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RESEARCH ARTICLE

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Describing, organizing, and maintaining video game development artifacts

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Abstract

Game development artifacts resulting from the creation process of video games, such as design documents, style guides, test builds, and marketing materials, provide rich contextual information about how and why the game was created. Better organizing and preserving these materials will not only enrich our understanding of the history of these media but also educate and inspire the next generation of video game creators. This research aims to improve our theoretical understanding of how to organize and represent game development artifacts by examining the various types of artifacts created and their attendant issues and challenges. We adopted a multimethod approach employing an examination of existing collections and 29 interviews with creators, information professionals, and game researchers. From these data, we analyze the current practices, expressed values, and perceived challenges of these stakeholders, produce a taxonomy of game development artifacts, and provide best practices recommendations for describing them.

1 | INTRODUCTION

Digital games are prevalent in our everyday lives and play a widespread role in our society. Recent statistics from the Entertainment Software Association (ESA) show video games sales exceeded $43.4 billion in 2018. More than 164 million Americans play video games, and three out of every four U.S. households have at least one game player (ESA, 2019). Games are an important part of our cultural heritage, a focal point in social interactions, and a commonly used resource in education, science, and engineering. Video games and interactive media are undeniably embedded in our social, cultural, and economic lives.

Although video games have been in American homes for nearly 40 years, academia and cultural heritage institutions (such as archives, museums, and libraries) have only recently started to accept digital games as culturally significant and include them in their collected holdings as objects of study. Early disregard by academics and cultural heritage institutions has resulted in a loss of the industry's early history, which lies either in the hands of private collectors or boxed up in the closets and attics of players. To reverse the effects of early disregard, an increasing number of institutions are collecting and providing access to digital games as objects of cultural heritage. For instance, The Strong National Museum of Play (The Strong) in Rochester, New York, collects and preserves games of all types—arcade, console, computer, handheld, and mobile—that have enjoyed popularity over a sustained period and have influenced the video game industry or popular culture and society in general (The Strong, 2020). Living Computers: Museum + Labs in Seattle, Washington, curates a large and growing collection of functional computer and game systems, along with their compatible games, that visitors can play on original machines. Internationally, Ritsumeikan Center for Game Studies at Ritsumeikan University in Kyoto,

Japan, the National Videogame Archive in the United Kingdom, and the Computerspielemuseum in Berlin, Germany, also catalog, classify, archive, and preserve digital games. The American Library Association and its Games and Gaming Round Table (GameRT) promote gaming in libraries via International Games Week (2017), and a growing number of university libraries also circulate video games for academic inquiry.

To date, game archival efforts have largely focused on cataloging and preserving final representations of cultural works. However, as with other cultural objects, one must explore the circumstances of game creation, revealed only by examining associated artifacts, to properly understand and appreciate the history of games as a medium. Future generations will undoubtedly want to know about the games that shaped their lives: how they started, how they were developed over time and by whom, and what impact they made. Just as archeologists spend years in excavation sites analyzing minute details to better understand human history, digital archeologists will dig through what remains of our preservation attempts. They will sift the media objects themselves, finding related information and artifacts—such as early drafts, design documents, prototypes, and research notes—crucial for understanding a game's creation processes and creative intent. Historians and researchers rely on such materials to tell a vivid story, and these materials are also critical for educating and inspiring the next generation of creators. Without an organized effort to collect, represent, and preserve these materials, we risk losing history.

This research aims to advance our understanding of how to organize and represent artifacts related to the development of video games. In particular, we focus on the following research questions:

1. What types of documents and artifacts are created during the video game design and development process?
2. What issues and challenges do stakeholders in game development artifacts—specifically creators, information professionals, and game researchers—currently face in organizing and accessing these materials?
3. What recommendations can we offer to these stakeholders as best practices based on our understanding of the context of video game design and development?

2 | LITERATURE REVIEW

Throughout the late 20th century, video games rose to prominence as a hugely popular media form, and they continue to push technological and artistic boundaries to this day (Wood & Carter, 2018). Published video games, the final products of game development, are being ingested into cultural heritage institutions including the Library of Congress and game-focused repositories with increasing frequency, and these acquisitions are used by members of the public for recreational purposes and by scholars across a number of research disciplines (Kaltman et al., 2016; Taves & Gibson, 2011). Although study of final, published video games is unquestionably necessary, these media objects convey only a hint of the larger web. Video games are a complex network involving industry, technology, and culture, and their multifaceted nature also requires an understanding of sociocultural networks (Ruggill & McAllister, 2011). Considering that "[t]he 'text' of a work is not just its viewing, but also the information surrounding and promoting it, which all has relevance," (Taves & Gibson, 2011, p. 82), it is necessary to investigate what surrounds published video games, much of which may be found in game development artifacts.

