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Publication Date

2018-06-08

Peer reviewed

Theorizing success: Measures for evaluating digital preservation efficacy

Extended abstract

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Abstract

Digital information is indispensable to contemporary commerce, culture, science, and education. No future understanding of a prior time in the digital age is possible without proactive preservation of our digital heritage. But how can one know whether or not that preservation has been effective? There are two primary assessments of digital preservation efficacy: *trustworthiness* of managerial systems and programs, and *successful* use of preserved resources. The first has received extensive treatment in the literature, but the second has been little investigated. This stems from a too narrow conceptualization of the preservation domain as synonymous with data management. Given that the goal of that management is to facilitate future use, and that use is inherently contingent with respect to time, place, person, and purpose, digital preservation should be seen more broadly as facilitating human communication across time. My research asks what measures can meaningfully evaluate the efficacy of such communicative acts. It proposes a communicological theory in which success is evaluated with regard to situational verisimilitude. Evaluation metrics are derived from a semiotic-phenomenological model of preservation-enabled communication and the affordances supported by preserved digital resources. This work contributes new conceptual clarity to the theory and practice of digital preservation, a more rigorous basis for demarcating the limits of preservation efficacy, and a more nuanced means of stating, measuring, and evaluating intentions, expectations, and outcomes.

Categories and Subject Descriptors

• **General and reference~Metrics** • **General and reference~Evaluation** • **Information systems~Digital libraries and archives**

Keywords

Digital preservation, efficacy, trustworthiness, success, communicology, semiotics, phenomenology

1 Introduction

The discipline of digital preservation encompasses the actors, policies, procedures, and technologies ensuring the usability of digital resources over time. Impediments to

success stem primarily from the temporal distance that inexorably interposes itself between the points of content production, acquisition, and consumption. As that distance accumulates, concomitant disparities in technology, cultural context, and lived experience also grow, necessitating increasingly sophisticated forms of intervention to ensure the meaningful reception and understanding of preserved resources by their consumers. Those interventions and their results can take many forms. For example, a future request for a previously preserved resource could be satisfied by variously providing:

- Original physical media holding the resource (say, a magnetic tape);
- Contemporary media holding the resource (USB drive);
- Individual file, about which nothing more is known;
- File in original known format (WordPerfect);
- Derivative file of known format (PDF);
- File and rendering software (Acrobat Reader);
- File and provenance (PREMIS metadata);
- File and token of authenticity (PKI signature);
- File and intellectual description (MARC record);
- File and productive context (methodology statement);
- File and curatorial context (finding aid);
- File and prior consumptive context (citing article);

and so on. At what point can one say whether or not the preservation outcome was successful? Without knowing, how can one rationally plan for, reasonably expect, effectively measure, or meaningfully be held accountable for that outcome?

Current scholarship does not provide adequate treatment of the notion of preservation success. The state of the field regarding preservation efficacy has not advanced significantly from its position in 2006, when Lynch declared digital preservation “a metric that’s defied measuring” [48]. My research is focused on making tangible progress towards measurable metrics for evaluating the success of the digital preservation enterprise.

2 Research Question

The primary imperative for the preservation enterprise is to ensure that preserved information resources remain

accessible and usable in the future [56, 75, 78, 79]. Use entails exploitation for some particular purpose; that use is successful if the purpose is fulfilled. Purposes, however, are uniquely situated with respect to time, place, and person [55]. Thus, evaluating the success of a given instance of use is dependent upon the preserved state of the resource being used and the alignment of participating actors' intentions, expectations, and experiences. Consequently, my research focuses on the core research question:

RQ 1. What theoretically-informed criteria and metrics can and should be used to evaluate the success of the digital preservation enterprise in enabling human communication across time?

Commensurate with the positioning of digital preservation as a problem of situated human communication, my research program is grounded in a communicological perspective. Communicology is the science of embodied discourse [12]. Its theoretical and methodological foci are on modeling communication processes, the semiotic functioning of communicated messages, and the phenomenological experience of actors exchanging messages [47]. Thus, my investigation is directed in terms of three subordinate research questions:

RQ 1.1 What are pertinent components of a process model for digital preservation-enabled communication?

