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Digital Content Reuse in Dynamic Settings: An Organizing Typology for Digital Content Users

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Abstract
The term "reuse" is a puzzling term when used in the context of stored digital content. In temporal terms, digital content "reuse" is both static and dynamic. In its static form digital content reuse means subsequent use by an initial user. In its dynamic form, digital content reuse means initial use by a subsequent user. It is within the dynamic context of stored digital content reuse that we develop a theoretical framework to answer the following question: Given the dynamism of digital content in organizational transacting systems, and based upon variability in user perceptions, how can digital content be sorted theoretically as to its reuse potential? Based on stored digital content (data, information, knowledge) and digital content attributes (symbols, meaning, application), we theoretically explore the potential for value-creating reuse of digital content through modification of digital content attributes.

Keywords: Digital content, digital content attributes, digital content reuse, knowledge management, knowledge management theory, reuse

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DIGITAL CONTENT REUSE IN DYNAMIC SETTINGS:

AN ORGANIZING TYPOLOGY FOR DIGITAL CONTENT USERS

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ABSTRACT

The term "reuse" is a puzzling term when used in the context of stored digital content. In temporal terms, digital content "reuse" is both static and dynamic. In its static form digital content reuse means subsequent use by an initial user. In its dynamic form, digital content reuse means initial use by a subsequent user. It is within the dynamic context of stored digital content reuse that we develop a theoretical framework to answer the following question: Given the dynamism of digital content in organizational transacting systems, and based upon variability in user perceptions, how can digital content be sorted theoretically as to its reuse potential? Based on stored digital content (data, information, knowledge) and digital content attributes (symbols, meaning, application), we theoretically explore the potential for value-creating reuse of digital content through modification of digital content attributes.

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INTRODUCTION

The term "reuse" is a puzzling term when used in the context of stored digital content. This is because, in temporal terms, digital content "reuse" is both static and dynamic. In its static form digital content reuse means subsequent use by an initial user. In its dynamic form, digital content reuse means initial use by a subsequent user. It is within the dynamic context that this paper is set, because – of the two – it is least developed in the Information Systems (IS) literature. In this paper we therefore address the following research question: Given the dynamism of digital content in organizational transacting systems, and based upon variability in user perceptions, how can digital content be sorted theoretically as to its reuse potential?

This question is important to the IS literature, because user perceptions are many and varied (Moore & Benbasat, 1991; Vandenbosch & Huff, 1997). For example, a given user may consider digital content as a "fact," the record of an observation (e.g. a "song" exists on an iPod); as "data," the symbolic representation of certain observations (e.g., the song is in a song list on an iPod); as "information," the addition of meaning to a symbolic representation (e.g., the iPod song list is sorted into "favorites"); or as "knowledge," the application of information toward some purpose (e.g., a given song from the iPod playlist is played to hear the desired music.) In this paper, we develop a framework of user perception-based digital content reuse as either: a function of the addition, or as a function of the changes, made to the symbols, meanings and applications that adhere to stored digital content. Thus, a fundamental assumption in our analysis is that high-level/ conceptual storage parameters imply reuse possibilities, in (dynamic) cases where digital content reuse specifically involves the first use of stored digital content by a subsequent user. Thus, for purposes of this analysis, we assert the idea of re-initialization: that in the dynamic context, specifically in the case of organizational transacting systems, what may in

the past have been termed subsequent use, must be considered (in actuality) to be initial use by a subsequent user (re-initialization), and ought therefore to be separately identified in the literature as its own general type of reuse: dynamic digital content reuse.

The dynamic functional relationship among facts, data, information, and knowledge developed in this paper: (1) is supported by a specific stream of literature (Table 1) that suggests hierarchical ordering among facts, data, information and knowledge (Figure 1), and (2) is evoked by the variety in subsequent-user perceptions that tends to relax the assumptions of hierarchical ordering, to suggest the interpenetration of subsequent users' context, interpretations, and technical limitations due to pre-existing classifications of digital content in the storage environment, which together yield overlaps in the symbols, meaning and application that adhere to digital content (Figure 2). We further argue that these overlaps, in turn, have implications for reuse potential – specifically in the report types that can be conceptualized to emerge from the overlaps in user perceptions (Figure 3).

In the following sections we first define the terms of our research question: dynamism of digital content, organizational transacting systems, and variability in user perceptions. Second, we review the literature pertinent to the three digital content attributes we utilize in our argument (symbols, meaning, application), and suggest the eight qualitative classes of stored digital content that emerge from an "overlap" analysis using these three attributes in the conceptual model (Figure 2) along with exemplar vignettes to illustrate (Table 2), and the theoretical proposition which flows from the analysis. Third, we address the reuse potential portion of the research question by interpreting the theoretical model through the lens of our second proposition, to induce from the eight qualitative classes of digital content, eight likely reporting reuse classes (Figure 3) along with corresponding modifications to a given "existing report"

(Table 3), as a function of user-perception-based modification(s). We conclude by exploring the implications of our analysis for digital storage parameters as they impact reuse possibilities.

The intended contributions of this paper are threefold (cf., Popper, 1979): (1) to add to our capability to better explain the notion of "reuse," (2) to enhance theoretical and operational utility in IS research through the construction of helpful typologies for dynamic digital content reuse using relevant literature, and (3) (given the dynamism of stored digital content in organizational transacting systems), to assert – based upon variability in user perceptions – how digital content can be sorted theoretically as to its reuse potential.

DIGITAL CONTENT REUSE: DEFINITIONS

In this section, we develop working definitions of the first three elements of the research question: (1) dynamism of digital content, (2) organizational transacting systems, and (3) variability in user perceptions. In the sections following this, we then proceed to develop a theoretically-based sorting of digital content as to its reuse potential.

Dynamism of Digital Content

The term "reuse," in the digital context, is a somewhat "mushy" concept (Davis, 2011) that has been employed in research focused on knowledge management systems and repositories (e.g., organizational memory systems) as a step toward a theory of knowledge reusability (Markus, 2001). Problems of knowledge reusability are thought to be a subset of a broader class of "knowledge problems in organizations," other such problems being "coordination" and "transfer" (Sambamurthy & Subramani, 2005, p. 193). A brief summary of key developments in the literature supports this assertion.

In prior work that develops foundational concepts for the idea of digital content reuse, Kelly (1970) suggests that new knowledge may be invoked from a given set of known elements,

which confirms the importance of reuse to knowledge building; Blair (1984) suggests a taxonomy that enables researchers to effectively parse reuse problems according to their underlying structure, introducing the importance of user perceptions in effective reuse to the IS literature; and Lansdale (1988) argues that effective reuse in actual application faces mental hurdles as well, and depends heavily on users' psychology: specifically including recall, recognition, and categorization. Cohen & Levinthal (1990) continue to emphasize the critical importance of the user; and they suggest reuse is related to the reuser's prior related knowledge. They note that reuse involves organizing/categorizing knowledge across space and time through linking concepts with prior concepts to provide meaning and to make sense of knowledge in a new context. This insight, in turn, suggests that reuse is more likely to be found in the organizational context due to knowledge being aggregated or grouped within a definable repository: i.e., an organization.

So as the next foundational idea in the reuse chronology, Walsh and Ungson (1991) introduce the concept of organizational memory, which presents theory consistent with the notion of reuse: that retention, content, and retrieval of information are core to the composition of organizational memory (1991, p. 61). Following this logic, Orlikowski (1993), using groupware as an illustration, echoes the idea that reuse is not an individual endeavor, but rather is a social/group (organizational memory-like) endeavor. Orlikowski emphasizes that the technology that fosters reuse is not enough – that structural properties/culture supporting reuse must also exist organizationally. Ackerman (1996) extends, by implication, the notion that organizational memory (as a metaphor) enables reuse developments to proceed in practice, but as constrained by: (1) frame of reference, (2) organizational context, and (3) technical feasibility. (We note here that in a later section in our paper we argue that these three constraints

are representative of the underlying attributes that produce variability and therefore dynamism among reuse categories: e.g., frame of reference ↔ symbols, organizational context ↔ meaning; technical feasibility ↔ application.)

The concept of knowledge reusability eventually moved from implicit to explicit use of "reuse" terminology in the literature, when Markus (2001) linked the concepts of knowledge management and organizational memory. A typology derived from an extensive literature review of type of reuser and/or purpose of reuse suggests four types of knowledge reuse: ". . . (1) shared work producers, who produce knowledge they later reuse; (2) shared work practitioners, who reuse each other's knowledge contributions; (3) expertise-seeking novices [who reuse stored content to create new content of their own]; and (4) secondary knowledge miners [who analyze the attributes of the digital content repository to produce subsequent analyses]" (2001, p. 57). Helpfully, analysis of these four suggested types of knowledge reuse situations enables us to propose a definition of digital content reuse which is not only realistic (in that it corresponds to what has been observed in the real world (cf., Markus, 2001), but is tractable by the two primary variables in the reuse calculus: (1) time: being categorized as "initial" vs. "subsequent," and (2) function: being categorized as "use," vs. "user," together producing a comprehensive definition of digital content reuse: *Either the subsequent use of stored digital content by an initial user, or the initial use of stored digital content by a subsequent user*. . . the former, having a static impact on a digital content repository, and the latter a dynamic one. It is dynamic reuse that is the focus of our analysis, where the phenomenon of re-initialization (i.e. the initial use of stored digital content by a subsequent user) is the focus.

