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COMMENTARY

# Integrating Information Technology into Accounting Research and Practice

**Guido L. Geerts, Lynford E. Graham, Elaine G. Mauldin, William E. McCarthy, and Vernon J. Richardson**

**SYNOPSIS:** As information and communication technologies (IT) become more deeply ingrained and inextricably woven into the fabric of organizations, more perplexing research and practice questions emerge. This commentary applies an organizing information systems research framework to accounting. The framework explicitly recognizes that complexities of the accounting value chain define relevant practice issues for research. We demonstrate application of the framework with examples that integrate different accounting disciplines and different research methodologies. Using a select number of prior research studies, we emphasize how design science, archival, and behavioral research paradigms work together to advance theory and inform practice. We also demonstrate how the framework directs future research for both well-established and emerging practice issues.

**Keywords:** information technology; research framework; REA; enterprise systems; internal controls; continuous audit; XBRL.

**JEL Classifications:** M15; M41.

## INTRODUCTION

Accounting's existence and evolution are strongly based on artifacts, things created by humans in order to solve a problem in a specific environment (Hevner et al. 2004). Accounting artifacts take many shapes and forms, including a new costing method such as Activity Based Costing (Cooper and Kaplan 1992), a model of internal control such as the COSO framework (Committee of Sponsoring Organizations of the Treadway Commission [COSO] 2013),

*Guido L. Geerts is a Professor at the University of Delaware, Lynford E. Graham is a Visiting Professor at Bentley University, Elaine G. Mauldin is an Associate Professor at the University of Missouri, William E. McCarthy is a Professor at Michigan State University, and Vernon J. Richardson is a Professor at the University of Arkansas.*

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Corresponding author: Vernon J. Richardson
Email: vrichardson@walton.uark.edu

or complex information and communication technologies (IT) such as enterprise resource planning systems (ERPs). Relevant, rigorous research involves developing or refining artifacts, building and justifying theory about artifacts, and evaluating artifacts. The relevance of an artifact, in practice, is determined by its substance and organization (its inner environment) and how it operates in its surroundings (its outer environment). Simon (1996, 6) notes that "if the inner environment is appropriate to the outer environment, or *vice versa*, the artifact will serve its intended purpose."[1]

We focus on research about IT artifacts that support and improve the input, processing, and output of accounting phenomena. We present a research framework to help understand existing accounting research in IT and provide guidance to future accounting researchers and practitioners. More specifically, we adapt an information systems research framework presented in Hevner et al. (2004) by incorporating a variation of the accounting value chain from Hunton (2002) that delineates the inner and outer environment of complex accounting artifacts. We then place selected prior research in the framework to demonstrate how using the framework makes three related contributions.[2] First, the framework's relevance cycle highlights the importance of understanding the practice environment and integrating systems issues into financial, managerial, auditing, or tax accounting sub-disciplines. Second, the framework's design cycle highlights the importance of iterative research cycling through developing artifacts, building and justifying theory, and evaluating artifacts. Third, the framework's rigor cycle emphasizes the importance of appropriately applying foundations from reference disciplines and using different methodologies to attack and solve complex problems in a complex world.

The remainder of the paper is organized as follows. In the second section, we discuss the components of the research framework. In the third section, we demonstrate the usefulness of the framework by exploring the research dynamics of three accounting IT artifacts: IT internal controls, resource-event-agent (REA) enterprise systems, and continuous auditing (CA). In the fourth section, we discuss the Extensible Business Reporting Language (XBRL) artifact as an emerging issue in accounting research, and in the final section, we present concluding comments.

## RESEARCH FRAMEWORK

The research framework in Figure 1 is an adaptation of the information systems research framework developed as "a conceptual framework for understanding, executing, and evaluating IS" (Hevner et al. 2004, 273). In Figure 1, the framework is divided into three cycles, relevance, design, and rigor, which continuously interact with each other.

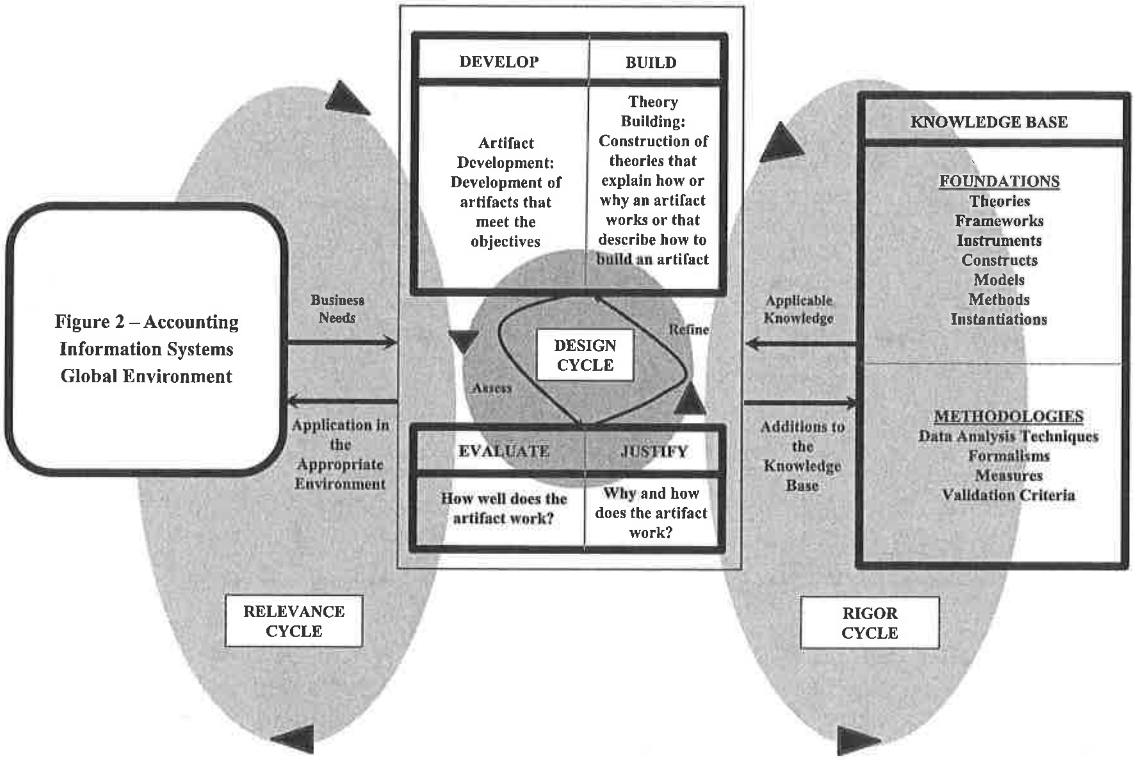
### Relevance Cycle

Our adaptation of Hevner et al.'s (2004) model is motivated by a series of essays based on presentations to the American Accounting Association's (AAA) Executive Committee in 2011, which raise and discuss concerns about accounting research's lack of relevance, including Basu (2012), McCarthy (2012), and Moser (2012). Figure 1 emphasizes the importance of relevance by illustrating continuous interaction between the research design cycle and the global environment of accounting practice.

Hevner et al. (2004) note that the environment defines the problem space or "business needs" and should frame research activities relevant to practice. Thus, researchers must first understand the practice environment to identify problems or opportunities for building and refining artifacts. Given

[1] Simon's book, *The Sciences of the Artificial*, was first published in 1969. We refer here to the most recent (third) edition published in 1996.
[2] We do not attempt to provide a complete synthesis of prior research, but select areas with which we are most familiar that illustrate the usefulness of the research framework.