The personal papers of video game developers created and used over the course of game development illuminate a host of research questions focused on video games (Winget & Sampson, 2011). Documentary artifacts created by game developers convey information about the context within which a game was created, the creators of the game, and various iterations of the game itself that is not possible to see through examinations of published video games alone (Kaltman et al., 2016; Winget & Sampson, 2011). Although video games have recently become objects of scholarly attention, the role these objects play in contemporary culture indicates a continued scholarly focus; in years to come, game development artifacts, which may be considered unimportant or outdated by game developers, will be incredibly important to game historians, game studies scholars, and other scholars studying video games.

As academics focus on video games and game development artifacts with increasing frequency, a need has arisen to reevaluate standards for representing these materials within cultural heritage institutions. There have been a few efforts to establish various standards or vocabularies for describing and organizing video games, such as the Video Game Metadata Schema (VGMS) (Lee, Perti, Clarke, Windleharth, & Schmalz, 2017), the GAMECIP platform vocabulary for MAchine-Readable Cataloging (MARC) records (Kaltman et al., 2016), and the Online Audiovisual Catalogers, Inc. Video Game Resource Description and Access (RDA) Best Practices Task Force's Best Practices for Cataloging Video Games using RDA and MARC21 (2018), but their primary focus has been on published games rather than game development artifacts. The Anglo-American Cataloguing Rules

(AACR), AACR2, and RDA have notable shortcomings when applied to complex digital objects (de Groat, 2015). Describing Archives: A Content Standard (DACS) has been the de facto standard for use with personal papers, such as game development artifact collections. DACS's suitability for describing born-digital materials has been a topic of discussion among archivists and archival studies researchers, but its usefulness when applied specifically to collections of game development artifacts remains to be seen, as only a relatively small number of game development artifact collections have been accessioned into archives and special collection libraries.

The newness of game development artifact collections in archives or other repositories has resulted in a dearth of discussion regarding the applicability of archival descriptive standards when describing complex digital materials (Kaltman et al., 2016). While there has been increasing attention given to preservation of video games demonstrated by works like the white paper published by the Game Preservation Special Interest Group of International Game Developers Association (Lowood et al., 2009) and the "Preserving Virtual Worlds Final Report" by McDonough et al. (2010), video game-related preservation endeavors tend to focus on challenges that may arise during the preservation of published games. Due to the conceptual distinctions between published games and collections of game development artifacts, the findings of these endeavors are not necessarily applicable when considering game development artifact collections. Since most libraries acquire a game as "a discrete, published work, not as a small portion of the larger set of archival records from the publisher," (McDonough, 2012, p. 1630), preservation efforts are more often directed at the published game itself, with development materials rarely mentioned or accommodated.

A number of challenges exist regarding development companies' ability and willingness to keep video game development artifacts. Although most major publishers and developers have some preservation-related policies in place, few are implemented due to a focus on development, frequent reorganizations, and uncertainty regarding responsible parties for materials created (Andersen, 2011). As a result, these materials are at risk of being lost due to negligence, a lack of familiarity or guidance, or a decision to keep only specific types of materials (Kraus & Donahue, 2012). Game development artifacts now face a crisis, as volatile media and older means of representation become less and less available.

Robust organizational practices are necessary to maintain video game development artifacts during the game development process. Because these materials frequently change hands, they are often repurposed and reused depending on the context for representation; thus, the name and even potentially the type of the material changes depending on the context in which it is used, causing "increasing organizational entropy as development processes continue" (Kaltman et al., 2016, p. 5). Access is also a concern, internally and externally. Businesses frequently need access to old materials for a variety of reasons, though recently such access largely has been linked to porting older material to new platforms for additional sales and emphasizing its historical significance: a rising interest in classic and what are now defined as "retro" video games has created an active incentive to represent old contexts, old versions, and old materials related to games (Andersen, 2011).

As new games and technology emerge, old games and technology quickly fade into the background, making access to these cultural artifacts ever more difficult, particularly for those who want to experience historical artifacts in a representative context (Bachell & Barr, 2014). Players themselves are often involved in preservation due to long-term interest and investment, but the lack of rigor in these processes also reflects a less-than-symbiotic relationship between players and cultural heritage institutions. The result is often a divergence between these groups (Brand, 1999). Institutions have been encouraged to work with the pre-existing and now-robust practices of once-amateur collectors, curators, and developers in order to organize a body of work built, in many cases, from the ground up (Lowood et al., 2009). Without a more symbiotic relationship, there may be many unresolved long-term issues with players, collectors, and the cultural heritage institutions that seek to serve their passion for preservation.

3 | STUDY DESIGN AND METHODS

In order to answer our research questions, we pursued two complementary activities: a top-down examination of existing collections and a bottom-up collection of interviews with professional game workers, information professionals, and game researchers.

3.1 | Interviews

We conducted in-depth, semi-structured interviews with a total of 29 participants. Recruitment took place through email and followed a snowball methodology that started with recommendations from the project's advisory board, consisting of researchers and practitioners with expertise in game preservation. Information on participants is included in Table 1. Some participants had multiple roles and were categorized in their current or primary role.

TABLE 1 Participant information

Number	User type	Specific occupations
12	Creators	Producers, designers, and developers
11	Information professionals	Curators, librarians, and archivists
6	Game researchers	Historians and academics

We adopted a user-centered approach, which identified the needs and behavior of our target users, explored their practices regarding game development artifacts, and mapped their conceptualization of the domain. This approach was intended to ensure our results would be relevant to stakeholders.

