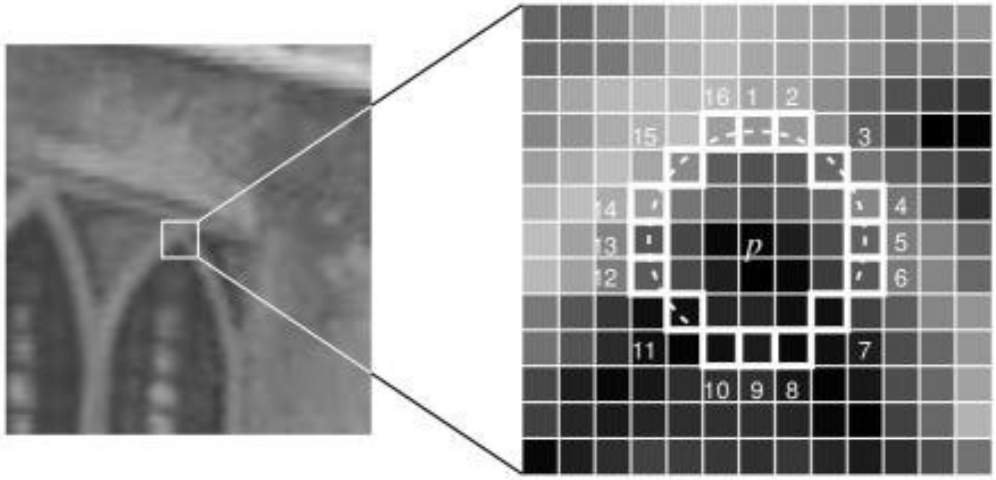


Figure 2.15: FAST's segment test (Illustration by Tyagi.[39])

An implementation of the segment test is described by the pseudocode in Listing 2.1. The function `detect()` takes an image `image` and a threshold value `threshold` as its parameters. The threshold value determines how much its intensity

[38] Deepanshu Tyagi, "Introduction to FAST (Features from Accelerated Segment Test)," Medium, January 7, 2020, https://medium.com/analytics-vidhya/introduction-to-fast-features-from-accelerated-segment-test-4ed33dde6d65.

[39] Tyagi, https://miro.medium.com/max/443/0*iB26EPO33F4LSig3.jpg.

needs to vary in order for it to be considered brighter or darker than another pixel. For example, if the intensity value of pixel p is I_p, then for pixel p' to be brighter than p, $I_{p'}$ has to be greater than $I_p + threshold$. The data type of `image` is not an actual representation of the image, but a two-dimensional matrix containing the intensity values of each pixel in the image. For example, for an image of size 2000×1000 pixels, the argument passed to parameter `image` is a 2000×1000 matrix. In the pseudocode, `image` is represented by a list, and `image[x][y]` accesses the intensity of the pixel at row x and column y.

Listing 2.1: Find corners in image

```
def detect(image: list, threshold: float) -> list:
    """
    Takes an image matrix and returns the list of corners
       detected as tuples

    :param image: two-dimensional list containing the image
       's pixel intensities
    :param threshold: a float value for the threshold
    :return: list of tuples containing detected corners'
       coordinates
    """
     corners = []
     rows = len(image)
     cols = len(image[0])
     for x in range(4, rows - 4):
         for y in range(4, cols - 4):
             i_max = image[x][y] + threshold
             i_min = image[x][y] - threshold
             circle = []
             # Fill the list circle with the intensity
                values of the pixels
             # chosen by the Bresenham circle algorithm
             feature = is_corner(circle, i_max, i_min)
             if feature:
                 corners.append((x, y))
     return corners
```

First, the algorithm starts at pixel $(4, 4)$ and loops through every single pixel in the image. Pixels on the first and last four rows and columns are excluded because

a Bresenham circle cannot be drawn for these border pixels. For each pixel, the maximum and minimum intensity thresholds are calculated. Then a circle is drawn around the current pixel using the Bresenham's circle drawing algorithm (refer to Figure 2.15 for an example of the circle). Lines 10 and 11 in Listing 2.1 assume that the Bresenham circle has been drawn and the intensity values of the chosen pixels are appended to the list `circle`. Then the algorithm calls the `is_corner()` function (Listing 2.2) to check if the pixel is a corner or not. If the pixel is a corner, its indices (x, y) will appended as a tuple to the list `corners`. This list stores the indices of all the corners, or interest points, in the image and is returned at the end.

The segment test described in `detect()` calls `is_corner()` (pseudocode in Listing 2.2) to determine whether a pixel is a corner or not. `is_corner()` takes the list of the intensity values of 16 pixels in the Bresenham circle as its parameters. The maximum and minimum threshold values `i_max` and `i_min` are also passed to the function. Recall from Figure 2.15 that initially only pixels with indices 1, 5, 9, and 13 are examined. The counters `brighter` and `darker` keep track of how many of these four pixels are brighter or darker than the thresholds. If there are more than three that hold the same criterion (all brighter or darker) then the function will check if there are at least 12 continuous pixels on the circle that also hold this criterion. This process is done by keeping a counter and incrementing it every time the pixel passes the check. The counter is reset to 0 if the test fails or returns `True` if the counter reaches 12. Because a circle has no beginning or end, there might be a contingency of pixels that pass the test at the start of the loop and others that pass the test at the end of the loop. These also count as one continuous strip. For instance, pixels 1 through 5 and 10 through 16 might all be brighter. However, when iterating from pixels 5 to 10, the counter might have been reset. To account for the continuity of the first pixels examined and the last ones, some extra variables are used to store this information. Boolean variable `is_first` is `True` only when the

loop iterates through the first continuous strip found. `first_strip` records the number of continuous pixels that pass the test at the beginning, which is added to the counter at the end of the loop to get the length of this entire strip.

There are some limitations to this method. The order in which the pixels are examined affects the performance of the algorithm. A machine learning approach optimizes this using decision trees. First, the 16 pixels around the pixel in question are divided into three subsets: darker, similar, or brighter, represented by P_d, P_s, and P_b respectively. Let x be a pixel from one of the 16 in the Bresenham circle and p the center pixel. We have

$$x \in \begin{cases} P_d, & \text{if } I_x \leq I_p - threshold, \\ P_s, & \text{if } I_p - threshold < I_x < I_p + threshold, \\ P_b, & \text{if } I_x \geq I_p + threshold, \end{cases} \tag{2.5}$$

where I_x is the intensity of x and I_p is the intensity of p. To create the decision tree, the classifier algorithm is recursively applied to each subset to find the pixel x that provides the most information about whether the center pixel p is a corner. This decision tree determines the sequence of pixels to examine in order to achieve faster detection.[40]

Another constraint of FAST is that it can end up detecting multiple corners for the same edges. Better variations of FAST use non-maximum suppression to remove noise around corners. To achieve this, for each detected corner, a score V is calculated by finding the sum of absolute difference between the intensity of the corner pixel and the other 16 pixels in the Bresenham circle.[41] When two adjacent corners are found, whichever has the higher V is chosen as the corner.

[40] Alexander Mordvintsev and Abid K., "FAST Algorithm for Corner Detection," OpenCV-Python Tutorials, 2013, https://opencv-python-tutroals.readthedocs.io/en/latest/py_tutorials/py_feature2d/py_fast/py_fast.html.

[41] Mordvintsev and K.

Listing 2.2: Check for corner at given pixel

```
def is_corner(circle: list, i_max: float, i_min: float):
    """
    Takes a list of intensities from the pixels in the
       Bresenham circle and returns if the pixel in the
       center is a corner.

    :param circle: list of floats for pixel intensities
    :param i_max: float value of the threshold for
       brighter intensities
    :param i_min: float value for the threshold for darker
        intensities
    :return: True if the center pixel is a corner, False
       otherwise
    """
    brighter = 0 # counter of brighter pixels
    darker = 0 # counter of darker pixels
    for i in range(4):
        if circle[i * 4] > i_max:
            brighter += 1
        if circle[i * 4] < i_min:
            darker -= 1
    results = False
    counter = 0
    first_strip = 0
    is_first = True
    if brighter >= 3:
        for i in range(16):
            # Replace with circle[i] < min for testing
               darker intensities
            if circle[i] > i_max:
                counter += 1
                if counter == 12:
                    return True
            else:
                if is_first:
                    is_first = False
                    first_strip = counter
                counter = 0
        if counter + first_strip >= 12:
            return True
    if darker >= 3:
        '''
        Repeat the previous loop.
        Replace the condition with circle[i] < min.
        '''
    return False
```

2.5 AR Development Platforms

Development platforms for AR have been expanding with the evolution of detection algorithms in computer vision and computer graphics. Currently, the main AR software development platforms are ARCore, ARKit, and Vuforia. All of these platforms provide support for the Unity game engine.

2.5.1 ARCore

ARCore is a platform by Google for AR mobile development. ARCore provides three main functionalities: motion tracking, environmental understanding, and light estimation.[42] Tracking is also done using the same principles as SLAM, by identifying point clusters and using inertial sensors to estimate the camera's pose. A point cluster is a set of oriented interest points. Each interest point returns a directional vector that can be used for designing interactions between virtual and physical content.[43] The construction of point clusters can be used to define planar surfaces and deduce their angles.[44] Figure 2.16 demonstrates a net of point cluster found from a table surface; virtual Andy Androids are placed on this surface. ARCore provides multiplayer experiences using Cloud Anchors, which sync selected anchors to Google Cloud, making them accessible to other devices. This feature allows multiple users to view the same AR scene simultaneously. ARCore also supports instant preview of real-time modifications on apps that are currently running on Android device(s).

[42] "Fundamental Concepts | ARCore," Google Developers, accessed October 17, 2019, https://developers.google.com/ar/discover/concepts.

[43] *Unite Berlin 2018 - Getting Started with Handheld AR* (Berlin, 2018), https://www.youtube.com/watch?v=MqA0XhfKIE0.

[44] "Fundamental Concepts | ARCore."

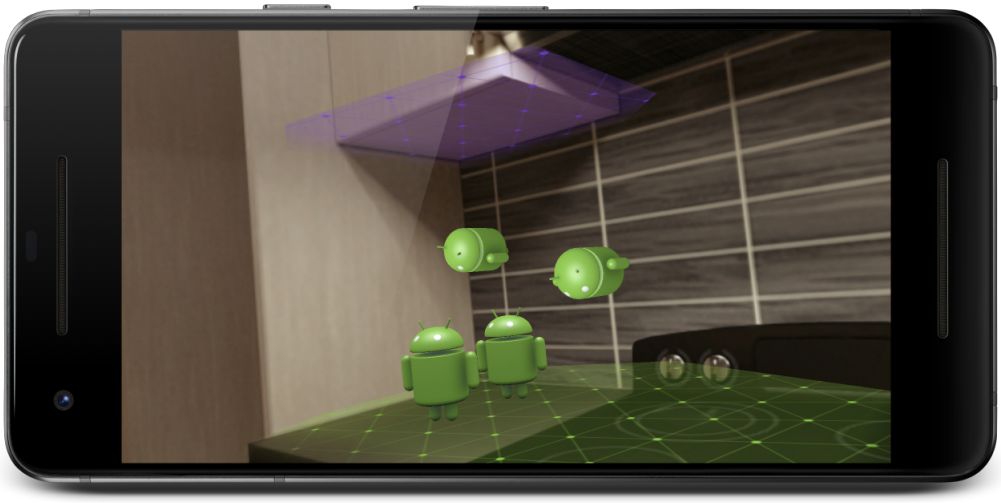


Figure 2.16: The point cluster is used in this ARCore app to track a table surface (Illustration by Google Developers.[45])

2.5.2 ARKit

ARKit is Apple's AR development platform for iOS devices. ARKit 3 introduces people and object occlusion, enabled by motion capture and facial tracking. A child framework, RealityKit, allows for better simulation and rendering with additional functionality that includes audio AR, animation, real-time response to user input, and cross-device multiplayer experiences.[46] ARKit comes with a companion app (Reality Composer) with a drag-and-drop interface for AR prototyping and development.

2.5.3 Vuforia

Vuforia is a software development kit for AR mobile devices. Acquired by PTC from Qualcomm in 2015, Vuforia is one of the most widely used platforms for AR development.[47] Vuforia provides cross-platform support for Android, iOS, and Universal Windows Platform, as well as the Unity game engine. Apps developed

[45] "Explore the HelloAR Sample App Code | ARCore," Google Developers, accessed March 9, 2020, https://developers.google.com/ar/images/hello-ar.png.

[46] "Augmented Reality," Apple Developer, 2020, https://developer.apple.com/augmented-reality/.

[47] "PTC Acquires Vuforia," PTC, November 3, 2015, https://www.ptc.com/en/about/vuforia.

with Vuforia can be deployed on various phones, tablets, and other eyewear devices such as the HoloLens and Vuzix M300/M400. Vuforia's main feature is its ability to track an array of targets, including models, images, objects, and a hybrid of these targets. The latest release includes support for tracking horizontal planes.[48] This project uses the Vuforia plug-in with the Unity game engine.

2.5.4 Unity

Unity is a real-time development platform by Unity Technologies. As a game engine, Unity provides support for a range of platforms, including major native platforms such as Android, iOS, Windows, as well as all the aforementioned AR platforms. The Unity environment includes both drag-and-drop functionality and a scripting API in C#. Unity can be used to create 2D and 3D games in addition to VR/AR and other simulation experiences.[49] With its evolving graphics features and usability, Unity has grown to become the most popular game engine and platform for AR and VR content.

AR Foundation is the multi-platform support package for AR by Unity. AR Foundation provides a common abstract API for both ARCore and ARKit. The package provides a collection of Unity scripts that enable high-level functionalities such as surface detection, point clouds, reference points, light estimation, and world tracking.[50]

AR hardware and software continue to evolve with the introduction of new mediums, devices, development platforms, and algorithms. The level of engagement and immersion improve with each iteration, while development and design

[48] "Vuforia Engine Features," Vuforia Developer Library, accessed March 9, 2020, https://library.vuforia.com/content/vuforia-library/en/features/overview.html.

[49] Unity Technologies, "Unity - Manual: XR," Unity Documentation, accessed March 9, 2020, https://docs.unity3d.com/Manual/XR.html.

[50] Unity Technologies, "About AR Foundation," Unity Documentation, accessed March 9, 2020, https://docs.unity3d.com/Packages/com.unity.xr.arfoundation\spacefactor\@m{}3.0/manual/index.html.

processes are streamlined. The growth of AR is demonstrated by its expansive applications in gaming, business, education, and medicine.

2.6 Augmented Reality & Digital Humanities

In recent years, computer vision technologies such as virtual reality and augmented reality have found more uses in everyday life. Developments in fundamental AR components, such as feature detection, and supporting frameworks, such as Vuforia, help improve the technology's accessibility and potential in various fields. New advances are letting humans see in ways that were previously unthinkable. X-Ray machines can look where the unaided eye cannot, through multiple layers, even into the human body. Facial recognition algorithms have gained popularity for its accurate and robust performance, but have also come into criticisms for invading privacy. Ethical applications of these powerful and sometimes invasive technologies require careful considerations over their implications. For augmented reality, who is allowed to see with AR and what or who is being seen through it become questions of great consequence for designers and users of this technology.

On the other hand, technological progress implies tremendous potential but also possible drawbacks. For history and other humanities and social sciences, these advances provide more methods for research and new perspectives, with the focus on data and more thorough analysis techniques. In fact, a new discipline has emerged to study the intersection between technology and these other fields, called digital humanities. Digital humanities is concerned with the use of computational tools to produce new methods for finding patterns, visualization, and analysis.[51] On the other hand, as far as the limitations of technology are concerned, digital humanities is also self-critical as a discipline; alongside utilizing technological

[51] Michael J. Kramer, "What Does Digital Humanities Bring to the Table?," *Michael J. Kramer* (blog), accessed March 9, 2020, http://www.michaeljkramer.net/what-does-digital-humanities-bring-to-the-table/.

affordances, scholars also challenge the pitfalls that come with culturally constructed assumptions behind designs. Technology reinforces privileges that discriminate against certain groups of users, can also invade the privacy of non-users as well.[52]

In terms of history, AR and VR are most commonly found in public history institutions, especially with museums, archives, and libraries. The obsession with seeing is now extended to the past through historical photographs, texts, and now virtual reconstructions enabled by AR/VR platforms. But the possibilities are much broader. Techniques such as optical character recognition allow for the processing of hundreds of thousands of sources simultaneously, multiplying the scope of research.[53] By manipulating spaces, AR brings history outside texts and into the world, transcending physical barriers by employing them as platforms for virtual media. Location-based immersive experiences such as Museum of the Hidden City by Walking Cinema make history accessible in the space where it happened. The app presents a multimodal narrative for a walking tour around the Fillmore neighborhood of San Francisco, where the forces of gentrification uprooted marginalized populations through affordable housing acts.[54] Figure 2.17 is taken directly from the app and shows an illustration of historical Fillmore superimposed on an image of present-day Fillmore from the camera feed. Multimodality introduces new ways of presenting different perspectives, and in the Fillmore example, these perspectives include oral histories, historic images, and physical primary sources (in the form of the buildings themselves). Museum of the Hidden City is an example of

[52] James E. Dobson, "Protocols, Methods, and Workflows: Digital Ways of Reading," in *Critical Digital Humanities: The Search for a Methodology* (Urbana: University of Illinois Press, 2019), 6–7.

[53] Devon Elliott and William J. Turkel, "Faster than the Eye: Using Computer Vision to Explore Sources in the History of Stage Magic," in *Seeing the Past with Computers: Experiments with Augmented Reality and Computer Vision for History*, ed. Kevin Kee and Timothy Compeau, Digital Humanities (University of Michigan Press, 2019), 83–94; Ian Milligan, "Learning to See the Past at Scale: Exploring Web Archives through Hundreds of Thousands of Images," in *Seeing the Past with Computers*, ed. Kee and Compeau, 116–36.

[54] "Museum of the Hidden City," Museum of the Hidden City, accessed March 9, 2020, http://www.seehidden.city.

digital storytelling using location-based AR. The England Originals app is another example of AR storytelling. England Originals (Figure 2.18) is a relatively successful example of the tabletop model with plane detection. Users can place virtual maps of English cities on horizontal planes and click on individual buildings for further context.

Figure 2.17: A screenshot of the immersive AR experience exploring the history of affordable housing in Fillmore, San Francisco (Screen capture from *Museum of the Hidden City Trailer. By Walking Cinema, 2019.*[55]).

This project is concerned with digital storytelling using augmented reality on a smaller scale; it presents an analysis of Ho Chi Minh City's history and its memory. Instead of using the location-based method, the app is designed for table tops and vertical planes. It employs feature detection and tracking to provide a localized spatial experience on the Vuforia and Unity platforms. The design takes into consideration questions about the implications of using these computational tools. As the analysis delves into politics and power, it is important that any product from this project also makes transparent the power and politics underlying such technology.

[55] Walking Cinema, *Museum of the Hidden City Trailer*, 2019, https://vimeo.com/358878249

Figure 2.18: A table-top AR application for mobile phones about the history of England (Screen capture of the England Originals app by England's Historic Cities by Thuy Dinh.)

Chapter 3

Designing an Augmented Historical Narrative with Vuforia

Like most AR platforms, Vuforia's functionality revolves around marker detection and tracking. The main difference between Vuforia and other prominent AR development platforms is its focus on customized markers, or targets, using the terminology by Vuforia documentations. Users are allowed to register their own targets on an online database and then download the target database as a package that can be imported into Unity or deployed in Visual Studio, Xcode or other integrated development environments. This chapter provides an overview of the functionality of the Vuforia framework and introduces the use of Vuforia through Unity. Section 3.3 discusses the complete workflow of developing an AR mobile application using Vuforia and Unity and considerations for designing a digital narrative in this medium. All materials on Vuforia in this chapter are drawn from Vuforia Developer Library.[1]

3.1 Features

As previously noted, the prominent feature of Vuforia is its ability to track customized targets. Figure 3.1 lists the targets that can be tracked in a Vuforia-enabled app.

[1] PTC Inc., "Overview," Vuforia Developer Library, accessed March 10, 2020, https://library.vuforia.com/getting-started/overview.html.

In Vuforia terminology, all of these targets are considered `Trackable`s. Recall the definition of interest points in the previous discussion on feature detection. A `Trackable` is a set of interest points that can be recognized and tracked at run time. Since the targets are customized, these interest points are preregistered offline and stored in a database. Interest points detected by the camera at run time are compared against this database to identify the targets. Once a target is matched, its pose is retrieved and the orientation and position data are used to align virtual contents to the physical targets. These targets are divided into three main categories: images, objects, and environments. Each category is further divided into several smaller subgroups (Figure 3.1).

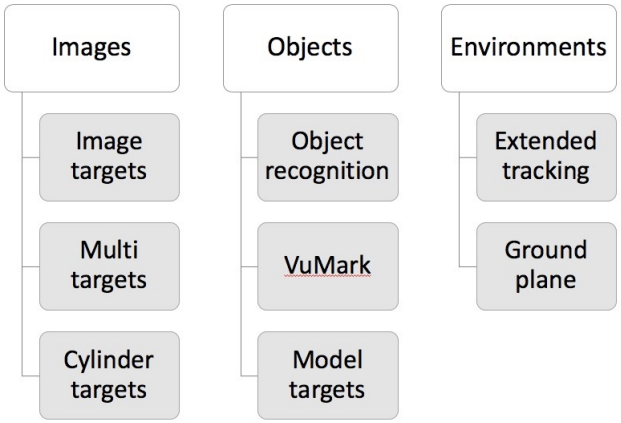


Figure 3.1: Vuforia targets (Adapted from Vuforia Developer Library. By PTC.[2])

1. Image targets

   An image target is a flat image that Vuforia can detect and track. The engine uses natural feature detection to select interest points from the camera feed and match them to a known database of targets. Vuforia is capable of tracking a detected image as long as it is partially visible to the camera. Usually, virtual contents are attached to the image target (see Figure **??** for an example of a

[2] PTC, "Vuforia Engine Features," Vuforia Developer Library, accessed March 9, 2020, https://library.vuforia.com/content/vuforia-library/en/features/overview.html.

virtual teapot attached to an image target). Its most common use cases are for augmenting product packaging and posters.

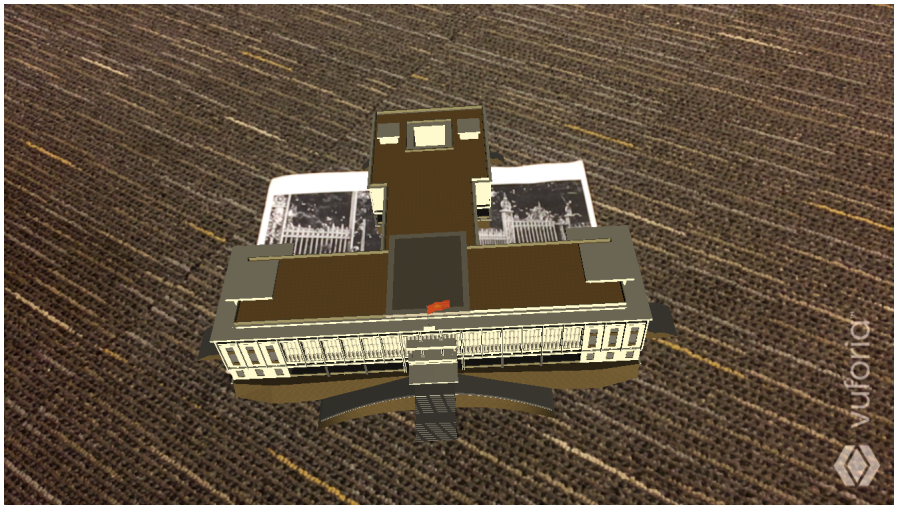


Figure 3.2: A detected image target with Ho Chi Minh City's Independence Palace attached to it (Screen capture by Thuy Dinh.)

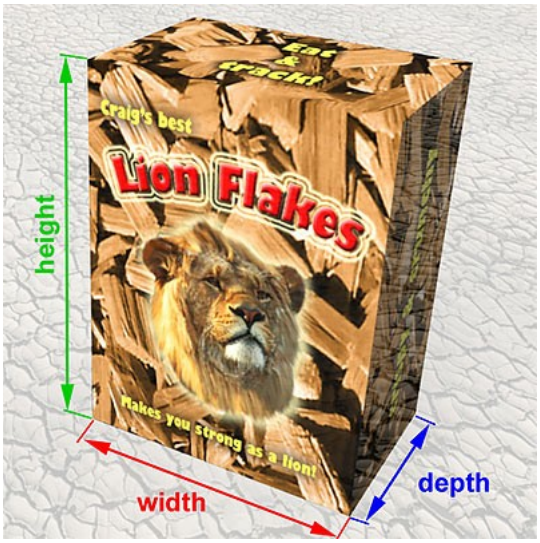


Figure 3.3: A box can serve as a multi target (Illustration by PTC in Vuforia Developer Library.[3])

2. Multi targets

A multi target is a set of image targets with a predefined geometric arrangement. An example of a multi target is the box in Figure 3.3. The box is comprised of

[3] PTC, "Multi-Targets," Vuforia Developer Library, accessed March 10, 2020, https://library.vuforia.com/content/dam/vuforia-library/articles/training/multiTargetDimensions.jpg/_jcr_content/renditions/cq5dam.web.1280.1280.jpeg.

six images (one for each face), each of which makes a separate image target. The pose of these image targets are defined relative to one another. When detecting a multi target, the identified interest points must not only match the image targets, but their pose must also match the predetermined geometric arrangement.

3. Cylinder targets

   A cylinder target is an extension of an image target, wrapped around a cylindrical or conical object. The object's dimensions (diameter and size length) must be defined. The system can also track the images on the top and bottom faces of the cylindrical target if defined.

4. Object recognition

   The object recognition feature of Vuforia allows users to create trackable targets from physical objects. The Vuforia Object Scanner creates a digital representation of a real-life 3D object by extrapolating the features and geometry of the object from the scan. Unlike image targets, object targets do not have to be planar.

5. VuMark

Figure 3.4: VuMark (Illustration by PTC. In Vuforia Developer Library.[4])

VuMarks (Figure 3.4) are Vuforia's version of marker-based tracking. The existence of both image targets and VuMarks might appear redundant, but VuMark designs allow for the coexistence of millions of trackable instances

[4] PTC, "VuMark," Vuforia Developer Library, accessed March 10, 2020, https://vuforialibrarycontent.vuforia.com/Images/Vuforia_6_Images/DesignGuide/image5.png.

as well as the ability to encode a variety of data formats. Because of the uniqueness of each VuMark instance, these markers can also be used as a means of identification for similar products.

6. Model targets

   Model targets are targets that are created from a digital 3D model of an object and can be used to track it. The Model Target Generator converts 3D object files into Vuforia Engine databases. Vuforia supports the real-time tracking of the registered models in the databases. In order to initiate the tracking, the Vuforia app must detect the object from a specific angle, prompted by the guide view (see Figure 3.5 for a screen capture of the guide view).

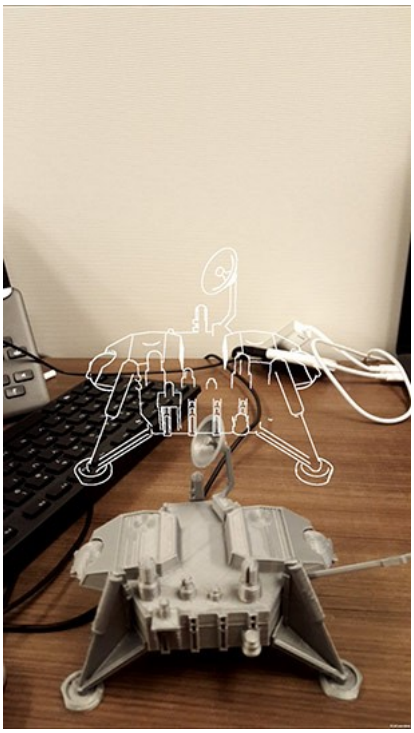


Figure 3.5: Model target guide view (Illustration by PTC in Vuforia Developer Library.[5])

7. Extended tracking

   The main problem with tracking targets is that pose calculation desists when

[5] PTC, "Introduction to Model Targets in Unity," Vuforia Developer Library, accessed March 10, 2020, https://library.vuforia.com/content/dam/vuforia-library/articles/solution/unity-model-target/gp_08.jpg/_jcr_content/renditions/cq5dam.web.1280.1280.jpeg.

the target is no longer visible in the frame. Vuforia supports extended tracking as a solution to this issue. Extended tracking makes use of Device Tracker feature to enable six-degrees-of-freedom tracking. Device Tracker provides information about the device's pose relative to the targets and the rest of the world at all times. After the device's position has been established the first time a target is detected, alignment between real-world objects and virtual contents persists even after the camera has moved from the target's position. Extended tracking makes space-aware AR experiences possible, for example games that require lots of space or when tracking a large object.

8. Ground plane

   The ground plane detector identifies horizontal surfaces and allows users to place content on top of the plane or elsewhere relative to the detected plane. The Mid Air Stage places virtual content in mid air based on its preset position from the target ground plane. Vuforia ground plane detection is enabled by platforms such as ARCore and ARKit.

The functionality of Vuforia is based around its ability to recognize different kinds of targets. The next section explains the back-end framework that enables tracking for a variety of objects.

3.2 Core Components

An application created with Vuforia in Unity requires several core components. The Unified Modeling Language (UML) class diagram in Figure 3.6 shows the class hierarchy of the core of Vuforia. Consider a simple AR app that scans an image target and overlays the target with a 3D model. As the app starts, a new AR session is initiated. The `VuforiaARController` class stores the information

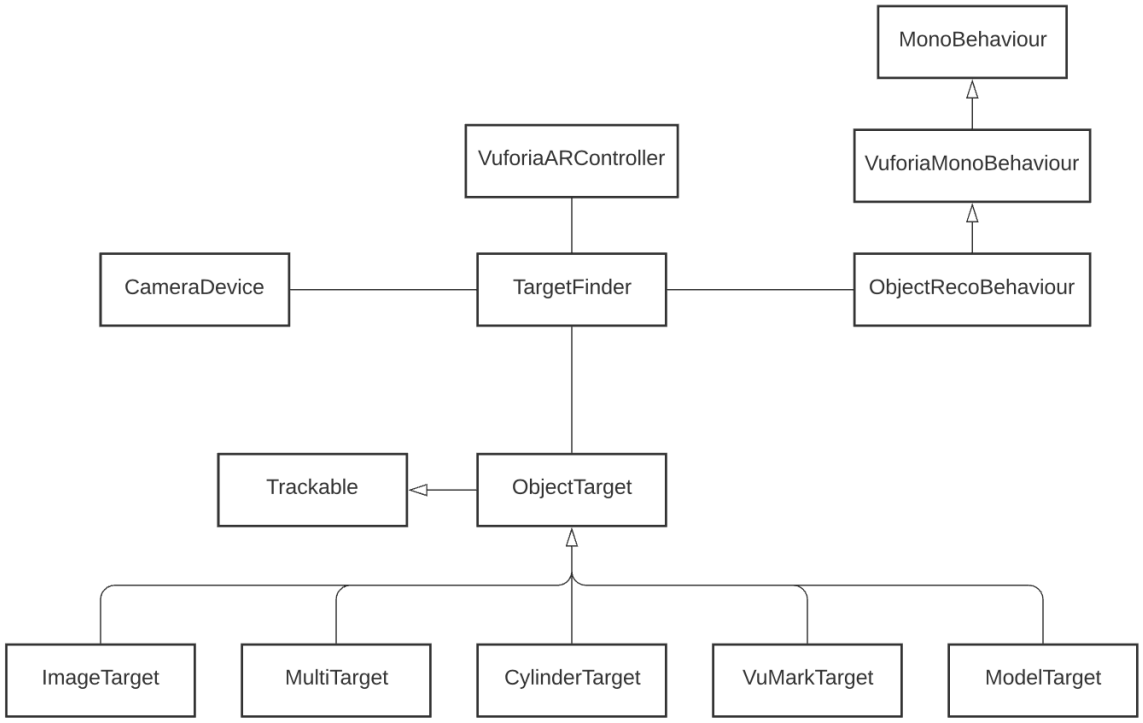


Figure 3.6: UML diagram of Vuforia core classes for Unity (Adapted from Vuforia API Reference by PTC.[6])

about the new AR session. At the beginning of the session, information about the camera is registered in `CameraDevice`. During each frame, the image captured by the camera feed can be obtained from `CameraDevice` as well. Each picture frame is then passed on to the `TargetFinder`, which scans the image for features and prepares it for matching using a separate process of object recognition. This process is represented by the class `ObjectRecoBehaviour`. Notice that `ObjectRecoBehaviour` is a child of `VuforiaMonoBehaviour`, which is derived from `MonoBehaviour`, the base class for all Unity scripts, which offers functions for handling the life cycle of an app. For every single object/image that is found by `TargetFinder`, the result is compared against a reference database by `ObjectRecoBehaviour`. If the result matches a preregistered target, its position and orientation are assigned to the Unity game object that represents the target. When a target is located and paired

[6] PTC, "Unity Reference: Main Page," Vuforia API Reference, accessed March 10, 2020, https://library.vuforia.com/content/vuforia-library/en/reference/unity/index.html.

to its representation, a corresponding `ObjectTarget` is created. An `ObjectTarget` inherits the base class behavior `Trackable` for all trackable types in Vuforia. The classes for different target types (e.g. `ImageTarget`, `MultiTarget`) are all subclasses of `ObjectTarget`. The appropriate subclass is chosen to match the kind of target identified by `TargetFinder`.