**FIGURE 1**
**Research Framework[a]**



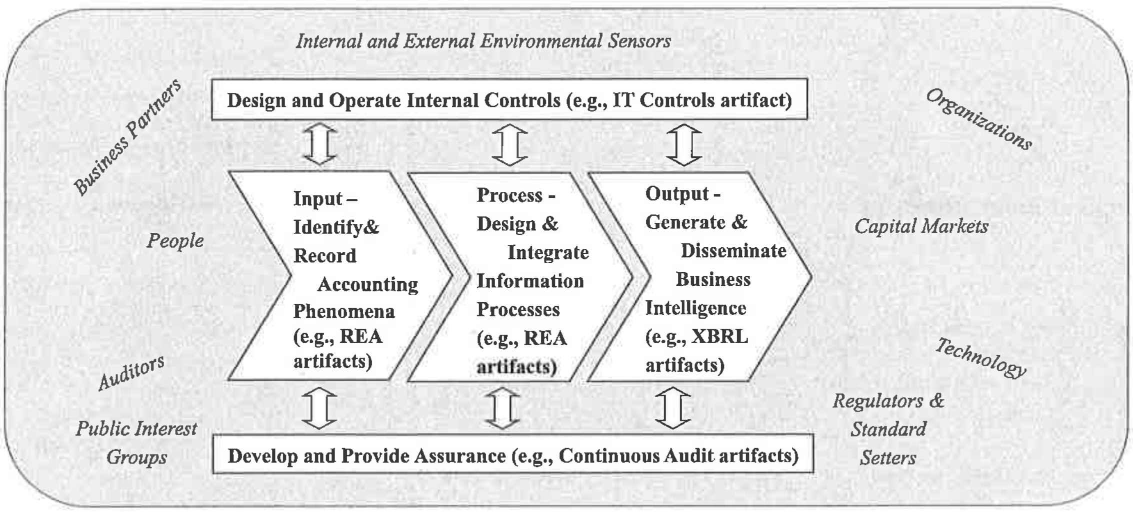

[a] Adapted from Hevner et al. (2004).

the complexity of the accounting artifacts embedded in IT, we draw from Hunton's (2002) accounting information systems value chain framework to provide supporting detail for the global environment structure of accounting practice that identifies the problem/opportunity space for research in Figure 1. As shown in Figure 2, the global environment consists of a set of artifacts operating within broader constraints, both internal and external to the organization.

The center of the global environment, shown in Figure 2, depicts the input, process, and output functions of an accounting information system in practice. The input function reflects quantitative and qualitative accounting artifacts that are allowed in the system by standards and practice. The process function includes the complexity of designing business process and related IT artifacts aimed at classifying, organizing, storing, and retrieving the accounting phenomena. The output function includes generating, managing, and disseminating business intelligence artifacts to various internal and external stakeholders. The system also operates self-regulating features, effectuated through designing and operating internal control artifacts and developing and providing internal or external assurance artifacts. The self-regulating artifacts work by feeding information into and receiving information from the input, processing, and output artifacts.

The global environment shown in Figure 2 also recognizes that IT operates within, and adapts to, global internal and external constraints. Internal constraints include people designing, implementing, and using IT artifacts, organizations' strategy and structure, and the technology infrastructure and development capabilities. External constraints include business partners, auditors, capital markets, regulators and standard setters, and public interest groups. Because fallible humans

**FIGURE 2**
**Accounting Information Systems Global Environment[a]**




[a] Adapted from Hunton (2002).

design, implement, and use IT, understanding the realities of system performance in the global environment aids in the ongoing development and optimization of the system artifacts. Importantly, the internal and external environmental constraints interact not only with the system, but also with each other at multiple levels. As a result, research must integrate the rich institutional knowledge from various accounting sub-disciplines (i.e., managerial, financial, auditing, tax) into IT concerns. Without such integration, IT research in accounting only "helps perpetuate various suboptimal practices, delays the refinement and adoption of new best practices . . . and, thus, in sum, acts to the detriment of our modern society as a whole" (Vasarhelyi 2012, 1).

The relevance cycle identifies important research questions from practice issues and supports problem identification at the micro-level (firm or individual) or macro-level (profession) of analyses. Such analyses should provide motivation for individual accounting research studies. However, the relevance cycle also identifies an important role for conceptual or historical research discussing key issues from practice. For example, Gupta et al. (2013) provide an in-depth analysis of the Sarbanes-Oxley Act (SOX) Section 404 that mandates reporting on internal controls for public companies. Summarizing issues within the environment assists researchers in understanding the complexities of the environment as they design their research agenda. Finally, the arrow from the design cycle to the environment (as shown in Figure 1) illustrates that the output of the design cycle is assessed within the context of a business need in the appropriate practice environment, and can also identify important implications for practice.

## Design Cycle

The box in the center of Figure 1 elaborates the dynamics of the research process, the design cycle. The design cycle for accounting starts with the development of an artifact or the building of a theory and then iterates, often repeatedly, through the different activities applying a diverse set of research methods in a sequence of integrated studies. Understanding the network of studies within the global environment helps identify implications for practice, as well as important problems or opportunities yet to be resolved.

### *Artifact Development*

Design science research aims to solve problems through the creation or development of artifacts (Simon 1996). The nature of artifacts has been studied by many, but the most useful classification is undoubtedly the one presented by March and Smith (1995). They distinguish four types of artifacts, and we provide examples in an accounting context:

(1) Construct: the vocabulary of a domain—e.g., *XBRL taxonomy*;
(2) Model: a set of propositions expressing relationships among constructs—e.g., *the REA accounting model*;
(3) Method: a set of steps used to perform a task—e.g., *continuous auditing*; and
(4) Instantiation: the realization of an artifact in its environment—e.g., *ERP/SAP*.

Simply creating an artifact does not represent research. The artifact must fit within the framework's requirements for relevance and rigor. Hevner et al. (2004) suggest a relevant artifact not only addresses an important problem but also provides an innovative solution to an unsolved problem or an innovative solution that makes an existing solution more effective and efficient. Building a new airplane addresses an important problem, but it might not be innovative. Designing a robot that can solve Rubik's cube might be innovative, but it does not solve an important problem. We also note that the concepts of importance and innovation are time and environment sensitive (e.g., designing a more effective horse carriage is no longer relevant). In addition to design science research, professional practice may also develop artifacts (e.g., internal control frameworks or XBRL).

### *Theory Building*

The design cycle also includes research that builds theories explaining how or why an artifact works or describing how an artifact should be built. Theory building adapts theories from base disciplines (e.g., agency theory, human-machine interaction, or system-task fit theories) or develops new, general theories (March and Smith 1995). While the aim of developing artifacts is utility, theory building aims to understand artifacts (Hevner et al. 2004).

### *Evaluation and Justification*

Developed artifacts become the input of research that evaluates how well the artifact works in its practice environment. Similarly, after a theory has been built, it becomes the input of research that justifies why and how the artifact works. Thus, evaluation and justification research seeks to determine the artifact's usefulness in the practice environment and to understand what works, what does not work, and how and why it works. The evaluate/justify process should result in feedback for practice that can be used to refine the artifact or further build theory.

Developing an artifact, evaluating the artifact, building a theory, and justifying the theory may occur in one study or across a series of research studies. Further, the design cycle center in Figure 1 represents a continuous process with a series of evaluation, theory building, justification, and refinement activities seeking to improve the relevance cycle through the use of the artifact in practice. The design cycle can be thought of as a complex network of activities representing the dynamics of the research process. The idea of such networks is new and helpful for understanding and recognizing the strengths and weaknesses of specific types of artifacts in a particular domain.

## Rigor Cycle

Hevner et al. (2004, 80) note that "rigor is achieved by appropriately applying existing foundations and methodologies." The knowledge base in Figure 1 provides the raw materials for IT research in accounting. The foundations in the knowledge base include various theories from supporting disciplines, as well as models and methods used to develop artifacts or theories. For example, theories about human-machine interactions from psychology research provide a foundation for building theory that explains how certain IT artifacts do, or do not, work. Methodologies provide guidelines for evaluation or justification and include data collection and empirical analysis techniques, as well as mathematical methods used in analytical research. The framework recognizes the necessity of drawing foundations from reference disciplines and using different research methodologies to attack and solve complex problems in a complex world. Too often, in our view, academics conduct research within a narrow paradigm with too little comparison to other, complementary paradigms. In the next section, using the dynamics of the research framework, we demonstrate how the research paradigms can work together and how developing ideas for valuable extensions to other paradigms can contribute to quicker advancement of knowledge.

## DYNAMICS OF THE RESEARCH FRAMEWORK

Figure 1 presents a very broad conceptualization of accounting research in IT. Thus, and to keep this commentary to a reasonable length, we illustrate the framework and implications for future research by choosing representative IT artifacts from each area of the global environment depicted in Figure 2. Beginning at the top of the figure, we use IT internal control as an example of the self-regulating feature of internal control artifacts. Next, we use REA enterprise systems as an example of input and process function artifacts.[3] We end this section with CA as an example of the self-regulating feature of assurance artifacts. These three examples also represent distinctly different research network dynamics, allowing us to demonstrate how research in one paradigm can lead to potential extensions to other paradigms. For each, we review selected examples of prior research related to the artifact using the template in Figure 3 to organize the network of research within the design cycle depicted in Figure 1. Figure 3 is based on Geerts' (2011) graphical portrayal of an artifact's evolution. We do not portray a full network of research, but simply draw upon sample studies to exemplify the dynamics of the research framework. We discuss the relevance and rigor cycle as we review the examples.