We asked how these different stakeholder groups perceive and express needs for organizing, retrieving, sharing, and accessing game development artifacts. We also asked about current practices and challenges dealing with these materials. Interviews were transcribed and inductively coded for analysis as prescribed by Corbin and Strauss (2015). The final codebook contained 13 codes and an "other" category to initially capture any emergent concepts (see Table 2). We followed a consensus model where two coders independently coded the data, discussed discrepancies, and utilized a third researcher as tiebreaker when consensus could not be reached (Hill, Thompson, & Williams, 1997).

3.2 | Examination of collections

In addition to the interviews detailed earlier, we also examined several collections related to game development artifacts. Living Computers: Museum + Labs provided access to the Doug Sharp Collection. The Strong National Museum of Play provided access to the Brøderbund Software, Inc. Collection; Her Interactive, Inc. Collection; and Minnesota Educational Computing Corporation (MECC) Collection, as well as the Jordan Mechner Papers. Table 3 summarizes the content of each of these collections.

At each institution, we spoke to staff responsible for the given collection. The staff walked us through the cataloging process for games and game development artifacts in their collections. During our study of the Doug Sharp collection, we also spoke with Doug Sharp, reviewing individual items. He identified each item, explaining how it was created and used in the process of the game development. In each collection, the research team assigned at least two people to examine and discuss all the items in the collection. We took notes on the artifacts and documents and took photos or made scans of items for later analysis. For a group of similar items in each folder, the team made sure to take at least one photo that is representative of those items. We also interacted more deeply with a few of the artifacts—playing the game itself or viewing recordings of gameplay—when

TABLE 2 Codes and description

Code	Description
Roles	How one's position in their organization impacts how they interact with game development artifacts
Artifact types	Game development artifacts, including documents, physical objects, and digital objects
Artifact definition/ description	Explanations of the goal, intention, scope, limit, content, or use of artifact types
Significant properties	Features of artifact types considered to be important
Design process	Description of game design processes and practices, how they have evolved/ changed over time, and comparison of the game development process in different contexts
Storage/access	Practices for storing and maintaining artifacts, including aspects such as size, location, and access control
Search/retrieval	How people find game development artifacts, including methods for searching and browsing, common access points, finding aids, and so on
Sharing	Practices for sharing artifacts or information about artifacts with others inside and outside of their organization
Tools/tech	Specific tools and technologies used for maintaining, organizing, sharing, and accessing game development artifacts (e.g., cloud services, software)
Influences	Factors impacting or restricting the decisions related to organizing and accessing video game development artifacts (e.g., compatibility, company requirements, contract)
Challenges	Difficulties experienced while interacting with artifacts
Perceived values	Benefits expected from artifact organization systems
Wishlist	Desires expressed regarding potential improvements to organizations and systems dealing with artifacts, such as methods or tools to improve storage, metadata, and accessibility

TABLE 3 Collections of game development artifacts examined

Name of collection	Content description	Primary date range
Doug Sharp Collection	Materials relating to the career of Doug Sharp and creation of his software titles, including unpublished work.	1984–1988
Her Interactive, Inc. Collection	A sampling of internal files from Her Interactive, Inc. along with information on game design and the company's teen advisory board. (http://archives.museumofplay.org/repositories/3/resources/27)	1996–2012
Minnesota Educational Computing Corporation (MECC) Collection	A compilation of six separate donations from the design team of The Oregon Trail and MECC. (http://archives.museumofplay.org/repositories/3/resources/113)	1967–2015
Jordan Mechner Papers	Materials relating to the career of Jordan Mechner and the creation of his most popular software titles. (http://archives.museumofplay.org/repositories/3/resources/34)	1913–2016
Brøderbund Software, Inc. Collection	A sample of corporate records from Brøderbund software, Inc. including two large bound scrapbooks of publicity and product information. (http://archives.museumofplay.org/repositories/3/resources/37)	1979–2002

possible. The research team as a whole reviewed and discussed the photos/scans and notes in a series of meetings. The domain knowledge of the Video Game History Foundation (VGHF) staff participating in the research team was helpful in understanding the purpose and context of some of the items in the collections. In addition to identifying all the possible terms that could be included in taxonomy, the research team's discussion focused on paying closer attention to unique items either due to their purpose (e.g., VHS tape containing video recordings of the employees of a game company participating in a comical skit), format (e.g., punched tape codes; 3D clay model of person's head, which was scanned and used in the game), or content (e.g., letter from a player discussing their reaction to the game protagonist's words or actions). One thing that became apparent during this observation was that the collection of game development artifacts contained a much wider variety of materials beyond the development assets such as code or art that were used in the game itself. Examining and discussing these collections informed the design of the taxonomy of video game development artifacts.