All of these components are embedded in the Vuforia framework and do not feature in the actual developing workflow. Users designing a Vuforia app with Unity can use Unity's graphical user interface access with these components at the graphical level.

3.3 Workflow

The workflow of designing a Vuforia-enabled app in Unity follows the general workflow of the Unity game engine. This section highlights Vuforia-specific aspects of designing an AR app in Unity.

3.3.1 Installation and Activation

The Vuforia Engine is available through two channels in Unity, as a package downloadable from Package Manager (for Unity 2019.2 or later) and as a separate component that can be installed using the Unity Download Assistant (for Unity versions before 2019.2). Activation of the Vuforia Engine can be done by enabling Vuforia Augmented Reality Supported in **Player Settings**. Activation is successful when Vuforia appears in the **GameObject** menu (Figure 3.7).

3.3.2 Creating Target Databases

To be able to use custom targets in Unity, developers have to create target database(s) and import them as an asset package. This process can be done on the **Developer Portal** through the Vuforia Engine website. The Target Manager function has buttons for creating new databases. There are two options for storing a database, on

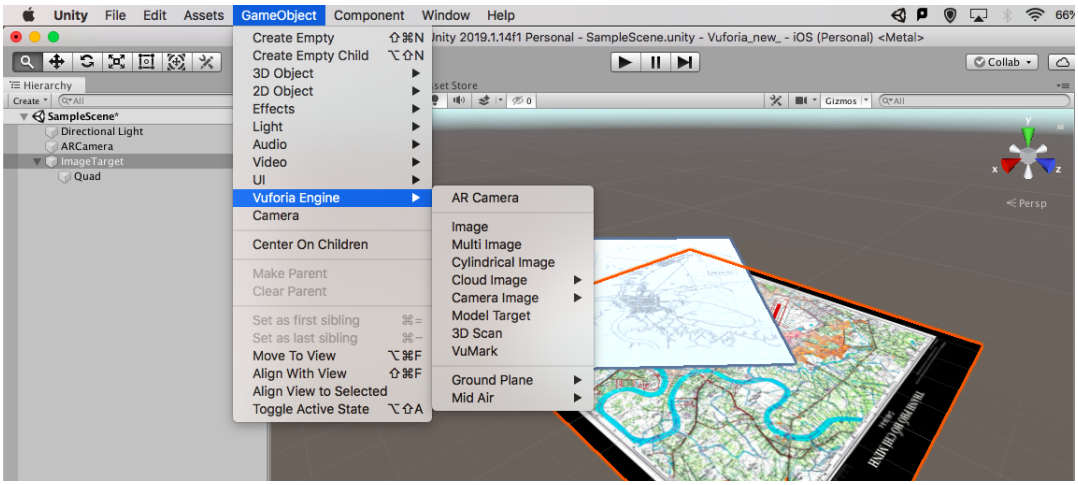
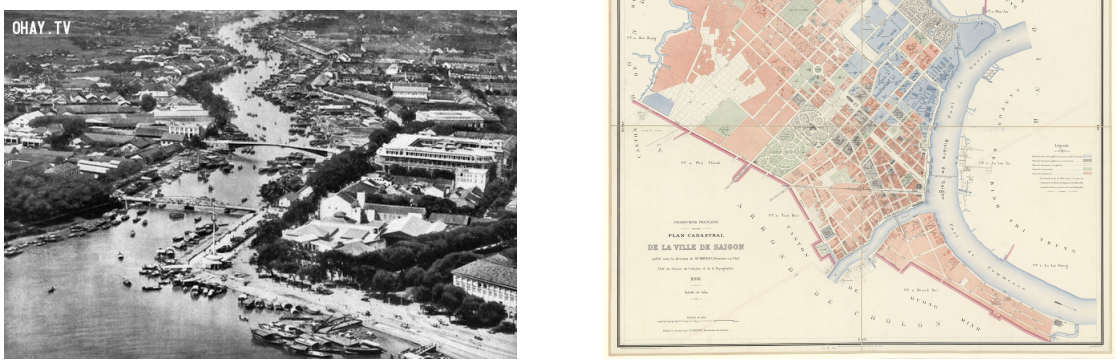


Figure 3.7: Vuforia submenu (Screen capture by Thuy Dinh from within the Unity Game Engine.)

the cloud or offline. Since the Cloud Recognition feature is for industrial use only, this section only explains the offline mode, which is called **Device** on the portal. The **Add Target** button is for uploading a new target. Among the different target types, there are five that can be customized: image, cuboid multi target, cylinder, object, and model. Model target databases are created using the **Model Target Generator**. While The **Target Manager** deals with images, multi targets, cylinders, and objects. After the file has been uploaded, the target's properties should be changed to match its actual dimensions. For all image targets, the Manger gives each target a rating of 0 to 5. A 5-star rating means that the image is highly augmentable. These are images that are rich in detail and have good contrast with no repetitive patterns. Figure 3.8 provides examples of a 5-star and 0-star image targets. Figure 3.8(a) has great contrast between bright and dark areas, while Figure 3.8(b) is too repetitive and has uneven feature distribution. The Vuforia Target Manager has a feature visualizer function for image targets that is useful for understanding how well feature detection works for different inputs. See Figure 3.9 for the interest points detected (marked yellow) in the two images in Figure 3.8. The 0-star image target has much sparser features than the 5-star rating one, making it less recognizable. As a result, optimizing the trackability of image targets is important.



(a) 5-star rating (b) 0-star rating

Figure 3.8: Image target ratings (Photograph from "Một vài hình ảnh Sài Gòn xưa"by Nguyễn Đăng Khoa. Map by M. Bertaux and A. Chauvet.[7])

(a) 5-star rating (b) 0-star rating

Figure 3.9: Vuforia feature visualizer (Marked-up photograph and map from Vuforia Target Manager.[8])

Because of the nature of maps, this project faces several challenges with trackability. Because maps have many repetitive details (lots of similar symbols) and not much contrast (no extreme brightness difference), it is harder to optimize maps.

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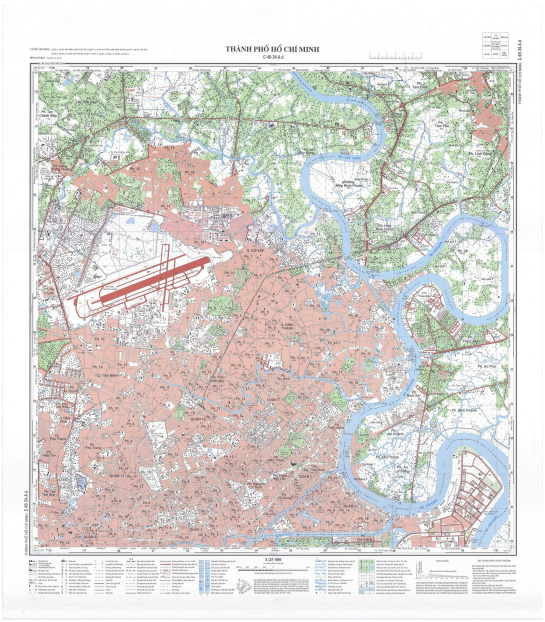
[7] PTC, "Target Manager | Vuforia Developer Portal," accessed March 19, 2020, https://developer.vuforia.com/targetmanager/singleDeviceTarget/deviceSingleImageTargetDetails.

[8] Nguyễn Đăng Khoa, "Một Vài Hình Ảnh Sài Gòn Xưa," Ohay TV, August 3, 2015, https://media.ohay.tv/v1/content/2015/08/1-cau-khanh-hoi-va-cau-mong-ohay-tv-93077.jpg; M. Bertaux and A. Chauvet, Cochinchine Française: Plan Cadastral de La Ville de Saïgon, 1:4000 (Service du cadastre et de la topographie, 1898), https://gallica.bnf.fr/ark:/12148/btv1b530297676.

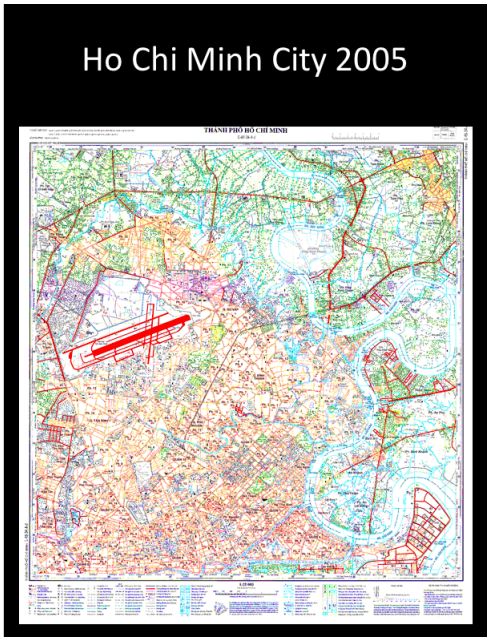
There are several ways to prepare images for better target detection. The actual process of optimizing a 2005 map of Ho Chi Minh City used in this project is described in Figure 3.10. The original map in Figure 3.10(a) has very few distinguishable interest points and poor contrast. In version 3.10(b), the contrast of the map was increased by adding a black border and lightening the pink and green areas. This action increases the local contrast between darker details such as roads, and the brighter background. To achieve the 4-star rating in Figure 3.10(c), the foreground/background contrast was further enhanced and repetitive features were removed. However, the optimization process has a major effect on the integrity of the 4-star image because it eliminates some important information on the map. Due to the excessive alteration to achieve the 4-star image, it makes sense to choose the 2-star image to preserve the map's historical accuracy, as it still yields a robust performance for iOS devices.

In addition to images, users can also upload 3D object scans to create object targets. The **Vuforia Object Scanner** is an Android application that makes object targets from 3D scans of an object. The Object Scanner generates the data necessary to define an object target. Preparing the scan environment is important for obtaining a good model. The lighting in the environment should be diffuse and sufficiently bright, without any directional light sources. This should prevent specular highlights, which lead to false interest points. A cluttered background also flags false points. The object space of the model is defined relative to the coordinates provided by a target image (Figure 3.11). The object to be scanned must be placed in the grey box in the top left corner of the target image. The box is set by the axes defining the object space. Any part of the object outside of the space delimited by the grids is culled. The pose of the object is calculated relative to the pose of the target image.



(a) Before optimizing (0-star)

(b) After adding borders and increasing local contrast (2-star)



(c) After increasing foreground/background contrast and eliminating repetitiveness (4-star)

Figure 3.10: Optimizing image target for detections (Map by Bộ Tài nguyên và Môi Trường, 2005.[9])

The principles for detecting an object are generally similar to the ones used in feature point detection. After the scanner has established a general shape of an object,

[9] Bộ Tài nguyên và Môi trường, Thành Phố Hồ Chí Minh. C-48-34-A-d, 1:25000 (Ha Noi: Nhà xuất bản Bản đồ, 2005), http://virtual-saigon.net/Maps/Collection?ID=1141.

a mesh appears to cover the object. In Figure 3.11, regions that have a sufficient number of points detected are colored green. Regions unscanned or with sparse interest point distribution are not colored. Found interest points are represented by green dots. To improve the model, scanning should be repeated twice with the target image replaced by a dark and a light background.

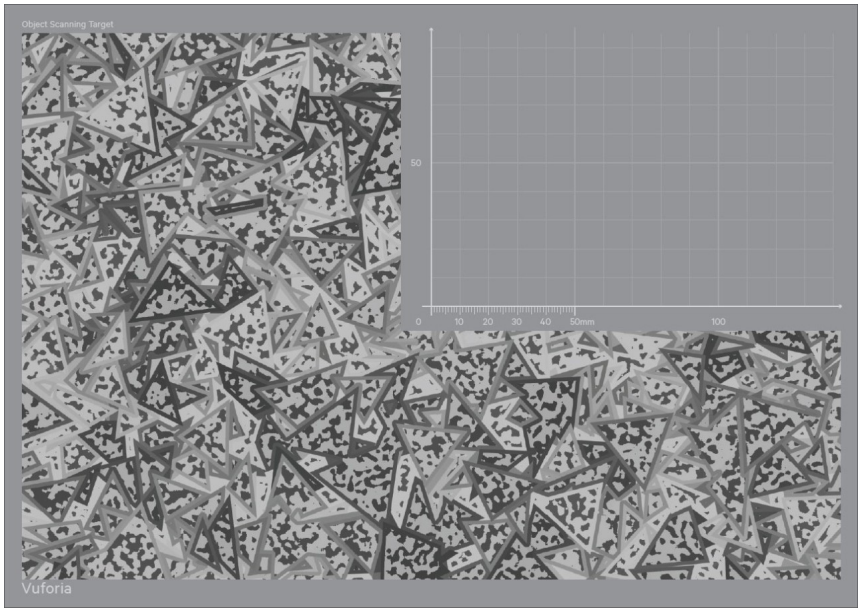


Figure 3.11: Object Scanner target image (Image from the Vuforia Object Scanner APK.)

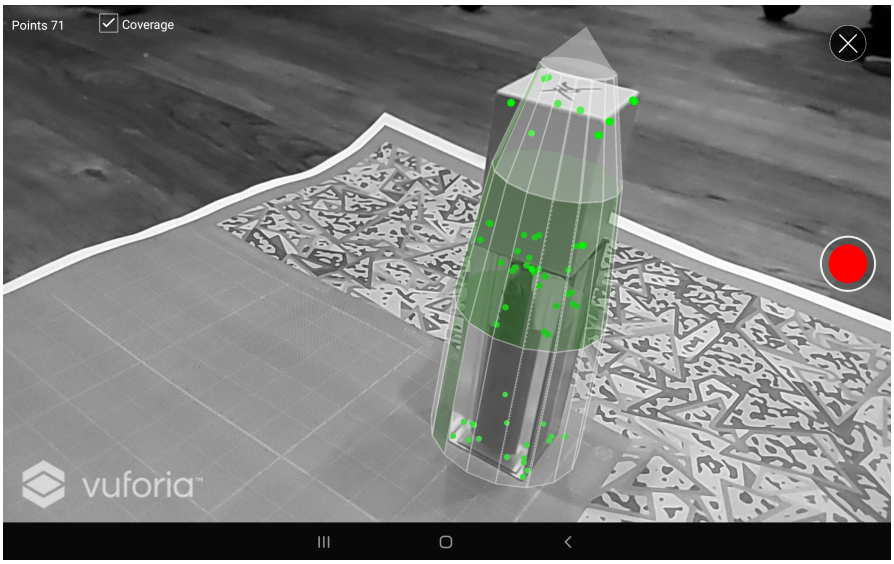


Figure 3.12: A scan in progress (Screen capture by Thuy Dinh from the Vuforia Object Scanner app.)

The file generated by the Object Scanner is an Object Data (*.OD) file. OD files can be uploaded using the online Target Manager to create object target databases. An object target is treated the same as an image target in Unity. Children of the object target **GameObject** are the augmented contents attached to it in Unity's hierarchy.

After all targets have been added, the database is ready for download. The **Unity Editor** option allows the package to be imported and extracted like any other asset package in Unity.

3.3.3 Creating a Scene

All features of Vuforia are accessible as a **GameObject**. A **GameObject** in Unity is any object in a scene, which can rage from lights to cameras to characters.[10] A default scene in Unity always includes the default camera **MainCamera**. However, as the position and orientation of the camera in an AR app depends on the actual pose of the device's camera, the **MainCamera** is replaced by an **ARCamera**, found in **Vuforia Engine** under the **GameObject** menu. **ARCamera** is configured to simulate the pose of the device's camera. To make the app detect a target, the appropriate target GameObject needs to added to the scene. For instance, the Image GameObject creates an Image Target for tracking. The imported target database is selected in the Inspector window under the Image Target Behaviour component. The properties of the **ImageTarget** object have already been preconfigured. Unless users want to add more properties, the target is now ready for tracking. To place other virtual contents in relation to the position of the target, the relevant **GameObjects** must be added as children of the target. This hierarchy ensures that the children objects' pose are always calculated relative to the detected target. This AR app is now deployable

[10] Unity Technologies, "Unity - Manual: GameObject," Unity Documentation, accessed March 12, 2020, https://docs.unity3d.com/Manual/class-GameObject.html.

with one scene that tracks a single target and overlays it with the chosen virtual contents.

3.3.4 Creating Augmented Contents

As discussed, augmented contents can be any 3D **GameObject** in Unity. This project is concerned with two main types of **GameObject**s, quads and 3D models. Quads are used to create augmented maps, textured with the actual map images. The 3D models used are FBX files, downloaded from Sketchfab and imported as assets into Unity. One of the models was created using photogrammetry, a technique that produces 3D models of objects and scenes from raw photographs. The software used to create this model is Meshroom, an open-source 3D reconstruction software.

3.4 Digital Storytelling

In addition to the technical aspect of creating an AR experience, narrative is another important component for producing immersive content. Digital storytelling describes a form of narrative that uses technology and digital media in its production.[11] An AR application is a digital story that utilizes techniques in computer vision and graphics to narrate. As a result, an AR narrative has to follow the same principles as traditional storytelling, which entail having a clear goal, an established structure and format, with consistent and logical behaviors and events, as well as encompassing additional interactive components such as interface, navigation, point of view, gameplay and use of time and space.[12] The process of creating an AR experience, whether done in Unity with Vuforia or on other platforms, must conform to the same principles for designing the narrative.

An AR-enabled historical exhibit performs digital storytelling through the screen

[11] Carolyn Handler Miller, "Storytelling, Old and New," in *Digital Storytelling*, 3rd ed. (Burlington, Massachusetts: Focal Press, 2014).

[12] Miller, "Old Tools/New Tools," in *Digital Storytelling*.

medium. The goal of the AR experience in this project is to demonstrate how the multi-layer memory of Ho Chi Minh City is embedded in objects and spaces such as maps and buildings. To achieve this goal, the experience is structured around physical and virtual exhibit items. Both categories are interactive. Physical items are wall maps, table-top maps and 3D-printed models of buildings. These objects, specifically the 3D-printed models, allow users to access them as they would with tangible objects; they can be picked up, rotated, and moved around. The AR virtual contents also have interactions that users can perform through the mobile device's screen, like dragging and dropping or pinching. An AR narrative moves along by prompting user interactions with visual and audio cues, both onscreen and offscreen. The audio cues in this project are provided by an audio playback during the experience, which advances the narrative through traditional (oral) storytelling and provides guidance for AR interactions.

An important consideration when designing a digital story is deciding whether an immersive treatment is going to enhance it.[13] Physical immersion should only be employed if it makes the narrative more effective. For this project specifically, augmented reality brings perspective agency, which is difficult to achieve on other mediums. Part of the argument is that the recollections provoked by cartography and architecture do not allow much freedom on the side of the citizens of Ho Chi Minh City. Therefore, the exhibit is produced with the hope that it elicits a different kind of recollection that is critical and context-sensitive. Augmented reality supports that freedom, empowering users with the agency to decide their perspectives. Through engagement with and manipulation of space and virtual objects, the experience encourages users to think critically about who is manipulating these sites in reality, how memory is engendered, and what technology has assisted this process of memory formation.

[13] Rebecca Poulson, "Designing Immersive Experiences for Journalism" (The Society of News Design, Chicago, April 4, 2019), https://speakerdeck.com/rapoulson/vr-workshop-2019.

At the intersection of historical scholarship and digital technology, historical digital storytelling using augmented reality must be understood from both a historical and a technological perspective. Understanding the theoretical underpinnings of technologies help designers and users grasp the capabilities and shortcomings of the system in order to utilize it effectively. Narrative design is also as important as the technology supporting it. The next two chapters discuss the historical research behind this AR application narrative.

Chapter 4

The Urban Blueprints: Cartography and the Creation of the City

Mùa xuân trên thành phố Hồ Chí Minh quang vinh!
Ôi đẹp biết bao biết mấy tự hào.
Sài Gòn ơi cả nước vẫy chào.
Cờ sao đang tung bay cao qua hết rồi những năm thương đau.
Xa ba mươi năm nay đã gặp nhau vui sao nước mắt lại trào.

Spring on the glorious Ho Chi Minh City!
How beautiful and proud.
Saigon, the whole country waves its salute.
The flag flies high; all the painful years have passed.
Thirty years apart now we have met again, in tears of happiness.

Xuân Hồng[1]

Following the end of the American war, in 1976, the National Assembly of Vietnam approved the change of the city's name from Saigon to Ho Chi Minh City, after the first Prime Minister and leader of the Democratic Republic of Vietnam.[2] The

[1] Mây Trắng, *Mùa Xuân Trên Thành Phố Hồ Chí Minh*, accessed March 10, 2020, https://nhac.vn/bai-hat/mua-xuan-tren-thanh-pho-ho-chi-minh-may-trang-sodRBWw.

[2] Nghia M. Vo, *Saigon: A History* (Jefferson, N.C: McFarland, 2011), 8.

change of name to the famed communist leader did not spark much controversy in Vietnam. Interestingly, the use of the former name, "Saigon,"is not necessarily subversive.[3] In fact, the name “Saigon” is common in daily conversations and is often interchangeable with Ho Chi Minh City, especially in cultural publications. Songwriter Xuân Hồng, in his famous song "Spring on Ho Chi Minh City"dedicated to the liberation of Saigon in 1975, referred to both names with great pride and adoration. The name change signals a turning point in the city’s memory and marks the onset of a new urban discourse of rapid development. However, as the attachment to the former name Saigon suggests, even amid the current pace of urbanization, leaders and residents of the city still turn to the past in their framing of the city’s present and future. The nuances in other sites of memory are less obvious than in the city’s name. They are embedded in seemingly innocuous sites like maps and land surveys, embraced by different actors to explain past creations and future visions for the city.

A remarkable feature of writings on Ho Chi Minh City is the emphasis on its short history and the monumental accomplishment in this span of time.[4] The memory of the city is rooted in a sense of exceptionalism that has allegedly enabled its

[3] It was mostly among the international community where there was an outrage against the new nationalist name. Erik Harms, “Beauty as Control in the New Saigon: Eviction, New Urban Zones, and Atomized Dissent in a Southeast Asian City,” *American Ethnologist* 39, no. 4 (2012): 748.

[4] Minh Hương, *Nhớ Sài Gòn* (Ho Chi Minh: Nhà xuất bản Miền Nam, 1994).

enormous economical advances.[5] Vietnamese writers sing praises of the favorable climate and geography, which they claim shape the identity of its people, characterized by their resourcefulness, hard work, and open-mindedness people. However, according to this periodization and narrative, Saigon seems to have materialized out of nowhere in the 17th century, despite its former (and current) connections with the Kingdom of Funan, Champa and its Khmer roots.[6] Selective amnesia is theorized in the discourse of memory as an active process that denies the space for exchanges of remembering, or in other words, deletes them from collective memory.[7] The process of ideologizing memory is the constant redefinition of the meaning and boundaries of the city, both in terms of time and space, and requires the use of special sites of memory, or *lieux de mémoire*.[8] This section surveys the use of cartography by the state as a site of memory, complicit in the fashioning of the geographical and social features of Ho Chi Minh City.

The following chapter discusses four different maps of Ho Chi Minh City to explore the relationship between governance and mapmaking and how these dynamic

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[5] During the American war period, Saigon's population doubled from 1.3 million to 2.8 million people. Vietnam's GDP doubled from 1995 to 2006, most which was accounted for by Ho Chi Minh City. The city's population grew from 2009 to 2019 at a rate of 1.77% for urban areas and 4.47% for suburban area. Economic growth was at 8.32% for 2019. Vo, *Saigon*, 16–19; Philippe Peycamm, "Saigon, From the Origins to 1859," in Saigon, Ba Thế Kỷ Phát Triển Và Xây Dựng [Three Centuries of Urban Development], ed. Quang Ninh Lê and Stéphane Dovert, 4th ed. (Ha Noi: Nhà xuất bản Hồng Đức, 2015), 11–16; Thanh Giang, "TP Hồ Chí Minh: Tăng Dân Số Cơ Học Quá Nhanh," *Đại Đoàn Kết*, October 12, 2019, http://daidoanket.vn/do-thi/tp-ho-chi-minh-tang-dan-so-co-hoc-qua-nhanh-tintuc449624; "Ho Chi Minh City Economic Growth in 2019 Estimated at 8.32%," *Nhân Dân Online*, December 1, 2019, https://en.nhandan.org.vn/politics/item/8177902-ho-chi-minh-city-economic-growth-in-2019-estimated-at-8-32.html; "Population Estimates for Ho Chi Minh, Viet Nam, 1950-2015," Mongabay, accessed March 12, 2020, https://books.mongabay.com/population_estimates/full/Ho_Chi_Minh-Viet_Nam.html; "Market Report – Vietnam – Economics," BMI, accessed March 12, 2020, https://bmiglobaled.com/Market-Reports/Vietnam/economic-strength.

[6] The official periodization of Ho Chi MInh City's history is from the 1600s to the present, excluding its pre-Vietnamese past.

[7] Alexandre Dessingué and J. M. Winter, eds., *Beyond Memory: Silence and the Aesthetics of Remembrance*, Routledge Approaches to History 13 (New York: Routledge, 2015), 4; Paul Ricœur, *Memory, History, Forgetting* (Chicago: University of Chicago Press, 2004), 448–52.

[8] Pierre Nora, *Rethinking France: Les Lieux de Mémoire*, trans. Mary Trouille, vol. 1 (Chicago: University of Chicago Press, 2001).

forces are manifested through modifications in the real and imagined landscapes of the city. The four examples studied include (1) an 1815 map by Nguyễn dynasty official Trần Văn Học, (2) an 1895 cadastral map by the French administration of Saigon, (3) an American/South Vietnamese 1961 map, and (4) a 2005 map by the current Ministry of Natural Resources and Environment. The exhibit accompanying this analysis is a mobile augmented reality experience featuring these maps in digital forms, presenting the narrative in its time and space dimensions.

4.1 Cartography in Pre-1800s Vietnam

In the 17th century, European practices of cartography, influenced by Cartesian logic, resembled that of mathematics and other sciences, which emphasized exactness, objectivity, and infallibility. Under by Kant's critical philosophy and Kantian space, the shift in the philosophical concept of space from strictly geometrical to social from the 18th century onward necessitates the reconsideration of representations of space not as an objective science but also as a social project.[9] Following the groundbreaking work by Henri Lefebvre on the production of space, researchers of cartography such as J. B. Harley and Denis Wood have critiqued the relationship between power and mapping.[10] In *Les Lieux de Mémoire*, Pierre Nora considers the role of geographic representations in carving out the boundaries of the state and its national borders.[11] Geography and visual representations of geography are powerful sites of memory for the state. Using examples from royal itineraries from the Renaissance, Nora argues that the visual memory of borders created by French

[9] Henri Lefebvre, *The Production of Space*, trans. Donald Nicholson-Smith (Malden, MA: Blackwell, 1991), 1–2.

[10] Denis Wood and John Fels, *The Power of Maps* (New York: Guilford Press, 1992); J. B. Harley, "Maps, Knowledge and Power," in *The Iconography of Landscape: Essays on the Symbolic Representation, Design, and Use of Past Environments*, ed. Denis Cosgrove and Stephen Daniels, Cambridge Studies in Historical Geography 9 (Cambridge: Cambridge University Press, 1988), 277–312.

[11] Nora, *Rethinking France*, 1:105–32.

kings' tours turned preexisting borders recorded in books into a material reality.[12] According to this theory, mapping is as much a presentation of physical spaces as a representation of the political powers that have carved out these spaces. The social aspect of cartography is thus an important discussion in the history of Vietnam's mapmaking, which is closely entangled with the changing social and political scene.

The history of cartography in Vietnam is a relatively untapped subject, both domestically and internationally, limited by the availability and accessibility of sources.[13] Historiography of the creation and usage of maps in Vietnam is still thin. Vietnamese textbooks on cartography mention the existence of pre-1000 CE plans for building dams and citadels, but no records remain of these documents.[14] Another explanation for this gap is the general unpopularity of cartography in the area due to historic preferences for other modes of cosmological representations of space.[15] Southeast Asia as a whole and other Asian countries such as Japan observed the same void with premodern maps because they utilized different forms of representations.[16]

The first major phase in Vietnam's cartographic history is from the 15th to the late 17th century, starting with the landmark creation of the *Hồng Đức Bản đồ* (Maps of the Hồng Đức Period [1471-97]) under the Lê dynasty. Historian of cartography John Whitmore traces the legacy of this collection and the Lê dynasty's cartographic

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[12] Nora, 1:113.

[13] John K. Whitmore, "Cartography in Vietnam," in *Cartography in the Traditional East and Southeast Asian Societies*, eds. J. B. Harley and David Woodward, The History of Cartography, v. 2, bk. 2 (Chicago: University of Chicago Press, 1994), 478–79.

[14] Lê Văn Thơ, Phan Đình Binh, and Nguyễn Quý Ly, *Giáo Trình Bản Đồ Học* (Ha Noi: Nhà Xuất Bản Nông Nghiệp, 2017), 5; Đại học Tài nguyên và Môi trường Hà Nội, *Bản Đồ Học* (Ha Noi: Đại học Tài nguyên và Môi trường Hà Nội, 2010), 15–16, http://lib.hunre.edu.vn/Ban-do-hoc--5158-47-47-tailieu.

[15] Whitmore, "Cartography in Vietnam," 479–80.

[16] Joseph E. Schwartzberg, "Southeast Asian Geographical Maps," in *Cartography in the Traditional East and Southeast Asian Societies*, ed. J. B. Harley and David Woodward, The History of Cartography, v. 2, bk. 2 (Chicago: University of Chicago Press, 1994), 741; Mary Elizabeth Berry, "Maps Are Strange," in *Japan in Print: Information and Nation in the Early Modern Period* (Berkerley: University of California Press, 2006), 54–103.

traditions in his overview of the cartographic history of Vietnam. The *Hồng-đức Bản-đồ* is a collection of maps of the different provinces of Đại Việt (Great Viet) commissioned by King Lê Thánh Tông in 1467 and finished in 1490.[17] According to Whitmore, this document was the first effort by any Vietnamese courts to perform countrywide mapping.[18] Despite the absence of existing records of the original maps, Whitmore's analysis draws evidence from later attempts at reproduction by the Mạc dynasty and the Trịnh-Nguyễn families during the 16th and 17th centuries to map Vietnam's territories.

Lê dynasty's cartography showed the influence of the Ming map system. The earliest records of Vietnamese maps only date back to the 15th century, during which time the Lê kings adopted the Ming administration model of civil service examinations and literati-officials.[19] Whitmore argues that the expansion of the bureaucratic model both created the need and provided the data for mapmaking. As the court deployed state officials to remote provinces, information began to flow back to the capital and more knowledge were accessible from previously unknown or unreachable areas. A feature of early East Asian cartography is the different modes of representation apart from scale mapping. Scale and mathematical considerations became important with advances in measured mapping under the Ming.[20] Models such as the *Da Ming yitong zhi* (Comprehensive gazetteer of the Great Ming) introduced "comprehensive maps"to supplement geographic information for the gazetteer entries. Maps made during this period by the Lê, such as the *tổng quát* map, illustrate heavy Ming influence. The *tổng quát* map in Figure 4.1 is a possible

[17] Ngô Sĩ Liên, *Đại Việt Sử Ký Toàn Thư* [Complete Annals of Đại Việt], vol. 3 (Ha Noi: Nhà Xuất Bản Khoa Học Xã Hội, 1972).

[18] Whitmore, "Cartography in Vietnam," 479.

[19] Whitmore, 481.