### IT Internal Controls

Figure 4 shows a sample research network for IT internal control artifacts. IT internal control provides an example where artifacts are primarily developed in practice and evaluated using archival methodologies with little formal theory development or justification.

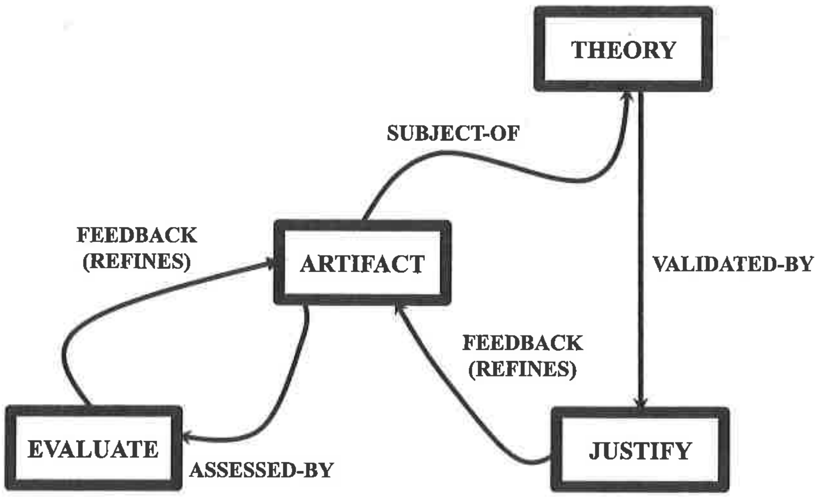
#### *IT Internal Controls Artifact Development*

Accounting internal controls form part of the global environment's self-regulating feature in Figure 2. Even though internal control concepts developed over a considerable time, dating back to early civilizations around 3600 BC, progress has periodically slowed (Lee 1971). Perhaps as a result of the difficulty of consistently maintaining strong accounting internal controls over time, public interest groups, regulators, and standard setters regularly intervene to push for stronger controls, providing relevance for research regarding developing and refining accounting internal control artifacts (Shapiro and Matson 2008).

Existing accounting internal control artifacts were largely developed from practice in response to periodic fraudulent financial reporting crises (Shapiro and Matson 2008; Gupta et al. 2013). The

[3] For an example of output function artifacts, we use XBRL in the following section on emerging artifacts.

**FIGURE 3**
**Design Cycle Dynamics**




Sarbanes-Oxley Act (SOX; U.S. House of Representatives 2002) requires registrant management to publicly disclose an assessment of their accounting internal controls, and that auditors of accelerated filers opine on the effectiveness of those controls.[4] The *de facto* standard recognized by regulation is the COSO model of internal controls, an artifact.

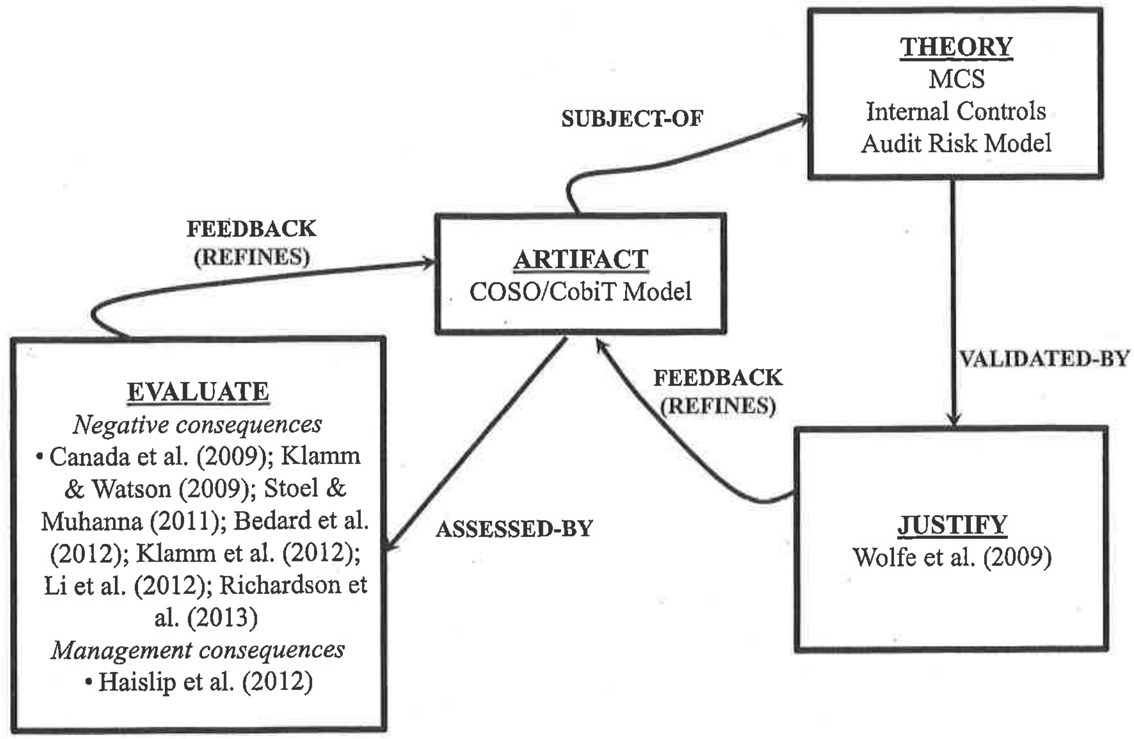
The initial COSO model contained only a paragraph regarding IT controls. The exposure draft of an expanded version adds IT guidance, but lacks full integration of technology within the framework (Janvrin et al. 2012). The 2013 final release (COSO 2013) does identify effective general computer controls as a principle (required for rating the internal controls as effective under the framework). However, while numerous approaches and examples are provided to help users understand what is meant by general computer controls, the revised guidance does not provide detailed templates for preparing IT controls assessments. Because the COSO model is a general framework of internal controls over financial reporting that lacks the depth needed for assessing and testing IT controls, the IT Governance Institute published CobiT and its derivative publications beginning in 1996 and most recently updated in 2012. CobiT enumerates IT-related control objectives for measuring the effectiveness of IT systems. Compared to the COSO model, CobiT control objectives are consistent, but more extensive, and organizations can use these objectives for compliance with SOX (IT Governance Institute 2006). Thus, we organize a sample network of research starting from the COSO/CobiT model artifact.

### *IT Internal Control Evaluation*

The largest research stream in the network evaluates IT controls using the archival financial accounting paradigm to study the consequences of reporting internal control deficiencies. We consider this stream of research evaluation of the internal control artifact because an absence of negative consequences from internal control deficiencies would call into question the artifact's ultimate relevance. A summary of the research literature, excluding consideration of IT, finds mixed

[4] Accelerated filers are firms with market capitalization greater than $75 million.

**FIGURE 4**
**IT Internal Controls**




evidence for the consequences of deficiencies for earnings quality and cost of equity (Schneider et al. 2009). Given the increasing integration of IT in organizations as shown on Figure 2, understanding IT control weaknesses is important in its own right, and could help explain inconsistent findings for non-IT internal controls.

Bedard and Graham (2011) document that 21.4 percent of deficiencies identified in 76 smaller public company financial reports were associated with IT issues and 21.7 percent of these remained unremediated at year-end.[5] Using a larger sample of all public companies from 2004–2006, Bedard et al. (2012) document that 3.6 percent of companies report at least one unremediated material weakness associated with an IT control, suggesting that even larger companies sometimes have weak IT controls.[6] Companies with higher-rated IT integration have more effective controls, fewer severe deficiencies, and a higher rate of deficiency remediation (Bedard and Graham 2011; Graham and Bedard 2013). Thus, IT control deficiencies represent a significant class of deficiencies and integration of the underlying input and processing functions supports strong IT controls, confirming the arrow from the accounting system to the self-regulating internal controls in Figure 2.

[5] This study considered all deficiencies identified in the engagements, regardless of whether publicly disclosed.
[6] This study considered only publicly disclosed material weaknesses (unremediated at year-end).