RQ 1.2 Given that model, what are the pertinent semiotic concerns of preserved digital resources?

RQ 1.3 Given those concerns, what are the pertinent measures of actorial experience of those resources?

These questions are distinguishable from general communicological inquiry through their fundamental concern with *digital* communication across *time*. Neither the digital nor temporal dimension has been subject to significant prior communicological analysis. While these concerns are the primary focus of the preservation literature, that scholarship has not accepted a communicological perspective. This dissertation bridges the gap between these two diverse strands of scholarly inquiry. In doing so, it provides scholars with a new conceptual approach to the digital preservation enterprise and the efficacy of its activities, and practitioners and stakeholders with new operational measures of the success of those activities.

3 Related Work

3.1 Preservation Management

A fundamental question underpinning scholarship in any discipline is its proper definition, which directs, if not circumscribes, the parameters of legitimate inquiry [15].

Digital preservation is primarily defined in the literature in terms of custodial stewardship of digital resources by archival institutions [35, 79, 83], most often expressed in the language of data management, e.g., [17, 33, 75]. At the center of that management are a set of actors and processes securing ongoing access to and use of managed digital resources [81]. The imperatives underlying those processes are assurances of authenticity, integrity, and intelligibility [10, 34, 49].

The field's primary conceptual framework is provided by the ISO 14721 Open Archival Information System (OAIS) reference model [8, 58]. An OAIS encompasses both an archival organization and its technical capabilities [34], with instrumentality for preservation provided by OAIS infrastructure and responsibility residing with OAIS managers. Under this formulation, digital preservation is synonymous with preservation *management*, and the boundaries of an OAIS demarcate the boundaries of that management. Consequently, the needs and concerns of management and managers have been accorded paramount importance, and the roles of information producers and consumers have not received sufficient critical attention.

Cognizance of those roles broadens the framing of digital preservation to a *flow* of information from producers to consumers, consistent with an alternative definition for the discipline as a means of "communicating with the future" [5, 52, 53]. However, while these authors deploy the *metaphor* of communication for descriptive purposes, they do not follow through on its consequences to *re-conceptualize* the domain in communicological terms or rely upon communicological analysis. Instead, the underlying focus remains on the narrower subdomain of preservation management. Positioning preservation as digitally-mediated communication supports a more inclusive foundation for the discipline and its assessment.

3.2 Communication

Communication processes have been analyzed from many different perspectives, including the propagation of signals independent of their human interpretation, as well as the subjective experience of human participants [77]; the degree to which participants share a common field of experience underlying the interpretation of messages, and the alignment of intent and consequence as reflected in the effect a communicated message has upon its receiver [64]; the psychological and anthropological implications of communication through intrapersonal, interpersonal, group, and cultural structures [77]; and the context of expressive and interpretive coding and decoding strategies, and the external referents, whether real or conceivable, of communicated epistemic meaning [47]. These aspects can be aligned and compared by reference to a formally-defined meta-model [45]. A compelling framework for such meta-analysis is provided by semiotics.

Semiotics is the study of signs and signification, that is, things that *carry* communicable meaning or affect, and the

ways in which they are expressed, experienced, and understood [59]. The semiotic affordances of signs in the Peircean tradition are threefold: semantics, or abstract meaning; syntactics, or concrete expressive form; and pragmatics, or interpretive understanding [51]. The antecedents of the Peircean triad are identified in scholastic and classical philosophy [24, 59], which assumed analog sign transmission: spoken words, inscribed stone, ink on paper, paint on canvas, etc. The advent of the digital age necessitated an extension of semiotic concerns to explicate fully technology-mediated communication.