4 | FINDINGS AND DISCUSSION

In addition to stakeholders from the creation phase of game development artifacts, we included stakeholders who manage artifact collections in cultural heritage institutions, including museum curators, archivists, and librarians. We also consider game researchers who use such artifacts in their research studies. In the following text, individual participants have been anonymized. They are represented by the letter P and the ordinal number of the interview.

4.1 | Understanding video game artifacts

Because there is no formulaic approach to game development, the artifacts born from each game often vary in unique and unexpected ways. Examining different collections reveals that no two games produce the same set of artifacts, so that it is often difficult to predict what each collection of game development artifacts will contain. Some artifacts include highly technical documents, while others are simply notes or sketches. Artifacts are frequently unique and difficult to define under a standard schema, yet are invaluable to a researcher. For example, the Mechner Collection contains thin paper masks used for video capture of hired actors, which were eventually digitized into the game's graphics. The masks reveal part of the game's artistic process but are hardly standard.

Source code is one of the few consistent artifacts in game development and is also among the most difficult to deal with, as it relies on multiple contingencies in order to be studied. Source code is the set of computer

instructions that are compiled into a video game, but is difficult to parse without access to the tools associated with it, much like audio and graphics programs used in its creation. Metadata regarding a source code's technical requirements related to hardware and software are as important as the code itself.

Development of a commercial digital game is more than just a blueprint or the final product: It also includes important organizational practices such as marketing, staffing, and accounting. Each of these practices produces its own game development artifacts, which include advertising materials, recruiting materials, and financial documents, respectively. These artifacts are often created uniquely for each project or organization, with no universal structure or naming system to categorize them. The taxonomy created by the research team (discussed further later) relies on being broad enough to capture these types of documents even when they do not share the same structures, internal organization, or naming schemes.

4.1.1 | Life cycle of video game artifacts

The interviews helped us better understand the game development life cycle, confirming existing literature on the topic (Bethke, 2002; Dovey & Kennedy, 2006; Kerr, 2017) while providing details of both organizational and individual game developers' documentary practices. A game often begins development as a "proof of concept" intended to share ideas about core features and mechanics. A majority of game concepts are abandoned early in the development process because the proof of concept fails to convince core development and management staff that the end product will be sufficiently "fun" or find commercial acceptance (Schmalz, Finn, & Taylor, 2014). Games that pass a proof-of-concept phase tend to get official teams and staff for production. While big game franchises and titles can take years to produce with hundreds of employees, smaller titles are produced with relatively few project team members and/or in much shorter periods of time. Regular game builds are tested by quality control (P15), and many organizations include milestone builds to show progress to management, partners, media, outside playtesters, and/or the general public (P16, P29).

> I think 438 is the build number that we're on of the latest official system. There were probably 100 or more before that. Yes, in three years of development. We do them every day. (P15)

> You get to the end of the project and just be like, 'Hey, I just want the ones that, the major milestones. Give me the vertical slice, get me the alpha build, the beta build and the final submission...' (P29)

Game companies now also offer releases of minimum viable product (MVP) games, with a minimum feature set deemed acceptable to consumers, and continue to improve the product with patches and updates. The MVP option was not available for early game developers who sold packaged games—software burned to optical disks (CDs and DVDs) or cartridges (carts) could not be easily updated—to brick-and-mortar stores (P04, P29). After the game is published, game development artifacts are not typically given much attention as focus moves to the development of the next product (P12, P29).

Collections of game development artifacts are sometimes accessioned to cultural heritage institutions. Accessioning integrates a collection into a cultural heritage organization's established infrastructure—the collection is assigned a unique identifier, administrative and legal files related to the deposit or donor agreement are collected into a single location and stored, catalog records are created, and the collection is given a physical location that is logged by information professionals (P23, P25, P27). When possible, an inventory of the collection's general contents is taken during processing. The artifacts in the collection are then put into archival housing to ensure long-term preservation (P25). Once the collection is inventoried and properly housed, the cultural heritage institution writes an archival description and finding aid, which are made available to users (P23); finding aids and archival descriptions are the primary tools that facilitate access to the collections.

4.1.2 | Tools and technologies used

In the interview, we asked stakeholders about the tools and technologies used to create, store, share, and access game development artifacts. Software development projects usually include a standard set of technology types. Source control applications (e.g., Confluence [Atlassian Corporation Plc, 2004], Perforce Helix Core [Perforce Software, Inc., 1995]) share and synchronize code (and other development assets) used across the project team. Software engineers use an integrated development environment (IDE) (e.g., Unity [Unity Technologies, 2005], Unreal Engine [Epic Games, Inc., 1994]), which is a software package or suite that assists in the creation and testing of code. Audio engineers and graphic artists use unique software for audio and art production. Producers (project managers) commonly use tools for tracking a project's progress and reporting its current state (e.g., Jira

[Atlassian Corporation Plc, 2002], Shotgun [Shotgun Software, Inc., 2006]). There are also communication tools used across disciplines to coordinate work, such as email, chat, instant messaging, and teleconferencing software (e.g., Slack, Google Hangouts). The work often requires special testing environments, including special test servers or test builds, which are burned to optical disks or carts used in specialized computers, consoles, or devices. These technologies use computer file systems to store application data on desktop machines, local area network servers, or cloud servers. Many interviewees shared that they tend to save and share files via general cloud services (e.g., Dropbox, Google Drive). Information professionals also mentioned several organizational tools (e.g., ArchivesSpace [University of Illinois at Urbana–Champaign, 2013], Argus [Lucidea, 2020], SirsiDynix [SirsiDynix, 2005], WorldCat) and standards (e.g., MARC, RDA, DACS, and encoded archival description).