Other evaluative research compares non-IT material weaknesses with IT material weaknesses (ITMWs) to assess IT deficiencies within the COSO internal controls model artifact. Research finds firms with ITMWs report more total material weaknesses that are more severe and persist longer into the future than firms without ITMWs (Klamm and Watson 2009; Klamm et al. 2012; Bedard et al. 2012). This research demonstrates a pervasive negative impact of weak IT controls within the self-regulating feature in Figure 2, especially in the entity-level areas of the control environment, risk assessment, and monitoring.

Evaluative research also demonstrates financial reporting consequences associated with ITMWs, confirming the arrow from the self-regulating feature to accounting system outputs. First, firms reporting ITMWs also report more misstatements than firms without ITMWs (Klamm and Watson 2009). In addition, firms reporting ITMWs have lower accounting earnings compared to firms with stronger IT internal controls, and firms reporting ITMWs have a lower earnings multiple after controlling for firms with other MWs (Stoel and Muhanna 2011). Finally, firms with ITMWs have significantly lower risk-adjusted buy-and-hold market returns (by up to 8 percent) and less accurate and more dispersed analysts' forecasts than firms with other MWs (Richardson et al. 2013). In sum, IT deficiencies have negative financial consequences that impact capital market intermediaries and capital market pricing.

IT deficiencies also impair the internal information quality needed for management's own decision making, consistent with management's inability to make corrections for IT deficiencies. Firms with ITMWs publish fewer and less accurate management forecasts (Li et al. 2012). The coefficient on ITMWs is three times larger and significantly different from the coefficient for other MWs, suggesting a more pervasive impact of ITMWs on the decision-relevant information coming out of the system. Consistent with more pervasive negative consequences, firms reporting ITMWs pay substantially higher audit fees than firms with other MWs or with no material weaknesses (Canada et al. 2009). On the positive side, Masli et al. (2010) find client implementation of internal control monitoring IT lowers the likelihood of subsequent material weaknesses and reduces audit fees and audit delays compared to control firms.

Documenting that organizations recognize the more pervasive negative consequences of IT weaknesses, firms with ITMWs experience higher chief executive (CEO), chief financial officer (CFO), and director turnover rates than firms with other MWs (Haislip et al. 2012). Further, firms with ITMWs more likely make replacements with executives possessing a higher level of IT expertise than their predecessors (Haislip et al. 2012). These findings are consistent with the notion that executives and directors are accountable for IT issues (Feld and Stoddard 2004).

In summary, research evaluating IT internal control COSO/CobiT model artifacts supports the importance of IT internal controls with implications for practice and future research. For practice, given the consistent and widespread negative consequences of IT deficiencies and the finding that smaller companies more likely have IT deficiencies, regulatory agencies may need to revisit the recent exemption for auditors of non-accelerated filers from opining on the effectiveness of internal controls (Gupta et al. 2013).

For future research, reviewing the research network identifies issues not yet evaluated. For example, the COSO/COBiT model artifacts recognize inherent limitations of controls and expect organizations to conduct cost/benefit analyses before implementing controls. Future research should examine the average cost (in terms of time and resources) to implement IT controls or to remediate IT deficiencies, compared to the benefits, and how this varies across different industries.[7] In addition, even though Bedard and Graham (2011) recognize the importance of accounting system

[7] For example, differences likely exist between highly regulated and unregulated businesses or between integrated manufacturing/sales entities and a single store retail sales entity.

integration, future research could evaluate how underlying models of input and processing functions impact costs and benefits of IT internal controls.

### *IT Internal Control Theory Building and Justification*

Perhaps because the COSO/CobiT internal control artifacts were developed in practice, their relevance is not at issue; however, rigor is a larger issue because little theory-building research exists (Gupta et al. 2013). Recognizing the importance of theory building, many of Janvrin et al.'s (2012) suggestions for future research, based on a review of the revised COSO model, point to the lack of theory related to artifacts. Tuttle and Vandervelde (2007) test the internal consistency of the CobiT framework as a first step in developing a theory of IT internal control and encourage future research that builds a more comprehensive and validated (i.e., justified) theory. Such theory-building research should draw from existing knowledge bases to achieve appropriate rigor when seeking to understand why IT internal control artifacts work and provide feedback for developing more refined artifacts by either research or practice.

Management accounting has a rich history of theory-building research in management control systems (MCSs), of which accounting internal control is only one aspect (Chenhall 2003; Luft and Shields 2003). For example, Widener (2007) and Mundy (2010) extend theory on control levers to develop a framework for identifying inter-dependencies and balancing dynamic tensions across different MCS goals. We suggest a similar approach to developing theory for IT internal controls could result in more rigorous refinement of IT internal control artifacts. For example, theory-building research could develop a framework for understanding inter-dependencies among controls within the COSO/CobiT artifacts and between these artifacts and other MCS components in the global environment. We also suggest management accounting researchers integrate IT implications for MCS, consistent with Dechow and Mouritsen's (2005, 691) conclusion that "control cannot be studied apart from technology and context because one will never get to understand the underlying infrastructure."

Research should also draw from existing theories in the knowledge base to justify IT internal control artifacts. For example, existing theories, such as resource dependency or agency, may suggest contexts supporting, or not supporting, the widespread belief and anecdotal evidence that the control environment's problem of upper management circumventing controls is more important than control activities.

Recognizing interconnections between internal control artifacts and assurance artifacts, we also suggest future theory-building research develop an audit risk model for opining on controls that recognize IT. Akresh (2010) begins development of a new risk model for opining on internal controls, recognizing that the risk of material weakness is different from the risk of material misstatement in the financial reporting risk model. We suggest future extensions to this internal control risk model—in either research or practice—explicitly consider IT internal controls because of potential differences in auditor judgments related to IT, versus manual, internal controls. Psychology-based systems research in the knowledge base suggests that people do not assign humans as much blame for technology breakdowns as for manual breakdowns, even though humans are equally responsible for both (e.g., Naquin and Kurtzberg 2004). Consistent with auditors falling into this common judgment trap, auditors blame management less, and make lower assessments of control deficiency, when management admits an IT deficiency, but not a manual deficiency (Wolfe et al. 2009). Future research could also consider how IT controls affect management's judgments that, in turn, affect the auditor's evaluation of internal control. For example, if managers also under-assess IT control deficiencies, then they may devote fewer resources to implementing strong IT controls and internal control audit risks could increase without appropriate recognition by the auditor.

In summary, using the framework from Figure 1 to organize and analyze the research network on IT internal control artifacts suggests the need for more theory development and justification to add rigor to developing and refining IT internal control artifacts and associated audit risk models. Thus, the framework indicates the need for future design science research. We suggest such research would benefit from collaboration with existing design science research in the area of REA enterprise systems.

## REA Enterprise Systems

Figure 5 shows a sample research network for REA enterprise systems as an example of the input and process function artifacts. In contrast to IT internal controls, REA provides an example where developed artifacts are strongly rooted in robust theory building, using design science methodologies.

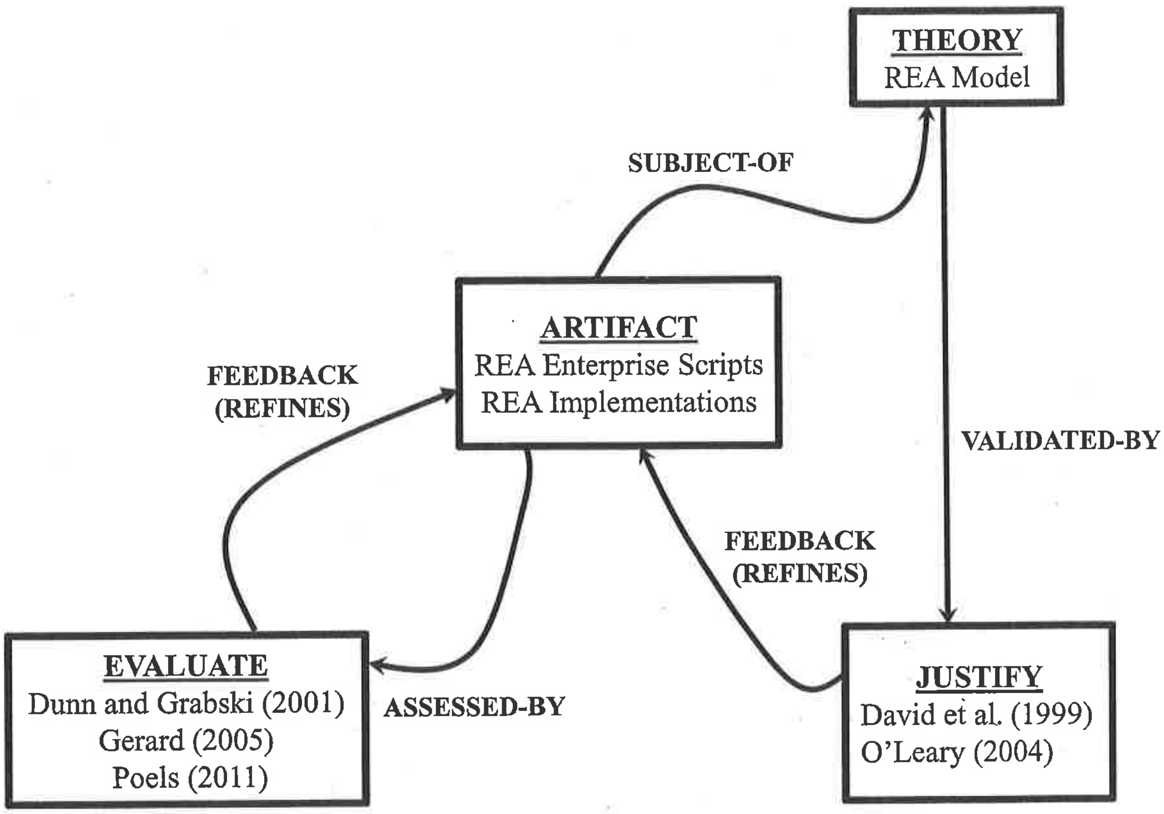
### *REA Enterprise Systems Theory Building*