The traditional concept of syntactics can be subdivided into three aspects: syntactics proper, concerned with symbolic expressive form; empirics, concerned with binary coding strategies; and physics, concerned with tangible manifestation, e.g., bits in memory, on media, or over networks [6]. Additional extensions are suggested by consideration of the *digital* nature of digital resources. These resources are inherently dependent upon mediating technology to be rendered into perceptible form, emphasizing the role of performative behavior [39, 55]. They are also inherently susceptible to mutability, highlighting the need for constant assessment of authenticity and integrity [66]. Finally, the open-ended temporal horizon of their stewardship reinforces the need to consider the manifold ways in which their representation, management, and presentation can, should, or must evolve over time [32]. While these concerns were not originally articulated from a semiotic perspective, they should be incorporated into the semiotic canon for a full appreciation of the digital preservation enterprise.

There are many contemporary forms of digitally-enabled communication, e.g., email, texting, mobile telephony, social media, streaming video, etc. How can digital preservation be distinguished from these alternatives? The differentiating characteristic is preservation's focal attention to the corrosive impact of time. The communicological literature does not address this temporal concern; instead, communication is tacitly assumed synchronous in time. Conversely, while the preservation literature is focused on temporal consequences, it does not incorporate communicological perspectives. My work seeks to integrate these diverse philosophical and methodological traditions for applicability to the question of preservation efficacy.

3.3 Trustworthiness

Current scholarship addresses the question of how best to evaluate efficacy by focusing on the design and implementation characteristics of archival systems and programs [43, 74], the scope of the collections and services they offer [85], the ability of their users to reference, reuse, and understand managed content [50], and their trustworthiness [8]. Trustworthiness is an important property of information systems to assuage customer concerns over uncertainty, vulnerability, and technical dependencies [18, 44]. In the preservation domain, an assertion of

trustworthiness is based upon a justified belief that a system or organization is capable of meeting its obligations [27]. Trustworthiness is the predominant evaluation metric for digital preservation because it is a more tractable quality than success, the measurement of which remains elusive [1, 48], and the very definition of which lacks broad scholarly consensus, particularly given its inherently contingent and contextualized nature [23].

However, while the promotion of trustworthy solutions is broadly represented in the literature, e.g., [34, 40, 56], it is not accompanied by explicit critical justification. Instead, there is a tacit assumption that trustworthiness is self-evidently beneficial, and that trustworthy solutions will *necessarily* lead to successful outcomes. Given a choice between trustworthy and untrustworthy alternatives, a decision to favor the former seems inarguable. However, what if the choice was not between trustworthy and untrustworthy options, but rather trustworthy and *successful* ones? Success can result from untrustworthy means, but it is difficult to imagine attributing trustworthiness to a patently unsuccessful system or program.

Trustworthiness is a condition properly associated with the processes and actors that *lead* to outcomes, not the outcomes themselves [87]. Thus, it is a property of the subdomain of preservation management. The focal attention given to trustworthiness is not misplaced, but is insufficient for a true measure of preservation efficacy. Trustworthiness and success are complementary values: the latter vindicating the former's presumptions regarding future outcomes. In this sense, the relationship between the two comports well with the philosophical priority of a state of actuality over one of potentiality [82]. A system is deemed trustworthy if it has the *potential* to succeed, but it is successful only if that capacity is *actually* exercised with beneficial outcomes. My research pursues the question unaddressed in the literature regarding how best to evaluate preservation outcomes.

3.4 Managerial Prerogative

Accepting success as a legitimate metric raises a further question regarding evaluative perspective. The literature concentrates evaluative attention on preservation management and custodial managers [22, 35] through language pointedly couched in terms of managerial agency and action, e.g., [14, 17, 49]. While consistent with the narrow managerial conceptualization of the field, this position minimizes opportunities for consideration of pre-acquisition or post-retrieval activities, and the concomitant experiences of information producers and consumers [20, 58]. Since the goal of preservation is to enable future use, it is important to incorporate the perspective of those users [11, 14].