Interestingly, the literature analyzed by Markus (2001) provides examples of static (shared work producers), dynamic (expertise-seeking novices), and hybrid-type (shared work

practitioners) reusers – and in addition identifies a key phenomenon in digital content reuse which, we argue, is not a reuser type, but rather is a unique phenomenon that is becoming central to digital content reuse: what Markus (2001) types as secondary knowledge miners, and which we term to be the organizational transacting system.

Organizational Transacting Systems

We acknowledge at the outset of this section that the definition of organizational transacting systems that we develop herein is bounded, in that it is limited to the systems that create dynamism within digital content repositories. In a static reuser transacting system, such as checking email, Google queries, retrieval of a telephone number from a contacts list, etc., no re-initialization occurs. Rather, a reuser simply engages in the subsequent use of digital content as an initial user. However, in a dynamic reuser transacting system – what we henceforth refer to as an Organizational Transacting System (OTS) – re-initialization occurs because the system records user exchange behavior for the purpose of making changes in the reuse potential of digital content. For example, such systems currently include (non-exhaustively): business intelligence/ analytics systems such as SAS Business Intelligence, Oracle BI Tools & Technology, or IBM Smart Analytics System; (2) web analytics systems such as Google Analytics, Piwik, or Optimizely; and (3) recommender systems, such as Amazon, Netflix, or Pandora. And in each of these OTS environments, substantial rework of the digital content in the repository is implicated (Markus, 2001) based upon the intended reuse. Thus, for purposes of this paper, we define an organizational transacting system to be: *a system that records user exchange behavior for enhancing future reuse potential*.

Why are such systems central to the understanding and future development of effective digital content reuse? In later sections in this paper, we argue that due to variability in user

perceptions, that a variety of changes/ rework of digital content within repositories are/is required; and that certain attributes relating to the qualitative nature of these necessary changes are systematically ordered. Hence, it is important to understand the nature of user perceptions, and especially the dimensions along which variability in these perceptions is to be expected.

Variability in User Perceptions

Users' views serve as a standard against which digital content quality may be assessed (Wand & Wang, 1996). In the introduction to this paper we argued that such factors as the context, interpretations, and technical limitations due to pre-existing classifications of digital content in the storage environment, all affect variability in the perceptions of users engaged in dynamic digital content reuse (subsequent use of digital content by an initial user). We can therefore expect the behavior of users to vary, predicated on how they perceive the digital content (cf., Kraemer, Danziger, Dunkle, & King, 1993).

For example, users who are focused on reporting, e.g. the users of executive information systems (EIS) have variety in their perceptions; and so ". . . depending upon on functionality and inclination, EIS may be used for performance monitoring, 'what-if' analyses, trend spotting, problem identification and resolution, and generally keeping up-to-date" (Vandenbosch & Huff, 1997, p. 82). In such cases, perceptions may vary depending upon application objective. Users' perceptions also vary based upon the meaning systems within which information systems reside; and such meaning is conveyed by the signs and symbols employed (Mingers, 1995). Mingers further suggests that meaning is intersubjective – that is, dependent on shared understanding which can vary among users and groups. Thus, when the role of IS is " . . . to provide a representation of an application domain (also termed the real-world system) as perceived by the user; [then] representation deficiencies . . . the differences between the view of the real-world

system as inferred from the information system and the view that is obtained by directly observing the real-world system" (Wand & Wang, 1996, p. 88), become another source of user variability. We therefore draw from the literature on user perceptions that variability in user perceptions may be defined, for use in this analysis, to be: *The extent to which, as perceived by users, changes in symbols, carry variations in meaning, suitable for varied applications.* In later analysis, these user-centric variables become useful in creating a framework for dynamic digital content reuse. In the next sections we therefore examine these digital content attributes as sorting criteria for the proposal of digital content classes, and the subsequent analysis of digital content modification as the essential feature of dynamic digital content reuse as applicable to organizational transacting systems.

DIGITAL CONTENT ATTRIBUTES[1]

Digital content attributes require construct clarity (cf., Suddaby, 2010) for there to be value in their use for theory development; and this requires some degree of consistency in terminology. However, we note within the IS literature that there exists substantial breadth in terminology use. For example, at times the terms information and knowledge are used interchangeably; as are the terms data and information. At other times, the phenomena to be included (i.e. the attributes of these terms) is more or less inclusive. While this variability in use and inclusion had proven initially to be somewhat frustrating in our attempt at rigor in our theoretical analysis, it also produced an opening for careful definition and consequent framework-building. We therefore undertook to obtain from the literature enough boundary-

[1] To this point in the paper, we have of necessity, utilized "reuse"-focused terminology as it has appeared in the literature, e.g., knowledge reuse, information reuse, data reuse, etc.. We have also, where possible, introduced the term "content reuse" or "digital content reuse" as an umbrella term that offers the possibility to streamline the argument. From this point forward, we use content reuse or digital content reuse accordingly.

setting language surrounding the terms data, information, and knowledge, such that we could form working definitions of each term for purposes of this paper.[2]

Table 1. Conceptual Foundations of the Data / Information / Knowledge Hierarchy – A Selected Chronology

Source		Digital Content	Chronological Narrative
Shannon	1948	"The fundamental problem of communication is that of reproducing at one point either exactly or approximately a message selected at another point. Frequently the messages have *meaning*; that is they refer to or are correlated according to some system with certain physical or conceptual entities. These semantic aspects of communication are irrelevant to the engineering problem." (emphasis in original) (p. 379)	Shannon introduces a mathematical theory of communication (also called *Information Theory*) to solve a purely technical problem with the transference of a set of symbols from one point to another. Information is described as a message where, from a purely technical standpoint, *meaning* is not important. From Shannon's work, we find a foundational implication that digital content can be considered in different ways: from a technical viewpoint and from a semantic viewpoint.
Shannon & Weaver	1949	"Relative to the broad subject of communication, there seem to be problems at three levels. … The *technical problems* are concerned with the accuracy of transference from sender to receiver of sets of symbols (written speech), or of a continuously varying signal (telephonic or radio transmission of voice or music) or of a continuously varying two-dimensional pattern (television), etc. … The *semantic problems* are concerned with the identity, or satisfactorily close approximation, in the interpretation of meaning by the receiver, as compared with the intended meaning of the sender. … The *effectiveness problems* are concerned with the success with which the meaning conveyed to the receiver leads to the desired conduct on his part." (emphasis in original) (p. 2)	Shannon and Weaver make explicit the idea of multiple viewpoints to information, and add structure to these viewpoints in discussing communication problems that occur at different levels that correspond to these viewpoints. Importantly, this work implicitly forms the beginnings of the hierarchical perspective of digital content.
Bar-Hillel & Carnap	1953	"The Mathematical Theory of Communication, often referred to also as Theory (of Transmission) of Information, as practised nowadays, is not interested in the content of the symbols whose information it measures. … This deliberate restriction of the scope of Statistical Communication Theory was of great heuristic value and enabled this theory to reach important results in a short time. Unfortunately, however, it often turned out that impatient scientists in various fields applied the terminology and the theorems of Communication Theory to fields in which the term 'information' was used, presystematically, in a semantic sense, that is, one involving contents or designata of symbols, or even in a pragmatic sense, that is, one involving the users of these symbols. There can be no doubt that the clarification of these concepts of information is a very important task. However, the definitions of information and amount of information given in present Communication Theory do not constitute a solution of this task. To transfer these definitions to the fields in which those semantic or pragmatic concepts are used, may at best have some heuristic stimulating value but at worst be absolutely misleading." (p. 147-148)	But Bar-Hillel & Carnap point out that, while a clarification of the concepts of information are important, Shannon's (1948) theory is limiting in this regard, and that theory concerning the content of the information is needed.
MacKay	1969	"The view I have offered is that while the connection between statistical and semantic features of information cannot but be indirect, these are features of one and the same central concept, which admits of a single universally applicable operational definition. … On what does information operate? Ultimately, we say, 'on the receiver's mind'." (p. 58)	MacKay recognizes that both the technical and the semantic features of information as important and are features of one and the same central concept: on what information operates on – the mind of the receiver. Significantly, this recognition highlights the importance of considering the receiver (human mind) in the hierarchical perspective of digital content.
Davis	1974	"A useful general definition of information for information systems purposes is the following: *Information is data that has been processed into a form that is meaningful to the recipient and is of real or perceived value in current or prospective decisions.* The relation of data to information is defined as that of raw material to finished product. In other words, the information processing system processes data into information. Or more precisely, the processing system processes data in unusable form into usable data that is information to the intended recipient. ... Because of this relation between data and information, the two words are used somewhat interchangeably." (emphasis in original) (p. 32) "*Data*, the raw material for information, is defined as groups of nonrandom symbols which represent quantities, actions, things, etc. Data is formed from characters. These may be alphabetic, numeric, or special symbols such as *, $, and ~." (emphasis in original) (p. 33)	Davis applies prior conceptualizations of information to the Information Systems field and in doing makes explicit the distinction between data and information, defining the terms in relation to one another and reaffirming the hierarchal structure of digital content. For our understanding of digital content, the distinction between data and information is paramount.