Following Gregor and Jones (2007, 313), we characterize the REA model as a design theory for enterprise systems, because this model gives "explicit prescriptions on how to design and develop an artifact." As a design theory, the REA model focuses on how symbols representing economic phenomena should be structured and defined. The REA model can also be characterized as a content theory describing, "the sort of objects, properties of objects, and relations between objects that are possible in a specified domain of knowledge" (Fonseca 2007, 788). The REA model consists of primitives—such as economic resources (e.g., inventory)—and structuring rules—such as the stock-flow principle that mandates at least one inflow event and one outflow event for each economic resource (McCarthy 1982; Geerts and McCarthy 2000; Hruby et al. 2006; International Organization for Standardization [ISO] 2007).

The REA model was originally defined as a theory for designing accounting systems (McCarthy 1982), and was later extended as a theory for designing within-enterprise systems (Geerts and McCarthy 1999) and between-enterprise systems (ISO 2007). A within-enterprise system (i.e., an ERP system) integrates all the information flowing through a company—financial and accounting information, human resource information, supply chain information, customer information, etc. (Davenport 1998). This depiction indicates the relevance of the REA model given that it provides input and processing functions at the heart of the accounting information systems' global environment (Figure 2). Further, changing business needs and emerging technologies drive the evolution of enterprise systems (David et al. 2003; Moller 2005; Xu 2011). Taking into account such changes, the REA model, as a theory, has evolved accordingly throughout the years. The following are the three main phases in the evolutionary process (Dunn and McCarthy 1997): integrated representation of economic exchanges (its database orientation), extended definition of enterprise value chains and supply chains (its structuring orientation), and explicit and active use of semantics (its semantic orientation).

In the model's original form, the REA model defines the underlying principles of a shared data environment where different groups of decision makers—including accountants—are interested in maintaining information about the same set of economic phenomena (McCarthy 1982). A key principle of the REA model is the unbiased recording of economic phenomena; that is, "information concerning economic events and objects should be kept in as elementary a form as possible to be aggregated by the eventual user" (McCarthy 1980, 628). Thus, the REA model prescribes a different way of structuring accounting phenomena on the left side (input) of the accounting value chain shown in Figure 2. Such changes obviously ripple throughout the remainder of the value chain and enable innovative ways of information processing and generating business

**FIGURE 5**
**REA Enterprise Systems**




intelligence. Much of the potential resulting from integration and unbiased recording of economic phenomena has been realized in the current generation of ERP systems. Among other things, these software systems "help standardize procedures across global divisions, consolidate detailed transaction data from different functions, and provide methods to access data throughout the entire range of organizational activities" (David et al. 2003, 67). For a more in-depth discussion of the potential resulting from integration, see McCarthy (1982), Davenport (2000), David et al. (2003), and Xu (2011).

Extensions of the REA model, as a content theory, have come in many shapes and forms, as responses to changes in business needs. First, as a response to the increased focus on business processes and value chains, Geerts and McCarthy (1999, 2001) describe a three-layer architecture that (1) defines business processes as REA templates, (2) defines structuring rules that integrate the business processes into a value chain, and (3) defines workflow patterns that execute the business processes. Second, Geerts and McCarthy (2000) capture a more complete specification of the business process cycle (e.g., integrating commitments), which is then further extended by the ISO (2007). The latter recognizes a business process cycle as the following five phases: planning, identification, negotiation, actualization, and post-actualization. Third, Geerts and McCarthy (2006) further extend the REA model with a policy infrastructure that encompasses structures such as budgets and internal controls. In addition to describing the economic activities that have occurred, the policy infrastructure describes, "what could be or should be" at the type level. Fourth, ISO (2007) reconfigures the REA model and describes economic phenomena from an independent view, as opposed to a dependent view, resulting in a design theory for between-enterprise systems that could be used as the backbone of e-commerce and supply chain systems.[8]

The REA model explicitly defines the role of each element in a business entity's value chain and thus supports the idea of enterprise systems with enhanced semantic content. Explicit semantics support automated reasoning and enable knowledge to be aggregated and business intelligence to be generated through inference. The materialization of accounting information based on REA semantics is illustrated in Geerts and McCarthy's (2000) work, but in practice, this logic-based structuring of enterprise systems is, at best, in its infancy, and its potential needs much more exploration.

### *REA Enterprise Systems Artifact Development*

As shown in Figure 5, the REA model generates two primary artifacts. The first artifact is an REA enterprise script for a specific business entity or for a specific set of business problems. This is a platform-independent model of specific business functionality and behavior. The REA model design theory provides principled guidance for creating enterprise scripts. The relationship between an enterprise script and the REA model is one of application or instantiation. Creating the scripts requires an in-depth understanding of the REA model, plus its cognate theories (e.g., the theory of the firm). For example: (1) How are services modeled? (2) How do you differentiate between market exchanges and conversions? (3) What circumstances would necessitate less-than-full-REA structures? Robust modeling solutions for specific business practices can be generalized and captured with a "best practice" specification. The application or instantiation process further implies an important feedback loop. The emergence of new business practices is driven by the environment and might result in feedback regarding the recognition of additional phenomena and principles as part of the REA model.

The second artifact—an REA implementation—is a software system (platform-specific) that can implement REA enterprise scripts and does so for actual data at the instance level. Such an enterprise system should be able to implement a wide variety of enterprise scripts—for example, manufacturing factories versus financial institutions. The strength of an enterprise system largely depends on the extent to which the system can use the potential of such enterprise scripts. For example, can it use the semantics for reasoning purposes, and can the policy infrastructure be used for validation purposes?

The manner in which REA enterprise scripts can be used to solve problems strongly depends on existing technologies. For example, model-driven architectures (MDAs) and timeless systems aim at making system changes more flexible (Geerts and Wang 2007). In the case of MDAs, software implementations are semi-automatically generated from enterprise scripts. In timeless systems, enterprise scripts are recorded as data and are therefore easy to manipulate and use. This dependency on technology can be further illustrated with a historical example. Although the idea of a central depository for disaggregate accounting transactions was first discussed by Goetz (1939) more than 70 years ago, it was not until database technology emerged that the idea was actually realized (Dunn and McCarthy 1997).

### *REA Enterprise Systems Evaluation and Justification*

Another important part of design science research is evaluation: How well does an artifact work in its environment? Hevner et al. (2004) enumerate several types of evaluation methods: observational, analytical, experimental, testing, and description. Artifact evaluation is mostly task

[8] An independent view describes economic phenomena from the perspective of a neutral observer, while a dependent view describes economic phenomena from the perspective of a specific business entity.



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related: How well does an artifact do regarding a specific task, compared to another artifact? For example, Dunn and Grabski (2001), Gerard (2005), and Poels (2011) use experiments to determine how well REA does in certain tasks compared to alternative representations of economic information. In a similar way, REA enterprise scripts could be compared to representations based on other enterprise ontologies. Evaluation could also be done using research methods other than experiments. For example, similar to Dorantes et al. (2013), archival research could evaluate whether, and to what extent, REA enterprise systems improve a firm's information environment. Evaluation activities provide useful feedback for artifact building, answering questions such as (1) what types of enterprise scripts (and thus practices) can and cannot be supported? and (2) what types of reasoning can be supported?