In contrast to the custodial prerogative, a more inclusive notion of post-custodial agency [22] recognizes the importance of all actors implicated in the preservation enterprise: producers and consumers as well as managers [48, 56, 69]. However, this more inclusive perspective has

not resulted in a corresponding expansion of scope for evaluating the enterprise, which remains focused on measurement of activities under managerial purview [83], and under which dissemination and use are considered out of scope [81]. Given that the preservation imperatives of accessibility, authenticity, and usability can be articulated as ensuring fitness for purpose [21, 65], that that purpose is to enable future use [16], and that the instigation of and control over that use ultimately lies at the discretion of the consumer [4], consumer experience should be the primary focus of preservation evaluation.

3.5 Descriptive Evidence

Asserting the preeminence of consumer experience raises another question regarding the appropriate evidence base for assessment. Current scholarship answers this in terms of documentation describing the essential characteristics of preservation systems and programs [85], insofar as those characteristics are indicative of programmatic and systematic trustworthiness [83]. Preservation systems are deemed trustworthy if they meet the needs of their users [2]; those needs coalesce around the qualities of preserved resources remaining accessible [75], intelligible and authentic [34], and useful and usable [76]. However, the literature pays insufficient attention to the different kinds of evidence needed to support assertions of trustworthiness [67], leaving the determination of appropriate metrics for assessing users' trust an open question [86].

Trustworthiness can be evaluated through either attributive or predictive processes [44]. The former rely upon assertions made *about* a system, while the latter looks at previous results *of* a system as a harbinger of future behavior. Appropriate objective criteria may not be available to directly measure trustworthiness, in which case its assessment must proceed from indirect or proxy indicators [25]. However, where metrics are available, they are more concerned with a system's abstract capacity to preserve, rather than verified evidence that something actually has been preserved [26].

The primary evidence base for trustworthiness is defined by the Trusted Repositories Audit & Certification (TRAC) checklist, which was subsequently standardized as ISO 16363 Audit and Certification of Trusted Digital Repositories (TDR) [40]. Both instrument identify a set of prescriptive attributes of trustworthy systems and archival programs [27]. The underlying evidence, however, takes the form of stated claims, documented intentions, and contractual assurances and is best classified as attributive or *descriptive* in nature. Predictive evidence, on the other hand, is based upon extrapolation of past observed outcomes to anticipated future situations, which is to say, it is essentially *operational* in nature. The evaluation of success should incorporate operational evidence of preservation outcomes as experienced by all actors, with preeminence accorded to consumers.

3.6 Pragmatic Preservation

Accepting the need for operational criteria raises a question regarding the proper basis for their derivation. In general, the preservation literature favors practical and methodological concerns rather than theoretical issues [66]. The strategic choices underlying preservation methodologies encompass the techniques of migration, encapsulation, and emulation [36, 49]. The maturity of those choices can be evaluated through the NDSA rubric, which is based upon a survey of codified practices [62]. Those practices coalesce around the use of preservation repositories adhering to the OAIS standard [8, 83] and organizations conforming to the TDR certification criteria [34]. While investigation into practical concerns is widespread in the literature, there is little inquiry into foundational theory [32, 83], and more funding is needed for significant research, development, and promulgation of robust theoretical models [57].

In some cases where claims of theoretical advance is made in the literature, "theory" is used in a narrow sense of a newly proposed thesis or pragmatic solution, such as the use of the TRAC to develop archives capable of preserving descriptions of managerial systems as well as records [80], or the definition of processes implementing managerial policies and validation criteria [53]. Other instances adhere to a more expansive notion of theory as a cohesive system of abstraction, explanation, and inference, but rely upon logical and mathematical formalisms tacitly assuming that preserved resources are complete encapsulations of the intentions and knowledge-states of their producers, and that those states can be unambiguously recovered and (re)experienced by consumers, e.g., [13, 32, 34]. This position is at odds with the post-modernist belief in the essential contingency of human information exchanges [38]. This implies that *any* use of a preserved digital resource is inherently situated with respect to time, place, person, and purpose and cannot be reductively generalized. Given that digital preservation should be seen as enabling communication with the future [5, 14, 52], the theoretical constructs of communicology [47] are appropriate to apply to preservation assessment. These constructs encompass the cultural semiotics of the communicative process [28] and the phenomenology of the communicative experience [71].