4.2 | Perceived values and desires

The stakeholders interviewed unanimously recognized the importance of preserving game development artifacts and of a robust organization process. However, the shared perception did not frequently translate to actual investment. Many interviewees, especially creators, shared frustration with this lack of investment, noting that insider knowledge is seldom documented and that needed materials can be difficult to find. They also mentioned a lack of time and incentive to devote to description and organization processes. Few discussed a lack of tools, focusing instead on practices like naming conventions, standardized vocabulary, or a central location for assets. Information professionals primarily discussed the need for a controlled vocabulary and increased visibility into the context for materials to improve the user's experience. Game researchers also discussed the importance of a taxonomy (to help them identify what kinds of materials they are examining) and a good finding aid (to help them decide if they want to travel in order to access collections physically).

4.3 | Challenges

The feedback we received from participants unanimously highlighted the disorganization characterizing the creation and maintenance of game development artifacts in the game industry. We can point to several specific reasons: (a) frequent reorganization of teams and changing of roles resulting in the loss of access to materials; (b) absence of (or uncertainty about) a responsible body for organization of materials; (c) emphasis given to the development of products rather than their documentation; and (d) lack of consistency in terms used to describe these materials. Information professionals discussed how organizations are siloed, resulting in a less-than-ideal user experience for people trying to find and access these materials. Game researchers noted difficulties in searching for and accessing research materials. In the following sections, we describe these challenges in more detail.

4.3.1 | Game industry professionals

One of the primary concerns creators had about reusing game development materials and eventually transferring material to a cultural heritage institution was related to copyright, proprietary technology, and nondisclosure agreements, not only in terms of access and circulation but also for long-term preservation. Creators were particularly concerned about legal considerations for assets and how their rights to their intellectual property would be respected.

> The industry as a whole obviously has secrets and we want to maintain our IPs and those sort of things, but I would love it more if games that have come out and maybe aren't live anymore or are basically archived—at that point it would be amazing to at that point be able to get more information about those games. (P13)

Additionally, there were concerns about how material is currently stored by creators. Interviewees (P13, P15) explained that naming conventions are not commonly established and implemented, nor are universal locations established for specific files. Interview data suggest this is because the creators' focus is on preserving the information by saving it "somewhere," rather than the accessibility of the information, positing that paying for more server space is easier and cheaper than paying for better organization of records.

> I would want that to still be accessible like on my network drive or something in case I need to view it for reference. In reality, what usually happens is nothing like that winds up being. It's on a network drive somewhere and eventually after a few projects you realize, 'We're running out of space.' Then IT goes in, cleans up stuff at that point and they

> archive things out or more likely what they do is they add more space because bad process ... [Figuring] out how to archive stuff is actually more expensive than buying more storage. (P29)

The result is an obstacle for collection processing and regular use of the items by creators. Multiple interviewees (P11, P12, P13, P18, P29) stated that the inability to easily find artifacts discourages creators from searching, leading to duplicate work or at least duplicate file creation. The dynamic nature of the game development environment often aggravates the situation. Typically, digital games are created by teams of professionals working under a corporate umbrella that owns the resulting intellectual property (Dovey & Kennedy, 2006). Interviewees shared how roles in game development are sometimes fluid, requiring a shift from one role to another, in some cases multiple times. Without good documentation, people often waste time tracking information or using information from wrong sources.

> I can't tell you how many times I waste time, like I'll go in and I'll say, 'Okay, I think this is the current state of this document or this is the state of the asset. I think this is the person who's working on it [...]' I may have been out sick and then I come in on Tuesday and it's like, "Oh no, Bill Johnson is working on this now. You got to look into his stuff." It's like, "Really?" They just wasted a whole day trying to parse through Bob Jones's work to see what's going on. I didn't know Bob is off the project now. (P12)

One of the most-cited hurdles by creators was the lack of structures in place to establish and maintain useful documentation that does not inhibit their productivity. Several interviewees held concerns that creating a documentation framework from scratch would be labor intensive and time consuming, thus detracting from the production of original work.

4.3.2 | Information professionals

One of the biggest challenges information professionals faced when curating collections of video game artifacts was a lack of contextual information about the materials. This is a common problem in special collections, perhaps aggravated in the context of gaming due to the rapid pace of media obsolescence.