[2] The literature review presented here is not intended to replace or supersede, for example, the philosophy-of-information literature; but rather, is only prepared to support the rationale necessary for consistent terminology usage within this paper and in possible future operationalization(s) of the theory proposed.

Source		Digital Content	Chronological Narrative
Tushman & Nadler	1978	"This article builds on the view of organizations as information processing systems facing uncertainty and extends this concept to develop a conceptual model for organizational design and structure. Information processing refers to the gathering, interpreting, and synthesis of information in the context of organizational decision making. This article distinguishes between information and data. Information refers to data which are relevant, accurate, timely and concise. As information must effect a change in knowledge, data may or may not be information, and data processing may or may not be information processing." (p. 614)	The distinction between data and information enables Tushman and Nadler to view the organization as an information system. In doing so they support the hierarchical distinction between data and information and also link information to knowledge in this hierarchy.
Dretske	1983	"Information is an artifact, a way of describing the significance *for some agent* of intrinsically meaningless events. We *invest* stimuli with meaning, and apart from such investment, they are informationally barren. This is one way of thinking about information. It rests on a confusion, the confusion of *information* with *meaning*. Once this distinction is clearly understood, one is free to think about information (though not meaning) as an objective commodity, something whose generation, transmission, and reception do not require or in any way presuppose interpretive processes. One is therefore given a framework for understanding how meaning can evolve, how genuine cognitive systems—those with the resources for interpreting signals, holding beliefs, and acquiring knowledge—can develop out of lower-order, purely physical, information-processing mechanisms. The higher-level accomplishments associated with intelligent life can then be seen as manifestations of progressively more efficient ways of handling and coding information. Meaning, and the constellation of mental attitudes that exhibit it, are manufactured products. The raw material is information." (emphasis in original) (p. vii)	Dretske suggests a conceptualization of information that does not include meaning. In this way, information can be thought of as an objective commodity removed from interpretive processes. While the distinction between this conceptualization of information with prior conceptualizations of data is debatable, this view nonetheless helpfully separates meaning from information/ data and suggests that meaning is a mental product being added to information/ data.
Drucker	1988	"Information is data endowed with relevance and purpose." (p. 46)	Drucker, in writing about the emerging information-based organization, provides further support for the hierarchical perspective of digital content and the distinction between data and information.
Ackoff	1989	"Wisdom is located at the top of a hierarchy of types, types of content of the human mind. Descending from wisdom there are understanding, knowledge, information, and, at the bottom, data. Each of these includes the categories that fall below it—for example, there can be no wisdom without understanding and no understanding without knowledge." (p. 3) "Data are symbols that represent properties of objects, events and their environments. They are products of *observation*. To observe is to sense. The technology of sensing, instrumentation, is, of course, highly developed. Information, as noted, is extracted from data by analysis in many aspects of which computers are adept. Data, like metallic ores, are of no value until they are processed into a useable (i.e. relevant) form. Therefore, the difference between data and information is functional, not structural, but data are usually reduced when they are transformed into information. Information is contained in descriptions, answers to questions that begin with such words as who, what, where, when, and how many. Information systems generate, store, retrieve, and process data. In many cases their processing is statistical or arithmetical. In either case, information is inferred from data." (emphasis in original) (p. 3) "Knowledge is know-how, for example, how a system works. It is what makes possible the transformation of information into *instructions*. … Knowledge can be obtained in two ways: either by transmission from another who has it, by instruction, or by extracting it from experience. In either case the acquisition of knowledge is *learning*." (p. 4)	In recognizing the centrality of the human mind to digital content, Ackoff then makes explicit possible types of content within the hierarchical perspective. In doing so he formalizes the hierarchy and possible transitions between types of content within the hierarchy.
Checkland & Scholes	1990	"… information equals data plus meaning." (p. 303)	In Checkland and Scholes work, the inclusion of meaning to data is what constitutes information. This work highlights the subjective nature of information: i.e., meaning can change depending on the individual.
Kuhlen	1991	"Information thus, as we know it, is recipient-dependent. This is one of the main drawbacks of current commercial (on-line) information systems; they have been designed for a more or less anonymous market. Information systems in general are neither provided with specific user-models nor do they have a component which could be called user-memory. The lack of user-models is responsible for inappropriate 'information.' The 'information' delivered is not tailored to a special user's interests." (p. 95) "…information is the subset of knowledge which is needed by but not available to a specific person in a concrete situation in order to solve a problem." (p. 98)	Like others, Kuhlen, in writing for the Information Sciences field, recognizes the centrality of the recipient in the conceptualization of information, and suggests that information systems have not been designed with the recipient in mind. Further, Kuhlen highlights that the information needed relates to the recipients actions (i.e., being able to solve a problem). In this sense, then, Kuhlen brings to bear the necessity of system design in digital content use for purposes of organization work.
Buckland	1991	"Faced with the variety of meanings of 'information,' we can, at least, take a pragmatic approach. We can survey the landscape and seeking to identify groupings of uses of the term 'information.' … Using this approach we identify three principal uses of the word 'information:' (1) *Information-as-process* …; (2) *Information-as-knowledge* …; [and] (3) *Information-as-thing*." (emphasis in original) (p. 351)	Buckland highlights that conceptualizations of information (and hence digital content) are still varied, suggesting that a single global definition is unlikely, but that local definitions are promising.

Source		Digital Content	Chronological Narrative
Mingers	1995	"This paper argues that both [objective and subjective] views [of information] have significant weaknesses and that it is vital for the IS [i.e., information systems] discipline to develop an effective and consistent concept of information and the related but distinct terms *data* and *meaning*. It will be argued in the paper that *meaning is created from the information carried by signs.* The consequences are that information is objective, but ultimately inaccessible to humans, who exclusively inhabit a world of meaning. Meaning is essentially *intersubjective* – that is, it is based on a shared consensual understanding. The implication is that information is only a part of what we understand by IS and that attention needs to be focused on the *meaning systems* within which *information systems* reside." (emphasis in original) (p. 286)	Following Dretske's (1983) approach, Mingers also proposes a conceptualization of information as an objective commodity, and because of this suggests that attention needs to be focused on the meaning adherence part of information systems design and use.
Nonaka & Takeuchi	1995	"Information is a flow of messages, while knowledge is created by that very flow of information, anchored in the beliefs and commitment of its holder. This understanding emphasizes that *knowledge is essentially related to human action*." (emphasis in original) (p. 58-59)	Nonaka and Takeuchi link information and knowledge, and emphasize that knowledge is also related to human action.
Davenport & Prusak	1998	"Knowledge is neither data nor information, though it is related to both, and the differences between these terms are often a matter of degree. … it is still important to emphasize that data, information, and knowledge are not interchangeable concepts." (p. 1) "Data is a set of discrete, objective facts about events. In an organizational context, data is most usefully described as structured records of transactions. … Peter Drucker once said that information is 'data endowed with relevance and purpose,' which of course suggests that data by itself has little relevance or purpose." (p. 2) "… there is no inherent meaning in data. Data describes only a part of what happened; it provides no judgment or interpretation and no sustainable basis of action. While the raw material of decision making may include data, it cannot tell you what to do. Data says nothing about its own importance or relevance. But data is important to organizations—largely, of course, because it is essential raw material for the creation of information." (p. 3) "Like many researches who have studied information, we will describe it as a *message*, usually in the form of a document or an audible or visual communication. As with any message, it has a sender and a receiver. … Strictly speaking, then, it follows that the receiver, not the sender, decides whether the message he gets is really information—that is, if it truly informs him." (p. 3) "Unlike data, information has meaning—the 'relevance and purpose' of Drucker's definition above. Not only does it potentially shape the receiver, it *has* a shape: it is organized to some purpose. Data becomes information when its creator adds meaning." (p. 4) "Knowledge is a fluid mix of framed experience, values, contextual information, and expert insight that provides a framework for evaluating and incorporating new experiences and information. It originates and is applied in the minds of knowers. In organizations, it often becomes embedded not only in documents or repositories but also in organizational routines, processes, practices, and norms." (p. 5) "… knowledge can be seen as both process and stock. Knowledge derives from information as information derives from data. If information is to become knowledge, humans must do virtually all the work." (p. 6)	In their work, Davenport and Prusak also emphasize the hierarchical perspective of digital content and suggest possible definitions of data, information, and knowledge, which imply possible transitions between each digital content type.
Tuomi	1999	"Data emerge last—only after knowledge and information are available. There are no 'isolated pieces of simple facts' unless someone has created them using his or her knowledge. Data can emerge only if a meaning structure, or semantics, is first fixed and then used to represent information. This happens, for example, when information is stored in a semantically well-defined computer database. In that special case, we have to decontextualize knowledge and structure it according to predefined semantics into 'isolated' and independent database entries. Ideally, the data so produced can be completely detached from any meaning, to be automatically processed using a computer program. Data, therefore, exist as a solution to a practical problem: how to dissect information into two forms, data and data structure, that can be modeled, represented, and processed separately. Since the computer does not have access to the meaning of the content it processes, computer programmers have to represent meaning in a way that enables automatic processing." (p. 107)	Tuomi also discusses the hierarchical perspective of digital content, but suggests that the hierarchy should be reversed, with knowledge preceding information and data. From this work we gather that the hierarchical order may not strictly apply in all situations.
Spiegler	2000	"Reading recent knowledge management (KM) articles, one cannot escape the impression of a recycled concept. Definitions of the new field look remarkably like those of information systems, decision support systems, and even data management of the past. Since we believe KM is essentially new, a refined articulation of KM is desirable. Our point of departure is the observation that yesterday's data are today's information, which will become tomorrow's knowledge, and knowledge, in turn, recycles down the value chain back into information and into data. We outline a framework of KM that articulates the basic terms of this perpetual process. The proposed model defines operations and transformations of data-to-information, information-to-knowledge, and their reverse order. Such transformations correspond to a time dimension of past-present-future and resemble the process of abstraction. Based on our analysis, we conclude that knowledge management is truly a new idea, not a recycled concept." (p. 2)	Spiegler suggests the traditional hierarchical order of data, information, and knowledge, but suggests the hierarchy is recursive, which implies flexibility within the structure of the hierarchy.