[20] Cordell D. K. Yee, "Reinterpreting Traditional Chinese Geographical Maps," in *Cartography in the Traditional East and Southeast Asian Societies*, 57.

reproduction of the maps in the Hồng Đức collection. The three-ridge representation of mountains is a distinct symbol in the Chinese map system.[21]

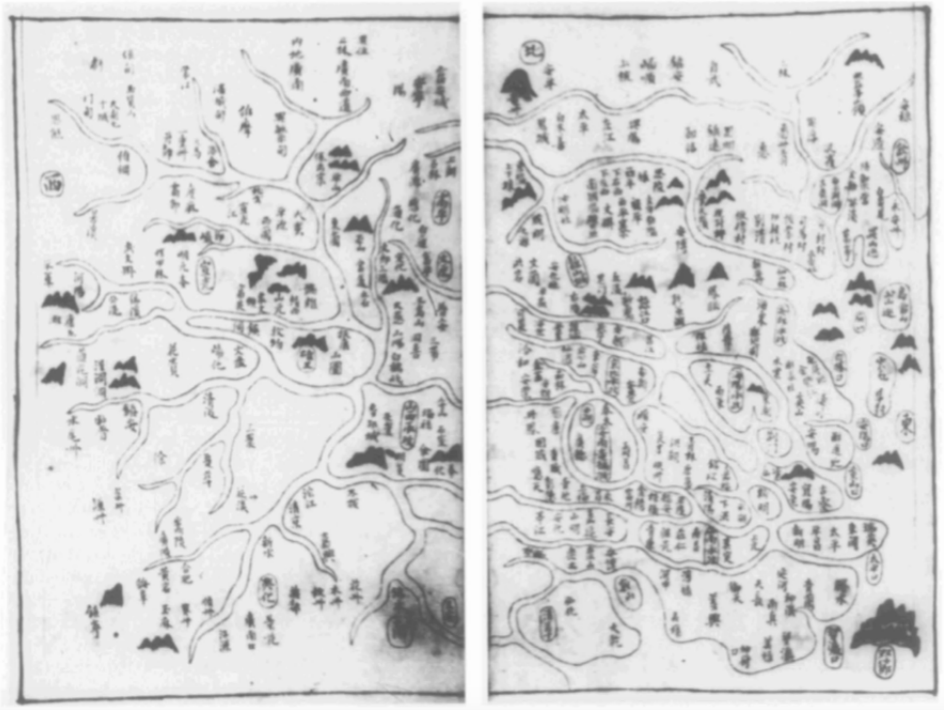

Figure 4.1: A *tổng quát* map of Vietnam, possibly made in the 16th century (Photograph in "Cartography in Vietnam."By Whitmore, 482.)

Vietnamese maps under the Lê were mostly for administrative and military purposes.[22] The few maps of the south were likely plans for military excursions into the lowlands of the Cham and the Khmers. Thus, itineraries, or route maps, played an important part in strategic planning.[23] Maps helped the state with taxation and with exerting control over distant (and foreign) lands. Research on cartography of the same time period in other East Asian regions also illustrates similar connections between maps and politics. Selection of maps and symbols reflects the political significance of the places they depict. Power, specifically the emperor's power, is a major theme; Bangbo Hu concludes that many maps in the Gazetteer of Jiankang Prefecture emphasized the prominence of the royal dwelling palace in comparison

[21] Whitmore, 483

[22] Whitmore, 496.

[23] Whitmore, 495.

to other sites.[24] The map of the capital city Thăng Long in the Hồng Đức collection shows a similar tendency.[25] Parallels between Vietnam and other East Asian countries in terms of cartography exemplify the connection between maps and politics in the region.

The following sections explore the themes of power, water, and identity through cartography. For each theme, the four maps are analyzed and contextualized to extrapolate the patterns of mapmaking and map reading in Ho Chi Minh City. This thematic approach is done at the expense of chronology, but it allows the analysis to delve deeper into common themes across different time periods.

4.2 The Mapmakers of Saigon

One of the questions surrounding cartography is the issues of readership and authorship, or in other words, who needs maps and who gets to produce them.[26] In the case of Ho Chi Minh City, the change in governance and the need for political legitimacy necessitated map production. Cartography is a form of power and knowledge, and this specific knowledge is only accessible by those in power. The cartographic history of the city demonstrates this entanglement between politics, governance, and mapmaking. Every ruling power of Ho Chi Minh City since the 19th century including the Nguyễn dynasty, the French colonial administration, the American-backed South Vietnam government, and the current Socialist Republic of Vietnam, has extensively employed cartography and its symbolic and concrete power to exert influence or control over the city.

Since the formal integration of Saigon into the rest of Vietnam in the 17th century,

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[24] Bangbo Hu, "Maps and Political Power: A Cultural Interpretation of the Maps in The Gazetteer of Jiankang Prefecture," *Cartographic Perspectives*, no. 34 (September 1, 1999): 18.

[25] "Bản đồ Thăng Long theo Hồng Đức Địa Dư (1490) – Plan de Thang-long," *36hn* (blog), January 1, 2015, https://36hn.wordpress.com/2015/01/01/ban-do-thang-long-theo-hong-duc-dia-du-1490-plan-de-thang-long/.

[26] Harley, "Maps, Knowledge and Power," 278.

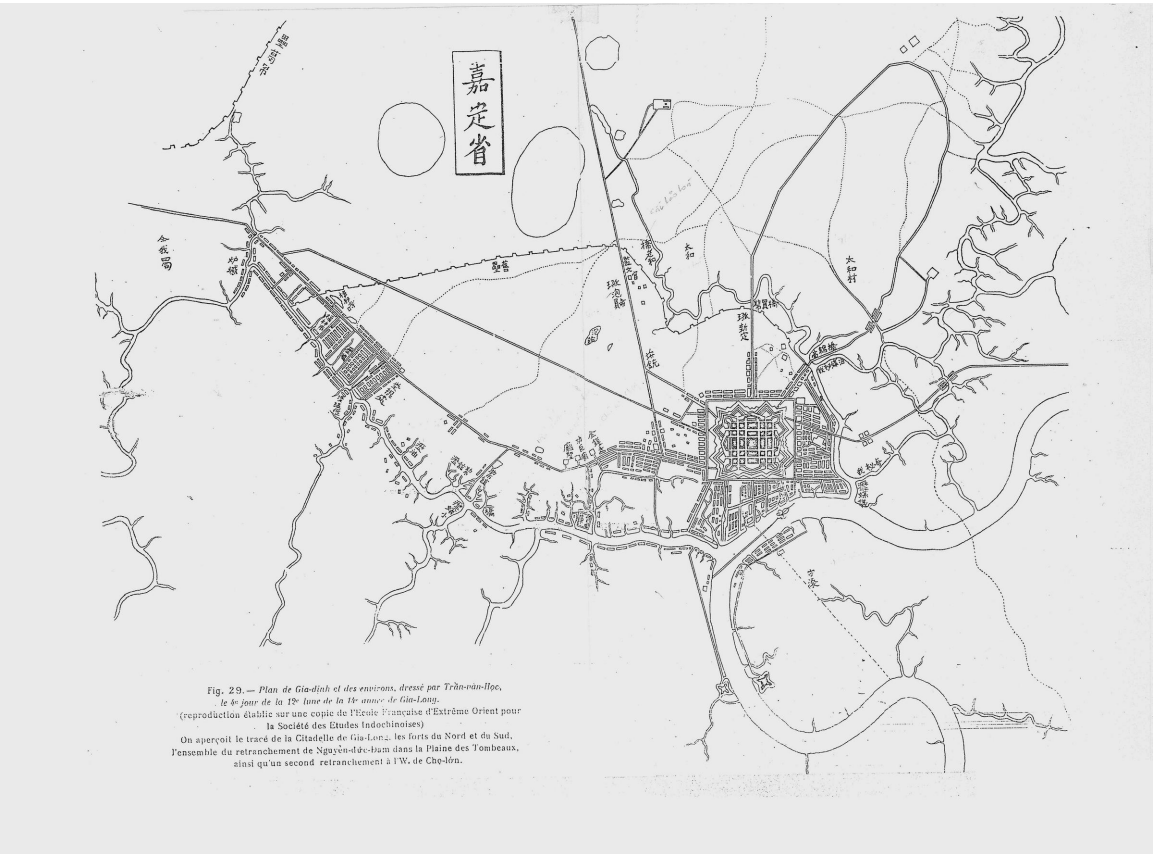

Figure 4.2: Trần Văn Học's 1815 map of Gia Định Province (Map from the CEFURDS Map Collection)[27]

the Nguyễn dynasty was the first prominent mapmakers of Saigon. The history of Vietnam's cartography reflects the surge in cartographic activities in the 18th and 19th centuries, which corresponded with the southward expansion, increased foreign presence, and French colonization.[28] During this period, cartography in Vietnam came under Qing and Western influence.[29] The early 19th century saw Vietnam divided under three rulers: the Nguyễn court in central Vietnam, Nguyễn Văn Thành was the governor in the north and Lê Văn Duyệt in the south.[30] Maps from this era reflected these political divisions, with the court orienting towards a

[27] Trần Văn Học, *Plan de Gia-Định et Des Environs, Dressé Par Trần-Văn-Học, Le 4e Jour de La 12e Lune de La 14e Année de Gia-Long* (Bulletin de la Société des Etudes Indochinoises, 1815), http://virtual-saigon.net/Maps/Collection?ID=1134

[28] Whitmore, "Cartography in Vietnam," 479.

[29] Whitmore, 497.

[30] Whitmore, 499.

Chinese model while the north continued with the Lê cartographic traditions and the south was exposed to Western influence.

In 1815, a Nguyễn dynasty official, Trần Văn Học, drew the first Vietnamese map of Gia Định Province, the administrative name given to the Saigon area by the Nguyễn (Figure 4.2).[31] Trần Văn Học was a prominent architecture for King Gia Long in the early 19th century. Fluent in modern Vietnamese and Latin, he had gone on various diplomatic missions to France and India for the court.[32] Trần Văn Học possessed an extensive knowledge of Western technology and translated many European scientific texts into Vietnamese. He was involved in the design of the Bát Quái citadel and the naming of streets in the inner quarter. In 1815, Trần Văn Học drew a complete map of Gia Định, presumably under the commission of the Nguyễn court. His technique was inspired by Western cartography, complete with Chinese labels of important areas. The making of this map took place while the Nguyễn was attempting to consolidate power in the south, especially in the context of the rise to power of Gia Định's governor Lê Văn Duyệt, who was rivalling the imperial influence of the court. The practice of cartography in Saigon by the state took precedent from this period and persisted into the next decades of colonialism, wars, all the way to the present.

The change in governance from the imperial Nguyễn to colonial French marked a shift in the stakeholders of the cartography industry in the south. Production of Saigon's maps continued, undertaken by the newcomers in town, who were awash with imperial ambitions and desire to achieve them through geographical conquest.

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[31] Trần Nam Tiến, *Sài Gòn-TP.HCM Những Sự Kiện Đầu Tiên Và Lớn Nhất* (Ho Chi Minh: Nhà Xuất Bản Trẻ, 2006), 285; Trần Văn Giàu, *Địa Chí Văn Hóa Thành Phố Hồ Chí Minh Tập 1 - Lịch Sử* (Ho Chi Minh: Nhà xuất bản Thành phố Hồ Chí Minh, 1987), 190.

[32] Thụy Khuê, *Vua Gia Long & Người Pháp: Khảo Sát về Ảnh Hưởng Của Người Pháp Trong Giai Đoạn Triều Nguyễn* (Ha Noi: Nhà xuất bản Hồng Đức, 2017), 267.

French colonial rule over Saigon began in 1961 with a series of plans for development.[33] In 1962, the French military engineer in charge of the urban development of Saigon, Colonel Coffyn, produced a plan for setting the delimitations of the city of Saigon.[34] Other cartographic works supporting this project included a cadastral map by the French cartographer A. Chauvet for the Service du Cadastre et de la Topographie [Department of Cadastre and Topography] in Saigon (Figure 4.3). The abundance of colonial maps exposes the link between cartography, urban planning and power. Colonialism requires mapping in order to dominate.[35] The relationship between cartography and empires is implied in access to geographical information and the technological know-how of mapmaking, which only comes with power.

The theme of power mapping carried over to the Republic of Vietnam era. Under the South Vietnamese government and the American authority in Saigon, production and circulation of maps continued with renewed fervor. The new regime was eager to redefine Saigon as a befitting capital of the new South Vietnamese state and established a new department for cartography in 1955, the National Geographic Service of Vietnam.[36] The American Army Map Service (AMS) also partook in the mapping of Vietnam. The AMS was responsible for the production and compilation of maps and related geographic information in the service of the U.S. Armed Forces.[37] The AMS boasted an extensive collection of military maps of Vietnam, created in close cooperation with the National Geographic Service of

[33] François Tainturier, "Architecture and Urban Planning during the French Administration in Saigon," in *Saigon*, ed. Lê Quang Ninh and Stéphane Dovert, 77–81.

[34] Tôn Nữ Quỳnh Trân, "Sài Gòn qua các bản đồ," in *Ấn tượng Sài Gòn - Thành phố Hồ Chí Minh* (Ho Chi Minh: Nhà xuất bản Trẻ, 2015), 14.

[35] James R. Akerman, *The Imperial Map: Cartography and the Mastery of Empire*, The Kenneth Nebenzahl, Jr., Lectures in the History of Cartography (Chicago: University of Chicago Press, 2009), 3.

[36] National Geographic Service of Vietnam, *Nha Dia Du Quoc Gio [i.e. Gia] (National Geographic Service of Vietnam): Ten Years of Operations 1955-1965*. (Ho Chi Minh: NGS, 1965), 1.

[37] Corps of Engineers, U.S. Army, *The Army Map Service: Its Mission, History and Organization* (Washington, D.C., 1960), 2.

Vietnam. The map in Figure 4.4 was made by the National Geographic Service made a map of Saigon in 1958 and was republished by the AMS in 1961, revised for strategic purposes. These two institutions monopolized cartographic production in Saigon from the end of the First Indochina War until the fall of South Vietnam (1955 - 1975).

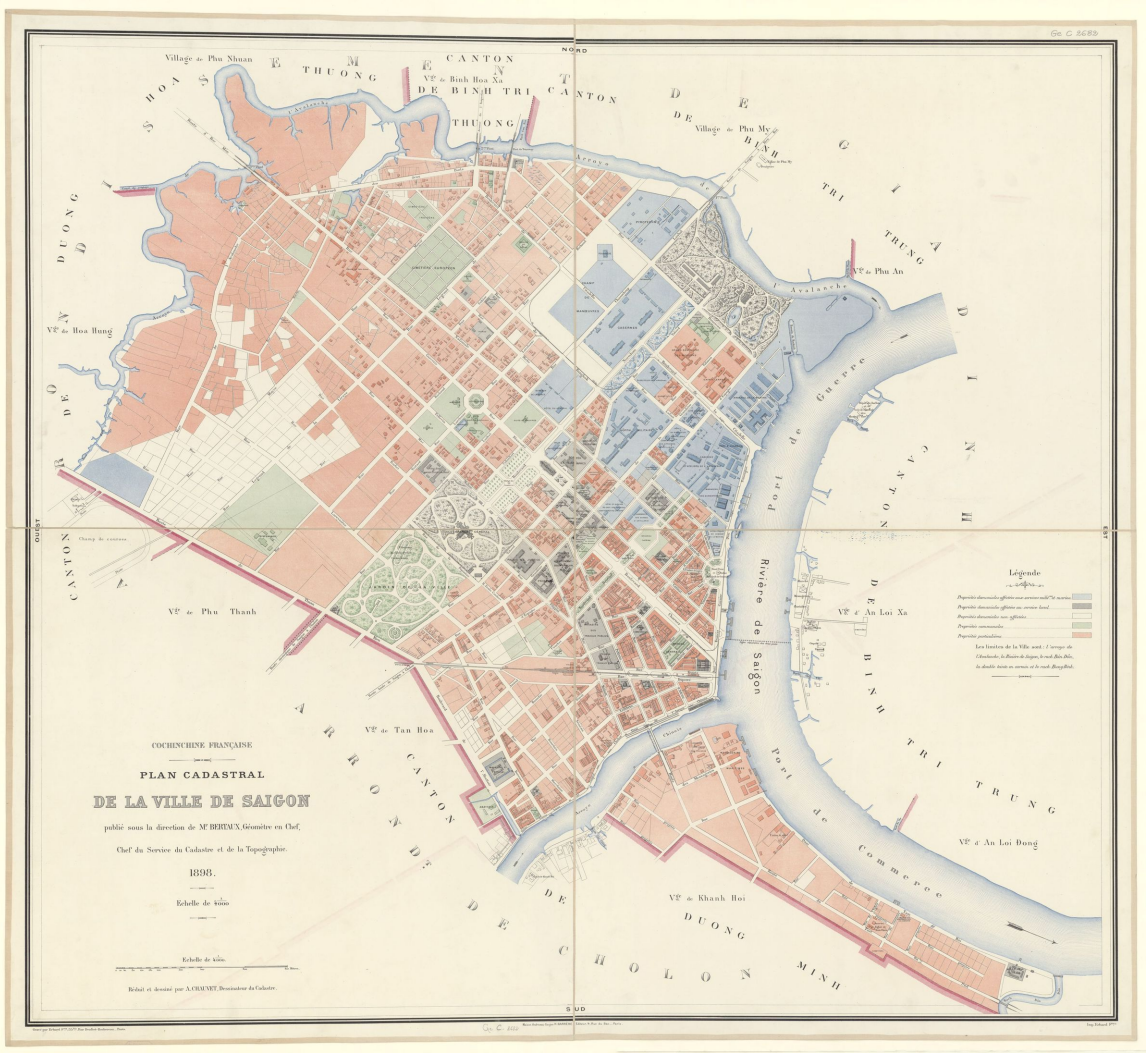

Figure 4.3: An 1898 cadastral map of Saigon commissioned by the Service du Cadastre et de la Topographie in Saigon (Map by M. Bertaux and A. Chauvet.)[38]

Nothing attests to the connection between governance and the need for cartography like the postwar effort by the socialist state to nationalize cartography. After

[38] M. Bertaux and A. Chauvet, *Cochinchine Française: Plan Cadastral de La Ville de Saïgon*, 1:4000 (Service du cadastre et de la topographie, 1898), https://gallica.bnf.fr/ark:/12148/btv1b530297676.

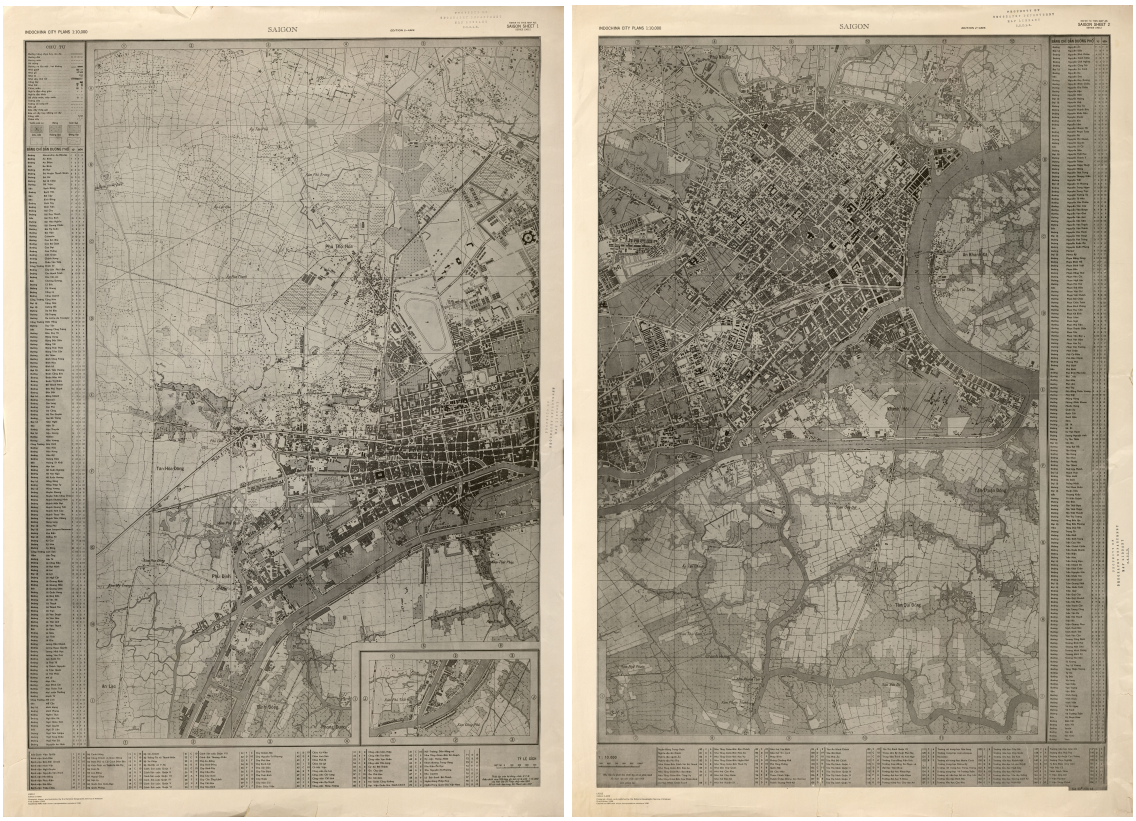

Figure 4.4: The U.S. Army Map Service 1961 edition of the *Saigon* map, first published in 1958 (Map from the Perry-Castañeda Library Map Collection.[39])

1975, the new Vietnamese government took over the task of imposing definitions and boundaries on the Saigon region through mapping. Government institutions continue to be responsible for overseeing the creation of cadastral and land use maps for urban planning and land development purposes.[40] The current regulating body of cartographic activities in Vietnam is the Department of Survey, Mapping and Geographic Information, a unit under the Ministry of Natural Resources and Environment (MONRE). The map in Figure 4.5 was made by MONRE in 2005. The Vietnamese government puts special emphasis on cartography as a tool for

[39] National Geographic Service of Vietnam and U.S. Army Map Service, *Saigon*, 1:10000 (U.S. Army Map Service, 1961), http://legacy.lib.utexas.edu/maps/world_cities/txu-pclmaps-saigon_sheet1-1961.jpg.

[40] Annette Miae Kim, *Sidewalk City: Remapping Public Space in Ho Chi Minh City* (Chicago: The University of Chicago Press, 2015), 58.

national security and land development.[41] Throughout its history, the mapmaking industry of Ho Chi Minh City remains an exclusively national business to facilitate the interests of whichever administration was in power at the time.

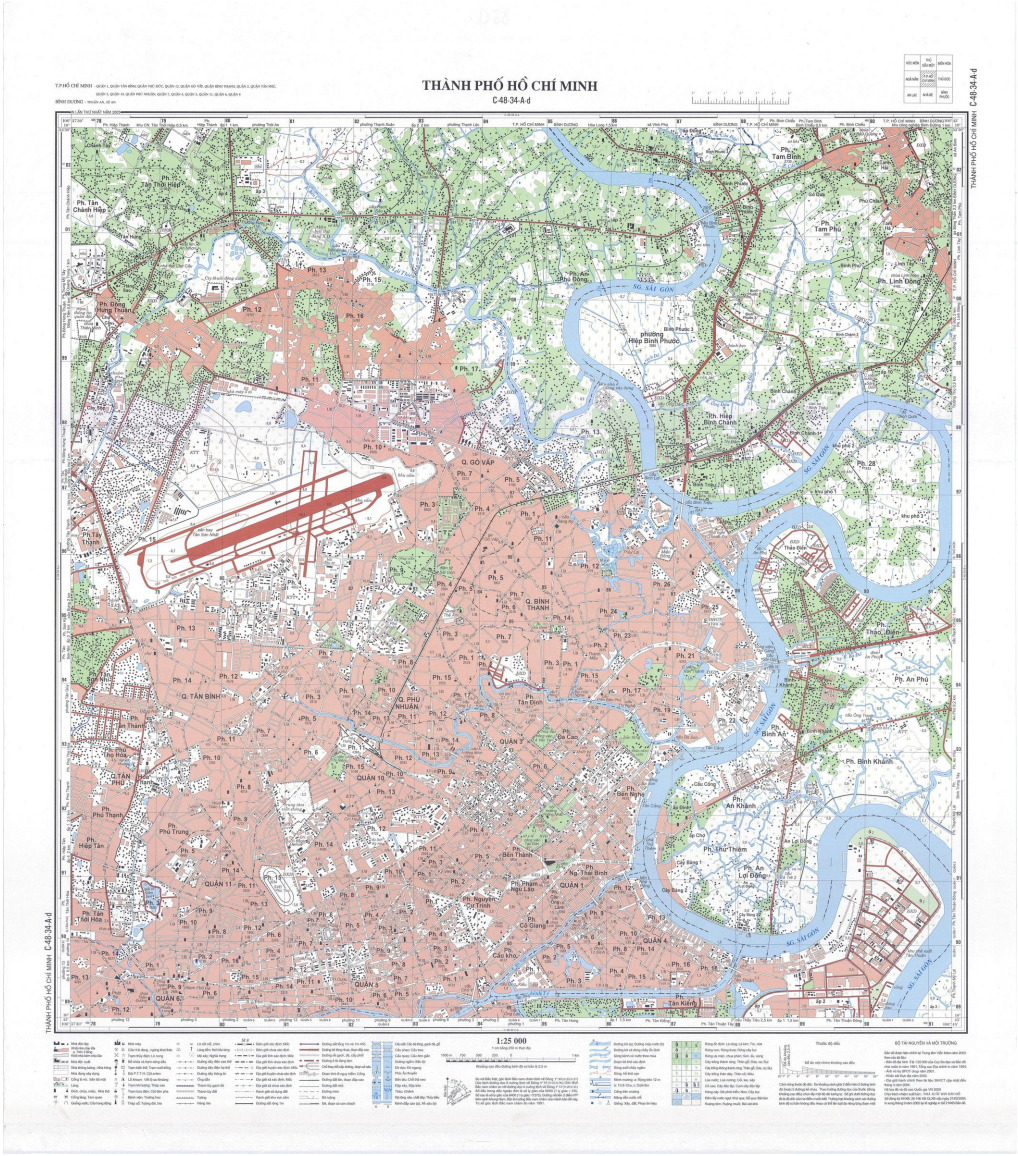

Figure 4.5: A 2005 map of Saigon by the Ministry of Natural Resources and Environment.[42]

Across the four maps, the symbolic and physical boundaries shifted from one period to another. The city of Saigon and now Ho Chi Minh City have been

[41] Bộ Tài nguyên và Môi trường, "Quy Định Chức Năng, Nhiệm vụ, Quyền Hạn và Cơ Cấu Tổ Chức Của Cục Đo Đạc, Bản Đồ và Thông Tin Địa Lý Việt Nam," May 16, 2017, http://dosm.gov.vn/SitePages/GioiThieu.aspx?item=568.

[42] Bộ Tài nguyên và Môi trường, *Thành Phố Hồ Chí Minh. C-48-34-A-d, 1:25000* (Ha Noi: Nhà xuất bản Bản đồ, 2005), http://virtual-saigon.net/Maps/Collection?ID=1141.

demarcated by tangible and imagined lines of waterways and borders. As the regimes produced blueprints, they also manufactured memoryscapes to facilitate remembrance in the city.

4.3 The Conquest of Water

Rulers make maps to develop and control the land, but it isthe land, and in Ho Chi Minh City's case, its water, that dictates the direction of development. Water has always been a part and parcel of life in Ho Chi Minh City. The water system is intricately connected to the lifestyle of the city's inhabitants, both as a resource and a challenge. Ho Chi Minh City was originally a marshland. The historic center, Bến Nghé, lies on the west bank of the Saigon river. The closest port to the city center is about 45 miles inland from the East Sea.[43] This awkward position hampered Saigon's potential to compete with more accessible ports further north and south with specialized products such as Sóc Trăng (red salt), Cà Mau (fish), and Hội An (spices) in the pre-Vietnamese period (before the 16th century).[44] The inhospitable tropical weather and marshy landscape of Saigon, with its crocodiles and tigers, limited the area's growth before the 11th century under the Cham and later the Khmer from the 11th century to the 16th century.[45] However, when the Vietnamese and extant Ming moved into the area and brought with them wet rice agriculture and trade in the 16th century, Saigon became a major hub for trading because it granted access to the riches of the Mekong Delta.[46] The marshes previously swamped with wild animals now provided access from the main river to the Chinese quarters. The

[43] Bảo tàng Thành phố Hồ Chí Minh, "Sài Gòn - Thành Phố Hồ Chí Minh: Thương Cảng, Thương Mại - Dịch Vụ," Bảo tàng Thành phố Hồ Chí Minh, accessed November 28, 2019, http://www.hcmc-museum.edu.vn/en-us/store/1123-sai-gon-thanh-pho-ho-chi-minhbrthuong-cang-thuong-mai-dich-vubr.aspx.

[44] Vo, *Saigon*, 7.

[45] Võ, 1; Sơn Nam, *Đất Gia Định - Bến Nghé Xưa & Người Sài Gòn* (Ho Chi Minh: Nhà xuất bản Trẻ, 2016), 47–60.

[46] Vo, *Saigon*, 1–7.

declining silt conditions at central Vietnamese ports such as Hội An also helped to elevate Saigon in the South China maritime trade.[47] These developments show that the economic progression of Saigon was as dependent on the local riverine system as it was restricted by the same water lines. To harness this part of land is to control the water system that governs the life of everything on it.

Figure 4.6: The bend of the Saigon River depicted by Trần Văn Học (Image cropped from map by Trần Văn Học.)

As the first Vietnamese government in the south, the Nguyễn dynasty put great emphasis on strategic understanding of the water network. This priority is noticeable in the 1815 map; Trần Văn Học, charged by the rulers to map Saigon, paid extreme attention to depicting the water system, especially in terms of the bend of the Saigon River. He improved the measurement methods used in previous French maps, exemplified by the measurement line around the river bend (Figure 4.6). The proportional accuracy of this map was adjudged to surpass the quality of previous French maps of Gia Định.[48] The map's details demonstrate how important it was for the new rulers of Saigon to establish an understanding of the layout of the land, and in this case its water, to consolidate power over the city.

The marshy landscape of Saigon posed an obstacle for the Nguyễn rulers, but it was also an opportunity, which the state exploited to build the city's defense. Figure 4.7 shows the strategic position of the city center, bounded on the north and south sides by two large arroyos, Bến Nghé and Chợ Lớn, and on the east side by the Saigon River. The Nguyễn governors in the city built their

[47] Ben Kiernan, *Việt Nam: A History from the Earliest Times to the Present* (New York: Oxford University Press, 2017), 252.

[48] Thụy Khuê, *Vua Gia Long & Người Pháp*, 267.

Figure 4.7: The Bát Quái citadel (Image cropped from map by Trần Văn Học.)

administrative and military structures around the main waterways. To fight off the Siamese, in 1772, Nguyễn Cửu Đàm, a general under the Nguyễn, built the Ruột Ngựa canal and Lũy Bán Bích (Bán Bích Rampart), connecting the two main arroyos, to close off the remaining open east side of the city with a perimeter of water and rampart.[49] In 1789, Lord Nguyễn Ánh (later became King Gia Long) commissioned the construction of the Bát Quái citadel (Figure 4.7) on the bank of the Saigon River.[50] Controlling the water and utilizing it as a defense became a mainstay for political regimes that governed Saigon since the 18th century.

Water was the lifeline of communications in the city under the Nguyễn Dynasty. The waterways were reproduced in extreme detail, compared to previous maps. Trần Văn Học provided careful annotations of rivers, canals, and bridges, in addition to riverine residential areas. An important Vietnamese writer on southern Vietnam, Sơn Nam, notices how the term *đất giồng* (alluvial banks along rivers and creeks), specific to the Southern Vietnamese dialect only, reflects the significance of water in the area.[51] Trần Văn Học's map clearly identifies *đất giồng* concentrations along the main riverways with small rectangular symbols. In addition to the water system and the riverine neighborhoods, markets and pagodas make the rest of the annotations on the map. The importance of water at the time was comparable to that of communal spaces. Their embankments served as both commercial and spiritual centers for Saigon inhabitants.

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[49] Huỳnh Ngọc Trảng, *Sài Gòn - Gia Định xưa: tư liệu & hình ảnh* (Ho Chi Minh: Nhà xuất bản Thành phố Hồ Chí Minh, 1997), 12–13.

[50] Vo, *Saigon*, 37.

[51] Sơn Nam, *Đất Gia Định - Bến Nghé Xưa & Người Sài Gòn*, 47.

When French imperial powers invaded the land in the second half of the 18th century, their conquest of Saigon also depended heavily on water. French strategy of "gunboat diplomacy" relied on water mobility for success.[52] French troops launched their first attack on Saigon in 1959. Their gunboats followed the Saigon river straight to the east gate of the citadel, which was only 500 meters from the nearest river port.[53] Despite serving their military interests, water also created major problems for French imperialists. After capturing Saigon, colonial forces encountered a marshy landscape of sparsely populated plains and a convoluted network of creeks and rivers.[54] Their imperial conquest did not end with the 1961 military victory. The conquest triggered more resistance from by the land and its people, which continued to manifest throughout French colonization of Saigon. French maps of the area during this period were one way to control these tensions.

Figure 4.8: Boulevard Charner (marked red) (Image cropped from map by M. Bertaux and A. Chauvet.)

The conquest of water is evident in the French cadastral map of 1898 (Figure 4.3). One of the map's curious features is the convenient absence of the complicated water system and marshy landscape of Saigon. The only waterways depicted are the Saigon River and short parts of the arroyos Bến Nghé and Thị Nghè. The wild, flooded plains did not fit French visions of a city. To fix this, the colonizers came

[52] David Biggs, *Quagmire: Nation-Building and Nature in the Mekong Delta* (Seattle: University of Washington Press, 2010), 23–26.

[53] Chung Hai, "Nếu còn thành cũ, Gia Định không dễ thất thủ ngày 17-2-1859," *Tuổi Trẻ Online*, February 17, 2016, https://tuoitre.vn/news-1052677.htm.