> Whereas I have the development server from [game] as it was 1995, and that's a total mess, that's basically incomprehensible. There's just tons of folders all over the place, and they didn't have any version control or documentation for what's going on inside. Traversing through that is a lot more archaeological and requires a significant more contextual information about what stuff they were doing development-wise at the time. (P07)

> Maybe the person who was processing the collection in the first place didn't have any data either because they get boxes of junk, basically, and then have to make something of it. At this point, getting a lot of obsolete media and things like that. (P06)

Information professionals also discussed legal hurdles, as copyright, NDAs, and intellectual property concerns restrict what archives can do to preserve and provide access to video game collections. Information professionals agreed with creators that the lack of documentation and file retention schedules pose significant problems to long-term preservation and access.

> We're still very much a physical format–only institution, and that's not because we necessarily want to be, but it's just the way it is. Until we can find a strategy to work with the various studios and various moving images and game studios to get direct file submission, it's just the nature of the business I think for now, because of the way that I think [is] very complicated for copyright with this current setup to accept this kind of thing, and then move them along to us. (P02)

Additionally, varied collection formats pose a potential issue to information professionals. In terms of processing, physical and digital archiving require distinct, specialized skill sets. Because video game development artifact collections include both physical and digital materials of varying complexities, they present a significant challenge to information professionals, particularly archivists. Varied formats also highlight the importance of documentation and file retention schedules, allowing cultural heritage institutions to plan for necessary staffing changes or training.

Also mentioned as obstacles were organizational practices, including the siloing of teams and a lack of clarity about which standards to adopt and use.

> You have all these other groups that are out there who are pulling from different—That's what we talked about ..., 'Well, how is Stanford cataloging their video games? How is University of Michigan cataloging their video games?' There's really not necessarily a standardization for it. Since they switched from AACR2 [...] to RDA that has helped but RDA is still being figured out right now. (P24)

4.3.3 | Game researchers

Issues faced by creators and information professionals lead to challenges for game researchers. A lack of documentation, consistent file names, and retention schedules presents varied obstacles, and can make finding aids more difficult to navigate by inhibiting keyword searching in databases.

> Whatever ILS [integrated library system] they use, the interface for searching is ... I find it awful. I get lots of content I'm not looking for. So I did try to put together a list for them. That's one of the things they asked for, you know, 'Right, great. You're coming to the museum, you give us a hand and tell us what you need.' And I basically gave up on using that catalog and just asked the archivist to give me everything they had that was in the [name] collection. So it was actually easier than it would have been otherwise. (P22)

P22's comment highlights an important point about description granularity in these collections. Archivists usually write collection-level descriptions, including series-level descriptions; this level of description serves general purposes for archivists and researchers and also makes finding aids more manageable for both parties.

> Theirs come in, they get a collection. They catalog it as a collection with a finding aid. They don't individually catalog each piece. They have a single MARC record that covers the entire collection. (P06)

It is relatively rare for a collection description to be item level, and information professionals specifically stated that they did not think item-level description would be possible or desirable. Item-level description requires a significant time investment from the archivist, and due to the sheer volume of materials coming into most repositories, archivists cannot afford to describe every single item of every single collection. Item-level description is also not necessary for most game researchers: as long as game researchers know the general scope of materials, they can request access to a series and use their own knowledge to examine the items within a series, evaluating which ones will serve their purposes.

Intellectual property and copyright laws also present a challenge in accessing materials. Even if the material ends up on deposit with a cultural heritage institution, it may be available only onsite due to copyright restrictions, limiting accessibility.

> The challenges I've had are some materials obviously. They're not going to be online and I can't necessarily fly up to The Strong Museum or the National Videogame Museum or the Computer History Museum to look through what they have on file. That's got to go with the field I guess, because a lot of them can't put that material online. (P20)

Although it is impossible for cultural heritage institutions to always provide access to digital surrogates of collections, this challenge at least highlights the importance of high-quality finding aids, which can help game researchers decide which physical collections to pursue when answering research questions.

> Yes, finding aids, the quality of the information in the finding aids is real hit or miss ... actually, being able to determine which ones would be most useful to me, that would be helpful. It's one thing to have a folder that says, 'studio four.' When the chunk of the material's in there, what are they specifically? We have these memos about the studio four, these meeting minutes, and schematics. Are they none of these things? (P20)

5 | RECOMMENDATIONS

5.1 | Taxonomy of game development artifacts

Based on the document and user data collected, we created a taxonomy of video game development artifacts. Our taxonomy is organized into three broad sections including (a) Development (with seven subsections), (b) Organization-Related Materials, and (c) Marketing

(with four subsections), representing different aspects and timelines of game development. A total of 123 terms are defined and cross-referenced. The overall taxonomy structure is presented below. The full taxonomy can be accessed at https://gamer.ischool.uw.edu/releases/.

1. Development
1.1 Design (Overall)
1.2 Engineering
1.3 Quality Assurance and Control
1.4 Art
1.5 Audio
1.6 Writing
1.7 Production
2. Organization-Related Material
3. Marketing
3.1 Marketing (Overall)
3.2 Advertising Materials
3.3 Public Relations
3.4 Promotional Materials

5.1.1 | Collection of candidate terms

We collected our initial set of terms representing each type of document or artifact from two sources: (a) coded interview transcripts and (b) field notes taken during examination of artifacts in a collection. Once terms were selected, the research team reviewed and clustered them in a smaller set of categories to collectively represent all the materials in a comprehensive way with minimal category overlap. A series of discussions followed where the research team reviewed and named each category and drafted the definitions and hierarchical structure.