Source		Digital Content	Chronological Narrative
Grover & Davenport	2001	"Today, any discussion of knowledge quickly leads to the issue of how knowledge is defined. A pragmatic definition defines the topic as the most valuable form of content in a continuum starting at data, encompassing information, and ending at knowledge. Typically, data is classified, summarized, transferred or corrected in order to add value, and become information within a certain context. This conversion is relatively mechanical and has long been facilitated by storage, processing, and communication technologies. These technologies add place, time, and form utility to the data. In doing so, the information serves to 'inform' or reduce uncertainty within the problem domain. Therefore, information is united with the context, that is, it only has utility within the context. Knowledge has the highest value, the most human contribution, the greatest relevance to decisions and actions, and the greatest dependence on a specific situation or context. It is also the most difficult of content types to manage, because it originates and is applied in the minds of human beings. People who are knowledgeable not only have information, but have the ability to integrate and frame the information within the context of their experience, expertise, and judgment." (p. 6) "Regardless of definition, however, knowledge managers often take a highly inclusive approach to the content with which they deal. In practice, what companies actually manage under the banner of knowledge management is a mix of knowledge, information, and unrefined data – in short, whatever anyone finds that is useful and easy to store in an electronic repository." (p. 7)	Grover and Davenport suggest that moving up the digital content hierarchy necessitates an increase in human contribution and context, thus highlighting digital content is increasingly dependent on the users of it. At the same time, Grover and Davenport suggest that for knowledge managers, storing digital content that is useful and easy-to-store in an electronic repository – regardless of whether the content is considered data, information, and/or knowledge – is what is important. This finding implies that how users of repository content actually use the content is less important in knowledge management system design.
Alavi & Leidner	2001	"Knowledge is thus the result of cognitive processing triggered by the inflow of new stimuli. Consistent with this view, we posit that information is converted to knowledge once it is processed in the mind of individuals and knowledge becomes information once it is articulated and presented in the form of text, graphics, words, or other symbolic forms. A significant implication of this view of knowledge is that for individuals to arrive at the same understanding of data or information, they must share a certain knowledge base. Another important implication of this definition of knowledge is that systems designed to support knowledge in organizations may not appear radically different from other forms of information systems, but will be geared toward enabling users to assign meaning to information and to capture some of their knowledge in information and/or data." (p. 109)	Alavi and Leidner, in a review the extant knowledge management and related literatures, build on the hierarchical perspective of digital content by positing that information can be transformed to knowledge and *vice versa*, supporting a more flexible view of the hierarchy.
Floridi	2005	"There is no consensus yet on the definition of semantic information. This paper contributes to the current debate by criticising and revising the Standard Definition of semantic Information (SDI) as meaningful data, in favour of the Dretske-Grice approach: meaningful and well-formed data constitute semantic information only if they also qualify as contingently truthful." (p. 351)	Floridi takes a philosophical approach and bounds the information-as-meaningful-data view to include a truth qualification. Thus for the hierarchical perspective of digital content, a truth boundary condition on digital content may exist.
Boell & Cecez-Kecmanovic	2010	"This paper introduces a *knowledge in action* view on information (Kuhlen, 1991) within a context of sociomaterial practices (Barad, 2007) which allows a particular understanding of attributes of information." (p. 1) "While information is a fundamental concept for understanding, defining and developing IS [i.e., information systems], it has not attracted much attention by IS researchers. The questions such as what is understood by information, what is the nature of information and what are (desirable) characteristics of information are rarely debated in IS research." (p. 1) "In this paper a different understanding of information is adopted called the 'knowledge-in-action' perspective on information (Kuhlen, 1991, 2004). In contrast to the hierarchical view of data-information-knowledge discussed above the knowledge-in-action view of information sees information not as prerequisite for knowledge but as a specific subset of knowledge. It is important to stress here that only what is understood by an individual can become information to an individual. … According to the knowledge-in-action view of information, information is context dependent and can vary from individual to individual as different individuals have different experiences, interpretive abilities and goals at different times. … This view of information has consequences for the view of IS. In this regard an IS is not a system dealing with information as such, rather it is a system that helps people derive information from its output and become informed. … In other words, IS outputs (reports, tables, etc.) can potentially become information for particular users in a given situation." (p. 2)	Boell and Cecez-Kecmanovic take a slightly different view than the hierarchical perspective of digital content (in the strict hierarchy sense) – where information is a specific subset of knowledge, is context dependent, and varies from individual to individual – which they term the *knowledge-in-action view of information.* Their view also highlights the attributes of information, rather than the information itself, as an important avenue for IS research.
Floridi	2012	"The article addresses the problem of how semantic information can be upgraded to knowledge." (p. 431) "Knowledge and information are members of the same conceptual family. What the former enjoys and the latter lacks, over and above their family resemblance, is the web of mutual relations that allow one part of it to account for another. Shatter that, and you are left with a pile of truths or a random list of bits of information that cannot help to make sense of the reality they seek to address. Reconstruct that network of relations, and information starts providing that overall view of the world which we associate with the best of our epistemic efforts." (p. 452-453)	Floridi takes a network theory account of information and knowledge to specify how information is "upgraded" to knowledge.

We include Table 1 in this paper as a means whereby the reader can be positioned to fairly evaluate the veracity of the literature-based definitional order that we impose within our analysis, which we require to effectively address our research question. Therefore, we refer the reader to Table 1 for a relevant (but selected) history of terminology development, and to support the following literature-based assertions. First, that a hierarchical perspective among the digital content terms: data, information, and knowledge, exists within the literature. Second, that the attributes that we argue (for purposes of this paper) adhere to each type of digital content according to the following calculus:

- data = facts + symbols;
- information = data + meaning; and
- knowledge = information + application;

are only "possible" adhering attributes; but as noted within Table 1, are not the only ones. Third, that the definitional order which we impose for our analytical purposes is reasonable to draw from the literature. Fourth, that the substantial breadth of use and variability of inclusiveness in terminology, which on the one hand tends to blur construct clarity, on the other hand tends to parallel, and to some extent comport well with, the variabilities that exist in user perceptions. Fifth, that in developing a systematic framework to sort among the various possibilities for dynamic digital content reuse, we are constrained by both variability in user perceptions and the state of the art in the literature regarding terminology use. And sixth, that the implication of the foregoing assertions for theory development is that the hierarchical view, while present in the literature, is not strictly applied; and therefore, that it is necessary to propose a dynamic model (where the various attributes that adhere to the digital content terms: data, information, and knowledge may or may not be present in a given case), and the possibility of a systematic sorting

of the likely dynamic digital content classes. In the following paragraphs, we therefore present and defend this sorting approach, along with the working definitions we have selected for use in our analysis based upon the literature and logic that emerged in our research.

Sorting Criteria

Overall, the information in Table 1 suggests that the still somewhat broad concept of dynamic digital content reuse must be better specified in order to serve the narrower interests of a variety of specific users. Otherwise the traditional approach, which, for example, builds the access paradigm on models of physical data deployment and arbitrary content organization schemas, rather than on the mental models of access held by knowledge consumers (Downs & Mohr, 1976; Moore & Benbasat, 1991), will likely continue to dominate, while at the same time not keeping up with the dynamics of stored digital content.

Yet, at the same time, we view it to be important to recognize that digital storage architecture has its limitations. We argue that the attributes that adhere to facts to render them into data, and to data to produce information, and to information to yield knowledge, can be employed as the core elements of a dynamic knowledge reuse model. We therefore argue that when the digital content reuse problem is evaluated in light of the fundamental attributes of the content itself (recalling importantly that this content exists because it has been created by initial users), a comprehensible, and dynamic user-centric model is the result.

Proceeding, therefore, from our summary analysis of literature (Table 1), we are enabled to argue that one can extract just a few attributes to identify different classes of digital content reuse that are relevant: (1) to users who vary in their perceptions, and (2) to scholars who seek a better understanding of the dynamic reuse phenomenon. We can also see (Table 1) that because the attributes that adhere to data, information, and knowledge (these being symbols,

meaning, and application, respectively – as we have ordered them) are frequently treated as interchangeable descriptors of reuse outcomes, when instead they are partially intersecting variables; that the intersecting attributes that adhere to data, information, and knowledge (symbols, meaning, and application) might be expected to interact, and in doing so, to create different categories of digital content reuse, with different expected behavioral patterns with respect to users – especially the kinds of reports that will be sought (as developed in a later section).