[54] Vo, *Saigon*, 75.

up with development plans to make it habitable and conforming to Western standards.[55] Colonial alterations to the water landscape ranged from marsh cleanups to bridge construction and canal projects facilitating the extraction of goods. In 1875, French Admiral Victor-Auguste Duperré conceived a major plan for building a new inland water network to connect Saigon to the Mekong Delta.[56] This mega plan involved the expensive project of the Chợ Gạo canal, creating a direct route by water from Saigon to the nearest delta Port, Mỹ Tho. Other projects included the filling of canal for land transport.[57] The construction of Boulevard Charner (Figure 4.8) revolved around the the cleanup and filling of the Chợ Vải Canal; this area used to be a floating market for Indian textile.[58] Urban planning projects from this period completely reconfigured the geographical landscape of Saigon, especially on the water frontier.

After the end of the First Indochina War in 1954, under President Ngô Đình Diệm, the Republic of Vietnam took control of the city and embarked on a series of modernizing programs building upon existing French groundwork with American aid funds.[59] Renovation projects solidified colonial alterations to the water environment with more bridges, dams, and other transportation and irrigation systems. The 1961 map of Saigon (Figure 4.4) shows the newly introduced ferries for transportation across the Saigon River. The South Vietnamese and American mapmakers continued to exhibit the conspicuous absence of marshes, a persisting cartographic pattern stemming from the French period. Urban infrastructure and plantations replaced the old flooded plains. Natural frontiers such as rivers and

[55] Tainturier, "Architecture and Urban Planning during the French Administration in Saigon," 79–80.

[56] Biggs, *Quagmire*, 32.

[57] Tainturier, "Architecture and Urban Planning during the French Administration in Saigon," 78–81.

[58] Sơn Hòa, "Những Kênh Rạch Xưa Thành Đại Lộ Đẹp Nhất Sài Gòn," *VnExpress*, April 10, 2016, https://vnexpress.net/thoi-su/nhung-kenh-rach-xua-thanh-dai-lo-dep-nhat-sai-gon-3380037.html.

[59] Biggs, *Quagmire*, 154–55.

canals, however, still served as a barrier to urban expansion. In the map, the east bank of the Saigon River is mostly covered by rice fields and canebrakes. The same can be said of the north and south banks of the Thị Nghè and Bến Nghé arroyos.

The battles of the American war were fought not only on land but also on the waterfront. Knowledge of water conditions became decisive for all sides. Cartographic techniques to depict water networks became more precise with the introduction of aerial photography.[60] The 1961 South Vietnamese map uses the Universal Transverse Mercator coordinate system and aerial photographs by the French Department of Geography. Enabled by advanced spatial and aerial technology, mapping remains one of the strongest weapons against North Vietnamese guerrilla resistance. While Americans and allies relied on staying above water for survival, Vietnamese revolutionaries depended on water for undercover. Competing technological and spatial knowledge of the delta landscape spawned different tactical orientations for each side.

The theme of water mapping is also dominant in the postwar period, with maps of Ho Chi Minh City focusing on urban development along water lines. The 2005 map of the city (Figure 4.5) outlines new development projects. Examples include the Saigon River bridge complex (Figure 4.9), the first permanent structures to connect the Saigon River's east

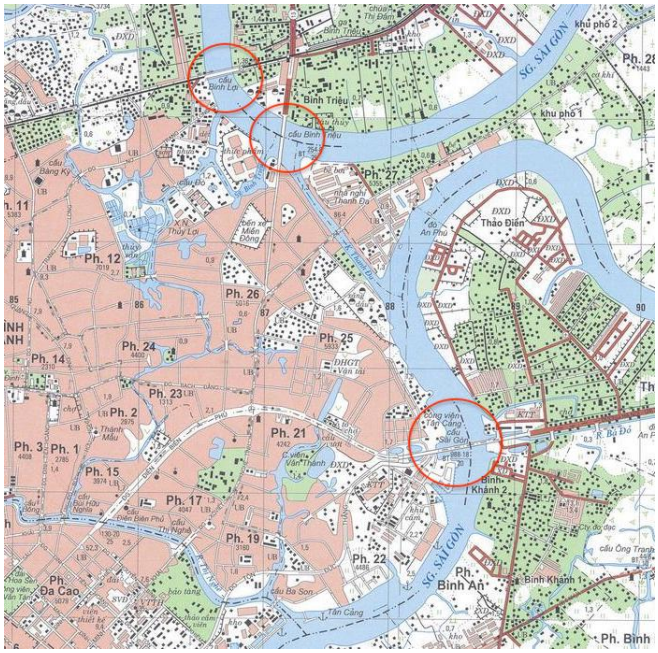

Figure 4.9: Saigon River bridge complex (circled red) (Image cropped from map by Bộ Tài Nguyên và Môi Trường.)

[60] Biggs, 200.

and west banks. The recent completion of the Thủ Thiêm bridge and tunnel complex has fully integrated the swampy eastern suburbs of Ho Chi Minh City into the center, expanding the metropolis to engorge areas previously unsuitable for development. Detailed riverine classifications on the map reveal how water is still central to the city's livelihood. The major difference in this map is how the water system has morphed into becoming a part of the urban network of roads, bridges, railroads, ferries, etc. Meanwhile, manmade augmentations are naturalized as part of the terrain and other natural configurations.

As much as these maps tell the story of water in the city, they also obfuscate the pitfalls of geographical modifications. Topography maps blur the lines between natural waterways and artificial structures, forged through violent use of technology to change the environment.[61] They fail to show the disastrous shortsightedness and a total disregard for the environmental sustainability of these masterplans. Development designs hide the permanent damages of nation-building projects on the natural and social landscapes. Public sanitation became a major problem for the French administration as issues with freshwater accessibility and waste disposal were overlooked, indicative of the superficial and hypocritical nature of urbanization.[62] Some of the canals dredged by the colonial administrations during this period have long silted up.[63] From 2005 to 2012, the Thị Nghè arroyo (now Nhiêu Lộc canal) underwent a major renovation which involved digging up the riverbed to enable trash removal and reorganizing the sewage disposal system.[64] Maps erase from memory deteriorating environmental conditions and natural disasters from transformations to the water landscapes.

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[61] Biggs, 71–73.

[62] Tainturier, "Architecture and Urban Planning during the French Administration in Saigon," 81.

[63] Biggs, *Quagmire*, 71.

[64] Văn Hiến, "Bài 3: Cải Tạo Kênh Nhiêu Lộc – Thị Nghè: 'Công Trình Thế Kỷ' Của TP. Hồ Chí Minh," *Báo Mới*, January 31, 2018, https://baomoi.com/bai-3-cai-tao-kenh-nhieu-loc-thi-nghe-cong-trinh-the-ky-cua-tp-ho-chi-minh/c/24818795.epi.

4.4 Imagining the City

By Merriam-Wester's definition of a city as "an inhabited place of great size, population, or importance," pre-eighteenth century Ho Chi Minh was by no means a city.[65] Originally, the region was mostly marshlands and barely habitable. Compared to other towns and cities in the south, the Saigon basin did not have any economic edge over port centers in the Mekong Delta. The city sprang into existence under the Nguyễn dynasty and continued to rise in importance, today with a population of 9 million.[66] Memory of Ho Chi Minh City mostly focuses on its short but rapid development and urbanization in the last three centuries, without considering its previous geographical and economic conditions and ethnolinguistic diversity. The reimagined history of the city needs to be compelling to legitimize and consolidate its creation. The official narrative of development as a result must consistently be reaffirmed to legitimize and consolidate the myths of its origin and development. Consideration of the role of political and social factors in urban construction is vital for understanding memory formation. The planning of a city is not only practical but also symbolic. Ho Chi Minh City is a product of imagination, conceived in development plans, brought into existence with construction projects, and preserved in the memory of the land by cartography. Maps communicate envisioned boundaries that define new spaces as well as their meanings.

The historical context of Vietnamese migration is important for understanding the emergence of the Saigon and Chợ Lớn conurbation. During the 16th and 17th century, social and economic developments in Vietnam elevated Saigon's status in the eyes of Vietnamese ruling powers. Evidence of this rise can be gleaned from the 1815 map (Figure 4.2). Saigon formally became part of "Phủ Gia Định" (Gia Định

[65] "City," in *Merriam-Webster* (Merriam-Webster), accessed November 28, 2019, https://www.merriam-webster.com/dictionary/city.

[66] Thông tấn xã Việt Nam, "Dân Số TPHCM Gần 9 Triệu Người, Đông Nhất Cả Nước," *Báo Sài Gòn Đầu Tư Tài Chính*, October 12, 2019, https://saigondautu.com.vn/content/NjcxMDQ=.html.

Province) under King Minh Mạng, but Vietnamese rulers had long set its perimeter and continued to draw new boundaries in the south, creating six delta provinces.[67] How the map depicts these borders reveals the value of gaining knowledge about newly acquired lands for the Nguyễn court, who later used this territorial repertoire to ratify administrative divisions of the Mekong Delta.

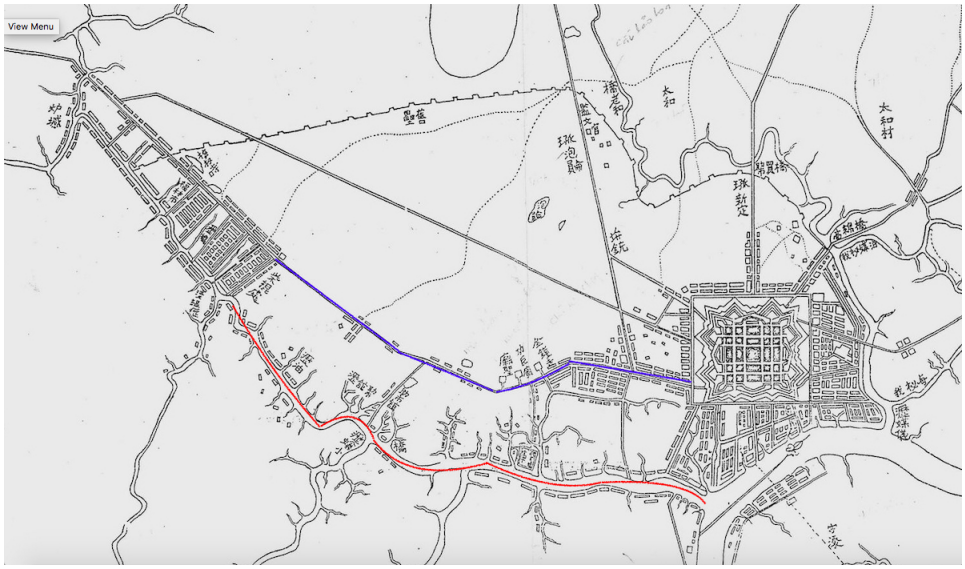

Figure 4.10: The communication lines of the Nguyễn Dynasty's Saigon. The Bến Nghé Arroyo is marked red and the Royal Road blue. (Image cropped from map by Trần Văn Học.)

The Nguyễn lords had already begun development of the Gia Định Province long before Trần Văn Học created the map in 1815. The design shows two main centers, Bến Nghé and Chợ Lớn. Chợ Lớn is the historic Chinese settlement, then dominated by Ming and Qing merchants. When Vietnamese ruling families arrived in the area, they settled down on the left bank of the Saigon River, separate from the Chinese end.[68] In the map, the Bát Quái citadel (Figure 4.7) stood in the center of Bến Nghé, bounded on the north and south sides by arroyos Thị Nghè and Bến Nghé and the Saigon River in the east.[69] Despite the separation of administrative quarters from commercial ones, lines of communication still connected the two ends

[67] Huỳnh Ngọc Trảng, *Sài Gòn - Gia Định xưa*, 37.

[68] Huỳnh Ngọc Trảng, 6.

[69] Vo, *Saigon*, 8-9.

of the city on both land and water. The map shows the Bến Nghé Arroyo joining the Chinese quarter to the administrative area. The two centers of Gia Định were also connected by Đường Cái Quan, the Royal Road that ran through the length of Việt Nam at the time, from the northern border with Qing China all the way to the southernmost province of Hà Tiên.[70] Communication was decisive as the Nguyễn felt the need to tighten their reins over "wayward Southern barbarians," who according to them were fraternizing with Chinese opium dealers and Catholic missionaries, abandoning their core Confucian values.[71] Urban development from this period was to rein in Saigon's autonomy, rendering it a subservient imperial city resistant against the encroachment of Western and Chinese influence.

These visions of a traditional city were soon supplanted by the French conception of a European city. The colonial government took over the groundwork of city building from the imperial court in the decades following their conquest. The abundance of development plans for Saigon during the colonial era tells the story of French colonial aspirations for building the city. The grand vision for a "Paris of the East" met with enormous challenges, and urban planning was especially important because of Saigon's special geography. Early development maps of Saigon were not just a symbol of power; they also exposed the colonizers' struggle to harness the land. In their attempt to control the geography of Saigon, French urban architects employed extensive use of cartography. Cadastral maps rose in prominence as the city was subdivided into smaller sections and plots.[72] The 1898 French map shows the different land ownership types, demarcating four main sections: administrative, commercial, industrial, and residential. The administrative quarter of the city was located on the left bank of the Saigon River, upstream from the commercial port.

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[70] Trung Sơn, "Những Con Đường Thiên Lý Đầu Tiên Của Vùng Đất Sài Gòn," *VnExpress*, September 5, 2017, https://vnexpress.net/thoi-su/nhung-con-duong-thien-ly-dau-tien-cua-vung-dat-sai-gon-3636181.html.

[71] Vo, *Saigon*, 54.

[72] Tainturier, "Architecture and Urban Planning during the French Administration in Saigon," 75.

Military facilities mostly occupied the northwestern bank, guarding the entrance to the city center and the administrative section. Most of the commercial and residential districts lie south of the Bến Nghé – Chợ Lớn border.

French development projects created the border between the Saigon city and Chợ Lớn. The geographical homogeneity of Saigon is a fabrication by governing regimes. The same applies to its imagined borders. While Trần Văn Học's 1815 map depicts Gia Dinh as one province, the 1898 French map clearly marks the borders of the city as separate from the market town of Chợ Lớn. The colonial map denotes the border splitting Saigon from Chợ Lớn with a thick red line; the Chinese side reads Arrond de Cholon (District of Chợ Lớn). The city of Saigon was created by French urban planning, its borders divided along geographical and cultural lines. In a critical cartography project on Ho Chi Minh City, Annette Kim proposes that the notion of Ho Chi Minh City as a single, continuous space is only a recent reimagination, and that its history is really the tale of two cities.[73] French planning created a stark difference in landscape between the two parts of town, resulting in social stratification within the city.

French visions for an ideal *métropole* came across in maps at the exclusion of ethnic Chinese and indigenous Cham and Khmer populations, but cultural segregation is not the only elusive aspect in cartography. Urban mapping captures the transformation of Saigon from marshlands into a city decked by colonial architecture and paved boulevards, while hiding issues with waste disposal and clean water accessibility.[74] Old water lines were now replaced by roads, tramways, and new canals.[75] Grandiose monuments distracted urban planners from the problems with environmental sustainability. The fabricated colonial city was doomed to failure

[73] Kim, 28-37.

[74] Kim, 38–39; Tainturier, "Architecture and Urban Planning during the French Administration in Saigon," 81.

[75] Kim, *Sidewalk City*, 32–39.

from the outset, and their development maps were just a series of disguise for the shortsightedness of this vision.

Similar to the French government, for the South Vietnamese state, urbanization was not only a side project; it provided justification for their authority and legitimacy. In the French case, civilization was the pretext for colonialism. This rhetoric is echoed in the Second Indochina war period. The Saigon government and its American counterparts needed to prove their supremacy over North Vietnam, and nation building was one such display of power.[76] Modernization theory is the premise of America and South Vietnam's nation-building programs.[77] In the first decade under the South Vietnamese state (1954 – 1964), Saigon experienced a major influx of migrants, especially from the north.[78] The fledgling Ngô Đình Diệm regime acquired a large set of new residents and many urbanization projects were underway to cater to this growing population. Contextualizing maps from this period can shed light on how the war was also fought on the ideological front through urban development.

Evidence of this ideological struggle lies in the infrastructure illustrated in the American Army Map Service's 1961 map (Figure 4.4). The historic center of Bến Nghé is densely drawn, with careful annotations of administrative and public institutions. These depictions were to showcase South Vietnam's administrative organization and its academic and economic advances. The sophisticated infrastructure described in the map served to validate Ngô Đình Diệm's government as the only legitimate Vietnamese government in the south. It makes no mention of American presence, even though the funding behind most of these institutions was from American aids. This intentional omission is also consistent with the choice

[76] Christopher Fisher, "Nation Building and the Vietnam War," *Pacific Historical Review* 74, no. 3 (2005): 441–56.

[77] Fisher, 442.

[78] Hy V. Luong, ed., *Postwar Vietnam: Dynamics of a Transforming Society, Asian Voices* (Singapore: Lanham, Md: Institute of Southeast Asian Studies; Rowman & Littlefield, 2003), 34.

of language in the map. Despite having been revised by the American Army Map Service (AMS), the only English-language text present is the map's name and edition number, along with captions about the AMS and the National Geographic Service of Vietnam. South Vietnamese cartography masked the real actors behind the façade of modernization and urbanization to display a modern southern capital that misleadingly appeared to be uniquely Vietnamese.

While previous French, American, and Republic of Vietnam maps depict Saigon as an exception, an island protected by water, the 2005 map by the Ministry of Natural Resources and Environment (MONRE) (Figure 4.5) is all about connectedness. Ho Chi Minh City has expanded tremendously in the past century, with new infrastructure to accommodate its growth. The map features lines of national highways stretching to the marshiest part of town, connecting the city center to its outskirts and other provinces. Interconnected networks solidify claims about the city being a historically contingent area. The map only shows a selected number of geographical features, including rivers, forests, marshes, and fields, while disregarding other characteristics. Interestingly, it features a large part of the northern patches of forests, cutting out most of the South Saigon area of Chợ Lớn. This observation is consistent with previous cartographic patterns, but in this case the omission is most likely due to the MONRE's intention to show the green suburbs to distract from the largely deforested center. The production of these maps creates and formalize the interconnectedness of the city.

The MONRE map continues to strengthen Ho Chi Minh City's identity built on rapid development and modernization. Black cubes on a pink background litter the city center, marking structures that are above three stories. Recent urban renewal policies focus on verticalizing the city landscape with skyscrapers and redefining street spaces to enable this socio-spatial restructuring.[79] In the years following 2005,

[79] Marie Gibert, "Moderniser La Ville, Réaménager La Rue à Ho Chi Minh Ville," EchoGéo, no. 12 (May 31, 2010).

new maps went on to show new high-rise centers of the city, including master-planned upscale neighborhoods such as Thủ Thiêm, Phú Mỹ Hưng, and Landmark. Urban development projects have become new grounds for imagining the city and experimenting with ideas about urban life for both the state and private agents.[80] Land-use rights provide the space for exercising political freedom that is otherwise restricted, hence the existence of maps as a tool to propagandize and legitimize the politically charged use of urban space.

Structural and social transformations through changes in governance constantly reshape the polysemous image of Ho Chi Minh City. From an imperial city to a European metropole, from a democratic capital to the "blossoming lotus" at the heart of the late socialist Vietnamese economy, new conceptions supplant old ones to create metamorphic narratives that are both dynamic and pervasive. Cartography is at the interface of the city's physical development and the mental configurations facilitating this process. The intersection of power, politics, and science creates avenues for maps to transcend material borders and bleed into the realm of urban consciousness.

4.5 Ho Chi Minh City in Three Degrees of Historical Freedom

In computer graphics, six degrees of freedom (6DOF) signify the ability to translate and rotate an object along and about three axes in three-dimensional space. A 6DOF object's movement can be quantified by positional changes caused by these six transformations: forward/backward (x-axis), left/right (y-axis), up/down (z-axis), roll (x-axis), pitch (y-axis), yaw (z-axis). 6DOF is ultimately an index of the freedom of movement an object possesses. This section applies the concept of degrees of

[80] Erik Harms, *Luxury and Rubble: Civility and Dispossession in the New Saigon*, Asia: Local Studies/Global Themes 32 (Oakland, California: University of California Press, 2016), 4.

freedom to describe the cartographic history of Ho Chi Minh City since the 18th century by creating an AR map of Ho Chi Minh City using the historical maps discussed previously. The map provides a three degree of freedom perspective of Ho Chi Minh City by allowing the audience to view the city's transformations along the political, geographical, and social lines. The AR app creates 2D virtual overlays of historic maps on top of a 2D real-word contemporary map of Ho Chi Minh City hanging on a vertical surface and provides an audio narrative of the historical context and significance of cartography in the past three centuries. This AR experience is created using the image target feature of the Vuforia Software Development Kit in Unity.

The Unity scene that presents this cartographic narrative is made up of a single image target, created using the 2005 map of Ho Chi Minh City (Figure 4.5). The three remaining maps are overlaid on the target. These maps are aligned so that the scale remains consistent across all four maps. Possible interactions with the overlaid maps include dragging and dropping. Each map can be moved to view the layers underneath. Dragging the map to the vicinity of its original position will automatically cause it to snap back into place. Figure 4.11 captures the interface of the app in use, with three active maps. The app also includes an audio guide to navigate the experience and provide the narrative.

The motivation behind the production of this interactive map is also the driving question behind this cartographic analysis, to attempt to understand the workings of urban memory and its mnemonic devices. To study the maps of Ho Chi Minh City is to trace the sites where remembrance is enforced and memory reinforced, imagined on paper and enacted by means of technology, wealth, and violence. Memory is untrustworthy, every recollection subject to distortion, whether intentional or not.[81] Memory is also powerful; collective memory provides shared identity, which

[81] J. M. Winter, *Remembering War: The Great War between Memory and History in the Twentieth Century* (New Haven: Yale University Press, 2006), 4.

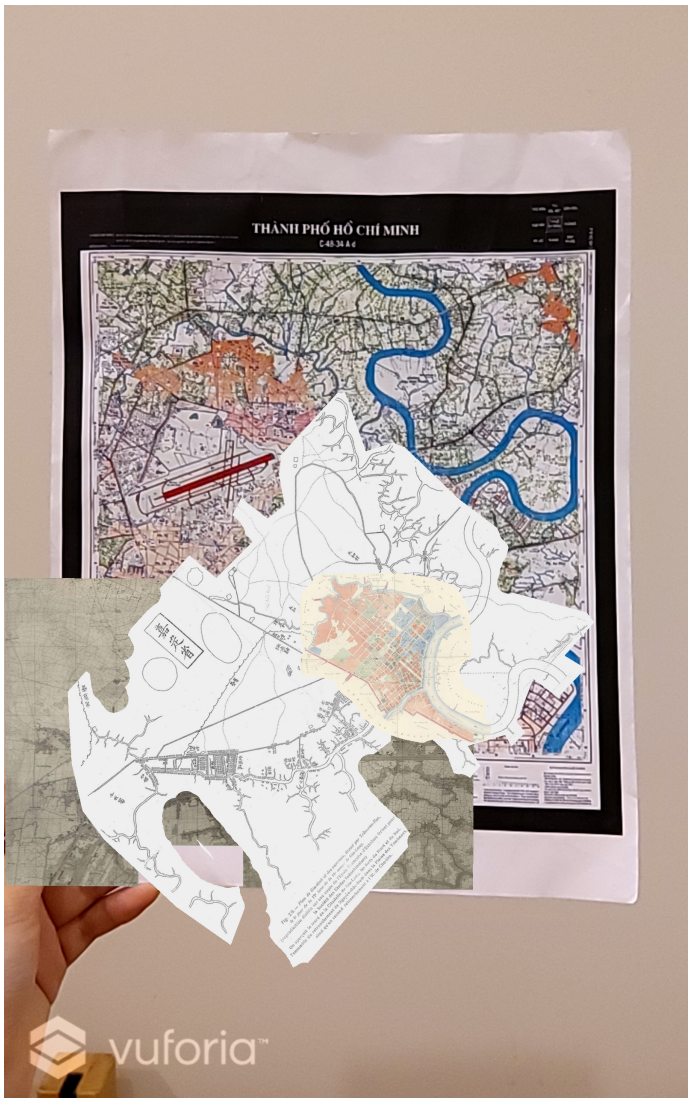

Figure 4.11: A screenshot of the map AR experience (Screen capture by Thuy Dinh.)

enables concepts and ideologies as compelling as nationalism and regionalism.[82] Memory creates cities. Yet because of its unreliability, memory construction is often both elusive and illusory. Every person has their own personal memory, which to them can often appear infallible. This conviction, however, could lead to the false conclusion that remembrance is a personal experience that exists without agency, while history, on the contrary, is "an objective story which exists outside of

[82] Benedict Anderson, *Imagined Communities: Reflections on the Origin and Spread of Nationalism*, Revised edition (London: Verso, 2006).

the people whose life it describes."[83] The abilities and pitfalls of memory are what motivate this historical analysis as well as its AR component.

[83] Winter 11.

Chapter 5

Architectural Monumentality: Memory, Identity, and Power in Saigon Symbolic Architecture

If maps are the encoding of power and control then buildings represent the execution of these arrangements, in a process where the imagined turns concrete. Maps depict the high-level network of interrelations between power and memory, in which each building is a node with the same characteristics as the parent network. Both cartography and architecture are visual modes of remembrance, but architecture, as a site of memory, can be more direct and explicit without the translation from two- to three-dimensional space. Within the built environment, the institutionalization of memory is done on several levels, through function, form, structure, material, and façade. The monumental architecture of Ho Chi Minh City elicits the same questions as its maps, with regards authorship, audience, narrative, and agency. These categories enable recollections of the past through an entanglement of power, memory, and identity. This chapter explores the interconnectedness of these three themes through an examination of the symbolic and functional significance of four monuments in Ho Chi Minh City, with each corresponding to a major era in the city's history.

The interplay between memory and architecture is an important avenue for

many memory studies, as monuments produce important sites of memory.[1] Eric Sandweiss's argument about the role of museums and cities draws on Lewis Mumford's vision of the city as a "storehouse of memory," which remains durable in times of change, a site of both "endurance and transformation," aided by institutions such as the city history museum.[2] Shelley Hornstein posits that architecture is not only defined by design, form, or structure, but as "spatialized visualizations and experiences" in the mental and emotional space.[3] Similar framing by Anthony Vidler theorizes the city as a collection of objects (or buildings) whose collective image "enables the citizen to identify with its past and present as a political, cultural and social entity."[4] In terms of Vietnam, architecture is connected to notions of urbanization and nation-building. For the period when Saigon was the headquarters of French Indochina, urban development was governed by colonial ideologies about civilization and modernization.[5] These frameworks continue into the post-colonial era, when land-use policies enforce specific framing of the urban landscape.[6] Studies on architecture and memory are rich but often limited in periodization and specificity. The following analysis spans the length of Ho Chi Minh City's history in the last 3 centuries, focusing on four major architectural symbols, Thiên Hậu

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1 Pierre Nora, *Rethinking France: Les Lieux de Mémoire*, trans. Mary Trouille, vol. 1 (Chicago: University of Chicago Press, 2001); Hue-Tam Ho Tai and John Bodnar, *Country of Memory: Remaking the Past in Late Socialist Vietnam* (Berkeley: University of California Press, 2001).

2 Eric Sandweiss, "Framing Urban Memory: The Changing Role of History Museums in the American City," in *Memory and Architecture*, ed. Eleni Bastéa (Albuquerque: University of New Mexico Press, 2004), 26.

3 Shelley Hornstein, *Losing Site: Architecture, Memory and Place*, Ashgate Studies in Architecture Series (Farnham, England: Ashgate, 2011), back cover.

4 Anthony Vidler, *The Architectural Uncanny: Essays in the Modern Unhomely* (Cambridge, MA: MIT Press, 1992), 177, quoted in Mark Crinson, ed., *Urban Memory: History and Amnesia in the Modern City* (London: Routledge, 2005), xiv.

5 Gwendolyn Wright, *The Politics of Design in French Colonial Urbanism* (Chicago: University of Chicago Press, 1991); Panivong Norindr, *Phantasmatic Indochina: French Colonial Ideology in Architecture, Film, and Literature*, Asia-Pacific, Culture, Politics, and Society (Durham: Duke University Press, 1996).

6 Erik Harms, *Luxury and Rubble: Civility and Dispossession in the New Saigon*, Asia: Local Studies/Global Themes 32 (Oakland, California: University of California Press, 2016).

temple, Notre-Dame Cathedral, Independence Palace, and Bitexco Financial Tower, to capture the transformations of the built environment in accordance to shifting political and social landscapes in the city.[7]

5.1 Thiên Hậu Temple

Thiên Hậu Temple, officially Tuệ Thành Assembly Hall, was first built by the Cantonese community of Ho Chi Minh City circa 1760.[8] Located in the heart of Chợ Lớn (the Chinese quarter), the temple (Figure 5.1) was originally part of a market complex with multiple other temples, assembly halls, shops, and houses in the 18th century. Today, Thiên Hậu Temple remains in District 5, the unofficial Chinatown of Ho Chi Minh City. The main alter is dedicated to the Empress of Heaven Thiên Hậu (Mazu), a protector of seafarers and ocean goers. The former assembly hall was and is still central to the spiritual and cultural practices of ethnic Chinese in Chợ Lớn. In both a symbolic and functional capacity, the site is a fascinating slice of religiosity in Ho Chi Minh City, where sacred spaces take on non-religious roles as the city transitions into a neo-capitalist period and material culture proves as central to life as spirituality. Believers still visit the temple to seek blessings, but younger generations have taken to it as a scene for having images taken for their social media.[9] Tourists visit from over the world, both Eastern and Western, with all levels of knowledge and belief in the sanctity of Mazu the Empress of Heaven,

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[7] This research leaves out the most recognizable symbol of Ho Chi Minh City, Bến Thành Market, for purposes of clarity and periodization. Bến Thành Market, like the cathedral, was officially established by the French in 1859, but were burnt down and then relocated several times throughout French colonization. The complexities of this market's history will add another dimension to the argument, but its counterpart, the cathedral, is better known for its French architecture that it is more often seen as the highlight of French colonization of Vietnam. This is the reason why the cathedral is analyzed instead. See Tim Doling, *Exploring Saïgon-Chợ Lớn: Vanishing Heritage of Hồ Chí Minh City* (Ha Noi: Thế Giới Publishers, 2019), 186–88 for more on Bến Thành Market.

[8] Lê Văn Cảnh, *Miếu Thiên Hậu - Tuệ Thành Hội Quán* (Ho Chi Minh: Nhà xuất bản Trẻ, 2000), 6.

[9] Trần Kim Anh, "Người Sài Gòn 'rủ nhau' đi chùa Bà Chợ Lớn đầu năm mới Canh Tý 2020," *Báo Thanh Niên*, January 25, 2020, sec. Du lịch, https://thanhnien.vn/content/OTE4NDIz.html.

to see its impressive collection of religious artifacts and unique Chinese temple architecture. The changing position of Thiên Hậu Temple in the mental and physical landscape of the city maps the dynamics of its symbolism and functionality in terms of memory and identity.

Figure 5.1: Thiên Hậu Temple in the 1860s (Photograph by Emile Gsell, 1866.[10])

The natural and economic characteristics of Chợ Lớn and the larger Saigon area explain the influence of the sea goddess Mazu on the local community in the 18th century. Starting from the 1680s, Ming loyalists arrived in Đà Nẵng seeking refuge. Sent by the Nguyễn sovereigns to southern territories, they cultivated the land in exchange for protection.[11] Water was integral to the life of these settlers and remained important as they carved out their livelihoods. Ming migrants, mostly

[10] T.B, "Chùa Bà Thiên Hậu ở Chợ Lớn qua Loạt Ảnh Trăm Tuổi," Kiến Thức, December 14, 2018, https://kienthuc.net.vn/kho-tri-thuc/chua-ba-thien-hau-o-cho-lon-qua-loat-anh-tram-tuoi-1157499.html.

[11] Philippe Peycamm, "Saigon, From the Origins to 1859," in *Saigon, Ba Thế Kỷ Phát Triển Và Xây Dựng [Three Centuries of Urban Development]*, ed. Quang Ninh Lê and Stéphane Dovert, 4th ed. (Ha Noi: Nhà xuất bản Hồng Đức, 2015), 33.

from merchant backgrounds, travelled to the southern coasts by sea and soon controlled commercial activities in the region. They established trade posts and took over import and export, mostly by monopolizing the water trade routes for transporting rice produce from the Mekong basin.[12] Heavily involved in water-related activities, merchants looked to the Lady to protect their voyages along the South China Sea trade routes, laden with rice and other produce from the hinterlands. In the liminal space of the temple, travelers said their prayers before a trip and made offerings after one to thank the deity for their safe travels.

The shared culture of worshipping Mazu became the binding factor for communities of settlers in this foreign land. The Guangdong community who built the temple also looked to the Lady for blessings with health and fortune. Important events in a person's life such as birth, marriage, new commercial ventures, and illness also brought supplicants to Mazu for guidance and favor.[13] Donations went to the upkeep of the temple and community building. As an assembly hall, Thiên Hậu temple spearheaded social projects that provided education and support for members of the congregation.[14] The spiritual center transcended its religious function to become a popular community site, where seafarers and locals connected in a sphere of shared backgrounds, business ventures, on top of cultures and beliefs. This practice was replicated all over the coasts of the South China Sea. Chinese merchants built temples dedicated to Mazu all over the port cities in China, Vietnam and other Southeast Asian countries, creating a spiritual network established on the routes of the existing trade network.