Research also seeks to validate the REA model theory by seeking evidence of the "REA-ness" of software solutions in current and forthcoming markets. For example, O'Leary (2004) found the SAP enterprise system generally conforms to REA. An alternative methodology for REA validation and justification is suggested by David et al. (1999): comparison of symbol sets derived from specific enterprise systems—such as specific ERP packages—with the REA model as a normative theory. Future justification evidence gathering could use these methods to examine emerging ERP solutions specifically designed to support the REA model, such as those offered by the Workday and REA Technology companies.

In summary, using the framework from Figure 1 to organize and analyze the research network on REA enterprise systems suggests a need for more evaluation/justification research using archival and behavioral methods. In addition, we suggest that the extension of the REA model for policy infrastructure could provide research and practice with insights for developing IT internal control theory, as well as more effective implementation and audit of IT controls (Geerts and McCarthy 2006).

## CA (Continuous Auditing)

Figure 6 shows a sample research network for CA as an example of self-regulating assurance artifacts. In contrast to IT internal control artifacts developed in practice, CA artifacts were developed initially in research, although without the same level of theory-building efforts related to REA enterprise systems. The CA research network demonstrates more variety of methodologies than either IT internal control or REA enterprise systems.

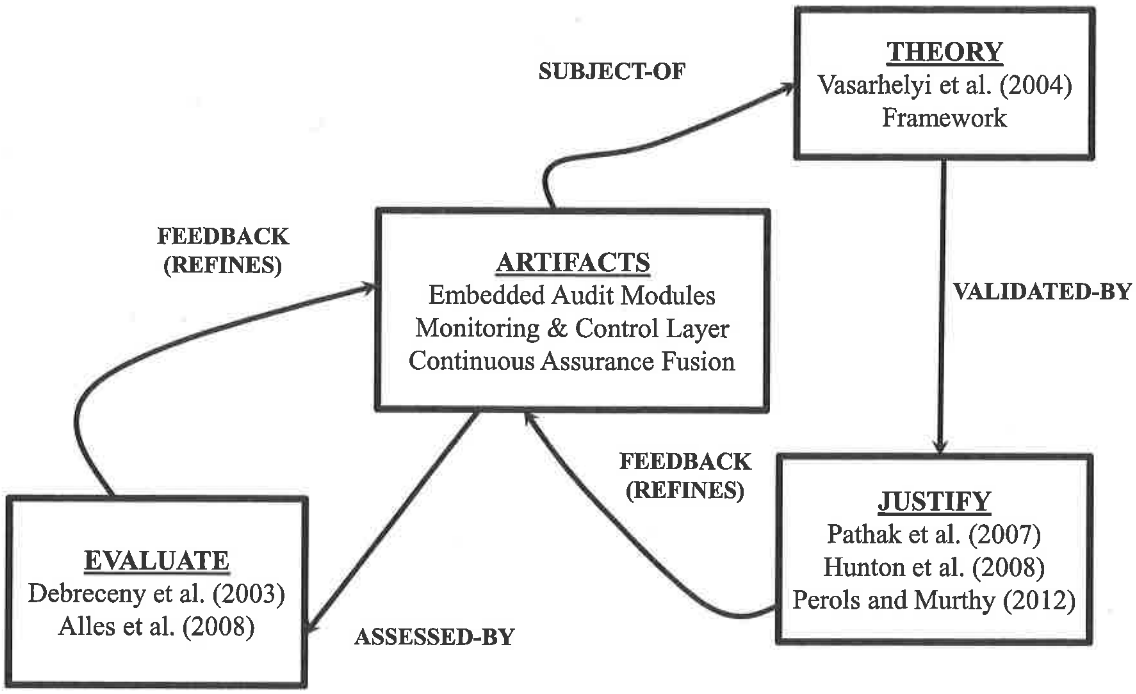
### *CA Artifact Development*

Initial developments in the application of CA artifacts emerged from academic research in the late 1980s (Bailey et al. 1988; Groomer and Murthy 1989; Vasarhelyi and Halper 1991). Researchers developed two types of architecture for CA artifacts: the embedded audit module approach in which exception detection logic is integrated within the accounting system (e.g., Groomer and Murthy 1989), and the monitoring and control-layer approach in which exception detection is a standalone system (e.g., Vasarhelyi and Halper 1991). For more detail about the development of these two approaches, see Brown et al. (2007).

Although much of the CA artifact development occurred in academic environments, the market for commercially developed artifacts is growing. In a notable example, Benjamin Bongiorno obtained a U.S. patent for a series of CA auditing routines that he developed in audit practice (Bongiorno and Bongiorno 2004).[9] The routines are particular to the real estate and financial

[9] Providers of computer audit assisted tools, such as IDEA by CaseWare, provide additional examples of commercialized CA routines.

**FIGURE 6**
**Continuous Audit**




services industries. Using his extensive industry and systems knowledge, Bongiorno developed a proprietary library of audit programs using preprogrammed audit routines and statistical analyses. However, even though technically feasible, CA artifacts are difficult to implement in practice, which impedes research in the evaluation part of the design cycle and suggests the need for continued theory building and justification.

### *CA Theory Building and Justification*

Possibly because CA artifact development stems largely from research, much of the development work also builds theory and demonstrates the feedback loop from theory building to artifact refinement. Recognizing that CA has not reached its potential, theory-building researchers attempt to understand how different artifacts contribute to CA in different settings, important for communicating CA capabilities and encouraging targeted implementations of CA. For example, Vasarhelyi et al. (2004) develop a theoretical framework for CA based on analytic processes that attempt to achieve the best match between techniques and audit objectives. The framework maps the use of different CA tools, such as continuity equations that model how data vary and migrate from process to process, direct versus indirect data collection methods, or automatic confirmation of transaction data between trading partners, to different audit objectives.

Other research justifying how and why CA artifacts work, provide feedback for further refinement of CA artifacts. For example, Pathak et al. (2007) develop an analytical model algorithm for identifying the optimal number of transactions and the optimal timing of an audit, to minimize the cost of CA. In another example, Perols and Murthy (2012) seek to minimize CA information overload problems by drawing on multiple foundations from the knowledge base. They develop a new continuous assurance fusion (CAF) architecture artifact focused on aggregating and analyzing detected exceptions, to reduce the human information processing required. They combine information fusion theory developed largely in defense systems with accounting's REA artifacts and systems' artificial intelligence artifacts. Information fusion theory models the intermediate and final processes for transforming input into decisions. Perols and Murthy (2012) suggest using REA ontology and artificial intelligence concepts to perform information fusion processing of detected exceptions, thus aggregating and processing detected exceptions to reduce information overload.[10]

Psychology-based accounting research also uses theory to better understand how and why CA artifacts work, with implications for improving their implementation. For example, Hunton et al. (2008) integrate systems research with an agency theory perspective on monitoring from the managerial accounting literature to examine the impact of CA on managers' judgments. Consistent with CA's theoretical benefits, Hunton et al. (2008) find a CA artifact offsets the tendency to maximize short-term profits at the expense of long-term profits, induced by short-term incentive plans. However, the CA artifact also dampened managers' willingness to invest in, and continue, a viable but risky project, demonstrating the unintended consequence of increased risk aversion. These findings suggest further refinement of CA to encourage implementation by helping organizations overcome unintended consequences. For example, Frow et al. (2010) demonstrate how one company's implementation of continuous budgets enhanced organizational flexibility and adaptation in response to rapid change. Perhaps implementing continuous budgeting along with CA would provide opportunities to adjust budgets to more accurately reflect current project conditions, thus attenuating CA's increase in risk aversion.

### *CA Evaluation*

Starting in the early 1990s and continuing today, Rutgers, The State University of New Jersey has sponsored a symposium to encourage research and practical applications in CA. A variety of presentations at the symposium indicates that CA artifacts potentially apply to at least three distinct elements of the global environment in Figure 2. CA could (1) change the generation and dissemination of business intelligence by providing real-time reporting of financial results, (2) change system assurance by providing artifacts for more efficient and effective independent audits of company financial statements, or (3) change the design and operation of internal controls by providing artifacts for monitoring transactions and identifying anomalies. Research evaluating CA artifacts for each objective differs considerably, with different implications for assessing and refining CA artifacts.