Defining Digital Content Attributes

Ackoff (1989) distinguishes data, information, and knowledge – one from the other – as do several other authors in the IS literature, not all of whom agree as to the particulars. However, in the brief discussion which follows, we are able, we think, to summarize the extant definitions of these three terms; but especially we are able from this literature to ascertain important and relevant attributes such that the construction of an exploratory digital content attribute framework is possible. As noted previously, the attributes in question are symbols, meaning, and application. Also note that underlying these attributes are facts: events that can be observed (Ackoff, 1989, p. 3).

Symbols. The first of the base phenomena from which we explore dynamic digital content attributes is data. Davis (1974) suggests that: ". . . data, the raw material for information, is defined as groups of nonrandom symbols which represent quantities, actions, things, etc." (1974, p. 33). We take this to mean that data are a representation of "observations," which – for purposes of this analysis – we term "facts." Ackoff (1989) likewise suggests that: ". . . data are symbols that represent properties of objects, events and their environments. They are products of observation. To observe is to sense. The technology of sensing, instrumentation, is, of course,

highly developed" (1989, p. 3). The exact nature of the symbols that make facts into data is explained by Davenport & Prusak (1998). "Data (are) a set of discrete, objective facts about events. In an organizational context, data (are) most usefully described as structured records of transactions" (1998, p. 1). From our reading we are therefore able to infer that it is the addition of symbolic structure to facts that results in data. Hence, we argue that an important and relevant dynamic attribute adhering to data, are the *symbols* that structure the facts.

Meaning. The second of the base phenomena from which we attempt to ascertain dynamic attributes of digital content reuse is information. We note that of the three digital content phenomena (data, information, and knowledge) the IS literature is, understandably, most replete with the attributes of information. Clarification of this high degree of breadth in the literature was offered relatively early by Davis (1974), who suggests: ". . . information is data that has been processed into a form that is meaningful to the recipient and is of real or perceived value in current or prospective decisions" (1974, p. 32). Accordingly, Drucker (1988) has described information as "data endowed with relevance and purpose" (1988, p. 46), and Checkland & Scholes (1990) assert that ". . . information equals data plus meaning" (1990, p. 303). We therefore assert that an important and relevant dynamic attribute adhering to information is the *meaning* that gives relevance and purpose to data.

Application. The third of the base phenomena from which we attempt to ascertain dynamic digital content attributes is knowledge. Kuhlen (1991) suggests that: "…information is the subset of knowledge which is needed by but not available to a specific person in a concrete situation in order to solve a problem" (1991, p. 98). Nonaka & Takeuchi (1995) argue similarly that: ". . . information is a flow of messages, while knowledge is created by that very flow of information, anchored in the beliefs and commitment of its holder. This understanding

emphasizes that *knowledge is essentially related to human action*" (emphasis in original) (1995, pp. 58–59). From these assertions we infer that application – in the form of such objectives as problem solving, and/or taking action in service of a belief or commitment – is an important attribute of knowledge. This inference is supported by Grover & Davenport (2001), who argue that: ". . . information is united with the context, that is, it only has utility within the context. Knowledge has the highest value, the most human contribution, the greatest relevance to decisions and actions, and the greatest dependence on a specific situation or context. It is also the most difficult of content types to manage, because it originates and is applied in the minds of human beings. People who are knowledgeable not only have information, but have the ability to integrate and frame the information within the context of their experience, expertise, and judgment" (2001, p. 6). We therefore draw from the foregoing excerpts that knowledge is information that is applied, and it is this *application* that distinguishes knowledge from information. We thus argue that the primary dynamic attribute adhering to knowledge is the *application* of information. In the next section we therefore utilize the three digital content attributes developed in this section to suggest eight sample digital content classes that can be imputed from an overlap analysis.

DIGITAL CONTENT CLASSES

Having selected attributes of digital content phenomena that are both important and relevant to our analysis, we may now explore the underlying structure of digital content phenomena such that exemplar classes of dynamic digital content can emerge and be labeled accordingly. Traditionally, digital content phenomena have been ordered hierarchically (Table 1). For example, Ackoff (1989) suggests:

> "Wisdom is located at the top of a hierarchy of types, types of content of the human mind. Descending from wisdom there are understanding, knowledge, information, and,

> at the bottom, data. Each of these includes the categories that fall below it – for example, there can be no wisdom without understanding and no understanding without knowledge" (1989, p. 3).

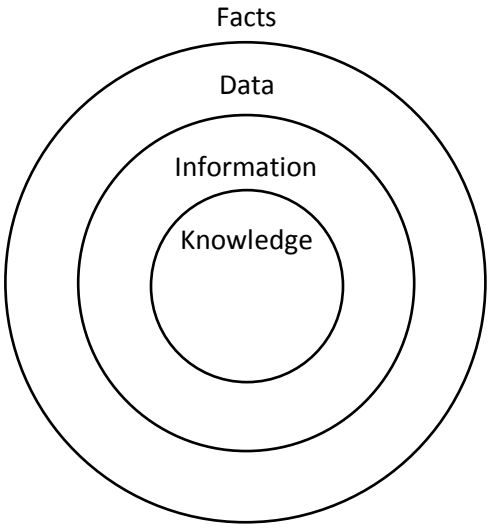
We represent this hierarchy using concentric circles (Figure 1a) for ease of theory development. And for the most part, there appears to be a somewhat unchallenged acceptance of the notion of hierarchical structure among these phenomena. However, depending upon perspective, it has also been argued that top and bottom of this hierarchy ought to be reversed, that: ". . . data emerge last – only after knowledge and information are available. There are no 'isolated pieces of simple facts' unless someone has created them using his or her knowledge" (Tuomi, 1999, p. 107). We also represent this reverse hierarchy using concentric circles (Figure 1b).

These conflicting perspectives raise a question, however, that is crucial to our analysis: If the data, information, knowledge chain while "stacked hierarchically" can be reversed depending upon the conceptual argument, then where there is dynamism (i.e., variability in the attributes that adhere to these content elements may or may not occur with linkage to the other attributes, and variability among users as to their perceptions), then it is logical to expect that in most dynamic situations the hierarchical order may not strictly apply. That is, for example, there may be certain cases where changes in one attribute may not necessarily mandate a change in the others. Consistent, then, with the ideas developed earlier in this paper, that these attributes may be partially intersecting variables, we propose an analytical technique (Figure 2) which illustrates the consequences of the interpenetration in the multi-attribute setting, of the attributes adhering to data, information and knowledge (respectively, symbols, meaning, and application). Various combinations of the attributes being present or absent suggest eight possible qualitative states of digital content. We therefore suggest:

Proposition 1: The nature of stored digital content concerning some fact (event) is positively associated with the cumulative number of content

attributes – symbols, meaning, and application – found to be present in a digital content repository.

1a. Data-to-Knowledge Hierarchy (e.g. Ackoff, 1989)



1b. Knowledge-to-Data Hierarchy (e.g. Tuomi, 1999)