The role of Thiên Hậu Temple in the Chinese community was not only revised

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[12] Peycamm, 35

[13] Haydon Cherry, *Down and Out in Saigon: Stories of the Poor in a Colonial City*, Studies of the Weatherhead East Asian Institute, Columbia University (New Haven: Yale University Press, 2019), 64.

[14] Hà Tăng, "Giữ Gìn Bản Sắc Văn Hóa Dân Tộc Xây Dựng Nếp Sống Mới Văn Minh," in *Miếu Thiên Hậu* (Ho Chi Minh: Nhà xuất bản Trẻ, 2000), 69.

for travelers but for locals as well. In the 19th century, life in Chợ Lớn was divided along geolinguistic lines, following the *bang* (congregation) system. Groups of Ming and Qing settlers formed different congregations based on their origins and dialects. Every congregation had its own market and place of worship, along with other collective properties such as hospitals, schools, cemeteries, etc. They each managed a separate assembly hall, and on top of its religious functions, also performed administrative duties such as immigration and emigration registration and tax collection.[15] The Cantonese population in Chợ Lớn built Tuệ Thành Assembly Hall (also known as Thiên Hậu Temple) circa 1790, at the height of Qing migration.[16] Near Tuệ Thành (Guangzhou) Assembly Hall, Ôn Lăng Assembly Hall (or Quan Âm Pagoda) was built by the Fujianese settlers.[17] These centers regulated life outside of the temples' thresholds through the regulation of ceremonies and rituals. Communal spaces served as a point of contact for new migrants, a gathering place for members of the same ethnic group, and as the coordinator of community-wide projects and events. These responsibilities could be educational, charitable, or ceremonial. One such evidence of these communal functions can still be found at Thiên Hậu Temple in the form of an antique fire extinguisher from the 1890s.[18] As part of a market complex, the temple resided at the intersection of all the activities that Chinese in Chợ Lớn participated in on a daily basis. Spirituality was tied to the fabric of the community.

The administrative capacity of the temple made this system desirable for the new rulers in town in the 18th and 19th centuries. Since the Ming had great influence in Saigon due to their economic stronghold, they had great leverage for negotiating with the political powers. The semi-autonomous congregation system lasted from the Nguyễn regime through French colonization, encouraged by a new influx of

[15] Doling, *Exploring Saïgon-Chợ Lớn*, 29.
[16] Doling, *Exploring Saïgon-Chợ Lớn*, 19.
[17] Doling, *Exploring Saïgon-Chợ Lớn*, 518–19
[18] Doling, 534.

migrants looking for new economic opportunities and escaping the political crisis in the Qing empire in the 19th century.[19] Under French colonization, Chợ Lớn enjoyed considerable autonomy. Colonial authorities communicated with representatives from the Chinese congregations, very often the same people who looked after the assembly halls. As an effort to appease local unrest, the French issued decrees to preserve scriptural materials and decorative objects in major temples such as the Guandong's Thiên Hậu Temple. As a result, religious spaces were some of the places where ethnic traditions and particularities were best preserved.

Figure 5.2: Thiên Hậu Temple in 2008 (Photograph by Christopher, 2008.[20])

Today, Thiên Hậu Temple (pictured in Figure 5.2) takes on completely different meanings. Chợ Lớn remains the dominant Chinatown, but the neighborhood is no longer predominantly Chinese. The process of assimilation as well as ethnic

[19] Laurent Gédéon, "Cholon: A 'Little China' in the Heart of Saigon," GIS ASIE (French Academic Network on Asian Studies), accessed March 13, 2020, http://www.gis-reseau-asie.org/en/cholon-little-china-heart-saigon.

[20] Christopher, Chinese Temple in Saigon, February 9, 2008, photo, February 9, 2008, https://www.flickr.com/photos/qilin/2329029122/.

Vietnamese migration to Ho Chi Minh City have reduced the percentage of ethnic Chinese in the city to around the 10% mark.[21] During the American War of Resistance (1954 - 1975), the Saigon government embarked on the socio-cultural and economic restructuring of Saigon, which included the revocation of permits held by Chinese owners in several trade fields, forcing them to adopt Vietnamese citizenship or change profession.[22] President Ngô Đình Diệm and his successors abolished from the semi-autonomous congregation system used by the Nguyễn and the French. In their effort to assimilate and limit foreign (non-American) influence, the government nationalized previously independent institutions such as schools, pagodas, cemeteries, etc. Foreigners, including Chinese, were no longer allowed to trade meat and fish or engage in the retail market for consumer products, but probably the most devastating blow was the ban on private transportation of people or freight by land and water. These laws blocked the Chinese community from relying on commerce as their main livelihood and drove many from Chợ Lớn into the Bến Nghé area of Saigon. The economy of Saigon was no longer controlled by the Chinese, or the French for that matter. A new body of Vietnamese nationals gradually took over, with the support of American companies.[23]

Chợ Lớn fell into dilapidation as social stratification grew with the changes in demographics and economics. Following the fall of Saigon in 1975 and the subsequent 10-year bao cấp (subsidy) period, life of the Chinese in Ho Chi Minh City for ethnic Chinese became even harder as the socialist state nationalized private

[21] "Thành Phố Hồ Chí Minh - Điều Kiện Tự Nhiên," Cổng thông tin điện tử Bộ Kế hoạch và Đầu tư, accessed March 13, 2020, http://www.mpi.gov.vn/Pages/tinhthanhchitiet.aspx?idTinhThanh=35.

[22] Natasha Pairaudeau and François Tainturier, "From Saigon to Ho Chi Minh City Growth and Changes since 1945," in *Saigon, Ba Thế Kỷ Phát Triển Và Xây Dựng*, 205.

[23] Pairaudeau and Tainturier, 204.

properties and imposed strict regulations on the exchange of goods.[24] Many left Vietnam during this time. It was only after the reforms off 1986 that the Chinese started to participate in Ho Chi Minh City's economy again. These economic and political transformations led to the social restructuring in Chợ Lớn. Restrictive policies curbed the influence of non-Vietnamese cultures and changed the role of sacred spaces like Thiên Hậu Temple for Chinese and non-Chinese in Ho Chi Minh City.

The functions of Thiên Hậu Temple have also adapted to changes in the social economic makeup of the new urban landscape. One of the most notable changes is in the temple's name in Vietnamese, which has the word *chùa* (pagoda).[25] The original term used by the Guangdong was *miếu* (temple). Both indicate a place of worship; while *chùa* is commonly affiliated with Buddhism, *miếu* is often dedicated to local deities. The blurred distinction between Buddhism and *đạo mẫu* (Religion of the Mother Goddesses), which includes Mazu, signifies the shifting characteristic of worshipping in the late socialist society. Visitors to the temple can be Buddhist, Christian, and are often non-Chinese. The Lady's sanctity is no longer specific to water-related prayers. Today's worshippers tend to be indiscriminate about which deity to make an offering to on New Year's Day. In this noninstitutionalized religious landscape, beliefs are shaped on an individual level by influences such as family, acquaintances, and popular publications.[26] The phenomenon is not particular to Thiên Hậu Temple or Mazuism. Spiritual plurality transforms most Vietnamese temples, with new rituals and ceremonies, as well as new meanings. In the war's

[24] The subsidy period lasted from 1975 to 1986, during which time the socialist state maintained a command economy and nationalized many private properties, driving many (especially in the south) to leave and others were stricken with poverty and lack of basic necessities. The subsidy period ended in 1986 with the introduction of a series of reforms called *Đổi Mới*, or "Renovation," which moved Vietnam towards a neo-capitalist market model.

[25] The Vietnamese name of the Thiên Hậu Temple is "Chùa Bà Thiên Hậu"(literal translation: pagoda of the Lady Thiên Hậu).

[26] Philip Taylor, "Introduction: An Outline of the Quest," in *Goddess on the Rise: Pilgrimage and Popular Religion in Vietnam* (University of Hawai'i Press, 2004), 3.

aftermath, these spaces ceased to perform their old communal functions, becoming less of a social and economic founding pillar while taking on a more strictly religious and spiritual capacity.

The rhetoric used by the temple leadership also evolved following the changes in political regimes. The temple's special publication celebrating the beginning of the 21st century started with a line rehashing the 25th Anniversary of Unification (marking the end of the American War of Resistance), followed by an expression of gratitude to the Party and the state.[27] The tone conforms with the national rhetoric of secularization, usually dressed in anti-superstitious language. In the post-Renovation era (after 1986), the Communist Party has struggled with creating a paradigm for religious freedom that still fits their agenda of urban redevelopment, especially when it comes to spiritual spaces.[28] An attempt to incorporate Thiên Hậu Temple into this framework was done in 1993 when the Ministry of Culture and Information recognized the temple as a national heritage site.[29] The question of reconciling spirituality with modernity and secularization continues to plague the current Vietnamese government as they maintain an ambiguous response to religion.[30] The attitude adopted by the state is indicative of the postwar secularized identity that the Communist Party embraced. Consequently, in terms of Ho Chi

[27] Lê Văn Cảnh, *Miếu Thiên Hậu*, 4.

[28] Daniel Goh makes a similar observation in his research on the Guanyin Temple in Singapore. Daniel Goh, "In Place of Ritual: Global City, Sacred Space, and the Guanyin Temple in Singapore," in *Handbook of Religion and the Asian City*, ed. Peter van der Veer, 1st ed., Aspiration and Urbanization in the Twenty-First Century (University of California Press, 2015), 21–36.

[29] Lê Văn Cảnh, *Miếu Thiên Hậu*, 9.

[30] Michael Dickhardt, "The Social Placing of Religion and Spirituality in Vietnam in the Context of Asian Modernity: Perspectives for Research," in *Dynamics of Religion in Southeast Asia*, ed. Volker Gottowik, Magic and Modernity (Amsterdam University Press, 2014), 57.

Minh city, the temple's image projects an identity built on ethnic diversity, rather than religious multiplicity.[31]

Despite the state's uncertainty towards the city's religious landscape, Ho Chi Minh City tourist agencies and the municipal government have also attempted to project the image of cultural diversity through their advertisement of the temple. The temple is among some of the most visited attractions on one-day city tours, framed as an immersive experience of life in Chinatown, notwithstanding how flimsy the connection is today.[32] From serving as a symbol *in* the Guangdong Chinese community, the temple has been rebranded and resold as a representation *of* the entire Chinese population in Ho Chi Minh City. Ethno-linguistic distinctions have become obscured and redressed in one form or another, masked as equality and accentuated to showcase only a selective and modified façade of diversity.

The city's sacred topography is important for cultivating cultural memory. For past and present temple-goers, the existence of these spaces provides a spiritual sphere with rites and objects that enable recollections of their origins and traditions. For the different Saigon regimes, state influence on the temple is a form of control over the Chinese community and their identity. Today, both public and private institutions in the service industry have attached new meanings to the temple such that the act of worshipping there becomes a mechanism of identification for citizens, in the effort to create an identity based on cultural diversity. The same process also takes place with other symbols in this architectural environment.

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[31] Other scholars on Vietnam such as Christina Schwenkel have pointed out that urban growth does not necessarily entail secularization in the case of socialist cities. See Christina Schwenkel, "Religious Reassemblage and Late Socialist Planning in Urban Vietnam," *Journal of the American Academy of Religion* 86, no. 2 (May 17, 2018): 526–53 for an example of how different actors use religious spaces in Vinh, a city in central Vietnam, to vie for control over memory.

[32] "Du Lịch Tham Quan Thành Phố Hồ Chí Minh 1 Ngày," Daily Travel Vietnam, accessed March 14, 2020, https://dailytravelvietnam.com/vi/tour/du-lich-tham-quan-thanh-pho-ho-chi-minh-1-ngay/.

5.2 Notre-Dame Cathedral of Saigon

On the website of the Roman Catholic Archdiocese of Ho Chi Minh City, under the series “Trùng tu nhà thờ Đức Bà"("Notre-Dame Restoration”), one finds the opening article “Nhà thờ Đức Bà Sài Gòn, sức hút của một công trình"("The Notre-Dame Cathedral Basilica of Saigon, the Attraction of a Construction”). The piece is a compilation of several perspectives on the values of the cathedral as an architectural symbol of Ho Chi Minh City. Architect Nguyễn Thu Phong writes:

> I wonder why it influences the emotional life of the city’s inhabitants so much… It acts as a hyphen between an urban life and spirituality… Around the cathedral, life carries on every day, parents picking up their kids after school, couples shooting their wedding photos from countless angles. On holidays, there seems to be a magnet drawing citizens to the cathedral. Nearby, the Diamond high-rise symbolizes the city’s commercial life. On the other side is the Cultural House of Youth. A bit further lies the administrative and political center. On its left is the municipal post office. The cathedral fits into a cultural and communal complex. Maybe that’s why it is such an attraction in the life and mind of the people of the city.[33]

Others have also expressed fascination with the seamless blend of spirituality and urbanism when it comes to the Saigon Notre-Dame Cathedral. Situated in the middle of a large intersection within walking distance of all major administrative and recreational sites in District 1, the proverbial downtown of Ho Chi Minh City, the Notre-Dame Cathedral has been well integrated into the city’s symbolic landscape as a beloved emblem. Nevertheless, even in the same article, the ambivalence with

[33] Nguyễn Thu Phong, “Nhà Thờ Đức Bà Sài Gòn, Sức Hút Của Một Công Trình,” Tổng Giáo phận Sài Gòn, July 1, 2009, https://www.tgpsaigon.net/bai-viet/nha-tho-duc-ba-sai-gonsuc-hut-cua-mot-cong-trinh-44657.

the cathedral's history and its religious implication is palpable. This uncertainty is reflected in the words of the architect:

> A construction that represents the dream of moving forward… [a] church accompanied by a post office, governmental headquarters, a theater, a square […] The complex projects the image of an urban center and the power of the authorities in the eyes of colonial subjects […] An architectural culture is the result of social interactionsacross the length of history. In the end, if there was no cathedral, there might have been another famous piece of architecture, but there won't have been a hundred years of French colonization.[34]

Such anti-colonial sentiment is not uncommon even though the concern is sometimes lost in total reverence of the cathedral's architectural brilliance. In the late socialist society, the church's colonial ties can make it difficult to justify such adoration. The sentiment can be passed off as love of the city or pure admiration for the architecture. Oftentimes, it is mixed with a hint of nostalgia, or "colonial blues" according to some critics, for the lost "Pearl of the Orient."[35] Scholars have studied the connection of colonial nostalgia and its architectural legacy. Historians of memory see architecture as a reflection and actor of memory. Eleni Bastéa theorizes the relationship between memory and the built environment through design, literature, and practice. In the cathedral, one sees the construction and reconstruction of memory, from its erection, to the changing iconography, and ongoing restoration.[36] The meaning of the cathedral shifts as actors of memory work to enact structural and symbolic modifications. A French badge of power, of religious superiority, a token

[34] Nguyễn Văn Tất, "Nếu không có một nhà thờ Đức Bà," in "Nhà Thờ Đức Bà Sài Gòn."

[35] Dansaigon, "Những Di Sản Tạo Nên Nét Đẹp Sài Gòn," Dân Sài Gòn (blog), January 10, 2020, https://dansaigon.com/nhung-di-san-tao-nen-net-dep-sai-gon/; Srilata Ravi, "Modernity, Imperialism and the Pleasures of Travel: The Continental Hotel in Saigon," *Asian Studies Review* 32, no. 4 (December 2008): 475–90.

[36] As of Spring 2020, the restoration of the Saigon Notre Dame Cathedral is still in progress.

of modernity, and now a proof of history, these are all the polysemous identities of this edifice are representative of an equally fluid city. To understand how these complex levels of symbolism have been developed in the 140-year history of the Notre-Dame Cathedral of Saigon, it is important to grasp the context of its creation and development.

Figure 5.3: Notre-Dame Cathedral in 1890 (Photograph from Maison Asie Pacifique.[37])

The Notre-Dame Cathedral Basilica of Saigon (Figure 5.3) started construction in 1877 and was consecrated in 1880, 22 years after French conquest of Saigon in 1858.[38] By the time, the city had been well established as the colonial capital of Cochinchina. To meet the religious needs of the colonial class in town and the demands of missionary work, the original church of Église Sainte-Marie-Immaculée was completed on the site of an old temple in 1863 but soon fell into dilapidation.

[37] "Saïgon: La Cathédrale (Façade)," Virtual Saigon, 1890, http://virtual-saigon.net/Photos/Images?ID=31948.

[38] Cherry, *Down and Out in Saigon*, 16.

A replacement, bid by numerous French contractors and won by Jules Bonard, was immediately underway.[39] Construction concluded in 1879, resulting in a Romanesque structure 93 meters in length and 36 meters in width, held by bricks imported from Marseille, in the traditional cruciform shape complete with a transept and a nave, in other words, a piece of architectural brilliance by all Western standards.[40]

As the colonial headquarters, Saigon boasted a complex of military and administrative institutions, now with the cathedral as its religious center. Visitors to Saigon did not fail to draw the connection between the "Paris of the Far East" with its original source of inspiration. An American war correspondent, Jasper Whiting, wrote about the city's broad and immaculate boulevards and the various miniatures of Champs Élysées, Bois de Boulogne, Avenue de l'Opéra. He sang praises of the "twin-spired cathedral, the Notre-Dame of the city."[41] The cathedral's bell towers were the first thing that greeted travelers from the bank of the Saigon River after a 74 kilometer trip from the coast.[42] Everything about the city was reminiscent of France, and adorning the grandiose of its Western-styled edifices was the tallest, grandest structure of all, the Saigon Cathedral. From the point of view of a colonial subject, the show of power through thiis imposing monument was an effective move.

During the colonial era, as the French sought physical domination over the colonized space by erecting Western edifices, they were also faced with the risk of completely eradicating traces of the native population in the built environment. By the start of the 20th century, Saigon already had all the marks of an urban city, but

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[39] Charles Appleton, ed., "Notes and News," *The Academy*, no. 195 (January 29, 1876): 108.

[40] Cherry, *Down and Out in Saigon*, 16.

[41] Jasper Whiting, "Café Society," in *Saigon: Mistress of the Mekong: An Anthology*, ed. Anastasia Edwards, Literary Anthologies of Asia (Oxford: Oxford University Press, 2003), 91.

[42] Demay Aline, "Saigon: Une Métropole Touristique?," *French Colonial History* 12 (May 8, 2011): 125–29; Hugues Krafft, "Saigon Through the Eyes of Early Travellers – Hugues Krafft in 1882," trans. Tim Doling, *Historic Vietnam* (blog), November 13, 2014, http://www.historicvietnam.com/hugues-krafft-in-1882/.

Figure 5.4: Pigneau du Béhaine Statue (Photograph in Tim Doling, "Inauguration of the Pigneau de Béhaine Statue."[43])

it did not exude the exotic vibe of a Far Eastern metropolis. The botanical gardens, the zoos, palaces, hotels, and now the church are emblems of the urban identity imposed on the colony by French settlers. It was too modern, too French, and lacking the special Asian character. The colonial government began to address this imbalance by producing designs that highlight Franco-Vietnamese collaboration, an example of which is the statue of Monsignor Pigneau du Béhaine and the Crown Prince Nguyễn Phúc Cảnh in front of the Notre-Dame(Figure 5.4). Monsignor Pigneau was the Apostolic Vicar of Cochinchina. He helped Nguyễn Ánh defeat the other factions to ascend the throne in the 18th century. Known as Bá Đa Lộc in Vietnam, Pigneau was a French legend here for his assistance with the Nguyễn and guidance of Prince Cảnh.[44] The emphasis on Pigneau's role in Prince Cảnh's

[43] Doling, http://www.historicvietnam.com/wp-content/uploads/2016/10/4906431779_1038ca9114_o.jpg

[44] Cherry, *Down and Out in Saigon*, 17; Tim Doling, "Inauguration of the Pigneau de Béhaine Statue, 10 March 1902,"Historic Vietnam (blog), October 6, 2016, http://www.historicvietnam.com/pigneau-statue-inauguration-1902/..

life reiterated the importance of French presence in Cochinchina and Vietnam, where "the French name [was] synonymous with progress, civilisation and true freedom."[45] The depiction of the French priest with a member of the royal family signified the colonial powers' intentions for Saigon to portray the statue, and the city by extension, as an example of THE ALLIANCE between the two peoples. Vietnamese presence were encoded into the environment to appease the native populations and create an illusion of cooperation and not assimilation, even though both processes were in progress.

While the Notre-Dame is a marker of Christianity's spread in Saigon and Vietnam, the cathedral has always been distinguished for its symbolic merits rather than its religious capacity. Even during the French occupation period, the cathedral was more popular among tourists than worshippers.[46] Given the limited potential for tourism in Saigon, such a monument was immediately earmarked for prospective visitors. The allure of architectural or historical substance of any kind made the destination an instant tourist hit in this otherwise dull neo-European city. Similar observations are made by Panivong Norindr, who presents the notion of Indochina as a "phantasm," a fiction cultivated during French colonial hegemony to indulge the French exotic fantasies and nostalgia for grandeur.[47] On this romantic canvas where borders were remapped, arts appropriated, and environments built, colonial configurations like the Notre-Dame were generated en masse to construct an imaginary space that showcased indigenous cultures while appealing to European aesthetics and the colonial ethos of civilization.

The concern with a lack of heritage also motivated later Vietnamese regimes to preserve certain colonial legacies (like the cathedral) while abolishing others.

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[45] Monsignor Mossard, in Doling, "Inauguration of the Pigneau de Béhaine Statue."

[46] Claudius Madrolle, in "Saigon-Cho Lon in Madrolle's Tourist Guidebook of 1913," trans. Doling, *Historic Vietnam* (blog), 1913, http://www.historicvietnam.com/madrolle-tourist-guidebook-of-1913/; Aline, "Saigon."

[47] Norindr, *Phantasmatic Indochina*, 2.

The Vietnamese Communist revolutionary force Việt Minh tore down the Pigneau statue in the August Revolution of 1945. On the old pedestal, a statue of the Virgin Mary was erected in 1959 by the Archdiocese of Saigon.[48] These transformations reveal the fraught nature of heritage conservation. Governments based the decision about which sites to preserve on ideological implications rather than their cultural values. When it comes to architectural masterpieces whose cultural values may outweigh any ideological justification for demolition, depoliticization was often the solution. One form of depoliticization was through romanticization to the extent where these sites are stripped bare of any historical context, as in the case of the Notre-Dame.[49]

Figure 5.5: Present-day Notre-Dame Cathedral (Photograph from the Vietnam Center of Information Technology.[50])

Today, the cathedral is publicly recognized by the municipal government and

[48] Doling, "Inauguration of the Pigneau de Béhaine Statue."

[49] See "Ngắm nhìn nét đẹp kiến trúc của nhà thờ Đức Bà Sài Gòn," Cẩm nang du lịch Việt Nam, March 10, 2017, https://www.vntrip.vn/cam-nang/kien-truc-nha-tho-duc-ba-sai-gon-19948 for an example of the decontextualized contents about the Notre-Dame in Vietnamese media.

[50] Center of Information Technology, "Nhà Thờ Đức Bà - Ave Maria Church - Sai Gon," Pinterest, accessed March 14, 2020, https://i.pinimg.com/564x/05/2b/b2/052bb22978e256254a9bc8cf41d02b8c.jpg.

Saigon citizens as a symbol of the city, an image among several objects and spaces around which urban identity is formed (Figure 5.5). However, the kind of memory it elicits does not focus on colonial exploitation, conforming with the official narrative for the colonial period. Instead, its symbolic status is solely as an architectural classic, a sign of European civilization, amidst a wave of nostalgia for a former Saigon, even in its colonial years. To accompany this trend of aestheticizing the past, old colonial establishments have been "architecturally re-enhanced and [their] aura of 'colonial distinction' reinvented" to cater to nostalgia seekers.[51] The Notre-Dame is undergoing its own restoration project, using materials imported from France and Germany, with the construction overseen by French and American contractors. Throughout its 140-year history, the meanings assigned to the Notre-Dame might have changed, but its symbolic function, a colonial token of power in the French Indochina capital and as a cultural and historical heritage site today, continues to exist, morphing from one form to another to accommodate the city's transformations.

5.3 Independence Palace

On the theme of metamorphosis, no other site in Ho Chi Minh City has undergone as many modifications to its physical and figurative façade as the Independence Palace. The changes to this monument are both tangible and symbolic, as forces of history performed alterations on its structure, functions, and significance throughout the years. The palace, originally named Norodom after the Cambodian king, was inaugurated in 1875. It served as the headquarter of the Governor-General of Cochinchia and became known as the Palais du Gouvernement-général (Governor's Palace).[52] Its construction was an expensive and extended affair; nevertheless, the

[51] Ravi, "Modernity, Imperialism and the Pleasures of Travel," 476.

[52] Doling, Exploring Saïgon-Chợ Lớn, 153.

building's usefulness never lived up to the exorbitant price tag. Rarely touched by the Governors of Cochinchina, who paled in comparison to the new Governor-General in Ha Noi, the place fell into disrepair, its capacity downgraded to mostly ceremonial.[53] In 1954, on the withdrawal of French military following the Geneva Accords, the palace was handed over to the new South Vietnamese administration headed by President Ngô Đình Diệm.[54] The French edifice's did not last very long as the new presidential palace. In 1962, disaffected members of the Saigon Air Force staged a coup on the Diệm government and wrecked the old structure in the process. At this point, Diệm commissioned a new presidential complex to be built on the site of the demolished palace, under the supervision of the up and coming French-trained Vietnamese architect Nguyễn Viết Thụ. The newly built Independence Palace became the home of succeeding South Vietnamese presidents from 1966 until the fall of Saigon in 1975. After unification, the site became a historic monument and a museum; its main hall was renamed to Reunification Hall and serves as a venue for ceremonies and entertainment.

The palace's history exhibits a strong link between architecture and power. The Indochina regime was well-versed in employing colonial ideology to establish architectural hegemony over Saigon.[55] With the Norodom Palace, even though its practicality fell short of expectations, the production of the monument set the trend for embracing symbolism. The colonial ethos of westernization and civilization came across in the neoclassical edifice, later supplanted by the modernist-oriental hybrid design under the South Vietnamese era.[56] The American War period was

[53] Doling, 154.

[54] Doling, 155.

[55] Norindr, *Phantasmatic Indochina*.

[56] Doling, *Exploring Saïgon-Chợ Lớn*, 47–51.

dominated by a new generation of Vietnamese architects eager to combine Vietnamese architectural precedents with their European training.[57] Nguyễn Viết Thụ's design incorporated several Chinese characters in its exterior façade (Figure 5.6). The use of symbolic architecture to make a statement is common in French colonial discourse. The symbolic power of architecture was well articulated by the words of a French publication on the opening of the Palais d'Exposition in France, a "museum of the colonies": architecture was a presentation of a "great modern state with the body of its political organization, the exact representation of its economic power, and the complete tableau of its social, intellectual, and artistic activity." [58] If the Palais d'Exposition was designed to showcase the exoticism of French colonies, the Independence Palace was a reversed manifesto.[59] The Saigon monument was a public display of French/South Vietnamese political and aesthetic visions, an exertion of power, and a claim of dominance over the entire city.

The Independence Palace is a site of transition, its identity in flux to accommodate whichever power was seeking to exploit its symbolism. To extend the idea that the palace is an expression of power, one can argue that the literal act of occupying the palace was synonymous with gaining control of Ho Chi Minh City. Compared to the other symbols of the city in the scope of this research, the Independence Palace is the most connected to the city's history. Almost every important turn of events since the 19th century was mirrored by changes to the monument. During Japan's brief imperial stint in Vietnam (1941 – 1945), Japanese military heads resided

[57] Truong Hai Thanh and Vu Thi Hong Hanh, "Modern Architecture of Saigon - Ho Chi Minh City," *MATEC Web of Conferences* 193 (2018): 4.

[58] Robert de. Beauplan. "Les Palais de l'Inchochine," *L'Illustration* 4612 (25 juillet 1931), in Norindr, *Phantasmatic Indochina*, 25

[59] Norindr, 24.

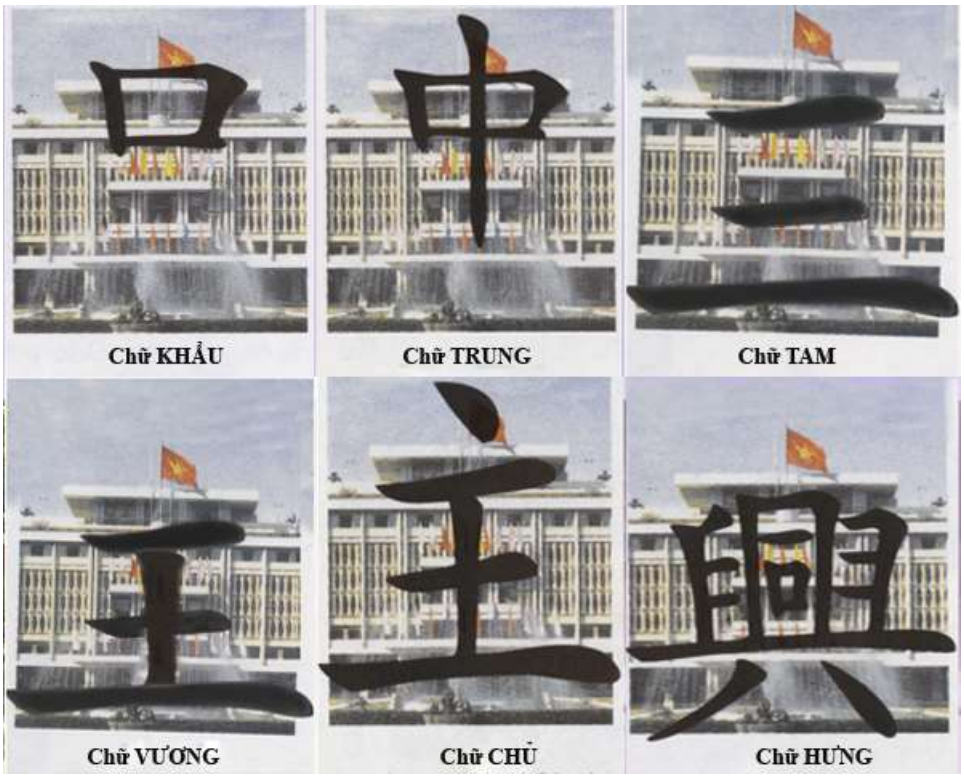

Figure 5.6: The Chinese characters in Ngô Viết Thụ's design. From top to bottom and left to right, the characters are *khẩu* (mouth), *trung* (loyalty), *tam* (three), *vua* (king), *chủ* (sovereignty), and *hưng* (rise). (Photograph from the Independence Palace's website.[60])

in the palace and negotiated shared control with the Vichy representatives over meals in its dining room.[61] At the height of Japanese imperialism in Asia, they even held French officials captive in the palace. The palace has always served as the residence of the highest authority in Saigon, South Vietnam and sometimes Vietnam. From French settlers to Japanese imperialists, from American militarists to South Vietnamese nationalists and present-day communists, staking claim over the palace has become the constant for all foreign forces seeking a foothold in the city.

The most striking example of the symbolic merit of this architectural complex is

[60] The upper floor has the form of the character *khẩu*, which signifies the prioritization of education and free speech. The flag pole creates the character *trung*, symbolizing loyalty. *Tam* represents the three principles of the people (nationalism, democracy, and livelihood). *Vương* is ruler, which is the South Vietnamese government, and *chủ* emphasizes the sovereignty of South Vietnam. The last character, *hưng*, expresses the desire for prosperity. "Kiến trúc Dinh Độc Lập," Di tích Dinh Độc Lập, March 23, 2018, https://dinhdoclap.gov.vn/wp-content/uploads/2018/03/1-1.jpg.

[61] Arthur J. Dommen, *The Indochinese Experience of the French and the Americans: Nationalism and Communism in Cambodia, Laos, and Vietnam* (Bloomington: Indiana University Press, 2001), 78.

the events of April 30, 1975, when a tank of the North Vietnamese Army bulldozed through one of the palace's secondary gates and Lieutenant Bùi Quang Thận replaced the South Vietnamese flag on the roof with the National Liberation Front's flag. This turn of events is invariably featured in history textbooks down to the details of the tank's model. The photo of the tank crashing the gate (Figure 5.7) captures the most recognizable moment of this historic day in the Vietnamese national discourse. April 30 became a national holiday in Vietnam, *Ngày giải phóng miền Nam, Thống nhất Đất nước* (Day of liberating the South for national reunification, or Liberation Day for short). The use of this symbolic takeover to mark the end of the war demonstrates the current authorities' continued desire to employ the palace as a site of memory, a place where narratives are produced and reshaped, imagined and rethought, in a struggle to define the city.