**Generating real-time financial reporting.** The Canadian Institute of Chartered Accountants (CICA) and the American Institute of Certified Public Accountants (AICPA) developed a joint monograph in 1999 to encourage continuous (or more frequent) company reporting to the marketplace (AICPA 1999). Numerous researchers identify or evaluate CA's potential for facilitating more continuous reporting (see Brown et al. [2007] for a review). However, practice demonstrates little enthusiasm for this application of CA. Reporting financial results more frequently or more timely than required by the SEC has not yet been broadly embraced as an objective of public companies. It is not clear that users are demanding such information, either. The shortening of the time lag in recent years between quarter- and year-ends, relative to the required 10-Q and 10-K reporting dates by public companies, has further reduced the impetus for continuous reporting. Some companies continue to struggle to meet these shorter SEC filing deadlines, although others are capable of producing very timely financial statements due to extensive

[10] For example, exceptions could be grouped in terms of resources, events, agents, or relationships among these objects.

automation of the closing process. Thus, evaluation of CA for continuous reporting suffers from inadequate development of the relevance cycle.

**Providing independent assurance.** CA has not seen much success in the context of a methodology to provide more efficient and effective independent audits of company financial statements, and little research exists for evaluating CA within this element. Auditing firms seem reluctant to abandon the traditional "busy season" business model to implement CA for auditing clients. Additionally, few "turnkey" or easily implemented routines facilitate external auditor implementation of online monitoring or "live" data processing. Customizing audit routines for individual clients is difficult, costly, and clients may not grant unfettered system access to third parties due to possible data corruption or system security compromise (Du and Roohani 2007). Although auditors clearly must have access to client data, the issue of "real-time" access for continuous monitoring purposes adds complications.

In addition, it is not clear that every entity is a candidate for CA applications since identifying anomalous transactions requires benchmarks to distinguish ordinary (low risk) transactions from anomalous ones. Some businesses are sufficiently complex to make such distinctions difficult to program into a set of parameters for identifying anomalies. As an example, even though Bongiorno's CA artifacts demonstrate the possibilities for CA for external auditor use, applying these techniques and interpreting their results require a high level of client and industry knowledge. Thus, evaluation of CA for external assurance points to a need for more theory development research to refine CA artifacts for external audit. Du and Roohani (2007) begin this process by proposing a CA model for the independent audit.

**Providing internal controls.** CA is most frequently adopted as a mechanism for monitoring transactions and identifying anomalies. The very characteristics that limit successful applications in external audits have enabled greater CA implementation by internal auditors. With deep knowledge of industry and company systems and easier access to data, internal auditors have an advantage in establishing online monitoring of individual transactions. Additionally, internal auditors have the onsite ability to follow up on anomalies and unexpected results. Various companies have made presentations at the Rutgers University CA Symposiums on their implementation of CA concepts (e.g., Siemens, UHC).

Research evaluating CA for internal controls monitoring generally points out impediments to widespread implementation (see Brown et al. [2007] for a review). Such research can provide useful feedback for developing theory and refining artifacts. For example, Perols and Murthy's (2012) artifact refinement work stemmed from research that evaluated actual implementation cases of CA and identified the "alarm overload" problem in which too many exceptions are generated for users to process (Alles et al. 2008; Debreceny et al. 2003).

In summary, IT research in CA provides examples of developing artifacts and refining those artifacts through problems identified by research that evaluates or justifies artifacts. Certainly, this process of development/refinement continues with much work yet to be accomplished. Organizing research on CA artifacts using the Figure 1 framework also identifies two broad suggestions for future research: evaluation of the benefits of implementations, and research recognizing the connections between CA and IT internal controls.

First, we do not know much about what business or environmental characteristics might be associated with the successful implementation of CA artifacts. Are the nature of the products produced and the pattern of sales and production indicators of the potential value of this tool to the entity? Do certain industries, such as real estate management and financial services, where external benchmarking data are more readily available, lend themselves to better application of CA than industries that may have lower volumes of transactions, greater volatility in the business drivers, and less readily available comparable peer-company data? What other organizational controls are affected by CA, and what types of adoption are most successful? In addition, we do not know much about the impact of the implementation of CA in organizations on external audit task performance. Does a client's use of CA impact, favorably or unfavorably, auditors' risk and materiality judgments? As CA becomes more widely adopted for internal controls monitoring, more clients may become candidates for external audit applications of CA, suggesting the importance of continuing research justifying or evaluating CA for assurance.

Second, analysis of CA through the Figure 1 research framework also confirms the need for research that explicitly recognizes connections between CA and the internal control design cycle, since IT internal controls impact the external audit through control risk. As recounted in the SEC litigation and enforcement literature, Livent Inc. demonstrates the dangers of failing to include IT in the scope of the audit (SEC 1999). Briefly, Livent Inc. made numerous adjustments to hide losses. The complexity of the adjustments required computer assistance and special programs to adjust for the audit period and then "un-adjust" the cost transfers so that management could then manage the business. Ineffective consideration of IT in the audit delayed detection (SEC 1999). In addition, Bedard and Graham (2011) found that auditors, not client entities, identified more than 70 percent of the deficiencies in all internal controls, suggesting that inadequate auditor consideration of IT could lead to less effective SOX 404 auditor reports and could weaken the value of self-reported control assessments of non-accelerated filers. In recognition of the importance of IT, the recent suite of American Institute of Certified Public Accountants (AICPA) standards (e.g., AICPA 2007a, SAS 106; AICPA 2007b, SAS 110; AICPA 2012a, AU-C Section 315; AICPA 2012b, AU-C Section 330) and Public Company Accounting Oversight Board (PCAOB) standards (PCAOB 2009, AS Nos. 12 and 13) attempt to more clearly integrate IT into the fiber of professional auditing standards. However, the research reviewed above indicates difficulties in auditor judgments surrounding IT, and the research on CA artifacts indicates difficulties in auditor adoption of advanced IT audit techniques. Thus, a promising direction for future research is emphasizing connections between IT internal control and CA artifacts in the design cycle. For example, in the hands of management, when does CA constitute control activities (e.g., embedded benchmark controls to identify anomalous transactions at recording) versus monitoring (e.g., inquiry of a database of recorded transactions for anomalies), and does such classification matter? Further, since an external audit is not an element of an entity's internal control, can CA routines still "count" toward entity controls' effectiveness if implemented with access given to, or implemented under, the direction or control of external auditors? IT internal control artifacts may similarly benefit from connections to CA artifacts. For example, could CA theory building on cost minimization algorithms extend more generally to evaluating cost minimization for other accounting internal controls?

## EMERGING XBRL ARTIFACTS AND FUTURE RESEARCH

In the previous section, we demonstrated the usefulness of the framework by exploring the research dynamics of three IT accounting artifacts: IT internal controls, REA enterprise systems, and CA. We further demonstrate the usefulness of the framework by discussing XBRL, an emerging IT accounting artifact, and indicating how the framework can direct further development of the XBRL artifacts.

The global environment depicted in Figure 2 emphasizes the integrated nature of information within an organization and between an organization and trading partners, investors, and other stakeholders. XBRL artifacts meet the relevance cycle criteria because the artifacts increase reporting transparency and comparability across entities and facilitate information communication among different systems. XBRL uses taxonomies, a set of standardized tags, to code information. XBRL's taxonomy development has relied on inductive reasoning—examining existing reporting formats and transaction classifications—to create taxonomies. Although conceptually simple, implementing XBRL in any complex entity poses significant challenges.

Similar to IT internal control artifacts, existing XBRL artifacts were largely developed in practice through collaborations among more than 600 international companies, accounting societies, universities, CPA firms, systems consultants, and vendors of accounting practice aids and tools. The development process focused first on a few industries, and then used these taxonomies to build bridges to other industries. Even though little research validates or theoretically justifies XBRL artifacts, legislators and regulators increasingly require XBRL use. After a period of voluntary experimentation starting in 2005, the SEC currently requires public companies to publish financial statements with XBRL coding.[11] In 2006, Australia initiated action to encourage the financial services industry to use XBRL tagged data (White 2013). In addition, in 2012 the U.S. House of Representatives passed a bill requiring that an open source reporting standard (e.g., XBRL) be used when the expenditure of federal monies is reported, to aid in transparency and compliance issues (U.S. House of Representatives 2012).