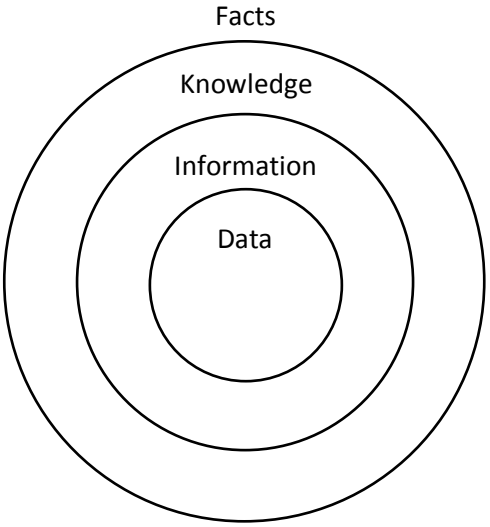


Figure 1. Comparison of Hierarchical Views of Digital Content Phenomena

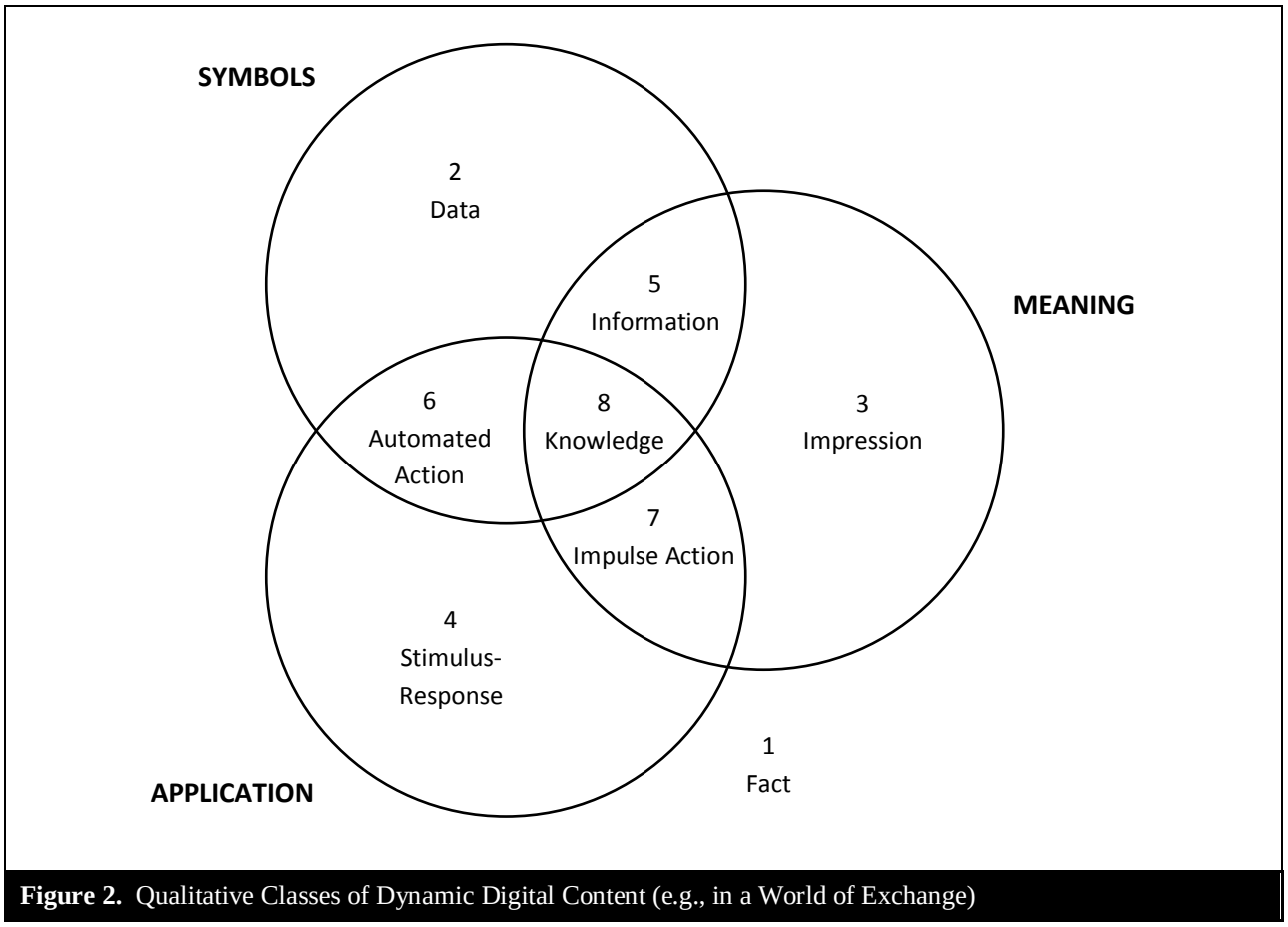


Figure 2. Qualitative Classes of Dynamic Digital Content (e.g., in a World of Exchange)

We note that in this proposition we are making distinctions based on the idea that attributes are either present or absent. However, these clear-cut distinctions are for the most part not expected in the real world, but instead may be expected to occur in degrees: degree of presence or degree of absence. So when we use terms such as "primarily" (e.g., in Table 2), we intend to more closely approximate our theoretical expectations in a given situation. We also note that while we theoretically expect the possibility of the occurrence of each of the qualitative states depicted in Figure 2, we should not assume that a given digital content repository would contain all the elements that *may* occur concerning a particular event: i.e., we would expect that there are likely to be greater or fewer elements that are stored; and that actual entry into storage will depend upon: e.g., inclusion decisions of repository builders, technological affordances, user digital

content storage policies and guidelines, etc. Our point is, however, that the representation that appears as Figure 2 is intended to provide a more systematic conceptualization of digital content "space" than is presently to be found in the literature. But notwithstanding the logic suggesting the theoretical structure depicted, it remains for us to unbundle these notions through an illustration provided to establish their reasonableness: the likelihood that each category derived theoretically, might be expected to appear in the phenomenal world.

Accordingly, to illustrate these qualitative states we employ a simple vignette. Imagine then, for illustration purposes, that an economic exchange event occurs as follows: a mother in a shopping mall purchases an ice-cream cone for her daughter. If we were to observe this exchange, we might observe the following: (1) a mother walks up to the ice-cream-shop counter and orders a Chocolate Starlight Mint ice-cream cone, reaches into her purse and pays for it, gives the ice-cream to her daughter whereupon she receives a hug; (2) a clerk takes the order, enters the purchase into a cash register, scoops and delivers the ice-cream cone, receives the money and gives change; and (3) a passerby sees the ice-cream being served and unconsciously licks his lips. Certain aspects of this exchange are recorded by a cash register and stored digitally, while others are not. The full set of theoretically possible content concerning this exchange transaction is developed and explained in Table 2[3].

We further note that, as may be observed in Figure 2, areas 1, 2, 5, and 8 correspond with facts, data, information, and knowledge, respectively, and are associated with the cumulative number of attributes – symbols, meaning, and application – present. The other areas in Figure 2 describe the remaining attribute combinations. Accordingly, with this digital content attribute

[3] These qualitative classes are developed for purposes of the reuse of digital content relative to events. It is within this context that Table 2 should be interpreted.

Table 2. Vignette of Dynamic Digital Content Classes in Organizational Transacting Systems (Corresponding to the 8 Areas in Figures 2)

Figure Area	Phenomenon
1.	**Fact.** Facts are observable events. In the business context, this is very often a simple economic exchange, e.g., A mother in a shopping mall buys an ice-cream cone for her daughter.
2.	**Data.** Data (for purposes of dynamic digital content reuse) are fact plus symbols (without meaning or application being included). In our example, symbols are added to the purchase event (while primarily excluding meaning and application) by mechanisms such as a cash register, which relates relevant numbers to the event. We therefore term this phenomenon "Data."
3.	**Impression.** Impressions are fact plus meaning (without symbols or application being included). In our example, meaning is added to the purchase event (while primarily excluding symbols and application) by interpretations such as the thoughts of the parties, which relate relevant observations to the event (the mother may interpret the purchase of ice-cream for her daughter as mother-daughter bonding). We therefore term this phenomenon "Impression."
4.	**Stimulus-Response (S-R).** S-R behavior illustrates fact plus application (without symbols or meaning being included). In our example, application is added to the purchase event (while primarily excluding symbols and meaning) by reactive (motor-like) response to observation (a passerby sees the daughter being given the purchased ice-cream cone and salivates). We therefore term this phenomenon "Stimulus-Response."
5.	**Information.** Information is fact plus symbols and meaning (without application being included). In our example, through observation, symbols are added to the purchase event by observation of the cash register, and meaning is added by the expectations of the parties invoked by that observation (while primarily excluding application), e.g., Information is conveyed to the mother by her observation of the cash register display, which conveys an expectation of required payment. We therefore term this phenomenon "Information."
6.	**Automated Action.** Automated action is fact plus symbols and application (without meaning being included). (Note: when we assert that meaning is not included, we conceptualize situations where meaning may have been previously established and is therefore assumed, such as the following assumptions: currency exists, cash is denominated, cash is kept in a purse, etc.). In our example, Automated Action characterizes this part of the purchase event by requiring symbols and application (while primarily excluding meaning), e.g., Automated Action occurs when the mother, seeing the purchase total of $4.50, pulls out a $5 bill from her purse. We therefore term this phenomenon "Automated Action."
7.	**Impulse Action.** Impulse Action is fact plus meaning and application (without symbols being included). In our example, Impulse Action characterizes this part of the purchase event by including meaning and application (while primarily excluding symbols), e.g., Impulse Action occurs when the daughter gives her mother a hug for purchasing her an ice-cream cone. We therefore term this phenomenon "Impulse Action."
8.	**Knowledge.** Knowledge is the combination of fact, symbols, meaning, and application. In our example, Knowledge is the sum of all the attributes pertinent to the event, and may be represented by a completed exchange experience, e.g., Digital content Knowledge occurs when a report may be generated that documents the receipt of the $5 bill, entry of a completed transaction into the cash register, and the return of change to the mother. We therefore term this phenomenon "Knowledge."

framework to use as a foundation, we can then begin to explore how attribute modification might impact digital content reuse.

To continue the analysis, we must imagine one further element in this example: that based upon the stored digital content resulting from the exchange (ice-cream example), a report is generated, which may then be variously modified. Mapping the expected digital content that results from dynamism would then consist of systematically developing the kinds of reports that can be generated depending upon which of the content attributes are modified. The result will be the specification of eight user "purposes" that are theoretically possible as a result of attribute modification.

DIGITAL CONTENT MODIFICATION

It has been our point thus far to sketch the underlying structure of dynamic digital content that is based upon the fundamental attributes of digital content phenomena (symbols, meaning, and application). We have utilized a vignette describing a simple economic exchange (ice-cream example) to illustrate and to suggest sample labels for the theoretically possible classes of digital content. We now may undertake the task of inferring the types of reports implicated by the digital content modifications that theoretically might occur; and thereby, we bring dynamic digital content reuse back into the discussion. We accomplish this by suggesting (as previously argued) that dynamism is introduced into digital content reuse primarily through attribute modification by the users involved in reuse. We consider an expanded vignette, based on the original described above, that illustrates dynamic digital content reuse classes, as a function of attribute modification, and as implied by the kinds of reports that can be generated based on this modification.