Commemoration is the unifying theme for postwar framing of the American War, and the Independence Palace is no exception.[62] Amidst monuments such as museums, battlefields, and cemeteries, the Independence Palace has become a commemorative class of its own. Historian Jennifer Dickey points out the distinction between the palace and other war monuments in the city, suggesting that the former presidential residence provides a more upbeat take on the war than its counterparts in Ho Chi Minh City, such as the War Remnants Museum or the Củ Chi Tunnels Complex, which focuses more on the strategic aspect and the heavy casualties.[63] Today, the palace functions as a museum, with most parts open to visitors interested in the former Vietnamese "White House." The whole presentation offers little context of the lives of the palace's former residents, opting to centralize the official war narrative of a national struggle for unification against an imperial power and its puppet regime. A more subtle interpretation can be gleaned from

[62] Tai and Bodnar, *Country of Memory*.

[63] Jennifer W. Dickey, "Review of Reunification Palace," *The Public Historian* 33, no. 2 (2011): 153.

the contrast between the excessive opulence on display as opposed to the scarcities in the North Vietnamese National Liberation Front. The Independence Palace, as well as war tourist sites in Ho Chi Minh City, is a tool for nation building, with which the state as a producer and curator of spaces legitimizes their authorities and establishes a shared identity among its citizens, reinforced by these physical markers of nationalism, patriotism, and belongingness.

Hình 5.7: The tank crashing the gate of the palace. A tank of the same model is still on display in the palace's grounds. (Photograph by Trần Mai Hưởng, in "Gặp tác giả bức ảnh: Xe tăng Quân giải phóng đánh chiếm Dinh Độc Lập ngày 30-4-1975."[64])

The Independence Palace exemplifies the polysemous nature of Ho Chi Minh City's architectural symbols. April 30 may be Liberation Day in Vietnam, but for many Vietnamese in the diaspora, it is remembered as the Fall of Saigon or Black April.[65] For them, the palace holds a different meaning. It is a relic from a bygone era, witness to what many see as the ultimate betrayal by the U.S. that led to Saigon's

[64] Cảnh Vũ, "Gặp Tác Giả Bức Ảnh: Xe Tăng Quân Giải Phóng Đánh Chiếm Dinh Độc Lập Ngày 30-4-1975"," Báo Công an nhân dân điện tử, April 28, 2017, http://static.cand.com.vn/Files/Image/bichthuy/2017/04/28/04994507-52af-4fa7-88ab-e90e2032b291.jpg.

[65] Anh Do, "Vietnamese Immigrants Mark Black April Anniversary," *Los Angeles Times*, April 25, 2015, https://www.latimes.com/local/lanow/la-me-ln-vietnam-reunion-20150425-story.html.

collapse.[66] Mitchell Owens writes about the palace in a *New York Times* article with the flippant description "East meets West, in a funky monument to wartime folly." That nostalgia for the height of the Republic of Vietnam and its elusive governing families is tangible throughout the article and its wistful title, "Madame Nhu Almost Slept Here."[67] The tensions between national and transnational remembrance create different identities. Different communities might all view the Independence Palace as an identity marker, but its meaning varies depending on how actors are shaping these markers to create memory.

5.4 Bitexco Financial Tower

At the height of 262 meters and a mere 5-minute walk from the bank of the Saigon river, the Bitexco Financial Tower looms over the historic business district of Ho Chi Minh City (Figure 5.8). Like various other constructions in the city, the tower's location is water-oriented, but its relationship with water is less a dependency than a strategic arrangement, an icon towering above the swamp that makes up the city. Inaugurated in 2010, Bitexco was the tallest structure in Vietnam until the introduction of the Gangnam Landmark Tower one year later in Ha Noi, but in Ho Chi Minh City, its height record remained unsurpassed for eight years. Even though this title has been overtaken by another superstructure, Landmark 81 (461 meters), Bitexco's status has endured as the symbol of modernity in the "new" Saigon.[68] The plan for Bitexco to define the urban landscape of Ho Chi Minh City was already in

[66] Yến Lê Espiritu, "Vietnamese Refugees and Internet Memorials," in *Looking Back on the Vietnam War: Twenty-First Century Perspectives*, ed. Brenda M. Boyle and Jeehyun Lim, War Culture (New Brunswick, NJ: Rutgers University Press, 2016), 18–33.

[67] Madame Ngô Đình Như is the wife of President Ngô Đình Diệm's brother. Madame Như, nicknamed the Dragon Lady, is one of the most influential women in the South Vietnam era. Mitchell Owens, "Madame Nhu Almost Slept Here," *The New York Times*, January 12, 2003, https://search.proquest.com/docview/215482763?OpenUrlRefId=info:xri/sid:summon&accountid=15131.

[68] Hà Mỹ Giang, "5 Biểu Tượng Kiến Trúc Sài Gòn qua Ngòi Bút S Pen Trên Galaxy Note 8," *Báo Điện Tử Tri Thức Trực Tuyến*, May 31, 2018, https://news.zing.vn/5-bieu-tuong-kien-truc-sai-gon-qua-ngoi-but-s-pen-tren-galaxy-note-8-post847437.html.

motion during its construction. Before the tower's completion in 2010, the owner and development group of Bitexco and the press had been touting its iconic stature as the new beacon of innovation and design.[69] According to the chair of the developer group Bitexco, the tower was an "iconic embodiment of the energy and aspirations of the Vietnamese people."[70] As far as the history of landmarks in Ho Chi Minh City is concerned, this building is yet another site where narratives are defined and memories constructed, a playground for contesting ideas, ideals, and powers.

Figure 5.8: Bitexco from a distance. On the far right is the Saigon River. (Photograph from *Tạp chí điện tử Bất động sản Việt Nam*.[71])

The Tower presents several ways to think about how architecture shapes identity, first on a regional level and then on the national level. From the earliest stages, the developers of Bitexco had shown ambitions for building an era-defining structure through their design concepts. The form of the tower was to embrace the traditional

[69] P. Hoàng and M. Thảo, "Bitexco Financial Tower: Sắp Khai Trương Tòa Nhà 'Búp Sen' Cao Nhất Việt Nam," *Báo Điện Tử Pháp Luật Thành Phố Hồ Chí Minh*, April 16, 2010, sec. Thị trường - Tiêu dùng, https://plo.vn/content/MTUyMzQz.html.

[70] Tran Van Khai, "The Development of the Architectural Form of a Tower Derived from a Traditional and Philosophical Symbol, Realized by Solutions of High-Class Technologies. The Case of the Bitexco Financial Tower," *E3S Web of Conferences* 33 (2018): 1–10.

[71] Vy Vy, "Bitexco - người đi xây biểu tượng và kiến tạo giá trị tương lai," *Tạp chí điện tử Bất động sản Việt Nam*, February 22, 2018, http://reatimes.vn/bitexco-nguoi-di-xay-bieu-tuong-va-kien-tao-gia-tri-tuong-lai-21299.html.

and philosophical symbol of a lotus bud, significant for its importance in Buddhism. The lotus flower represents enlightenment and purification.[72] Said to grow in mud and bloom when reaching light, the lotus flower purifies the water where it grows and blossoms even when the flow is stagnant. Its symbolism becomes a metaphor for vitality and strength.[73] Embracing the culturally rich image of the iconic lotus bud, Bitexco owners sought to present the tower as a budding symbol rising above the swampy landscape of Ho Chi Minh City (both in terms of its geographical and sprawling demographic conditions). In addition to its regional significance, this use of cultural symbolism in modern architecture also appeals to a shared notion about the Vietnamese national identity, which is centered on national unity and self-determination. The acclaimed national flower of Vietnam features in various folk poems:

> In swamps the lotus shines,
> Green leaves, white flowers, fine stamens.
> Blooms, leaves, and stamens gold,
> Near mud without the moldy stink.[74]

he Bitexco tower as a site of memory, while contributing to the Vietnamese national narrative through its symbolism, also gains its recognizability by enabling citizens to "identify with its past and present as a political, cultural and social entity."[75]

Bitexco is an example of the modern/traditional dichotomy prevalent in Vietnamese discourse of urban development. In this symbiotic relationship, the lotus bud structure was realized by high-class technologies. Its futuristic architectural

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[72] Tran Van Khai, "The Development of the Architectural Form of a Tower Derived from a Traditional and Philosophical Symbol," 1.

[73] Hiếu Nghĩa, "Hoa Sen - Biểu Tượng Văn Hóa Việt," Sở Văn hóa, Thông tin, Thể thao và Du lịch tỉnh Bạc Liêu, December 13, 2013, http://svhttdl.baclieu.gov.vn/diendan/Lists/Posts/Post.aspx?List=504f8c21-7f18-4116-80d4-6da2fa0e598f&ID=66.

[74] Harms, *Luxury and Rubble*, 1.

[75] Crinson, "Urban Memory - An Introduction," xiv.

style rejects the modernist trend that has dominated Saigon since the end of the First Indochina War, marked by monuments such as the Independence Palace.[76] The transition from old architectural patterns to new ones projects the inherent shift in the city's identity, characterized by changing notions of beauty and revised urban codes. These new high-rises are the image of the integrated and modern global city, defined by architectural ingenuity and stylistic aesthetics. A gravity-defying structure like a skyscraper in itself is a testament to advancement in the sciences. Its convex sides and rounded corners are a step further from the convention, an embodiment of innovation and uniqueness. The presentation of the city in this sky-piercing depiction aims to showcase Ho Chi Minh City's strides in modernization, urbanization, and rapid economic integration by means of symbolism, sign, form, scale, and materiality.[77] As an example of forward thinking and excellence in design, the landmark was built to "surprise, to astonish, and to alter perspectives." Meanwhile, this futuristic and unorthodox architectural rendering is still laden with ideals about culture, tradition, and history.[78]

Like other geographic and political processes in Ho Chi Minh City's history, the transformation into the contemporary notion of modernity and urbanization is far from straightforward. Nature-defying structures like Bitexco require tremendous alterations to the environment. Working with the soft soil conditions of the Saigon River alluvial plain, engineers had to sink the piles within the base of the building 75 meters underground in addition to creating a concrete mat foundation to ensure the skyscraper could withstand the force of nature (and water) that so

[76] Tran Van Khai, "The Development of the Architectural Form of a Tower Derived from a Traditional and Philosophical Symbol," 1.

[77] Tran Van Khai, "The Development of the Architectural Form of a Tower Derived from a Traditional and Philosophical Symbol," 7.

[78] Tran Van Khai, 2; Hà Anh, "Khánh Thành Tòa Tháp Tài Chính Bitexco - Biểu Tượng Kiến Trúc Độc Đáo ở Việt Nam," *Báo Sài Gòn Giải Phóng*, October 27, 2010, sec. Doanh nghiệp và Phát triển, https://www.sggp.org.vn/khanh-thanh-toa-thap-tai-chinh-bitexco-bieu-tuong-kien-truc-doc-dao-o-viet-nam-14510.html.

often plagues developments of the city.[79] Natural modifications were not the only violent processes to enable the monument's existence; controlling the human factor is also an important variable in building the perfect city. The emergence of new urban zones in Ho Chi Minh City is synonymous with mass displacement of people, in a process that is involuntary and oftentimes brutal.[80] The current discourse of urbanization is redefining the notion of a modern city to be synonymous with "grand buildings framing breathable and beautiful open spaces."[81] Urban programs of spatial cleansing forcefully clear the city of its slums to make way for an emerging urban upper middle class. The politics of control through urban building codes manifested in the additions of high-rises like Bitexco and recently Landmark 81. Land use becomes contentious as new projects reach lower-class residential and communal spaces, creating social stratification along the city's spatial lines.

The state is not the only player in the shifting Ho Chi Minh City's memoryscape with its zoning and urban projects. With the rise of private real estate projects comes the participation of private corporations in the reimagining of the city. Actors such as Bitexco, or more recently Vingroup (owner of the current highest building in Ho Chi Minh City), see these parcels of land as "a surface area on which to manage economies of scale."[82] The kind of memory engendered by these architectural structures and complexes legitimizes development plans for other peri-urban neighborhoods. The memory industry becomes lucrative in the face of diminishing unused urban land and climbing real estate prices. How enterprises justify the displacement of people and razing of current neighborhoods to make place for new

[79] Hill, How to Build a Skyscraper, 150.

[80] Erik Harms, "Beauty as Control in the New Saigon: Eviction, New Urban Zones, and Atomized Dissent in a Southeast Asian City," *American Ethnologist* 39, no. 4 (2012): 735–50.

[81] Harms, 737.

[82] Annette Miae Kim, *Sidewalk City: Remapping Public Space in Ho Chi Minh City* (Chicago: The University of Chicago Press, 2015), 60.

middle-class urban zones is built upon ideologies about urbanization, development, and progress that continue to be reinforced with renderings such as Bitexco Financial Tower. Urban planners also take another measure to ensure the validity of their constructions for citizens of Ho Chi Minh City by hiring French, Japanese, and American contractors in key design phases.[83] In this sense, postwar late-socialist Vietnam has not moved away from previous Western (colonial) configurations and ideals about how a good environment looks and functions, enforced through urban codes about hygiene, order, and beauty.[84] Key players outside of the state have carved their space in the urban planning business of Ho Chi Minh City, and by extension, the memory created by these spatial transformations.

Outside of its symbolic capacity, Bitexco Financial Tower serves all the usual functions associated with mix-use high-rises: $370,000m^2$ of office space, a $10,000m^2$ retail podium, completed with a sky deck and helipad cantilevers on the 52nd floor.[85] Grade A office suites are reserved for elite finance organizations and multinational corps.[86] The shopping center features retailers from high-end brands, as well as dining and entertainment services.[87] The experience provided by the shopping area of Bitexco is indicative of the upward trend in shopping malls in Vietnam.[88] There are currently more than 40 shopping centers in Ho Chi Minh City, most of which feature some combination of a food court, a movie theater, and middle to high-end stores. Even though the clientele of these shops is usually upper middle class, the restaurants, cafes, and movie theaters can attract large crowds on

[83] Harms, "Beauty as Control in the New Saigon," 743.

[84] Wright, *The Politics of Design in French Colonial Urbanism*, 1; Harms, "Beauty as Control in the New Saigon," 737.

[85] Tran Van Khai, "The Development of the Architectural Form of a Tower Derived from a Traditional and Philosophical Symbol," 6.

[86] Tran Van Khai, 8.

[87] Bitexco, "Shopping Archives," Bitexco Financial Tower, 2013, http://www.bitexcofinancialtower.com/?cat=15&lang=en.

[88] Bich Ngoc, "Race to Embrace Retail Mall Revolution," Vietnam Investment Review, October 24, 2010, sec. Investing, https://www.vir.com.vn/race-to-embrace-retail-mall-revolution-1888.html.

week nights and weekends. Bitexco is best known for its cinema and rooftop bars. These spots, often underground or dozens of meters above ground, provide the new communal spaces for Ho Chi Minh City, whose public sphere is characterized by its growing consumerist tendencies.

The desire for the urban landscape to manufacture the city's identity is made explicit in Bitexco's case. Following the ground-breaking of the Bitexco Financial Tower, the chairman of Bitexco Group board of directors Vũ Quang Hội explained their visions for the construction: "Before, when mentioning Vietnam, people often thought of war and poverty... [Now] the image of Bitexco Financial Tower will appear on all the postcards and souvenirs, so that when friends from all over the world come to Vietnam, they will bring home the image of a nation of innovation and development."[89] Architecture is not simply a representation of the present but a reconfiguration of the past, where new buildings have replaced old monuments in a restructuring of both the physical and mental landscape. For a private enterprise like Bitexco to become the "icon builder and creator of future values,"as the Vietnam National Real Estate Association Press calls it, it is clear that Ho Chi Minh City's identity, as embodied by these structures, is not only rooted in the past, or the present, but also in an idealistic orientation of the future that concerns notions of beauty that favor a capitalist and consumerist trajectory of urban development.[90]

5.5 Creating Memory Targets

In the 2019 exhibition hosted by Bitexco Financial Tower, "Memory Museum,"symbols of Ho Chi Minh City in the form of miniature handcrafted models took the spotlight. Part of what made the allure of this exhibition was its ability to take an immense structure and turn it into something small and manipulable. The narrative told

[89] Hà Anh, "Khánh Thành Tòa Tháp Tài Chính Bitexco."
[90] Vy Vy, "Bitexco."

through the use of distinguishable imagery was striking and effective, its comprehensibility enhanced by the models' small scale. The handcrafted models were interactive; they could be picked up and moved around by viewers. The idea of knowledge acquisition through interactions is important for designing computer user interfaces. The AR scene for this chapter makes use of interactivity to help explain and complicate the narrative. The four sites explored previously are represented by 3D printed models and augmented with their corresponding digital 3D models. An example of this is featured in Figure 5.9.

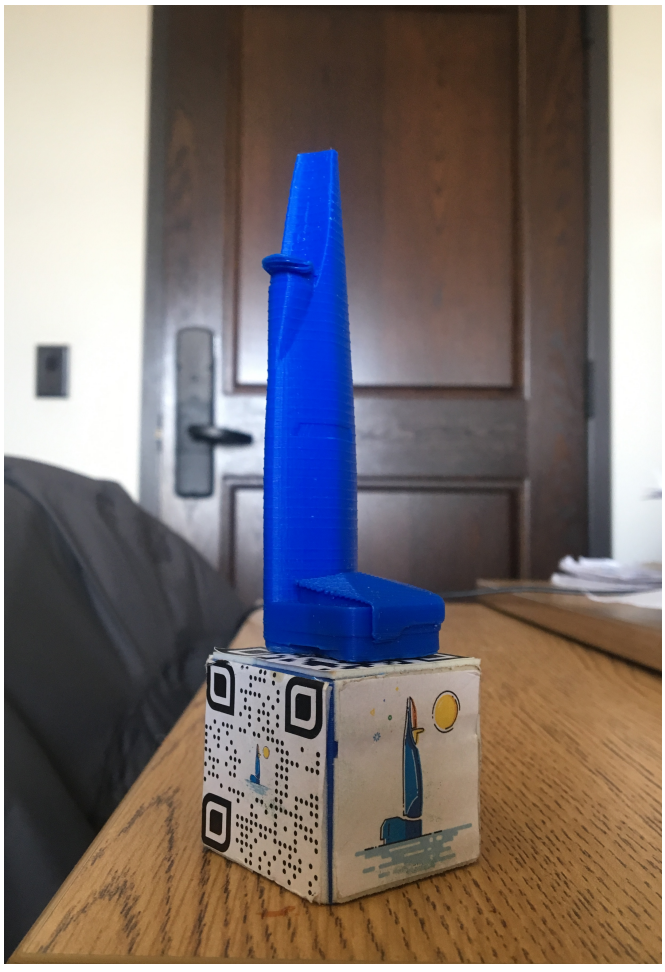

Figure 5.9: 3D printed Bitexco Financial Tower model (Photograph by Thuy Dinh.)

The experience encourages interactions on multiple levels, both on the screen medium and in the real world. Users can pinch the model on their device to change its scale, or they can move closer to the 3D printed objects to achieve a closer look at

the 3D models on their screen. The AR representations of the buildings are attached to their real-life models, so that when users manipulate the real models, their AR objects respond accordingly. The models are placed on a large map of Ho Chi Minh City on top of a table. Their positions on the map are approximately where the sites are in real life.

(a) The urn from Thiên Hậu Temple (Photograph by Thuy Dinh.)

(b) 3D model constructed with Meshroom (Screen capture by Thuy Dinh from within the 3D Builder software.)

Figure 5.10: The urn from Thiên Hậu Temple and model

Among the 3D printed models, two are miniature replicas of the Notre Dame Cathedral and the Bitexco Financial Tower. It was impossible to create a 3D model of the Thiên Hậu temple because its sides are connected to other buildings and houses in the neighborhood and cannot be separated. Instead, an urn from the temple was chosen to represent it, the 3D model generated using photogrammetry (Figure 5.10). Around 100 images of the urn were taken from various angles, and processed by the photogrammetry software Meshroom to produce a textured urn model. The remaining object, the Independence Palace, is only represented by a box

because its 3D model is not printable. There must be extensive alterations to the model structure to render it printable. As a result, a box is used instead.

In addition, since the 3D printed models are homogenous in terms of their color, with few distinguishing features, they have posed a challenge for tracking. To remedy this, the models are attached to an additional cubic pedestal, covered by QR codes and the logo of the corresponding building. Instead of detecting the 3D model, the software tracks the faces of the pedestal, represented by a multi-target in Vuforia. Multi-targets have turned out more stable for detection than object targets.

The motivation behind this setting is to create a sense of position and scale for viewers. The experience seeks to mimic the top-down perspectives that rulers of Ho Chi Minh City have over urban planning. Urban planners view the city through blueprints, maps, and construction plans. Their viewpoint is not at the ground level where daily activities happen. For citizens who interact with these spaces on a daily basis, the notion that these buildings are ultimately objects that were conceived and produced by some state and private enterprises is abstract and elusive. By presenting an immersive environment where users take on the role of urban planners, the exhibition encourages them to think critically about the often overlooked processes that take place to build and rebuild the urban environment. The intersection of memory, power, and identity is intricately encoded into the built environment of the city, and augmented reality helps deconstruct and visualize the layers making up its complexity.

Chapter 6

The AR Model for Historical Memory Studies: Results & Discussion

Chapters 4 and 5 present two AR experiences for visualizing memory, particularly focusing on its dynamic nature. The three layers of the research are demonstrated by different concepts in augmented reality. First, historical transformation comes across through spatial juxtaposition. Second, the artifact-centered narrative is enabled by object recognition. Third, perspective is realized by the interactability of the exhibit items. The success of these individual elements depends on the effectiveness of each technological component and the AR system as a whole.

Overall, feature detection works well for object and image recognition. Despite some limitations with repetitive and low-contrast images, tracking is robust and efficient for most inputs. The augmentability of image targets is indicated on the when targets are created. Once a pose has been established, tracking persists even when only a fraction of the target is in frame. **Extended Mode** in Vuforia configurations in Unity provides the option for maintaining the established pose even when the target is out of frame. 3D objects prove to be a more challenging target for detection than 2D images. **Vuforia Object Scanner** only registers larger objects with a substantial number of features. Objects with great difference in contrast also perform better. 3D printed models are especially hard to stably detect and track because they only have one color and very little contrast. Despite these

drawbacks, Object Scanner allows instantaneous testing of targets after the scan, so that users do not have to wait until the testing phase in Unity to determine the usability of a target.

Notwithstanding the difficulties with tracking, once target detection and pose calculation are complete, the tracking behavior is relatively stable for the duration of the app's run time. Augmented contents are highly responsive to changes in targets' poses. As mentioned previously, as long as part of the target is still in frame, the pose is maintained. For image targets, this means that augmented content remains active even when a flat target is extremely tilted. Such behavior facilitates great freedom of movement for the audience; the potential for unimpeded interactions is not hampered by technical restrictions. For object targets, the range of possible interactions is even more expansive, since flat image targets are only tracked and augmentable on one plane (the plane of the image), while object targets are augmentable from almost all angles. The only untracked plane is its bottom, which is hidden from the scan. Another limitation with Vuforia is that it does not support the simultaneous detection and augmentation of multiple object targets in the same frame.

While technical strengths and issues of the system are immediately observable, its effectiveness in terms of conveying the narrative depends on many factors. The simple AR experience cannot cover the depths of the historical research without overwhelming the audience. The tradeoff between simplicity and complexity is a balance that public historians constantly struggle with. The most compelling advantage that augmented reality provides is active engagement with primary sources. Handheld cross-platform AR experiences are portable and social; users are encouraged to engage in discussions or collaborate. Meanwhile, since the experience is on a personal device, each user can explore the exhibit and the app at their own pace in a self-customized session. Even if the historical narrative has

to be simplified, augmented reality provides affordances that are unique to digital storytelling that broaden the boundaries of traditional methods of engagement.

As the function of memory studies in history is to uncover this dynamic between memory and its actors, the purpose of this application in particular is to visually extract what has become muddled by the human mind and reclaim agency over the city's history. By superimposing layers of historic maps, the experience hopes to present the sites of memory in the history of Ho Chi Minh City in a way that shifts the agency to the audience. In the previous discussion of power and mapping, it is the ownership of knowledge and wealth that enables the creation of maps and architecture. This app provides users with the means to redress this power imbalance and to deconstruct the processes and practices imposed on them by cartographers and architects. The app is also a site of memory, a mnemonic device seeking to partake in the shaping of memory, but rather than dictating the perspective, it offers users the freedom to decide the angles from which the past should be viewed. This activity encourages historical awareness, particularly of forces of memory. Space is an important trigger of memory. Sources of spatial memory can be direct or indirect.[1] Knowledge of an environment can come from direct interactions via sensorimotor activities such as walking and observing, or from indirect sources like maps. This AR experience captures the essence of both direct and indirect sources by designing affordances that cater to both modes of acquisition.

Much as augmented reality can empower visualization of memory studies, as far as memory is concerned, such an application is subject to the same dangers that it seeks to deconstruct. Technology, knowledge, and power are always intertwined. The use of AR technologies to create a new kind of knowledge is a kind of power on its own. Therefore, it is important to consider the ethics of such a practice and its principles. The choice of which maps and buildings to use and their presentation

[1] Gary L. Allen, *Human Spatial Memory: Remembering Where* (Mahwah, NJ: Taylor & Francis Group, 2003), 252, http://ebookcentral.proquest.com/lib/wooster/detail.action?docID=335502.

are influenced by the need for a clear, thematic, and augmentable narrative. As a result, contextualization is crucial for understanding as well as for transparency.

Chapter 7

Conclusion

From the perspective of memory, the Saigon urban space is a locus where multiple identities and narratives about the city interact. Materials of this kind of memory are spaces such as maps and buildings that articulate the mindset of their creators, steeped in history, power, and ideologies. In this quest to construct a city, planners and builders are also constructing a specific way to use and remember these spaces. Maps represent ideas that, once built in reality, become ideologies. Architecture exemplifies the nature of this transition from imagined to concrete. Through the creation of these structures, actors of memory like the municipal leadership, private enterprises or citizens themselves are generating a mechanism for recollecting the past that is built into the city's physical landscape. These sites of memory collectively produce an urban memory, which does not only indicate how the city is remembered but also considers the city as "a physical landscape and collection of objects and practices that enable recollections of the past and that embody the past through traces of the city's sequential building and rebuilding."[1] This definition of urban memory by Mark Crinson also applies to other facets of the city such as art, literature, and events.

The connection between memory and power is what makes memory such an

[1] Mark Crinson, "Urban Memory - An Introduction," in *Urban Memory: History and Amnesia in the Modern City* (London: Routledge, 2005), xii.

attractive avenue for various groups with a stake in the city. Spatial markers like skyscrapers or even boulevards and bridges provoke remembrance of the past. Collective recollection by a city's population enables them to identify with its history and present, providing the grounds for developing a collective identity characterized by a shared pride in their mutual past. Going back to the example of Ho Chi Minh City, for its governing powers, constructing a collective identity was instrumental in this fragmented society that was never completely Vietnamese, Chinese, or French. Using the term by Benedict Anderson, the fostering of an "imagined community" through instigators like maps and buildings was what enabled these agents of memory to mobilize people and resources for colonial exploitation, wars, and industrial production.[2]

As with any kind of memory processes, the making of Ho Chi Minh City and its memory is subject to coercion, loss and distortion. On the one hand, the physical process of building the landscape often involves violent removal of existing designs, whether those are marshes or communities. It can also lead to forced changes in function for the spaces in question. The Bến Nghé area under French colonization is an example of the functions of a colonial administrative headquarter imposed on an urban area. Cartography and architecture also institute symbolic meanings through their manipulation of memory. The psychological nature of memory recollection implies loss and distortion. In the place of context-aware representations are prompts for recollections that exploit the fickleness of remembering to institute decontextualized or synthesized memory.[3] The result is a kind of romantic and glorified nostalgia that should describe brutal histories but is stripped of any context, a memory without the pain. Disruptive and delusive techniques like compulsion,

[2] Benedict Anderson, *Imagined Communities: Reflections on the Origin and Spread of Nationalism*, Revised edition (London: Verso, 2006).

[3] Crinson, "Urban Memory," xiv.

suppression and censorship allow for the production of specific narratives born out of political and commercial expediency.

All the same, to view memory as an expediently constructed product does not mean rejecting the city's legacy; rather, it calls for a reevaluation of the definition of legacy. Ho Chi Minh City is not a place without history. It is the implication of this complicated history that creates the need for memory, which ends up as a revised and streamlined version of the past. This project is a critique of the production and curation of these alternate narratives. At a time where the past is everywhere and nowhere and the business of memory booms with the commercialization of memorabilia, context becomes lost among sentimentality and misguided notions of aesthetic. The demand for memory drives selective preservation. What is branded and resold as legacy is only an uncomplicated part of history, while the other messier aspects of colonialism, civil war, forced cultural assimilation, and environmental crises get obfuscated. Going back to Ho Chi Minh City's legacy, this urban center has always been diverse, a product of thriving trade activities and an intersection of various cultural influences, but its sites of memory, represented by maps and architecture, are not products of its diverse and vibrant culture. These efforts are not only intended to represent the city's culture but to communicate the authority of the cartographers and architects behind them. Consumers of memory should be aware of these levels of subtext the next time they visit the Notre-Dame Cathedral and walk across the street to look at old Saigon maps in the city's Post Office. And when the next skyscraper claims the title of city symbol, one should pause and ask what it symbolizes after all.

With these considerations, what augmented reality provides is a new dimension for critically engaging with memory. Technology helps create sites of memory such as maps and buildings, and technology can help deconstruct them. The motivation for using augmented reality arises from the complexities of historical subjects in

general, and memory specifically—the AR model in this project is centered on spatial interactability of primary sources to exploit the spatial dimension of urban memory. Object recognition, which hinges on feature detection algorithms, is the backbone of the object-centered experience. The results demonstrate that AR can reliably be used for a variety of source materials. There are many potentials for augmented reality when it comes to non-traditional methods for studying and visualizing history.

On the other hand, the expansion of augmented reality in fields such as heritage preservation, tourism, education, and museum studies also creates the need for a theoretical framework for the application of this technology to history. The same complexities with memory can also be applied to the use of augmented reality. The use of technology of any kind in public history is implicated in the entanglement of knowledge, power, and memory. Who owns technology, who gets to see with augmented reality, and what it depicts are all valid concerns. While it is important that scholarship evolves to embrace new tools technology has to offer, the methodology and ethics of such practices must be taken into consideration to ensure that creators and users of these experiences are critical and cognizant in their usage. In addition, historiographical dialogues on the topic of science should not be limited to humanities disciplines only. In the true spirit of digital humanities, technology developers should also engage in conversations about the history and implications of their creations.

TIMELINE

Pre-1600s	Funan, Chenla, Champa and highland principalities
1920s	Vietnamese southward expansion
1680s	Arrival of Ming loyalists, receiving lands from the Nguyễn lords
1750s	Arrival of Qing settlers
1771	Tây Sơn Rebellion & massacre of thousands of Chinese in the South.
1802	Start of the Nguyễn dynasty. Nguyễn Phúc Ánh became King Gia Long.
1812	Lê Văn Duyệt became the military general of Gia Định.
1833	Lê Văn Khôi's rebellion
1859	French conquest of Gia Định
1862	Fall of Gia Định. The Nguyễn signed three southern provinces to the French.
1940	Japanese involvement in Vietnam
1945	Ho Chi Minh's declaration of Independence. The First Indochina War broke out.
1954	French defeat at Điện Biên Phủ
1955	Founding of the American-backed Republic of Vietnam under Ngô Đình Diệm
1975	Liberation Day/Fall of Saigon
1986	Đổi Mới (renovation reforms)

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36hn. "Bản đồ Thăng Long theo Hồng Đức Địa Dư (1490) – Plan de Thang-long." January 1, 2015. https://36hn.wordpress.com/2015/01/01/ban-do-thang-long-theo-hong-duc-dia-du-1490-plan-de-thang-long/.

ANNOTATION: This website has a copy of a map of the Thăng Long citadel according to the Hồng Đức map collection.

Appleton, Charles, ed. "Notes and News." *The Academy* , no. 195 (January 29, 1876): 108.

ANNOTATION: The Academy was a London publication from 1841 to 1916. This item, published in 1876, discusses the construction of the Saigon Cathedral by the French in Indochina. It mentions three possible styles for the cathedral, but says Gothic and Romanesque are preferable to Renaissance.

"'Bảo Tàng Ký Ức' lần đầu tiên của người Sài Gòn." *Dân Trí* Accessed February 26, 2020. https://dantri.com.vn/van-hoa/bao-tang-ky-uc-lan-dau-tien-cua-nguoi-sai-gon-20190425180415510.htm.

ANNOTATION: The article describes the "Bảo Tàng Ký Ức"exhibit showcasing miniature models of symbols of Saigon in the past.

Bảo tàng Thành phố Hồ Chí Minh. "Sài Gòn - Thành phố Hồ Chí Minh: Thương cảng, thương mại - dịch vụ." Accessed November 28, 2019. http://www.hcmc-museum.edu.vn/en-us/store/1123-sai-gon-thanh-pho-ho-chi-minhbrthuong-cang-thuong-mai-dich-vubr.aspx.

ANNOTATION: This webpage by the Museum of Ho Chi Minh City provides a brief summary of the commercial activities and services around the city's port area.