5.1.2 | Collaborative review, iterations, and testing

The categories were revised through an iterative and collaborative review process involving multiple groups of people, following a process as described in Lee, Clarke, and Perti (2015). The first set of iterations happened during the taxonomy design process within the research team as we aimed to reach a common understanding regarding the material type and intellectual content of each item. The version resulting from that design process was reviewed by the advisory board members for initial feedback. Afterwards, we sought additional feedback from all interviewees and select stakeholders that were recommended by interviewees. This process was useful for giving different types of stakeholders an opportunity to review the proposed CV and provide feedback.

The revised version of the taxonomy was then put through a test cataloging process in the graduate-level course "Metadata for Interactive Media," which enabled us to examine student domain expertise on games across multiple platforms, genres, and time periods. Student groups were given a set of game development artifacts to catalog using the taxonomy and were asked to provide feedback, which was incorporated into the revised version.

5.1.3 | Challenges in developing the taxonomy

Readjusting the scope

As we observed different game development artifacts collected by cultural heritage institutions, we noticed a group of objects that were not directly related to the development of particular game titles, yet provide important contextual information related to game development: company culture documents (e.g., mission statement, newsletter), company ephemera (e.g., business cards, holiday cards), keepsakes (e.g., awards, mementos), and day-to-day operational materials (e.g., meeting notes and presentation slides). Although we were initially focused on describing and organizing artifacts directly related to the development of game titles, we decided to also include these terms in our taxonomy, as these materials help us understand the environment in which the games were created, as well as the creators, thus supporting the goal of the project: to preserve game development history.

Another question that came up regarding the scope of the taxonomy concerned the formats of artifacts. For instance, the research team discussed the need to describe and distinguish the physical clay model created for a game character versus a digital character model. We eventually limited our scope to exclude detailed description of objects' formats because the goal of the taxonomy is to identify and describe the "types" of artifacts involved in game development based on the nature and role of the object rather than to enumerate how artifacts might be manifested in digital or physical environments.

Inconsistent and vague use of terms

From our interview data, we noticed that some of the terms referring to game development artifacts were extremely broad and vague. A good example is the term "design document," which was commonly used among stakeholders to refer to living documents intended to communicate game design elements to others. Yet the actual role or specificity of game design documents can

widely vary depending on organizational culture. Sometimes the term was also used ambiguously to refer to a more complete collection of information about the game, less temporary in nature, which we defined as "game bible" in our taxonomy. The term was also used to refer to a specific kind of design document, for instance, one focusing on a game's narrative structure; we defined separate terms to categorize those types of objects. Another example is the term "prototype," which can refer to the early game builds, paper prototypes built as a proof of concept, or technical prototypes reflecting early work on game hardware. We aimed to more clearly distinguish these terms in our taxonomy by using qualifiers.

Granularity of the taxonomy

Much of the discussion among the research team involved how granular the taxonomy should be in order to meet the needs of stakeholders. For instance, when discussing different types of game-related promotional materials, a wide variety of artifacts were identified, such as game contest-related materials, giveaways and swag, and sweepstakes, which could easily be broken down into dozens of categories. In such cases, our decision regarding the granularity of the categories was determined by considering the potential use of the taxonomy by stakeholders and the searching and browsing needs of someone interested in these materials. Given the importance of comprehensive search in such scenarios, the value of serendipitous discovery, and the desire for ease of application of this taxonomy, we were careful not to overcategorize promotional materials.

5.1.4 | Future evaluation plan

We plan to conduct a more systematic evaluation of the taxonomy in our next phase from three different perspectives: creators, information professionals, and researchers. For the creators' perspective, we plan to collaborate with DigiPen Institute of Technology and get additional feedback from students who are training to become game developers. For the information professionals' perspective, we will be testing the application of taxonomy to a larger size of sample collections of video game development artifacts in the "Metadata for Interactive Media" course with graduate students in the Master of Library and Information Science program at the University of Washington. Finally, for the researchers' perspective, our research team members in the VGHF will be testing the taxonomy by using it to catalog items in one of their collections. Based on the testing results, we will further refine the taxonomy and make necessary adjustments to improve its clarity and comprehensiveness.

5.2 | Best practices

Using information gathered from interviews, we constructed a list of stakeholder needs. We used the resulting wishlist as a basis for the development of a best practices framework aiming to address these needs[1]. In the following, we summarize a few key points from the best practices document.

Creators and researchers expressed difficulty finding materials. Consistent use of a controlled vocabulary and observed naming conventions for files would streamline description on the part of information professionals and facilitate access for researchers. Game development companies would benefit from using established and regularly maintained standards for ongoing documentation, enabling them to more easily and quickly navigate their files and cut down on duplicate work.