Attribute Modification

In order to consider digital content reuse, we need to have a means whereby we can make qualitative distinctions among the types of dynamic reuse that are possible. Helpfully, digital

content attributes provide such a means because they: (1) allow us to make distinctions among the different possible types of digital content phenomena (as seen in the digital content attribute framework developed in the prior section), and (2) allow us to distinguish digital content reuse types based on a given modification – or initial use requirement by a subsequent user – of the attributes themselves. We thus argue that dynamism is introduced into digital content reuse through user-driven attribute modification. Consistent with prior conceptual development, we now argue that digital content attributes are modified by changing the symbols, meaning, and/or application of stored digital content, either separately or cumulatively. The type of digital content reuse can thus be identified by the presence or absence of modification of (a) given attribute(s).

Digital Content Reuse Classes

Up to this point we have laid the foundations for digital content reuse classes that is based upon attribute modification and which is determined by users. Our arguments rest upon the assumptions: (1) that initial users who want to engage in the subsequent use of digital content to achieve an expected outcome pay some degree of attention to the various classes of digital content phenomena; (2) that (as previously argued) users' perceptions and expectations dictate attribute modification; and (3) that various classes of digital content reuse might be identified based on modifications of one, two, or all three of the digital content attributes: symbols, meaning, and application. Accordingly we suggest,

> *Proposition 2: The nature of the digital content reuse (e.g. report generated) is dependent upon which attributes – symbols, meaning, and application – are modified.*

We now proceed to explain our analysis of the digital content reuse classes that result from the various combinations of these attributes when modified. We first lay out the digital

content reuse types that emerge from the attribute modifications that are possible. In total, there are eight logical and conceptual classes that emerge in the analysis: one involving no attribute modifications, three involving one attribute modification, three involving two attribute modification, and one involving three attribute modification (Figure 3). As noted, to better-enable our discussion of these classes, we suggest that the kinds of reuse implied can be represented by the kind of report that would be generated and used from the respective digital content phenomena. In our use of report types representing digital content reuse classes, we have given each a descriptive name relating to the kinds of reports possible. We note here, however, that the names are only illustrative and therefore are less important than the theoretical types they represent.

As Figure 3 shows, with no modifications to the attributes, a report is *recycled*. For modifications involving only one of the attributes, a report is *revised* (symbols), *repurposed* (meaning), and *reinforced* (application). For modifications involving two of the attributes, a report is *replenished* (symbols and meaning), *refreshed* (symbols and application), and *resituated* (meaning and application). For modifications that involve all three attributes, a report is *renewed*.

To illustrate the qualitative classes of digital content reuse,[4] we now expand our initial ice-cream purchase example, and focus on the generation and reuse of a simple report used in the running of the ice-cream business (Table 3). Note that this simple report is our starting point to illustrate digital content reuse: that is, the report has been created prior to the user decision to access stored digital content, and in its initial state contains symbols, meaning, and application

[4] Our use of digital content reuse is very narrowly bounded here. As noted previously, when we discuss digital content reuse, we are not referring to every kind of reuse, but rather dynamic reuse – the initial use of stored digital content by a subsequent user – as it would apply to the attribute modification of a given report due to the rework of the stored digital content driven by an organizational transacting system.

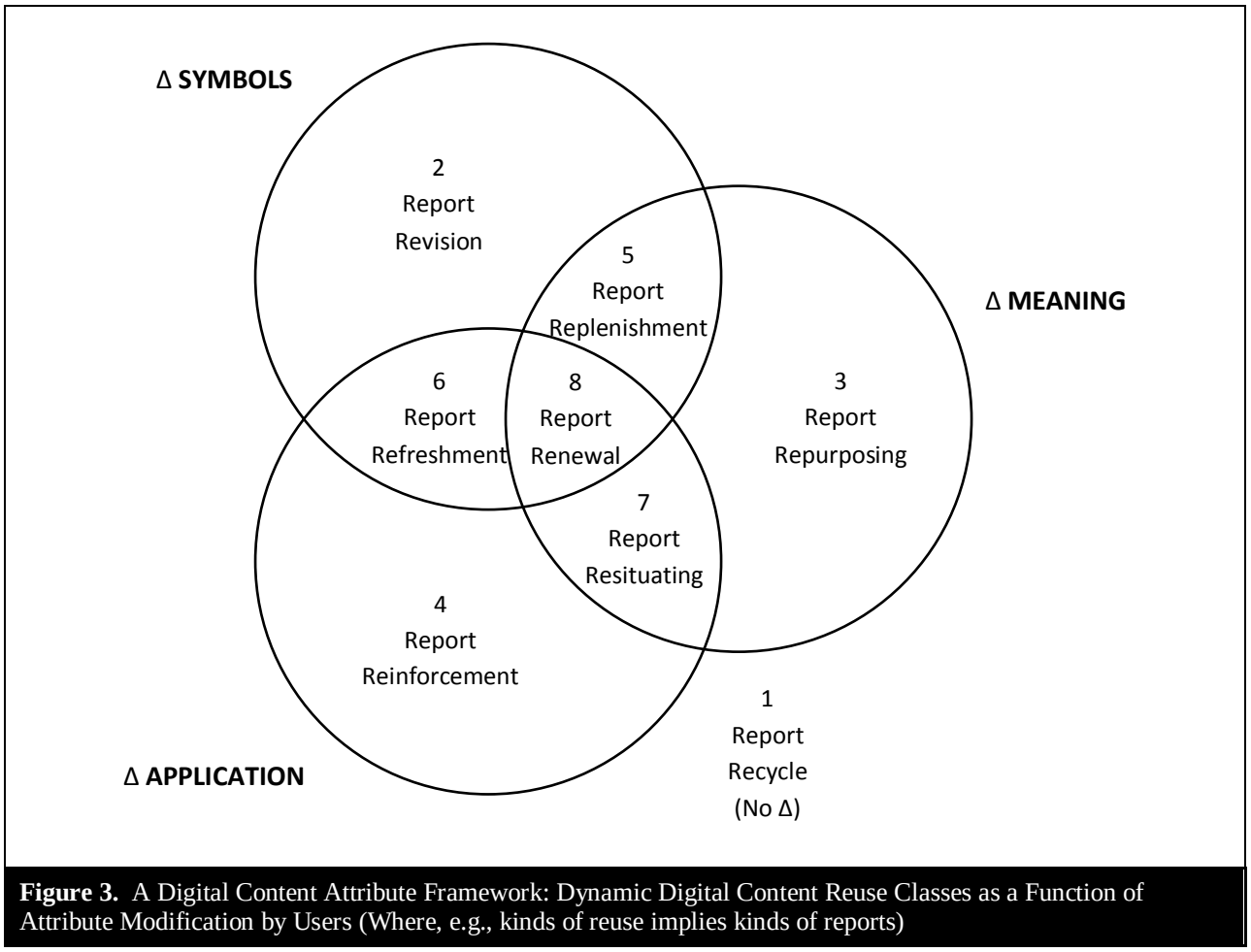


Figure 3. A Digital Content Attribute Framework: Dynamic Digital Content Reuse Classes as a Function of Attribute Modification by Users (Where, e.g., kinds of reuse implies kinds of reports)

(i.e., knowledge). The reuse of the report will thus be analyzed with respect to the presence or absence of attribute modification, where the created report may differ in character pragmatics[5] (symbols), purpose (meaning), and way used (application).

The specifics of this expanded vignette are as follows: A delicatessen ice-cream company owned by a U.K.-based individual runs several ice-cream shops: two located in New York City, NY (one at a shopping mall, and another at a stand-alone location), and one located in London, England. The Assistant Manager for the New York City shopping mall location initially generates the report in question, which contains the U.S. Dollar-denominated (symbols)

[5] where semiotics – the study of symbols – includes pragmatics [use], syntactics [flow], and semantics [meaning]

Table 3. Types of Modification to an Existing Report (Corresponding to the 8 Areas in Figures 3)

Figure Area	Modification
1.	**Report Recycle.** Report Recycle occurs where no attributes are modified. The created report represents the simplest kind of digital content reuse, e.g., The U.S. stores Manager reuses the report to confirm the reorder decision. We therefore term this "Report Recycle."
2.	**Report Revision.** Report Revision occurs where the report's symbols are modified (without modifying meaning and application). The created report is reused for the same purpose (meaning) in the same way (application), but with different character pragmatics (symbols), e.g., The U.K.-based owner reuses the report, but denominated in Pounds Sterling (modified symbols), to confirm the reorder decision (same meaning) for the ongoing operation of the business (same application). We therefore term this "Report Revision."
3.	**Report Repurposing.** Report Repurposing occurs where the report's meaning is modified (without modifying symbols and application). The created report is reused with the same character pragmatics (symbols) and in the same way (application), but for a different purpose (meaning), e.g., The U.S. stores Manager reuses the report, denominated in U.S. Dollars (same symbols), to compare sales (modified meaning) of Chocolate Starlight Mint ice-cream for December 2011 to the other U.S. standalone location for the ongoing operation of the business (same application). We therefore term this "Report Repurposing."
4.	**Report Reinforcement.** Report Reinforcement occurs where the report's application is modified (without modifying symbols and meaning). The created report is reused with the same character pragmatics (symbols) for the same purpose (meaning), but in a different way (application), e.g., The U.K.-based owner reuses the report, denominated in U.S. Dollars (same symbols), for opening a new store in Boston, MA (modified application) to confirm a hypothetical reorder decision (same meaning) in a similar market. We therefore term this "Report Reinforcement."
5.	**Report Replenishment.** Report Replenishment occurs where the report's symbols and meaning are modified (without modifying application). The created report is reused in the same way (application), but with different character pragmatics (symbols) and for a different purpose (meaning), e.g., The U.K.-based owner reuses the report, but denominated in Pounds Sterling (modified symbols), to compare sales (modified meaning) of Chocolate Starlight Mint ice-cream for December 2011 to the U.K. location for the ongoing running of the business (same application). We therefore term this "Report Replenishment."
6.	**Report Refreshment.** Report Refreshment occurs where the report's symbols and application are modified (without modifying meaning). The created report is reused for the same purpose (meaning), but with different character pragmatics (symbols) and in a different way (application), e.g., The U.K.-based owner reuses the report, but denominated in Canadian Dollars (modified symbols) and for opening a new store in Toronto, Canada (modified application), to confirm a hypothetical reorder decision (same meaning) in a similar market. We therefore term this "Report Refreshment."
7.	**Report Resituating.** Report Resituating occurs where the report's meaning and application are modified (without modifying symbols). The created report is reused with the same character pragmatics (symbols), but for a different purpose (meaning) and in a different way (application), e.g., The U.K.-based owner reuses the report, denominated in U.S. Dollars (same symbols) to create an estimated budget (modified meaning) for opening a new store location in Boston, MA (modified application). We therefore term this "Report Resituating."
8.	**Report Renewal.** Report Renewal occurs where the report's symbols, meaning, and application are modified. The created report is reused, but with different character pragmatics (symbols), for a different purpose (meaning), and in a different way (application), e.g., The U.K.-based owner reuses the report, but denominated in Canadian Dollars (modified symbols), for the purpose of creating an estimated budget (modified meaning) for opening a new store location in Toronto, Canada (modified application). We therefore term this "Report Renewal."