Bertaux, M., and A. Chauvet. "Cochinchine française: Plan cadastral de la ville de Saïgon." 1:4000. Service du cadastre et de la topographie, 1898. https://gallica.bnf.fr/ark:/12148/btv1b530297676.

ANNOTATION: This map was made by the French Department of Cadastre and Topography in Saigon in 1898.

Bitexco. "Shopping Archives." 2013. http://www.bitexcofinancialtower.com/?cat=15&lang=en.

ANNOTATION: This is the official website of Bitexco Financial Tower. It contains information about the Tower's inspiration, motivation, and spaces.

BMI. "Market Report – Vietnam – Economics." Accessed March 12, 2020. https://bmiglobaled.com/Market-Reports/Vietnam/economic-strength.

ANNOTATION: This report provides the economic growth rates of Vietnam after U.S.-Vietnam normalization.

Bộ Tài nguyên và Môi trường. "Thành phố Hồ Chí Minh. C-48-34-A-d." 1:25000. Ha Noi: Nhà xuất bản Bản đồ, 2005. http://virtual-saigon.net/Maps/Collection?ID=1141.

ANNOTATION: This map was made by the Ministry of Natural Resources and Environment in 2005 and belongs in a collection of multiple maps of Ho Chi Minh City and its periphery. This specific map depicts the central area.

———. "Quy định chức năng, nhiệm vụ, quyền hạn và cơ cấu tổ chức của Cục Đo đạc, Bản đồ và Thông tin địa lý Việt Nam." May 16, 2017. http://dosm.gov.vn/SitePages/GioiThieu.aspx?item=568.

ANNOTATION: This document by the Ministry of Natural Resources and Environment specifies the function, responsibility, right and oganization of the Department of Survey, Mapping and Geographic Information (DOSM). It states that the DOSM is the main governing body of all cartographic activities in Vietnam and identifies areas for development in terms of spatial data collection and mapping technologies.

Cảnh Vũ. "Gặp tác giả bức ảnh: Xe tăng Quân giải phóng đánh chiếm Dinh Độc Lập ngày 30-4-1975"." *Báo Công an Nhân dân Điện tử*, April 28, 2017. http://cand.com.vn/Phong-su-tu-lieu/T18-Gap-tac-gia-buc-anh-Xe-tang-Quan-giai-phong-danh-chiem-Dinh-Doc-Lap-.ngay-30-4-1975-438835/.

ANNOTATION: This article is an interview with the photographer of the famous moment when the tank crashed the Independence Palace's gate on Liberation Day. The description of the event is steeped in heroism and glory.

Cẩm nang du lịch Việt Nam. "Ngắm nhìn nét đẹp kiến trúc của nhà thờ Đức Bà Sài Gòn." March 10, 2017. https://www.vntrip.vn/cam-nang/kien-truc-nha-tho-duc-ba-sai-gon-19948.

ANNOTATION: This article is typical of the usual contents featuring the Saigon Notre-Dame Cathedral in Vietnamese media.

Center of Information Technology. "Nhà thờ Đức Bà - Ave Maria Church - Sai Gon." Pinterest. Accessed March 14, 2020. https://www.pinterest.com/pin/320177854733939284/.

ANNOTATION: This is an image of the Saigon Notre-Dame Cathedral from the Center of the Center of Information Technology in Vietnam.

Christopher. "Chinese Temple in Saigon." February 9, 2008. Photo. https://www.flickr.com/photos/qilin/2329029122/.

ANNOTATION: This image by Christopher of the façade of the Thiên Hậu Temple was taken in 2008.

Chung Hai. "Nếu còn thành cũ, Gia Định không dễ thất thủ ngày 17-2-1859." *Tuổi Trẻ Online*, February 17, 2016. https://tuoitre.vn/news-1052677.htm.

ANNOTATION: This newspaper article analyzes the strategic location of Bát Quái, the old Saigon citadel. The author speculates that with the defense of the former citadel, royal troops could have prevented the French conquest of Saigon in 1859. The old citadel was destroyed after the 1833 rebellion and a smaller one was erected on its site.

Corps of Engineers, U.S. Army. *The Army Map Service: Its Mission, History and Organization*. Washington, D.C., 1960.

ANNOTATION: This document by the Army Map Service (AMS) details its mission, history, and operation. It served as the reference for orientation and training of AMS personnel and for visitors. The source advocates the need of cartography for military and security purposes, reinforced by arguments about the fascination with maps and cartographic technologies.

Cổng thông tin điện tử Bộ Kế hoạch và Đầu tư. "Thành phố Hồ Chí Minh - Điều kiện tự nhiên." Accessed March 13, 2020. http://www.mpi.gov.vn/Pages/tinhthanhchitiet.aspx?idTinhThanh=35.

ANNOTATION: This is the official website of the Ministry of Planning and Investment. The page linked here is a description of the natural conditions of Ho Chi Minh City.

Daily Travel Vietnam. "Du lịch tham quan thành phố Hồ Chí Minh một ngày." Accessed March 14, 2020. https://dailytravelvietnam.com/vi/tour/du-lich-tham-quan-thanh-pho-ho-chi-minh-1-ngay/.

ANNOTATION: This webpage is an example of a one-day package tour of Ho Chi Minh City, which includes the Thiên Hậu Temple, the Independence Palace, and the Saigon Notre-Dame Cathedral.

Dansaigon. "Những di sản tạo nên nét đẹp Sài Gòn." *Dân Sài Gòn* (blog), January 10, 2020. https://dansaigon.com/nhung-di-san-tao-nen-net-dep-sai-gon/.

ANNOTATION: This article was on an online blog, Dân Sài Gòn (Saigon Citizens). It laments the loss of heritage in Ho Chi Minh City and surveys some monuments in the city. Interestingly, most of these sites are from the Franco-American period, with all except for one built by the French colonialists. Such sentiment is common accross the board in Vietnamese media when it comes to colonial architectural legacy.

Di tích Dinh Độc Lập. "Kiến trúc Dinh Độc Lập." March 23, 2018. https://dinhdoclap.gov.vn/di-tich/kien-truc-dinh/.

ANNOTATION: This is the official website of the Independence Palace. It provides official information on the Palace's history, architecture, and ongoing events.

Do, Anh. "Vietnamese Immigrants Mark Black April Anniversary." *Los Angeles Times*. April 25, 2015. https://www.latimes.com/local/lanow/la-me-ln-vietnam-reunion-20150425-story.html.

ANNOTATION: This article exemplifies the use of the name "Black April"to indicate the event of April 30, 1970 in international media.

Doling, Tim. "Blog Articles." *Historic Vietnam* (blog). Accessed March 15, 2020. http://www.historicvietnam.com/publications/.

ANNOTATION: This blog is by historian Tim Doling. He worked on the development of the arts management training curricula for three Ha Noi universities. This blog is a series of articles on Vietnam's history, including primary sources in the form of writings by European visitors to Vietnam under the French and the American/South Vietnam administrations.

Du Tử Lê, Lưu Vĩ Lân, and Nguyễn Tường Bách. *Sài Gòn những biểu tượng*. Ho Chi Minh: Nhà Xuất Bản Văn Hóa - Văn Nghệ, 2018.

ANNOTATION: This book is a collection of short writings of desriptions of Saigon through its symbols and special places.

Edwards, Anastasia, ed. *Saigon: Mistress of the Mekong: An Anthology*. Literary Anthologies of Asia. Oxford: Oxford University Press, 2003.

ANNOTATION: Anastasia Edwars went to the Phillips Exeter Academy, Wesleyan University and the School of Oriental and African Studies. This anthology is a series of primary source extracts on Saigon, mostly written in French and Vietnamese. A lot of them are writings by travellers to the city observing the scenery and people of Saigon.

Hà Anh. "Khánh thành Tòa tháp tài chính Bitexco - Biểu tượng kiến trúc độc đáo ở Việt Nam." *Báo Sài Gòn Giải Phóng*, October 27, 2010, sec. Doanh nghiệp và Phát triển. https://www.sggp.org.vn/khanh-thanh-toa-thap-tai-chinh-bitexco-bieu-tuong-kien-truc-doc-dao-o-viet-nam-.14510.html.

ANNOTATION: This newspaper article is on the inauguration of the Bitexco Financial Tower and includes the words of the Bitexco chairman about their intention for the Tower at its opening ceremony.

Hà Mỹ Giang. "Năm biểu tượng kiến trúc Sài Gòn qua ngòi bút S Pen trên Galaxy Note 8." *Báo điện tử Tri Thức Trực Tuyến*, May 31, 2018. https://news.zing.vn/5-bieu-tuong-kien-truc-sai-gon-qua-ngoi-but-s-pen-tren-galaxy-note-8-post847437.html.

ANNOTATION: This online news article by Hà Mỹ Giang is an ad for the Samsung Galaxy Note 8 S Pen. What is special is its use of so-called Saigon architectural symbols for a technology advertisement. The buildings chosen include the Bitexco Financial Tower, Vincom Center Đồng Khởi, Vietcombank Tower (state-owned), Saigon Times Square, and Petroland Tower. These are all skyscrapers.

Hiếu Nghĩa. "Hoa Sen - Biểu tượng Văn hóa Việt." Sở Văn hóa, Thông tin, Thể thao và Du lịch tỉnh Bạc Liêu, December 13, 2013. http://svhttdl.baclieu.gov.vn/diendan/Lists/Posts/Post.aspx?List=504f8c21-7f18-4116-80d4-6da2fa0e598f&ID=66.

ANNOTATION: This article by the Department of Culture, Information, Sports, and Tourism of Bạc Liêu Province explains the role of the lotus flower in Vietnamese culture. It uses examples from poems as well as references the state's decision to choose lotus as Vietnam's national flower to exemplify its symbolic importance.

"Ho Chi Minh City Economic Growth in 2019 Estimated at 8.32%." *Nhân Dân Onine*, December 1, 2019. https://en.nhandan.org.vn/politics/item/8177902-ho-chi-minh-city-economic-growth-in-2019-estimated-at-8-32.html.

ANNOTATION: This newspaper article has the most recent data on Ho Chi Minh City's economy.

Huỳnh Ngọc Trảng. *Sài Gòn - Gia Định xưa: tư liệu & hình ảnh*. Ho Chi Minh: Nhà xuất bản Thành phố Hồ Chí Minh, 1997.

ANNOTATION: The book provides a thorough chronology of all administrative and political events in the Saigon - Gia Định province area from after Nguyễn Hữu Cảnh laid down the first Vietnamese taxation system in the region until 1945. The volume also includes maps and old images of imperial and colonial Saigon, although they are used for illustration purposes rather than as a different kind of sources, with their own intentions and biases.

Institut d'Asie Orientale (Virtual Saigon). "Virtual Saigon." Virtual Saigon, 2015. http://virtual-saigon.net/.

ANNOTATION: Virtual Saigon is a website by the Institut d'Asie Orientale of the Lyon Institute of East Asian Studies, directed by Laurent Gédéon and François Guillemot. The site is part of the Virtual Cities Project, which aso includes Beijing, Hankou, Shanghai, Suzhou, Tianjin, and Zhejiang. The site is an archive of maps, photographs, and documents of Ho Chi Minh City, and links directly to these sources' host websites.

Lam Phong. "Sài Gòn của một miền ký ức." *Tuổi Trẻ Online*, January 19, 2014. https://tuoitre.vn/news-590460.htm.

ANNOTATION: This article's usage of "miền ký ức"is typical of the nostalgic sentiment in publications for an old Saigon.

Lê Văn Cảnh. *Miếu Thiên Hậu - Tuệ Thành Hội Quán*. Ho Chi Minh: Nhà xuất bản Trẻ, 2000.

ANNOTATION: This is a rare publication by the Thiên Hậu temple leadership on its history and development. The source outlines the origins of the Thiên Hậu Temple, its involvement in service today, and features maps and images of artifacts and scripts from the temple, complete with English and Mandarin translations. A copy could only be acquired from the temple's souvenir store as of 2020, and it has not been revised since 2000.

Mây Trắng. *Mùa Xuân Trên Thành Phố Hồ Chí Minh*. Accessed March 10, 2020. https://nhac.vn/bai-hat/mua-xuan-tren-thanh-pho-ho-chi-minh-may-trang-sodRBWw.

ANNOTATION: This webpage provides the lyrics of the song "Mùa xuân trên thành phố Hồ Chí Minh"by Xuân Hồng. This version is performed by the Mây Trắng group.

Minh Hương. *Nhớ Sài Gòn*. Ho Chi Minh: Nhà xuất bản Miền Nam, 1994.

ANNOTATION: This book is a piece of non-fiction literature on life in Saigon from the late 1940s to the end of the 20th century, during which time the author was a Saigon resident. A segment of this book is used in the Vietnamese official literature curriculum for 7th grade. This text has the style of nostalgic and romantic writing typical of Vietnamese-language histories of Saigon.

Mongabay. "Population estimates for Ho Chi Minh, Viet Nam, 1950-2015." Accessed March 12, 2020. https://books.mongabay.com/population_estimates/full/Ho_Chi_Minh-Viet_Nam.html.

ANNOTATION: This webpage provides the population estimates of Ho Chi Minh City from 1950 to 2015.

National Geographic Service of Vietnam. *Nha Dia Du Quoc Gio [i.e. Gia] (National Geographic Service of Vietnam): Ten Years of Operations 1955-1965.* Ho Chi Minh: NGS, 1965.

ANNOTATION: This primary source provides an overview of the foundation and operation of the National Geographic Service of Vietnam, the main governing body of cartography in the Republic of Vietnam. The document includes the mission statement, accomplishments, challenges, and cartographic techniques in one decade of operation.

National Geographic Service of Vietnam, and U.S. Army Map Service. "Saigon." 1:10000. U.S. Army Map Service, 1961. http://legacy.lib.utexas.edu/maps/world_cities/txu-pclmaps-saigon_sheet1-1961.jpg.

ANNOTATION: This map was first created and published in 1958 by the National Geographic Service of Vietnam. This edition was reproduced by the U.S. Army Map Service in 1961.

Nguyễn Đăng Khoa. "Một vài hình ảnh Sài Gòn xưa." Ohay TV, August 3, 2015. https://www.ohay.tv/view/mot-vai-hinh-anh-sai-gon-xua/tRdJ7.

ANNOTATION: This webpage provides an old image of Saigon, overlooking the Khánh Hội bridge.

Nguyễn Viết Ngoạn. *Di sản Sài Gòn [Saigon Heritage]*. Ha Noi: Nhà xuất bản Thời đại, 2014.

ANNOTATION: Dr. Nguyễn Viết Ngoạn is a professor at the Saigon University. The book is a collaborative work between the Saigon University and the Xưa \& Nay magazine to celebrate the 40th anniversary of Liberation Day. This is a collection of old images of historic sites in Ho Chi Minh City. The collection provides a glimpse of what is considered heritage in Vietnam's national discourse.

Owens, Mitchell. "Madame Nhu Almost Slept Here." *The New York Times*, January 12, 2003. https://search.proquest.com/docview/215482763?OpenUrlRefId=info:xri/sid:summon&accountid=15131.

ANNOTATION: This article describes the Independence Place in a nostalgic and wistful tone, with reverence for the edifice's magnificence and melancholy for its fading position in American consciousness.

P. Hoàng, and M. Thảo. "Bitexco Financial Tower: Sắp khai trương tòa nhà "búp sen" cao nhất Việt Nam." *Báo Điện tử Pháp luật Thành phố Hồ Chí Minh*. April 16, 2010. https://plo.vn/content/MTUyMzQz.html.

ANNOTATION: This article announces the upcoming inauguration of the Bitexco Financial Tower in 2010. It uses the terms "grandest"and "most valuable"to describe the construction of this skyscraper, which typify how Vietnamese press depicts the Tower.

Sơn Hòa. "Những kênh rạch xưa thành đại lộ đẹp nhất Sài Gòn." *VnExpress*, April 10, 2016. https://vnexpress.net/thoi-su/nhung-kenh-rach-xua-thanh-dai-lo-dep-nhat-sai-gon-3380037.html.

ANNOTATION: This newspaper article includes a list of important boulevards in Saigon that used to be a creek or a canal but were filled under the French to facilitate land transportation. Most of these waterways now form the most important streets in District 1, the central area of Saigon.

T.B. "Chùa Bà Thiên Hậu ở Chợ Lớn qua loạt ảnh trăm tuổi." Kiến Thức, December 14, 2018. https://kienthuc.net.vn/kho-tri-thuc/chua-ba-thien-hau-o-cho-lon-qua-loat-anh-tram-tuoi-1157499.html.

ANNOTATION: This webpage features several photographs of the Thiên Hậu Temple that were taken more than a hundred years ago. These rare images show the changes to the temple over time.

Tâm An. "Uống cà phê, nhớ những tháng ngày xưa cũ ở Đà Nẵng." *Dân Trí*, November 3, 2017. https://dantri.com.vn/doi-song/uong-ca-phe-nho-nhung-thang-ngay-xua-cu-o-da-nang-20171103065604954.htm.

ANNOTATION: In this article, Thanh Vũ, the owner of a subsidy coffee shop in Đà Nẵng, shares his passion for subsidy period artifacts as well as stories about his customers.

Thanh Giang. "TP Hồ Chí Minh: Tăng dân số cơ học quá nhanh." *Đại Đoàn Kết*, October 12, 2019. http://daidoanket.vn/do-thi/tp-ho-chi-minh-tang-dan-so-co-hoc-qua-nhanh-tintuc449624.

ANNOTATION: This online news article has the most recent population figures of Ho Chi Minh City.

Thông tấn xã Việt Nam. "Dân số TPHCM gần 9 triệu người, đông nhất cả nước." *Báo Sài gòn Đầu tư Tài chính*, October 12, 2019. https://saigondautu.com.vn/content/NjcxMDQ=.html.

ANNOTATION: This article reports the current statistics on the population of Ho Chi Minh City and describes the demographic trends in the past ten years, as well as the developments to accommodate this growth.

Tổng Giáo phận Sài Gòn. "Nhà thờ Đức Bà Sài Gòn, sức hút của một công trình," July 1, 2009. https://www.tgpsaigon.net/bai-viet/nha-tho-duc-ba-sai-gonsuc-hut-cua-mot-cong-trinh-44657.

ANNOTATION: This article was by the Roman Catholic Archdiocese of Ho Chi Minh City. It presents different perspectives by several notable Vietnamese architects on the Saigon Notre-Dame Cathedral. The wide-ranging opinions express the ambivalence by Vietnamese for the colonial legacy.

Trác Thúy Miêu. *Vọng Sài Gòn*. Ha Noi: Nhà Xuất Bản Hội Nhà Văn, 2019.

ANNOTATION: Trác Thúy Miêu is a Vietnamese MC and journalist from Ho Chi Minh City. \textit{Vọng Sài Gòn} is a collection of her experiences in this city. The book expresses the nostalgia for the old Saigon from a female perspective. Her Saigon is personal and sentimental, as are the tendency of most representations of the city.

Trần Kim Anh. "Người Sài Gòn 'rủ nhau' đi chùa Bà Chợ Lớn đầu năm mới Canh Tý 2020." *Báo Thanh Niên*, January 25, 2020. https://thanhnien.vn/content/OTE4NDIz.html.

ANNOTATION: This article is published in the online\textit{Thanh Niên}, a prominent newspaper in Vietnam. It captures images of visitors to the Thiên Hậu temple in celebration of the 2020 Lunar New Year. The activities depicted range from praying to photo taking to making offers.

Trần Văn Học. "Plan de Gia-định et des environs, dressé par Trần-văn-Học, le 4e jour de la 12e lune de la 14e année de Gia-Long." Bulletin de la Société des Etudes Indochinoises, 1815. http://virtual-saigon.net/Maps/Collection?ID=1134.

ANNOTATION: This map was made by Trần Văn Học in 1815, presumably under the commission of the Nguyễn court. The map is often regarded as the first one by a Vietnamese of this area. This copy is from a French publication.

Trung Sơn. "Những con đường Thiên Lý đầu tiên của vùng đất Sài Gòn." *VnExpress*, September 5, 2017. https://vnexpress.net/thoi-su/nhung-con-duong-thien-ly-dau-tien-cua-vung-dat-sai-gon-3636181.html.

ANNOTATION: This article describes the history of the first Royal Roads made under Nguyễn lords before and during the Nguyễn dynasty. These national roads served as communication links, connecting the land of Vietnam from North to South for the first time, facilitating the taxation system.

Văn Hiến. "Bài 3: Cải tạo kênh Nhiêu Lộc – Thị Nghè: 'Công trình thế kỷ' của TP. Hồ Chí Minh." *Báo Mới*, January 31, 2018. https://baomoi.com/bai-3-cai-tao-kenh-nhieu-loc-thi-nghe-cong-trinh-the-ky-cua-tp-ho-chi-minh/c/24818795.epi.

ANNOTATION: This article describes the renovation project on the Thị Nghè - Nhiêu Lộc canal. The report includes an overview of the water conditions before and after the renovation.

Vy Vy. "Bitexco - người đi xây biểu tượng và kiến tạo giá trị tương lai." *Tạp chí điện tử Bất động sản Việt Nam*, February 22, 2018. http://reatimes.vn/bitexco-nguoi-di-xay-bieu-tuong-va-kien-tao-gia-tri-tuong-lai-21299.html.

ANNOTATION: This article is typical of how the Bitexco Financial Tower is described as the icon of Ho Chi Minh City.

Secondary Sources

"City." In *Merriam-Webster*. Merriam-Webster. Accessed 2019-11-28. https://www.merriam-webster.com/dictionary/city.

ANNOTATION: This dictionary entry provides the formal definition of a city.

Akerman, James R., editor. *The Imperial Map: Cartography and the Mastery of Empire*. The Kenneth Nebenzahl, Jr., Lectures in the History of Cartography. Chicago: University of Chicago Press, 2009.

ANNOTATION: This volume includes a collection of essays on the connection between empires and the use of cartography in colonies. Analyses contemplate the role of power in mapping and its colonial functions. The collection also discusses alternate maps from colonial models and dissects the struggle for control and power between colonizers and indigenous groups on the cartographic front.

Aline, Demay. "Saigon: Une Métropole Touristique?" *French Colonial History* 12 (May 8, 2011): 123–142. http://rave.ohiolink.edu/ejournals/article/346740056.

ANNOTATION: Aline Demay is a historian specializing in tourism in French Indochina. This article surveys the potentials and challenges for tourism in French Saigon and what the French did to try to boost its attractiveness for Western visitors.

Anderson, Benedict. *Imagined Communities: Reflections on the Origin and Spread of Nationalism*. London: Verso, 2006, revised edition.

ANNOTATION: Benedict Anderson is a political scientist and historian. This book is his most renowned work, explaining the origins of nationalism and how communities are formed based on shared characteristics, in what he terms "imagined communities."

Bastéa, Eleni, editor. *Memory and Architecture*. Albuquerque: University of New Mexico Press, 2004.

ANNOTATION: Eleni Bastéa is a Professor of Architecture at the School of Architecture and Planning at the University of New Mexico. The book examines the relationship between memory and architecture on several scales, both personally and nationally. It focues on literature as well to study how architecture is characterized in literary consciousness.

Bich Ngoc. "Race to Embrace Retail Mall Revolution." *Vietnam Investment Review*, October 24, 2010, sec. Investing. https://www.vir.com.vn/race-to-embrace-retail-mall-revolution-1888.html.

ANNOTATION: This article discusses the recent growth in demand for shopping malls. The race to build the grandest, most modern retail space has resulted in a whopping number of malls.

Biggs, David. *Quagmire: Nation-building and Nature in the Mekong Delta*. Seattle: University of Washington Press, 2010.

ANNOTATION: In *Quagmire*, David Bigg traces how nation-building projects by the French and South Vietnamese/American governments rely on and transform the water landscape of the Mekong delta. The volume highlights problems with modernization and industrialization, both in terms of the environment and the social cost. Tensions between water and its conquerors and between local populations and their colonizers manifest through the process of nation-building.

Boyer, M. Christine. *The City of Collective Memory: Its Historical Imagery and Architectural Entertainments*. Cambridge, MA: MIT Press, 1994.

ANNOTATION: In this book on representational imagery and architecture in the city, Boyer argues for a need of counter-memory that deconstructs the systemic frameworks imposed on a city's collective memory through public representations such as buildings. In this so-called "memory crisis,"the "history"engendered by city plans and buildings is built on separation and repression and needs to be recontextualized.

Boyle, Brenda M., Jeehyun Lim, and Daniel Leonard Bernardi, editors. *Looking Back on the Vietnam War: Twenty-first Century Perspectives*. War Culture. New Brunswick, NJ: Rutgers University Press, 2016.

ANNOTATION: Articles in this volume decentralize the American view of the American-Vietnamese war and center Vietnamese voices from the diaspora as well as non-Vietnamese and non-American actors.

Bui, Long T. "The Debts of Memory: Historical Amnesia and Refugee Knowledge in The Reeducation of Cherry Truong." *Journal of Asian American Studies* 18, no. 1 (February 25, 2015): 73–97.

ANNOTATION: This article studies Cherry Truong's experience in the subsidy period, specifically with the reeducation camp, and later as a refugee. It considers the notion of silence and historical amnesia in refugee's memory of the postwar time.

Cherry, Haydon. *Down and Out in Saigon: Stories of the Poor in a Colonial ity*. Studies of the Weatherhead East Asian Institute, Columbia University. New Haven: Yale University Press, 2019.

ANNOTATION: Haydon Cherry is assistant professor at Northwestern University.This book by Cherry is a social history on the life of the poor and the marginalized in colonial Saigon. It follows a Vietnamese prostitute, a Hakka laborer, a French orphan, a Vietnamese rickshaw puller, a crippled Vietnamese, and a poor Frenchman to get at the contrast between the highest and the lowest social classes in French Saigon. These stories paint lives outside of the grandiose urban development by the French and analyzes the shortsightedness of this system.

Crinson, Mark, editor. *Urban Memory: History and Amnesia in the Modern City*. London: Routledge, 2005.

ANNOTATION: Mark Crinson is a Professor of Architectural History at Birkbeck, University of London. The series he edited theorizes urban memory and how it manifests through art, architecture, and objects within the city. Different examples connect concepts of memory such as amnesia, trauma, and commemoration to remembrance in cities. The book provides a framework for studying urban memory.

Dessingué, Alexandre, and J. M. Winter, editors. *Beyond Memory: Silence and the Aesthetics of Remembrance*. Number no. 13 in Routledge approaches to history. New York: Routledge, 2015.

ANNOTATION: This is a collection of articles on the politics of silence in remembering and how it has been used in various memory project to repress discussion about the topic until it is truly forgotten. They also suggest that silence is part of the process of commemoration. As we celebrate certain aspects, others get brushed under the carpet and glossed over by a false sense of commemoration. The construction of memory often goes with the deliberate repression of matters that do not align well with the agenda of parties of interests, or groups whose such memories are too painful and uncomfortable to handle.

Dickey, Jennifer W. "Review of Reunification Palace." *The Public Historian* 33, no. 2 (2011): 152–162.

ANNOTATION: Jennifer Dickey is an Associate Professor and Coordinator of the Public History Program at Kennesaw State University. The review provides a detailed description of a walkthrough of the current Independent Palace. Dickey criticizes the lack of context and analyzes the agenda of the state through this selective presentation of the heritage site.

Dickhardt, Michael. "The Social Placing of Religion and Spirituality in Vietnam in the Context of Asian Modernity: Perspectives for Research." In *Dynamics of Religion in Southeast Asia*, edited by Volker Gottowik, Amsterdam University Press, 2014. Magic and Modernity, 55–74.

ANNOTATION: This article discusses the place of religion and spirituality in post Đổi Mới (Renovation) Vietnam. Michael Dickhardt is the Program Coordinator at the Department for East Asian Studies at the University of Göttingen. He describes how the socialist state came to terms with religion in the era of "modernity."

Doling, Tim. *Exploring Saïgon-Chợ Lớn: Vanishing Heritage of Hồ Chí Minh City*. Ha Noi: Thế Giới Publishers, 2019.

ANNOTATION: Tim Doling worked on the development of the arts management training curricula for three Ha Noi universities. This volume introduces several tours around Saigon that features notable historical sites and context for understanding their histories. The compilation is one of the most thorough lists on Ho Chi Minh City's monuments.

Dommen, Arthur J. *The Indochinese Experience of the French and the Americans: Nationalism and Communism in Cambodia, Laos, and Vietnam*. Bloomington: Indiana University Press, 2001.

ANNOTATION: Arther J. Dommen was Saigon Bureau Chief for United Press National from 1959 to 1961 and for the Los Angeles Times from 1961 to 1971. This book is his account of the politics of Indochina during the Franco-American period. It describes how the Norodom Palace was used under French and South Vietnamese administrations.

Eisner, Rivka Syd. "Performing Prospective Memory." *Cultural Studies* 25, no. 6 (November 2011): 892–916.

ANNOTATION: This is a study conducted on cô Nhựt (miss Nhut), a former communist guerilla fighter and current social activist in Vietnam. The research is based on a concept called prospective memory, "a form of collective remembering that propels and compels the past into the present and future". By performing prospective memory, miss Nhut is seeking to influence the future with small acts of collective remembering, particularly sharing her life narratives with others. This highlights the contribution of ordinary people in the politically charged memory landscapes of Vietnam, not only to protect or contest the past, but as a shared effort to create socially equitable futures.

Espiritu, Yến Lê. "Vietnamese Refugees and Internet Memorials." In *Looking Back on the Vietnam War: Twenty-first Century Perspectives*, edited by Brenda M. Boyle, Jeehyun Lim, and Daniel Leonard Bernardi, New Brunswick, NJ: Rutgers University Press, 2016. War Culture, 18–33.

ANNOTATION: Articles in this volume decentralize the American view of the American-Vietnamese war and center Vietnamese voices from the diaspora as well as non-Vietnamese and non-American actors.

Fisher, Christopher. "Nation Building and the Vietnam War." *Pacific Historical Review* 74, no. 3 (2005): 441–456.

ANNOTATION: This articles uses the frameworks and paradigms of modernization and nation-building theories to analyze the ideologies underlying U.S. presence in the Second Indochina War. This historiographic essay contends the new language for modernization enables the transformation in the literature of the war by equating its counterinsurgency and development natures.

Gibert, Marie. "Moderniser La Ville, Réaménager La Rue à Ho Chi Minh Ville." *EchoGéo* , no. 12.

ANNOTATION: The article traces the recent restructuring of street spaces in Ho Chi Minh City to accomodate the new "politique du renouveau", or politics of renewal in urban development policies. Gibert considers Chinese and French heritage in shaping these networks of multi-function alleys and examines their redefinition to enable the verticalization of the urban landscape.

Goh, Daniel. "In Place of Ritual: Global City, Sacred Space, and the Guanyin Temple in Singapore." In *Handbook of Religion and the Asian City*, edited by Peter van der Veer, University of California Press, 2015. Aspiration and Urbanization in the Twenty-First Century, 21–36. 1st edition.

ANNOTATION: Daniel Goh is associate professor in the Department of Sociology at the National University of Singapore. This chapter argues that the state has failed to characterize religiosity and spirituality as cultural heritage. As a result, the temple acts as a resistance against the secular urbanism with its vernacular spirituality that cannot be easily integrated into the ideal global city.

Gédéon, Laurent. "Cholon: A "Little China" in the Heart of Saigon.", GIS ASIE (French Academic Network on Asian Studies). http://www.gis-reseau-asie.org/en/cholon-little-china-heart-saigon.

ANNOTATION: This post by the French Academic Network on Asian Studies discusses the ethnic Chinese in Saigon under French colonization. It explains the congregation system and the trade activity going on in Chợ Lớn at the time.

Halbwachs, Maurice. *The Collective Memory*. New York: Harper & Row, 1980, 1st ed edition.

ANNOTATION: This text by Maurice Halbwachs in the 20th century lay the groundwork for many memory studies. His definition of "collective memory"and its relationship with individual remembrance is used as the foundation for works that analyze the formation of collective memories for certain histories. Individual remembrance is framed by social milieus, creating a collection of memories shaped by the same environments and frameworks. This notion is important for examining social influence on society's memory.

Harley, J. B. "Maps, Knowledge and Power." In *The Iconography of Landscape: Essays on the Symbolic Representation, Design, and Use of Past Environments*, edited by Denis Cosgrove, and Stephen Daniels, Cambridge: Cambridge University Press, 1988. Number 9 in Cambridge Studies in Historical Geography, 277–312.

ANNOTATION: This essay by J. B. Harley introduces an iconological interpretation of maps to understand how they can be manipulated by power and represent the social worlds in which they were created. He suggests a change in the cartographic discouse in which maps are their own "class of rhetorical images"with specific codes and production and usage modes.

Harley, J. B., and David Woodward, editors. *Cartography in the Traditional East and Southeast Asian Societies*. Number v. 2, bk. 2 in The history of cartography. Chicago: University of Chicago Press, 1994.

ANNOTATION: This volume is one of the classic texts on cartography in East and Southeast Asia. Analysis of maps from this area takes into consideration the shared linguistic and religious spheres, while still emphasizing regional distinction in and discriminate appropriation of cartographic traditions. The chapter on cartography in Vietnam by John Whitmore provides a good overview of Vietnam's mapping culture from the 14th century to the end of the Nguyễn dynasty.