Although the relevance cycle supports the development of XBRL artifacts, the cycle also identifies many implementation challenges, suggesting the need for assessing and refining the artifacts. To demonstrate how the framework in Figure 1 identifies and directs future research opportunities, we discuss three issues: XBRL tagging methods, investor use of XBRL tagged data, and assurance regarding XBRL tagging. For each, we provide suggestions for applying the knowledge base to either theory-building or evaluative research with the potential to refine current XBRL artifacts in practice.

**XBRL Tagging Methods**

Current implementation primarily tags only publicly reported numbers and disclosures from aggregated transaction data. Intentional or unintentional tagging mistakes potentially affect financial presentations and financial positions (see, SEC 2009; Du et al. 2013; Roohani and Zheng 2011). XBRL is designed to increase reporting transparency and comparability, but management may be reluctant to make information readily available to competitors or may want to present information as favorably as possible. The "extensible" aspect of XBRL, in which companies can define and use additional tags, provides the potential for management to obfuscate reporting. With 16,000 financial accounting and reporting elements represented in the 2012 XBRL taxonomy, the need for custom extensions is limited (White 2013). Nevertheless, many companies use such custom tags (Harris and Morsfield 2012).[12] McNamar (2003) suggests SEC and fraud investigators target custom extensions to identify corporate reporting shenanigans.

The relevance cycle for current tagging methods suggests two broad areas for future design cycle research. First, future research could evaluate whether tagging practices reflect true differences between the suggested taxonomies and company information. Zhu and Wu (2011) use data quality standards from the information systems research knowledge base to develop and test a framework for evaluating the power and appropriate use of existing taxonomies. Second, and perhaps more important, future research could consider potential refinements of tagging methods. Refinement of XBRL artifacts could accommodate tagging transaction data that can direct and follow such data through the accounting system to the ultimate aggregation in the financial statements.[13] Tagging transaction data helps

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[11] Accelerated filers began mandatory reporting in 2010 and smaller public companies began in 2011.

[12] Based on 3,475 filings, an average of 16.1 percent of tags was custom extensions, varying somewhat by industry (Harris and Morsfield 2012, 42).

[13] Anecdotal positive experiences of an Australian company, Suncorp Bank, in driving the tagging process back to the transaction level provide some evidence of the feasibility and even potential efficiency of this step (Harris and Morsfield 2012, 6).

accurately identify the nature and source of the data and maintains the underlying character of the data as information is aggregated. In terms of the global environment represented in Figure 2, such tags can also aid the input and processing of accounting information by facilitating integration among disparate systems within an organization and between organizations (White 2013; Harris and Morsfield 2012). Future research is needed to develop and theoretically justify artifacts for integrating tagging within transaction processing systems. Amrhein (2011) suggests synergistic benefits from using REA ontologies from the knowledge base to facilitate XBRL tagging of data as part of information processing.

A final tagging methods issue is tagging for textual data. The SEC has no plans to require tagging of annual report management discussion and analyses (MD&A), in spite of the importance of MD&A to investors. Tagging narrative information is more complex than tagging transactional data, suggesting the need for design science and theory-building research to advance guidance regarding narrative information tagging. Arnold et al. (2012) integrate a financial reporting judgment model from the knowledge base with XBRL theoretical attributes to demonstrate the use of XBRL for MD&A reporting.

## Investor Use of XBRL Tagged Data

The relevance cycle also indicates concerns about whether investors effectively use XBRL tagged data. Early work justifying XBRL draws from judgment theories and behavioral methods in the knowledge base to demonstrate improvements in investor judgments from using XBRL. Hodge et al. (2004) find that investors using XBRL enhanced search capabilities, more likely recall footnote information and properly incorporate that information in their investment decisions than investors using a PDF (text) format. Arnold et al. (2012) find that tagging MD&A facilitates nonprofessional investors' ability to conduct a more directed information search and facilitates professional and nonprofessional investors' ability to incorporate risk information from MD&A in assessing risk and making investment decisions. However, Hodge et al. (2004) also find that only about 50 percent of investors who had XBRL available used the search capabilities, and Arnold et al. (2012) observe nonprofessional investors found tagged data more difficult to navigate. Thus, future design science research could develop refined XBRL artifacts to encourage use by investors.

## Assurance over XBRL Tagging

Errors and potential reduction in transparent reporting by management in implementing XBRL suggests a need for assurance (Rezaee et al. 2002). We see little progress in developing assurance over XBRL tagging. In 2005, the PCAOB issued a Q&A on XBRL and suggested a format for voluntary auditor reporting on XBRL tagged financial statements (PCAOB 2005). The AICPA issued guidance for an agreed-upon procedures engagement involving XBRL tags (AICPA 2009), yet professional standards do not address auditor responsibility for XBRL coded information. Further, legal implications for companies and auditors, in the event of mistaken tagging, are unclear. Although early "safe harbor" provisions applied to disclosures using XBRL tags, those provisions have expired. Though companies do not seem to desire assurance over XBRL, investors may find such assurance useful. For example, Pinsker and Wheeler (2009) find that expanded assurance over a sequential stream of firm disclosures beyond financial statements increases the value nonprofessional investors assign to stocks, whether the sequential stream is positive, negative, or mixed, and Boritz and No (2008) also suggest the need for assurance. Theory-building research, perhaps drawing from CA and IT internal control knowledge bases, could provide feedback useful for developing assurance artifacts over XBRL tagging and could include research directed to assurance implications of different tagging methods discussed above.

In summary, although the potential exists for XBRL to be a "game-changing" event that will further advance the quality of user, regulator, and academic analyses of published financial data, and increase the viability of CA, it is too soon to know whether these benefits will be realized. Some observers express doubts that the objectives of this new artifact will be fulfilled (Harris and Morsfield 2012). However, growing mandatory implementation in the United States and the international community suggests that assessing and refining XBRL artifacts is an important research and practice agenda. The research framework in Figure 1 provides guidance for rigorous design cycle research.

## CONCLUSIONS

We apply an organizing information systems research framework to accounting research and emphasize how design science, archival, and behavioral research paradigms work together to advance theory and practice, with rigor and relevance. First, the framework's relevance cycle highlights the importance of understanding the current practice environment and integrating research of identified IT practice problems/opportunities with research in other accounting sub-disciplines. Second, the framework's design cycle emphasizes the importance of understanding the network of iterative research, developing and evaluating artifacts, and building and justifying theory to identify practice implications and future research opportunities with the ultimate goal of refining artifacts. Third, the framework's rigor cycle highlights the importance of integrating findings from different theoretical foundations and methodologies, and from other disciplines. Overall, the framework provides the elements to create research networks satisfying both the relevance and rigor requirements discussed by many accounting researchers (e.g., Kaplan 2011).

We address each component of the relevance cycle (as depicted in Figure 2's global environment) by demonstrating the dynamics of the framework using selected research in IT internal controls, REA enterprise systems, and CA, and by using the framework to suggest practice and research implications in an emerging artifact, XBRL. Reviewing the example research networks also illustrates three issues with implications for research and practice.

First, the examples demonstrate the tension between relevance and rigor. IT internal control and XBRL artifacts developed largely in practice suggesting high relevance, but a lack of theory building and justification suggests need for improving rigor when further developing these artifacts. CA artifacts, on the other hand, developed largely in research drawing from multiple theories and methodologies in the knowledge base suggesting greater rigor, but slow implementation and lack of evaluation research suggests need for improving relevance of developed artifacts. Similarly, REA artifacts developed largely from research using rigorous design science methodologies, but need more evaluation/justification research using complementary methodologies.

Second, the example artifacts illustrate very different research dynamics. In some cases artifact building comes first (internal controls, continuous auditing, and XBRL), while in other cases theory building (REA enterprise systems) comes first. Future research could explore whether some of these paths could be generalized and whether best research practices could be developed for them. Important over-arching research questions include whether certain types of research should be emphasized more given a certain path, how to develop a research agenda for artifacts developed by practitioners, and how to test the relevance of artifacts developed as part of academic research when they are not yet widely adopted.

Finally, the example artifacts identify interconnections between the artifacts that we suggest could further advance research and practice. IT internal control artifact theory development could benefit from theories from REA enterprise systems and CA. REA enterprise systems evaluation research could benefit from methodologies used in IT internal controls, and CA artifact development and evaluation could benefit from problems identified in the IT internal control research network. Contributions of the IT internal control, REA enterprise systems, and CA artifacts to the knowledge base could benefit further development of XBRL artifacts. In summary, we suggest the research framework in Figure 1 supports the use of multiple, overlapping research paradigms to attack and solve complex problems in a complex world.

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