sales total of Chocolate Starlight Mint ice-cream for December 2011 for the purpose of a reorder decision (meaning) in the ongoing operation of the business (application). Subsequent uses of the report (digital content reuse) by both the U.S.-based stores Manager and the U.K.-based owner differ in symbols, meaning, and/or application, and are further described in Table 3.

DISCUSSION

In this paper, we have outlined an underlying structure of dynamically stored digital content, and demonstrated how various user-driven modifications to digital content attributes can systematically be made and understood, thereby showing how stored digital content can be reused in organizational transacting systems. Our research question is: Given the dynamism of digital content in organizational transacting systems, and based upon variability in user perceptions, how can digital content be sorted theoretically as to its reuse potential?

Scholars have begun to identify both the problem and the potential we cite. For example, a 2009 article in *CIO* suggests: "IT groups have, in good faith, built impressive infrastructures for knowledge management; yet, workers are still frustrated by an inability to get at information effectively when they need it. This is largely because the traditional approach builds the access paradigm on models of physical data deployment and arbitrary taxonomies rather than the mental models of access held by knowledge consumers" (Todhunter, 2009, p. 1). New frameworks are therefore needed to help both scholars and practitioners to develop better pathways toward the effective reuse of digital content.

In this paper we have developed a theoretical framework that – we propose – is capable of specifying both the underlying structure of stored digital content, and the potential for value-creating reuse of digital content through modification of its attributes. In Figure 2 and Table 2 we have proposed one version of a typology to identify the underlying structure of digital

content. In Figure 3 and Table 3 we have attempted to illustrate how the modification of single and multiple attributes of digital content can lead – in the illustrative case of a simple report – to extensions of the value of the digital content upon which it is based. These proposals have implications for both IS research and practice.

Implications for IS Research

The implications of new theorizing for IS research can be evaluated with respect to at least two critical viewpoints: capability for explanation, and theoretical and operational utility.

Capability for explanation. Because the field of IS has treated the term "reuse," in the digital context, as a somewhat "mushy" concept (Davis, 2011), research focused on knowledge management systems and repositories (e.g., organizational memory systems) has been moving toward a theory of knowledge reusability (Markus, 2001). In this paper, by beginning with fundamentals, we have been able to set forth a theory of reusability that is not limited to knowledge alone (as we have defined it); but rather we have been able to specify how data, information AND knowledge reusability can be enabled through the modification of core attributes (symbols, meaning, application). As a result, explanations that have heretofore been difficult to specify, have been made more tractable; and explanations that have been "mushy" have been made more concrete.

Theoretical and operational utility. Philosophers of science have repeatedly demonstrated that more than one theoretical construction can always be placed upon a given collection of data (Kuhn, 1970, p. 76). Thus, for new theory in a field to be taken seriously, it must be useful: in resolving some of the present theoretical difficulties in research, in simply relating previously unconnected things, in predicting phenomena which have not so far been

observed, and in being better testable (Popper, 1979, pp. 47–48). The following analysis is focused upon an examination of our framework with respect to these criteria.

In our theoretical analysis, we have begun the process of improving the theoretical and operational utility of digital content reuse theory. With respect to the foregoing criteria, for example, to enable the construction of our typology, we have – of necessity – proposed the resolution of theoretical difficulties that arise when distinctions are required among facts, data, information, and knowledge. We have also related previously unconnected phenomena, by suggesting that previously unconnected theoretical constructs (facts, data, information, knowledge) may in fact be connected, and that connection can yield a useful typology of digital content identification. Additionally, we have explicitly predicted phenomena that have not so far been observed within digital content repositories that concern (in our example) exchange transactions, primarily because current storage procedures are not attuned to capture these aspects of events (e.g. automated action and impulse action, Table 2). Furthermore, we suggest that testability is enhanced when a typology such as the one developed in this paper is available, because operationalizability is enhanced due to precision of definition, and data gathering can therefore be more highly targeted.

Implications for IS Practice

It is in the realm of IS practice that the typology we have developed also may be highly useful. In particular, where users are "saving pretty much everything" (Akers, 2009, p. 1) and are not (so to speak) "under control," it appears that digital content reuse policies and procedures that can utilize sophisticated software based upon parameters that flow from the fundamental digital content attribute framework that we identify, may enable digital content reuse value to be

enhanced. Where workers are still frustrated by an inability to get at information effectively when they need it, the foregoing procedures can become part of the solution.

Of course another implication for IS practice has to do with the potential for what we might term "digital content imperialism" or "digital content colonization." Once the potential of organizational transacting systems becomes more-practically accessible for the extraction and exploitation of reuse value; we also suggest that the implications for IS practice must include codes of digital content reuse ethics; industry standards of conduct; and possibly – and perhaps inevitably – digital content reuse law.

Conclusion

As a very specialized, but growing segment of the knowledge management task, dynamic digital content reuse poses a unique problem. This is because, for subsequent use by an initial user of stored digital content in an organizational transacting system, the relevance of most of what is stored is almost entirely dependent upon the perceptions of users, which in turn are almost infinitely variable as to symbol assignment, interpretation of meaning, and applicability to the solution of particular problems, or the achievement of specific objectives. Why, then, develop theoretical frameworks that attempt to systematically sort among various types of stored digital content?

It has been argued that the "value" of any pattern is frequently unknown during the time of formation (e.g., if a human had been around to watch uranium be deposited along creek channels, there was no way that human would have known that this was important). Data mining is a specific example of collection of data with the idea that, given enough data, patterns can be found, and some of those patterns may even be useful.[6]

[6] We thank an anonymous reviewer for the insight in this paragraph.

But, as we have argued herein, dynamic digital content reuse differs from data mining, primarily because data mining as conceptualized in the foregoing statement tends to be static – in the sense that uncritically, it has fallen under the analytical assumptions of "subsequent use by an initial user." In contrast, "initial use by subsequent users" of stored digital content that is part of a reuser tracking system – an organizational transacting system – that *records user exchange behavior for enhancing future reuse potential* – is dynamic. Thus, although the specifics of future reuse may not be known; by our having identified and isolated several relevant and important attributes of variability in user perceptions (those attributes: symbols, meaning, and application that adhere, respectively, to data, information, and knowledge); we argue that as researchers, along with the practitioners we serve, we can in some theoretically derivable ways, shape the actuality of the digital content that is stored; and thereby can, for example, supersede data mining as the default (but static) means whereby value in digital content reuse can be enabled. We argue that the patterns *can* be established, at least as markers . . . that storage parameters can, in fact, imply reuse possibilities. And, like explorers' maps as markers of new territory, which delineated major features without complete enumeration of all details that may have been relevant in that present or in the future, such markers can be enormously helpful as dynamic reuse tasks are undertaken.

In another literature, the notion of dynamic capabilities has come to represent a very useful and productive stream of research that explains how organizations can develop the capability to change capabilities (Teece, Pisano, & Shuen, 1997; Winter, 2003). Dynamic capabilities are thought to generate new capabilities in a strategic setting (Eisenhardt & Martin, 2000). In this same sense, we argue that the mapping of dynamic digital content in organizational transacting systems has the potential to enable more effective digital content

reuse, despite the inherent variability in user perceptions that has constrained more-static conceptualizations of digital content reuse, such as data mining.

Yet, as in many cases where progress is made in solving a conceptual or technological obstacle; solutions spawn additional challenges. We therefore offer the foregoing theoretical analysis and framework as a needed next step in the branch of IS research and practice, that seeks to better manage the ever-growing repository of stored digital content, where digital content in organizational transacting systems is dynamic, where variability in user perceptions is a given, and where digital content must be sorted theoretically as to its reuse potential.

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