3.7 Summary and Implications

Like any formal discipline, digital preservation should be viewed intellectually as a shared domain of knowledge and discourse [15], and operationally as a complex of actors, policies, technologies, and practices [81]. That practice should include a means for effective self-evaluation [30]. Unfortunately, the digital preservation field has not yet matured to the point of having established metrics for evaluating its outcomes [48, 63]. While the underlying assumptions and assertions of the various themes emerging from this literature review are valid and constructive, under analysis they are shown to be unnecessarily narrow in scope

and vision. Consequently, the superordinate question underlying my research asks what theoretically-informed measures should be used to evaluate the success of the preservation enterprise in enabling communication across time. This question responds to the significant gaps identified in the literature: it positions digital preservation as a problem of *communication*, rather than data management; it emphasizes a concern with communication across *time*, with an implied concern for consequences of concomitant technical and cultural distance; it seeks to quantify preservation *success*, rather than trustworthiness; it scopes the subsequent investigation in terms of the post-custodial preservation *enterprise*, rather than the subdomain of custodial management; it implicitly considers operational *outcomes* as experienced by all implicated actors; and finally, it places *theoretical* concerns on an equal footing with pragmatic ones, providing explicit opportunity for inquiry into the inherent contingency of preservation-enabled communication.

4 Methodology

This research is a conceptual investigation into criteria and metrics for evaluating digital preservation efficacy, leading to an evaluation rubric, descriptive vocabulary, and formal typology for the nuanced consequences distinguishing common patterns of preservation outcomes. These are based upon a conceptual framework and ontological model of information resources and preservation-mediated communication explicitly grounded in semiotic phenomenology. This position provides the key insight that communication is understandable only through the situated experience of the human agents participating in communicative acts expressing and perceiving culturally-coded signs [46]. Thus, the use of preserved digital resources is an inherently constructivist act.

The research program, however, is based upon pragmatic, rather than constructivist principles. The pragmatic research paradigm is characterized by an abductive, or exploratory, mode of inquiry leading towards interpretive, rather than causal or probabilistic explanations [19, 54]. Pragmatic research exploits the methodological eclecticism often seen in mixed methods research [31], with license to deploy a variety of techniques and strategies based upon their suitability for purpose [73] and exploratory and confirmatory power [60]. Pragmatic investigation is further characterized by an intersubjective stance, recognizing the implausibility of either complete objectivity or subjectivity, and accepting researcher intuition and interpretation tempered by purposeful self-reflection [54].

The specific methodological design is Conceptual Framework Analysis (CFA), a technique for deriving new interpretive constructs by which to understand complex phenomena, particularly those entailing cross-disciplinary knowledge [41]. CFA is a variant of the grounded theory method (GT) [29]. Although GT is generally described as an inductive technique [37], its goal of deriving substantive *new*

theory is an essentially abductive strategy [9]. As such, it is consistent with the open-ended investigatory approach of the pragmatic paradigm. Two subsidiary techniques, Evolutionary Conceptual Analysis (ECA) [70] and Critical Interpretive Synthesis (CIS) [3] are used for the core CFA activities of identifying contextual ambiguities, tacit assumptions, and explanatory contexts; deconstructing them in terms of their ontological, epistemological, and methodological roles; and finally integrating them into a new cohesive set of higher-order synthetic entities and properties.