Harms, Erik. "Beauty as Control in the New Saigon: Eviction, New Urban Zones, and Atomized Dissent in a Southeast Asian City." *American Ethnologist* 39, no. 4 (2012): 735–750.

ANNOTATION: Erik Harms is an Associate Professor of Anthropology and Southeast Asia Studies at Yale University. In this article, Harms argues that the eviction of residents in the Thủ Thiêm neighborhood of Ho Chi Minh City is justified by the discourse of beauty in urban development. As a result, the construction of new urban zones in the city, despite facing individual resistance from residents, still enjoys general approval because of their conviction in their role in beautifying the city.

———. *Luxury and Rubble: Civility and Dispossession in the New Saigon*. Number 32 in Asia: local studies/global themes. Oakland, California: University of California Press, 2016.

ANNOTATION: In *Luxury and Rubble*, Erik Harms examines two "New Urban Zones"in Ho Chi Minh City (Phú Mỹ Hưng and Thủ Thiêm). Harms argues that the emergence of these new centers has reorganized the city's landscape, more oriented towards global modernity. However, they are also the grounds for expressing contesting ideas about urbanization, particularly for locals stuck in between the transfer to private owners of nationalized spaces.

Hill, John. *How to Build a Skyscraper*. Buffalo, NY: Firefly Books, 2017.

ANNOTATION: This book by John Hill, author and founder of the architecture blog \textit{A Daily Dose of Architecture}, provides a list of the tallest buildings in the world and details about their construction. The Bitexco Tower was the 37th tallest skyscraper at the time of the book's publication.

Hornstein, Shelley. *Losing Site: Architecture, Memory and Place*. Ashgate studies in architecture series. Farnham, England: Ashgate, 2011.

ANNOTATION: Shelley Hornstein is Professor of Architectural History and VIsual Culture at York University. Her book presents the question of how architecture can trigger memory, answered through analysis of memorials, sites of traumatic historical events, postcards, demolished architecture, museum, forgotten sites, and the Internet.

Hoài Nam. "Tản văn, từ một cái nhìn lướt." *Báo Công an nhân dân điện tử* http://antgct.cand.com.vn/Nhan-dam/Tan-van-tu-mot-cai-nhin-luot-340089/.

ANNOTATION: This newspaper article explains the genre \textit{tản văn}. Hoài Nam surveys the origins and definition of \textit{tản văn} and notable writers of the genre.

Hu, Bangbo. "Maps and Political Power: A Cultural Interpretation of the Maps in The Gazetteer of Jiankang Prefecture." *Cartographic Perspectives* , no. 34 (September 1, 1999): 9–22.

ANNOTATION: This article is an examination of how political power factored into the creation of Jiankang Prefecture's gazetteer. Political influence is manifested by the state-controlled compilling process. Bangbo Hu suggests that maps be treated as cultural images indicative of the societies they depict.

Kee, Kevin B., and Timothy Compeau, editors. *Seeing the Past with Computers: Experiments with Augmented Reality and Computer Vision for History*. Digital Humanities. Ann Arbor: University of Michigan Press, 2019.

ANNOTATION: Kevin Kee is the Dean of the Faculty of Arts and Professor at the University of Ottawa. Timothy Compeau is an Assistant Professor at Huron University College and historian of colonial North America and the Atlantic World. \texitit{Seeing the Past with Computers} explore the use of augmented reality in studying and teaching history and establishes a paradigm for best practices when using augmented reality.

Khanh, Tran. "The Role of the Chinese in Vietnam's Economy." *Sojourn: Journal of Social Issues in Southeast Asia* 6, no. 1 (1991): 126–139. https://www.jstor.org/stable/41056815.

ANNOTATION: This article surveys the participation of ethnic Chinese in Vietnam's economic activites, within the context of the political changes in the 20th and 21st centuries.

Kiernan, Ben. *Việt Nam: A History from Earliest times to the Present*. New York, NY: Oxford University Press, 2017.

ANNOTATION: This textbook provides a comprehensive history of Vietnam from 1000 B.C.E. to the present, drawing from ancient textual sources and archeological discoveries. The collection is a satisfactory, if incomplete, starting point to Vietnam's history.

Kim, Annette Miae. *Sidewalk City: Remapping Public Space in Ho Chi Minh City*. Chicago: The University of Chicago Press, 2015.

ANNOTATION: Annette Kim's book documents her project of mapping the sidewalks of Ho Chi Minh City. She describes the project as a form of critical cartography, transforming the use of maps not only to "collect and analyze the spatial ethnography and property rights data, but [also] to consider the role that visual conventions plays in planning and policy making"(page 20). Her work on spatial ethnography surveys the cartographic patterns in Saigon and the political context informing them.

Laderman, Scott. *Tours of Vietnam: War, Travel Guides, and Memory*. American encounters/global interactions. Durham: Duke University Press, 2009.

ANNOTATION: Scott Laderman is a Professor of History at the University of Minnesota Duluth.

Lefebvre, Henri. *The Production of Space*. Malden, Mass.: Blackwell, 2011, nachdr. edition.

ANNOTATION: This book introduces the theory of producing space and provides a comparison between the real physical space to the mental, philosophical space. Lefebvre reconsiders the production and circulation of maps in giving meaning to spaces.

Luong, Hy V., editor. *Postwar Vietnam: Dynamics of a Transforming Society*. Asian voices. Singapore: Rowman & Littlefield, 2003.

ANNOTATION: The introduction of this series gives a good concise overview of the historical context of postwar Vietnam and the transition to today's society. The broad sketch of the economic landscape from 1975 to 1986 provides a solid foundation for understanding the economic structures of this period. Luong does a great job of highlighting the systematic issues with the command economy as well as analyzing the effects of continued military endeavors on the already debilitating financial health of the country.

Luong, Hy V. *Urbanization, Migration and Poverty in a Vietnamese Metropolis*. Singapore: NUS Press, 2009. https://www.press.uchicago.edu/ucp/books/book/distributed/U/bo25993364.html.

ANNOTATION: This volume analyzes the demographic trends of Ho Chi Minh City and explains the effects of migration on the socio-economic makeup of the city. Luong's multi-disciplinary project provides a comparative analysis of migration and its historical context through the lenses of economics, history, and sociology.

Lê Văn Thơ, Phan Đình Binh, and Nguyễn Quý Ly. *Giáo Trình Bản Đồ Học*. Ha Noi: Nhà Xuất Bản Nông Nghiệp, 2017.

ANNOTATION: This cartography textbook represents the school of thought in Vietnam regarding its mapmaking history. The actual study of cartography is more concerned with the science behind it rather than the history or the subtext of maps.

Marr, David G. "History and Memory in Vietnam Today: The Journal 'Xưa & Nay'." *Journal of Southeast Asian Studies* 31, no. 1 (2000): 1–25. https://www.jstor.org/stable/20072198.

ANNOTATION: This article is a historiographical essay on memory works in Vietnam by examining a Vietnamese history publication, the "Xưa & Nay"journal. David Marr identifies a revival of public concern for tradition, genealogy, and memory preservation, as well as outlining the paradigm undertaken by the Communist Party to promote history.

Nash, Steve, and Austin Wiliams. "The Historic City: False Urban Memory Syndrome." In *The lure of the city: from slums to suburbs*, edited by Austin Williams, and Alastair Donald, London: Pluto Press, 2011. 98–116.

ANNOTATION: This chapter focuses on the heritage industry in the United Kingdom and its connection to urban memory. In what they call the false urban memory syndrome, the authors capture the new sensibility cultivated about the past in relation to locality preservation and aversion to the future.

Nguyen, Nathalie Huynh Chau. *Memory is Another Country: Women of the Vietnamese Diaspora*. Santa Barbara, Calif: Praeger, 2009.

ANNOTATION: This book studies how Vietnamese women in the diaspora remember Vietnam, specifically the second Indochina War. It looks at mnemonic devices such as photographs and analyzes written accounts and oral histories of women to understand their rituals of remembrance.

Nguyễn Khắc Viện, and Hữu Ngọc, editors. *From Saigon to Ho Chi Minh City: A Path of 300 Years*. Ha Noi: Thế Giới Publishers, 1998.

ANNOTATION: \textit{From Saigon to Ho Chi Minh City} is representative of the historiography of Ho Chi Minh City in Vietnamese scholarship. The periodization of 300 years is typical for Vietnamese sources. Its focus is narrowed to precolonial Vietnamese settlements in Sai Gon and resistance movements within the city against the French/Japanese colonization and the American-Vietnamese war.

Ngô Minh Hùng. "Ký ức Sài Gòn - Chợ Lớn xưa." *Tạp chí Kiến trúc* , no. 10.

ANNOTATION: The article is an argument by a Vietnamese architect on the need for preserving historic monuments in Ho Chi Minh City. Ngô Minh Hùng discusses Maurice Halbwachs to explain the existance of the current obsession with the past, but argues that nostalgia is fragmented while heritage continues to be destroyed to make place for new urban constructions.

Ngô Sĩ Liên. *Đại Việt sử ký toàn thư [Complete Annals of Đại Việt]*, volume 3. Ha Noi: Nhà Xuất Bản Khoa Học Xã Hội, 1972.

ANNOTATION: This primary source is the official historical text of the Lê Dynasty, published in 1479. It provides the historical context for the production of the Hồng Đức map collection.

Ninh, Lê Quang, and Stéphane Dovert, editors. *Saigon, Ba Thế Kỷ Phát Triển Và Xây Dựng [Three Centuries of Urban Development]*. Ha Noi: Nhà xuất bản Hồng Đức, 2015, 4th edition.

ANNOTATION: This collection is a collaborative project between Ho Chi Minh City and Lyon to introduce the most iconic architectural symbols in Ho Chi Minh City's history. That these sites supposedly represent the historical identity of the city signifies a sense of nostalgia for the colonial period. The perception of history is intertwined with colonialism and imperialism.

Nora, Pierre. *Rethinking France: Les Lieux de Mémoire*, volume 1. Chicago: University of Chicago Press, 2001.

ANNOTATION: *Les Lieux de Mémoire* is a classic text on memory, in which Pierre Nora reexamines how French history is remembered through what he terms special "sites of memory."Nora defines the concept lieux de mémoire as the symbolic and functional tools in the construction of certain kinds of memory. Practices of remembering draw from these concrete sites of memory to frame narratives around them. One of the chapters in this collection is on the tools employed by the state of France to create boundaries and borders and the role of memory in reinforcing them.

Norindr, Panivong. *Phantasmatic Indochina: French Colonial Ideology in Architecture, Film, and Literature*. Asia-Pacific, Culture, Politics, and Society. Durham: Duke University Press, 1996.

ANNOTATION: Panivong Norindr is an Associate Professor of French and Italian and Comparative LIterature at the University of Southern California. This book on Indochina reflects on colonial culture, arguing that "Indochina"is a mythical concept, a phatasm created by French colonials to dominate over the architecture, film, and literature of the colonies to satisfy their desires of expression.

Olick, Jeffrey K. *The Politics of Regret: On Collective Memory and Historical Responsibility*. New York: Routledge, 2007.

ANNOTATION: Using postwar Germany as a case study, Jeffrey Olick explores the relationship between memory and politics. He explains the politics of regret and demonstrates the attempts by the postwar German society to escape this regret to legitimize the modern state nation. The book studies the intersectionality of memory, identity formation, politics, and culture in the context of postwar Germany.

Ravi, Srilata. "Modernity, Imperialism and the Pleasures of Travel: The Continental Hotel in Saigon." *Asian Studies Review* 32, no. 4 (December 2008): 475–490.

ANNOTATION: Srilata Ravi is a Professor of French Literature at the Faculté Saint-Jean of the University of Alberta. This essay describes the position of the Continental Hotel in Saigon's tourism, through the lenses of colonialism, modernity, and leisure. Even today, Ravi argues that the hotel still embodies the ethnocentric attitude of Western imperialism.

Ricœur, Paul. *Memory, History, Forgetting*. Chicago: University of Chicago Press, 2004.

ANNOTATION: This book provides the theoretical underpinnings of memory, specifically when it comes to forgetting. Paul Ricœur explains the biological and philosophical processes behind forgetting, which include intentional silencing and denial of spaces for remembering.

Sand, Jordan. *Tokyo Vernacular: Common spaces, Local Histories, Found Objects*. Berkeley: University of California Press, 2013.

ANNOTATION: This monologue discusses the memory of Tokyo through its vernacular. Jordan Sand argues that since Tokyo's landscape shifted so often, its people have tried to preserve the past by engaging in preservation. Grassroots prevervation efforts are connected to the urban lifestyle and desires that exist outside of the frameworks of formal politics.

Schwenkel, Christina. "Recombinant History: Transnational Practices of Memory and Knowledge Production in Contemporary Vietnam." *Cultural Anthropology* 21, no. 1 (2006): 3–30. https://www.jstor.org/stable/3651546.

ANNOTATION: Christina Schwenkel is an Associate Professor of Anthropology and Director of the Southeast Asian Studies Program at the University of California, Riverside. In the article, Schwenkel wrote about the contestation of memory through different sites, objects, and imagery. She discusses the actors and practices of memory across fields such as the tourism industry, both within and outside Vietnam's borders. The article provides an overview of the memoryscape of Vietnam in the postwar period.

———. "Religious Reassemblage and Late Socialist Planning in Urban Vietnam." *Journal of the American Academy of Religion* 86, no. 2 (May 17, 2018): 526–553.

ANNOTATION: In this essay, Schwenkel studies the relationship between rituals and urban growth and argues that urban spaces are not completely marked by secular modernity. Schwenkel uses the city of Vinh, Vietnam as an example to show how spirituality is entangled with urban planning, by analyzing a temple built after the war by the local authorities and one by grassroots donations to uncover the contest over control of urban spaces through religiosity.

Stoppani, Teresa. *Unorthodox Ways to Think the City: Representations, Constructions, Dynamics*. New York: Routledge, 2019.

ANNOTATION: This book considers unorthodox lenses for studying the city, through the means of architecture and cartography.

Sơn Nam. *Đất Gia Định - Bến Nghé xưa & người Sài Gòn*. Ho Chi Minh: Nhà xuất bản Trẻ, 2016.

ANNOTATION: This book is a collectioin of short pieces on the history of the former Gia Định Province by Sơn Nam, a renowned historian and writer on the history and culture of Southeast Vietnam and the Mekong delta. His writings are often melancholic and descriptive and carry a clear tone of Southern exceptionalism.

Tai, Hue-Tam Ho, and John Bodnar. *Country of Memory: Remaking the Past in Late Socialist Vietnam*. Berkeley: University of California Press, 2001.

ANNOTATION: Hue-Tam Ho Tai is a Professor of Sino-Vietnamese History at the Department of History of Harvard University. This is an excellent volume on memory projects studying postwar Vietnam. Tai gives solid background on how memory construction has been at work in Vietnam, and highlights the impact of Đổi Mới on the state's monopoly over history creation. She gives a thorough discussion of the commemorative methods and how these have gradually been replaced by alternative modes of representation, including new arts. The examination of cultural values and traditions after the reforms reveals some interesting inroads into the symbiotic relationship between these representational modes and how they can challenge one another.

Taylor, Philip. *Goddess on the rise: Pilgrimage and Popular Religion in Vietnam*. University of Hawai'i Press, 2004. https://www.jstor.org/stable/j.ctvsrhb6.5.

ANNOTATION: Philip Taylor is a Professor at the College of Asia and the Pacific at the Australian National University. This monologue studies the elevation of goddesses in religion in Vietnam. It explains the recent upsurge in the worshipping of goddesses, its rituals and practices, including pilgrimage, within the context of Vietnam

Thornbury, Barbara E., and Evelyn Schulz, editors. *Tokyo: Memory, Imagination, and the City*. Lanham, Maryland: Lexington Books, 2018.

ANNOTATION: Barbara Thornbury is chair of the Department of Asian and Middle Eastern Languages and Studies and Evelyn Schulz is a Professor of Japanese Studies at the Ludwig Maximilian University of Munich. This collection studies Tokyo's memory in cultural materials such as literature and movies.

Thụy Khuê. *Vua Gia Long & người Pháp: Khảo sát về ảnh hưởng của người Pháp trong giai đoạn triều Nguyễn*. Ha Noi: Nhà xuất bản Hồng Đức, 2017.

ANNOTATION: In this volume, Thụy Khuê analyzes French-Vietnam cooperation under Gia Long's regime, charting French participation in state affairs under the Nguyễn dynasty. Evidence is taken from both French and Vietnamese sources, comparing and contrasting them to capture how the presence of the French was recorded in these histories. Thụy Khuê depicts how involved the French was in Vietnam even before their official colonization.

Tran Van Khai. "The Development of the Architectural Form of a Tower Derived from a Traditional and Philosophical Symbol, Realized by Solutions of High-Class Technologies. The Case of the Bitexco Financial Tower." *E3S Web of Conferences* 33 (2018): 1–10. https://www.e3s-conferences.org/articles/e3sconf/abs/2018/08/e3sconf_hrc2018_01018/e3sconf_hrc2018_01018.html.

ANNOTATION: Tran Van Khai is a professor at Van Lang University, Ho Chi MInh City. His article describes the construction and development of the Bitexco Financial Tower from a technical perspective. The paper also outlines the symbolic feature of the lotus bud design.

Truong Hai Thanh, and Vu Thi Hong Hanh. "Modern Architecture of Saigon - Ho Chi Minh City." *MATEC Web of Conferences* 193 (2018): 1–15.

ANNOTATION: Truong Hai Thanh and Vu Thi Hong Hanh are both professors at the University of Architecture Ho Chi Minh City. This article surveys the history of architecture in Ho Chi Minh City, describing its main characteristics and developments through the years.

Tôn Nữ Quỳnh Trân. "Sài Gòn qua các bản đồ." In *Ấn tượng Sài Gòn - Thành phố Hồ Chí Minh*, Ho Chi Minh: Nhà xuất bản Trẻ, 2015. 6–25.

ANNOTATION: This book is a compilation of short writings by various Vietnamese others on Ho Chi Minh City's past and present. It presents a variety of perspectives for understanding the city.

Vo, Nghia M. *Saigon: A History*. Jefferson, N.C: McFarland, 2011.

ANNOTATION: *Saigon: A History* is a survey of Saigon's history from the 17th century to the present. Vo views the city from the perspective of a South Vietnamese who migrated to the U.S. after the war. His writing reflects a sense of nostalgia in the diaspora for Saigon under the South Vietnamese government and the anger at the current communist regime.

Winter, J. M. *Remembering War: The Great War between Memory and History in the Twentieth Century*. New Haven: Yale University Press, 2006.

ANNOTATION: In this book, Winter discusses the act of remembrance as well as the actors behind it. He argues for the presence of agencies in constructing collective memory, "the process through which different collectives [...] engage in acts of remembrance together" (p. 4). Collective memory is the product of a conditioned process, charged with conscious intentions and biases. The book uses the Great War as a case study of how acts of commemoration have served to create an official narrative, another form of what we like to call "collective memory". He contests the use of memory and suggests that it be replaced by remembrance, as a reminder of the pitfall of memories and how they do not exist above the influence of any other interactions.

———. *Sites of Memory, Sites of Mourning: The Great War in European Cultural History*. Canto classics. Cambridge: Cambridge University Press, 2014, canto classics edition.

ANNOTATION: *Sites of Memory, Sites of Mourning* provides a fascinating read on commemoration and history. Using the Great War as the main subject matter, Winter dissects the different means used by Europeans to remember and make sense of the past. He identifies two different modes of interpretation: the "modernist" and the "traditional" one. The "modernist" method, or the "modern memory", is the embrace of a new language in telling war stories, which promotes iconoclasm, revolution, and harsher "aesthetics of direct experience". This mode rejects the patriotic sentimentality and the glorification and romanticization of the past, which Winter classifies as the "traditional approach". The conventional approach to understanding Europe during the war and its aftermath aligns with the "modernist" perspective, wherein the 1914-18 war created a gulf between the old modes and facilitated the switch to new modernist values. The Great War had created a new world whose chaotic and destructive characteristics could only be captured by modernism. Winter, however, rejects the bifurcation of "traditional" and "modernist". He traverses the grey area between the two modes of interpretation to explore how "Europeans imagined the war and its terrible consequences" through the examination of mourning and its expression.

Wood, Denis, and John Fels. *The Power of Maps*. Mappings. New York: Guilford Press, 1992.

ANNOTATION: In *The Power of Maps*, Denis Wood performs close readings of maps in order to demonstrate the theoretical underpinnings of this field of study. He draws connections between the production and circulation of maps with exercises of power, and how technology and knowledge are also entangled in this power play.

Wright, Gwendolyn. *The Politics of Design in French Colonial Urbanism*. Chicago: University of Chicago Press, 1991.

ANNOTATION: Gwendolyn Wright is an architectural historian. *The Politics of Design in French Colonial Urbanism* discusses the codes of design in French colonial architecture and how they were intertwined with notions about modernity and hygiene. The three examples examined are Morocco, Indochina, and Madagascar.

Đoàn Khắc Tình. "Cái lý của nghệ thuật Kiến trúc thuộc địa." *Tạp chí Kiến trúc* https://www.tapchikientruc.com.vn/chuyen-muc/ly-luan-phe-binh-kien-truc/cai-ly-cua-nghe-thuat-kien-truc-thuoc-dia.html.

ANNOTATION: Đoàn Khắc Tình is an architect, writer, and former lecturer at the Ha Noi University of Architecture. The article is a critical essay about Vietnam's colonial architecture and the main figures behind the French legacy on Vietnam's built environment. This work is one of the rare pieces that places French architecture in Vietnam into the context of its colonization, describing the brutality behind these constructions. He analyzes the ideological undertone of this new "culture."He critiques the irony behind the "French architectural style"that people attribute to constructions from that period or are influenced by Wester architecture.

Đại học Tài nguyên và Môi trường Hà Nội. *Bản Đồ Học*. Ha Noi: Đại học Tài nguyên và Môi trường Hà Nội, 2010. http://lib.hunre.edu.vn/Ban-do-hoc--5158-47-47-tailieu.

ANNOTATION: This textbook is used in the Ha Noi University of Natural Resources and Environment as the coursework for Cartography. It charts the developments in the historical study of cartography in Vietnam and includes a nice overview of major documents in Vietnam's cartographic history.

Sources on Augmented Reality

bibitem[Alexandria Heston(Presented at the Grace Hopper Celebration 2019, Orlando, October 4, 2019)]hexton Alexandria Heston. "The Revolution of Spatial Computing: Emerging Design Frontiers in VR/AR." Presented at the Grace Hopper Celebration 2019, Orlando, October 4, 2019. http://signage.showprg.com/ghc19/9d29dc65-3774-41bb-9d33-6c2d1d76a575-96117-Alexandria-Heston.pdf.ANNOTATION: This presentation by Alexandria Hexton provides the terminology and definition for mixed reality, augmented reality, and virtual reality. It also includes helpful graphics for visualizing their differences.

Allen, Gary L. *Human Spatial Memory: Remembering Where*. Mahwah, NJ: Taylor & Francis Group, 2003. http://ebookcentral.proquest.com/lib/wooster/detail.action?docID=335502.

ANNOTATION: This volume by Gary Allen explains how the mind recognizes and remembers places. Understanding of spatial memory contributes to the development of virtual displays. It asks the question of how humans form an understanding of "scaled-down versions of places as symbolic representations of actual places."

Apple Developer. "Augmented Reality," 2020. https://developer.apple.com/augmented-reality/.

ANNOTATION: This website provides information on the features of Apple's augmented reality platform, ARKit, as well as supporting framewroks like RealityKit.

Arth, Clemens, Raphael Grasset, Lukas Gruber, Tobias Langlotz, Alessandro Mulloni, and Daniel Wagner. "The History of Mobile Augmented Reality." *arXiv* , 1505.01319. http://arxiv.org/abs/1505.01319.

ANNOTATION: This article provides a summary of the major achievements in the field of mobile augmented reality from 1968 to 2014. The article helps locate the major breakthrough in AR and concepts that are essential to understanding how AR works.

Aukstakalnis, Steve. *Practical Augmented Reality: A Guide to the Technologies, Applications, and Human Factors for AR and VR*. Boston: Addison-Wesley, 2017.

ANNOTATION: This book explains the technology behind tracking using sensors and visual inertial odometry in AR systems.

Bedal, Lauren. "Designing for the Human Body in XR." Virtual Reality Pop, November 16, 2017. https://virtualrealitypop.com/designing-for-the-human-body-in-xr-e9ac88931e45.

ANNOTATION: This article considers the human body's movements in VR designs, particularly using dancing as a reference point for body-centered designs.

Collins, Robert. "Lecture 06: Harris Corner Detector." University Park, Pennsylvania, 2007. http://www.cse.psu.edu/~rtc12/CSE486/lecture06.pdf.

ANNOTATION: This presentation explains the components of Harris Corner Detector and includes helpful equations for implementing the detector.

Craig, Alan B. *Understanding Augmented Reality: Concepts and Applications*. Waltham, MA: Morgan Kaufmann, 2013.

ANNOTATION: This volume provides an overview of the hardware and software required in AR systems.

Dobson, James E. "Protocols, Methods, and Workflows: Digital Ways of Reading." In *Critical Digital Humanities: The Search for a Methodology*, 1–31. Urbana: University of Illinois Press, 2019.

ANNOTATION: James Dobson is a lecturer at the Department of English and Creative Writing at Dartmouth College. This book calls for the need to establish a theoretical paradigm for digital humanities through analysis of the computational techniques from the perspectives of literary hermaneutics and critical theory.

Durrant-Whyte, H., and T. Bailey. "Simultaneous Localization and Mapping: Part I." *IEEE Robotics Automation Magazine* 13, no. 2 (June 2006): 99–110.

ANNOTATION: This article explains the concepts behind the problem of simultaneous localiztion and mapping.

Google Developers. "Fundamental Concepts | ARCore." Accessed October 17, 2019. https://developers.google.com/ar/discover/concepts.

ANNOTATION: This website contains the documentations of Google's augmented reality platform, ARCore. The manual includes tutorials and sample code for simple AR apps.

HUDWAY. "HUDWAY Drive." Accessed December 5, 2019. https://hudway.co/drive.

ANNOTATION: This web page provides information and images of the head-up display HUDWAY drive.

Kramer, Michael J. "What Does Digital Humanities Bring to the Table?" *Michael J. Kramer* (blog), September 25, 2012. http://www.michaeljkramer.net/what-does-digital-humanities-bring-to-the-table/.

ANNOTATION: Kramer is an Assistant Professor of the History Department at SUNY Brockport and specializes in the use of digital technology in historical scholarship, cultural criticism, and the arts. This blogpost describes the capabilities of digital humanities in comparison to traditional approaches in history, with a focus on big data.

Looking Class Factory. "Introducing The Looking Glass: A New, Interactive Holographic Display." *Looking Glass Factory Blog* (blog), July 24, 2018. https://blog.lookingglassfactory.com/announcements/introducing-the-looking-glass-a-new-interactive-holographic-display/.

ANNOTATION: This blog post introduces the holographic display Looking Glass and includes interesting use cases. The post also features the specifications of the glass's optics.

Magic Leap. "Magic Leap One Creator Edition." Accessed December 5, 2019. https://www.magicleap.com/magic-leap-one.

ANNOTATION: This web page provides the specifications of Magic Leap One.

Mahmood, Bushra. "A Quick Guide to Designing for Augmented Reality on Mobile (Part 3)." *Medium* (blog), February 3, 2019. https://medium.com/@goatsandbacon/a-quick-guide-to-designing-for-augmented-reality-on-mobile-part-3-2380f253467a.

ANNOTATION: This blog post provides a guide of key UI principles for designing AR apps on mobile devices.

Microsoft. "HoloLens 2—Overview, Features, and Specs." Microsoft. Accessed December 5, 2019. https://www.microsoft.com/en-us/hololens/hardware.

ANNOTATION: This web page provides the specifications of Microsoft HoloLens 2.

Miller, Carolyn Handler. *Digital Storytelling: A Creator's Guide to Interactive Entertainment*. Third edition. Burlington, MA: Focal Press, 2014.

ANNOTATION: Carolyn Handler Miller is a writer in emergent media and has worked on various digital storytelling projects including video games and immersive experiences. This book discusses how old principles in storytelling can be combined with technologically enabled tools to produce engaging digital stories.

Miller, Dan. *Unite Berlin 2018 - Getting Started with Handheld AR*. Berlin, 2018. https://www.youtube.com/watch?v=MqA0XhfKIE0.

ANNOTATION: This Youtube video is a presentation by Dan Miller, a developer at Unity, at the 2018 Unite Berlin conference, an event during which Unity introduces their newest technologies and innovations. It explains how ARKit, ARCore, and ARFoundation work with Unity.

Mordvintsev, Alexander, and Abid K. "FAST Algorithm for Corner Detection." OpenCV-Python Tutorials, 2013. https://opencv-python-tutroals.readthedocs.io/en/latest/py_tutorials/py_feature2d/py_fast/py_fast.html.

ANNOTATION: This page explains the basics of the Features from Accelerated Segment Test (FAST) algorithm and introduces how to use OpenCV to run FAST.

Museum of the Hidden City. "Museum of the Hidden City." Accessed March 9, 2020. http://www.seehidden.city.

ANNOTATION: This is the official website of the Museum of the Hidden City app, providing an overview of how the app works and the development team behind it. The app is meant as a walking tour with visual and audio guide for the Fillmore neighborhood in San Francisco, but will be expanded to include more narratives.

Peddie, Jon. *Augmented Reality: Where We Will All Live*. Cham, Switzerland: Springer, 2017.

ANNOTATION: This book by Jon Peddie provides a comprehensive overview of augmented reality (AR) technology for both beginners' and advanced readers. It defines AR and the basic concepts surrounding this medium. The underlying premise of this book is Jon Peddie's belief that AR would eventually be integrated into everyday life like smartphones. He also discusses the dangers of overabusing such a technology.

Poulson, Rebecca. "Designing Immersive Experiences for Journalism." Presented at the The Society of News Design, Chicago, April 4, 2019. https://speakerdeck.com/rapoulson/vr-workshop-2019?slide=48.

ANNOTATION: Rebecca Poulson is a senior developer at the MEDILL School of Journalism, Media, Integrated Marketing Communications at Northwestern University, leading AR/VR projects at Knight Lab, the Northwestern community for intergrated journalism. This presentation elaborates some important conerns for using AR in journalism, providing both technical background and storytelling principles.

PTC. "Vuforia Engine Features." Vuforia Developer Library. Accessed March 9, 2020. https://library.vuforia.com/content/vuforia-library/en/features/overview.html.

ANNOTATION: Vuforia Developer Library is the documentations for using Vuforia. It includes instructions for implementing apps with the different kinds of targets and the class hierarchy/structure of Vuforia.

PTC. "PTC Acquires Vuforia." November 3, 2015. https://www.ptc.com/en/about/vuforia.

ANNOTATION: This is an article from the company behind Vuforia, PTC, about their acquisition of Vuforia.

Pugnaloni, Fausto, Giovanni Issini, and Nam Dang Minh. "3D City Model of the Ancient Hue, Vietnam; Reconstruction of the City Environment for the Cultural Heritage Identity Conservation." In *Virtual Systems and Multimedia*, edited by Theodor G. Wyeld, Sarah Kenderdine, and Michael Docherty, 13–23. Lecture Notes in Computer Science. Berlin, Heidelberg: Springer, 2008.

ANNOTATION: This paper describes a reconstruction project on the city of Hue, Vietnam. The Italian-Vietnamese collaborative project attempted to catalogue Hue's historic sites and create a 3D model of the city's landscape.

Schmalstieg, Dieter, and Tobias Höllerer. *Augmented Reality: Principles and Practice*. Boston: Addison-Wesley, 2016.

ANNOTATION: This book includes the mathematical underpinnings of tracking technologies in AR, as well as an exhaustive overview of AR taxonomy.

Siltanen, Sanni. *Theory and Applications of Marker-based Augmented Reality*. Espoo, Finland: VTT, 2012.

ANNOTATION: This book explain the theory behind marker-based and some markerless AR systems.

Tyagi, Deepanshu. "Introduction to FAST (Features from Accelerated Segment Test)." *Medium* (blog), January 7, 2020. https://medium.com/analytics-vidhya/introduction-to-fast-features-from-accelerated-segment-test-4ed33dde6d65.

ANNOTATION: This blogpost provides a helpful step-by-step explanation of the Features from Accelerated Segment Test (FAST) algorithm and graphics for understanding how the algorithm works.

Unity Technologies. "About AR Foundation." 2019. https://docs.unity3d.com/Packages/com.unity.xr.arfoundation@3.0/manual/index.html.

ANNOTATION: This is Unity documentations for AR Foundation. It describes the features and processes of designing on both ARCore and ARKit.

———. "Unity - Manual: XR." 2020. https://docs.unity3d.com/Manual/XR.html.

ANNOTATION: This is the website for Unity documentations. It includes manuals for Unity supported XR frameworks such as Vuforia, ARCore, and ARKit.