Throughout the interviews, it also became clear that more communication and direct relationships between game companies and cultural heritage institutions would be beneficial to all stakeholders. Creators and game researchers expressed a desire for consistent standards that could be used to describe and organize material, without realizing that existing frameworks could be used or adapted for this purpose. This collaborative relationship could also address another concern of creators: spending too much time documenting the game creation process instead of engaging in the process. Rather than requiring copious documentation, findability could be drastically improved with a few relatively minor changes in procedure. If creators and cultural heritage institutions forged a more cooperative relationship, information professionals could provide guidance on such matters with an eye toward long-term preservation and knowledge organization. Collaboration would also benefit cultural heritage institutions after accessioning the collection, as it would create the opportunity for participatory archiving: a process where the creators of a collection help organize and describe the various connections that could be made. Engaging in participatory archival processing with creators could help cultural heritage institutions address knowledge gaps held by the information professionals processing those collections.

Information professionals and creators were also concerned about how to provide access to collections while still respecting copyright and nondisclosure agreements held by others. Several solutions address these issues. A game development company has a say in what material it gives to a cultural heritage institution, as well as the format of those materials. Many corporate entertainment organizations that give material to cultural heritage institutions place extremely strict access restrictions on their copyrighted materials as a condition of the donation or

deposit. In many cases, such restrictions are accomplished by making the material available exclusively onsite via a terminal with Internet and USB ports disabled, allowing users to view the materials but not modify or duplicate them. Any requests for copies are directed to the rights holder. Copyright and NDAs also present potential issues if a game industry professional donates personal materials to a cultural heritage institution. In such a case, we strongly recommend checking with the donor regarding any potential NDA or copyright concerns in the material before accepting the donation. In many cases, copyrighted material may be treated as outlined earlier: Cultural heritage institutions provide viewing access onsite, but refer all copy requests to the copyright holder.

There are several actions that information professionals could take to better facilitate research. Implementation of our taxonomy and best practices should help significantly. Additionally, stakeholders mentioned that research could be improved if established online catalogs were better able to represent connections between collections and across cultural heritage institutions.[2] Information divides occur within cultural heritage institutions, not just between them. Procedures for smaller-scale museums and community archives are often developed in a vacuum, resulting in siloed in-house cataloging systems that are not easily integrated into established systems or interoperable with other silos. It is possible to address siloed practices and modify them to increase usability, but it often requires a considerable investment of time and money.

6 | CONCLUSION AND FUTURE WORK

We have discussed numerous challenges experienced by various stakeholders who create, maintain, and use collections of video game development artifacts. In addition to technical difficulties, limited time, and scarce resources, our research revealed multiple obstacles resulting from organizational factors and a lack of clear standards. To help address these challenges, we created a taxonomy of video game artifacts defining 123 types of materials based on interview data with 29 stakeholders and an examination of six video game artifact collections and an in-depth best practices document that details the steps stakeholders can take to help ensure better description, organization, and maintenance of these materials. The collections examined and stakeholders interviewed were all from the North American context, and thus, more research will be necessary to understand how our findings may apply in other settings. In addition, we recognize the wide variety of roles related to game development that are not fully covered by the limited number of game industry professionals interviewed in this study; therefore, some sections of the taxonomy may not be specific enough for certain kinds of development materials. Continuing to get more stakeholders involved in the development and evaluation of this taxonomy will help us refine and improve it over time. We also recognize the need for continuing to examine more recent game development artifact collections that would be more digital in nature compared to the collections observed in this study.

As new forms and genres of born-digital objects emerge in all fields and domains, descriptive practices within libraries, museums, and archives must be revisited to ensure these practices are adept at representing new additions to institutional collections; ongoing adaptations to fundamental archival concepts and practices are crucial to ensuring that the field stays relevant (Sköld, 2018). Ideally, these adaptations should be "built upon the foundation of...principles and practices that have already been established" (MacNeil, 1995). Our taxonomy of game development artifacts, which has been developed using domain analysis and built to be integrated into existing descriptive standards, will be of immediate use to creators during their creative process, and to information professionals as they use these materials with increasing regularity. Instead of describing collections with terminology so broad that it is unhelpful, information professionals can instead use these specialized terms with certainty that they will be uniformly used and understood by creators and game researchers alike.

Although our work will help ameliorate some of the issues we have discovered, we believe that systematic efforts need to be made within the game industry to consistently describe and organize game development artifacts. Our stakeholders unanimously recognized the importance of such efforts, but increased specification of roles and responsibilities is needed in order to implement them comprehensively. Without such efforts, game development artifacts will be increasingly inaccessible as they are stored on platforms without useful metadata and documentation to help stakeholders understand the context of the materials.

We have focused on exploring solutions to challenges in describing and organizing video game development artifacts, but similar issues exist for other kinds of digital media objects that have complex creation contexts. For our future work, we plan to explore how development artifacts are created, managed, and organized for media such as music, videos, and contemporary art.

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ENDNOTES

[1] The full best practices document is accessible at https://gamer.ischool.uw.edu/releases/

[2] All stakeholder types mentioned this as a wishlist item, but linked data and entity reconciliation are too broad of a topic to be explored more deeply in this article.

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