The evidence base for this investigation is primarily documentary texts, rather than case study, survey, or interviews of domain actors. While CFA is an empiric method of inquiry, it is primarily a text-centric approach intended for “theorizing the concepts that emerge from the text” [41]. The exploratory nature of CFA is thus well-aligned with the pragmatic and abductive design of the research program. Applied to investigation of social phenomena, abduction seeks compelling explanatory concepts from social actors’ reflective descriptions of their activities and the meanings attributed to them [7]. The lack of prior cognizance of the concept of preservation success in the literature is suggestive of a problem not broadly recognized or well-formulated within domain discourse. Thus, analysis of representative texts – theories, policies, standards, practices – is the best avenue for uncovering tacit and acknowledged assumption, intentions, and expectations. These documents essentially constitute the “service contract” underlying use of preserved resources and are indicative of the circumstances and consequences of that use. Without a clear conceptual model rigorously explicating preservation-enabled communication – an intended contribution of this research – it would be premature to engage domain actors in data collection activities, as the necessary philosophical and conceptual framing for protocols and analysis would be unavailable. While such engagement subsequent to the completion of this work would be invaluable, particularly with regard to further inductive validation of its research findings, it is out of scope for the current research program.

5 Preliminary Findings

Because of the potentially open-ended time horizon of preservation commitments, preservation success should be understood properly as a provisional, rather than absolute value. One can’t make categorical assertions of success that apply meaningfully beyond the ever-forward-moving point of now, since the consequences of even the immediate future cannot be fully anticipated [23]. This bears a similarity to the concept of scientific falsification under which a theory is provisionally true so long as it has not been proven definitively false [61]; so too it is legitimate to assert the success of digital preservation *so far*.

The temporal distance that is the primary impediment to preservation success necessarily implies concomitant cultural distance [72] and culturally-situated contingency

with regard to experience of actors participating in the preservation enterprise. That contingency means that success should be evaluated relative to a standard of situational verisimilitude, rather than universal fidelity to some illusory canonical information state and experience. This bears a similarity to the concept of scientific truthlikeness under which the truth of a theory ranges along a spectrum of plausibility [42]; so too it is legitimate to evaluate success as the *relative* degree to which preserved resources can be purposefully exploited.

Since the goal of digital preservation is to enable future use, measuring its success properly assigns primacy to user, which is to say, consumer experience. The contingent and contextualized nature of that consumption places constraints on the ultimate efficacy of preservation efforts. Given the situated diversity of consumers and uses, success for one might very well be failure for another. Use encompass the purposeful exploitation of affordances supported by a preserved digital resource's abstract meaning, expressive form, symbolic representation, physical manifestation, archival integrity, situated context, performative behavior, perceptual form, and abstract understanding. The derivation of meaningful criteria and metrics for evaluating the success of that exploitive use arises through semiotic and phenomenological consideration of the individual affordances in the context of productive, managerial, and consumer intention and expectation.

6 Contribution

This dissertation promotes a broader and more nuanced conceptualization of the digital preservation enterprise as being fundamentally concerned with meaningful mediated communication across temporal, technical, and cultural distance. The underlying communicological model of semiotic and phenomenological affordances provides scholars with a new analytic toolset for subsequent research of preservation-related topics. The process by which evaluation criteria are derived from the model is explicitly cognizant of the post-custodial contexts and post-modernist contingencies that expand as well as constrain conceptual and practical considerations of the preservation enterprise.

These results will provide scholars with new insights into the theory, practice, and limits of efficacy of that enterprise. The evaluation rubric will offer practitioners a technical vocabulary by which to make significant nuanced distinctions regarding intentions and activities in a concise yet precise manner. It also will form a rational basis for prioritizing strategic organizational goals, optimizing the allocation of finite programmatic resources, defining achievable service levels, setting realistic expectations, and remaining accountable to stakeholders.

Acknowledgments

I wish to thank my supervisory team, Kate Devitt, Peter Bruza, and Anthony Bernier, for their constant support and encouragement; Marcia Bates, Michael Buckland, and

Clifford Lynch for constructive comments on an earlier presentation of this work; and my colleagues Salvador Barragan, Lettie Conrad, Lee Yen Han, Kim Morrison, and Pat Sandercock for ongoing review and feedback.

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