

AUDIT ANALYTICS and CONTINUOUS AUDIT

Looking Toward
the Future

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PREFACE

The world is evolving and so is the Accounting Profession (the profession). Recent technological advances offer both challenges and opportunities that will change the way CPAs operate into the foreseeable future. In order to stay on top of these new and emerging trends, we need to align the profession to continue to meet client needs and expectations. As a step in this direction, the AICPA Assurance Services Executive Committee (ASEC) Emerging Assurance Technologies Task Force Continuous Assurance Working Group has developed this book, *Audit Analytics and Continuous Audit: Looking Toward the Future*, which focuses on continuous auditing, continuous control monitoring, and advanced analytics.

In 1999, the Canadian Institute of Chartered Accountants (CICA) and the AICPA developed a research report entitled *Continuous Auditing*. This report discussed the viability of continuous audits, described a conceptual framework for conducting them and identified significant issues that auditors would likely encounter when performing this type of work. *Audit Analytics and Continuous Audit: Looking Toward the Future*, is intended to be an update to the CICA and AICPA research report, *Continuous Auditing*.

Audit Analytics and Continuous Audit: Looking Toward the Future is a compendium of essays written by different subject matter experts that expands upon the CICA and AICPA research report to discuss the following:

- The theory of modern continuous assurance
- The current state of continuous auditing and continuous monitoring
- The evolution of auditing and what the future could look like
- Audit analytics
- Continuous risk monitoring techniques

The book also includes detailed examples and case studies of companies today that have implemented elements of continuous auditing and continuous control monitoring into their day-to-day operations.

Each author brings unique perspectives and insights to each of the essays included within this book. The authors are made up of individuals in public accounting, business and industry, as well as academia. Each author shares a clear vision of the future, and is dedicated to the advancement of the profession.

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AICPA Assurance Services Executive Committee

Robert Dohrer, Chair
Dorsey Baskin
Bradley Beasley
Greg Bedard
Nancy Bumgarner
Chris Halterman
Charles E. Harris
Don Kluthe
Chris Kradjan
Michael Ptasienski
Beth A. Schneider
Miklos Vasarhelyi
Deetra B. Watson
Don Pallais (Observer)

AICPA Staff

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Director, Business Reporting, Assurance & Advisory Services

Dorothy McQuilken
Manager, Business Reporting, Assurance & Advisory Services

Rachelle Drummond, CPA
Technical Manager, AICPA Peer Review Program

Tanya Hale, CPA
Technical Manager, Business Reporting, Assurance & Advisory Services

AUTHOR BIOGRAPHIES

Abdullah Alawadhi, PhD

Assistant Professor, Kuwait University

Abdullah Alawadhi is an assistant professor in the College of Business Administration (CBA) at Kuwait University. He received his PhD from Rutgers University in 2015. His research interests include data visualization, audit analytics and big data. For four years he worked at the Continuous Auditing and Reporting Laboratory (CAR Lab) at Rutgers University, conducting many research oriented projects. Abdullah obtained his bachelor degree, majoring in Accounting, from Kuwait University in 2008. In 2011, he graduated from the University of Pittsburgh, Katz Business School, and obtained his Master of Science degree in Accounting. Abdullah presented in several conferences, including the 28th World Continuous Auditing and Reporting Symposium (28WCARS) and the American Accounting Association (AAA) 2014 Mid-Atlantic Region Meeting. In addition, he has several working papers on the area of audit analytics and data visualization.

Brad Ames, CPA, CISA, CRMA

Director, Internal Audit, Hewlett-Packard Company

Brad Ames's role involves close collaboration with Hewlett-Packard's governance groups, compliance functions, customers and external auditors in order to gain an ongoing view of emerging risk enterprise-wide. His team is responsible for innovating and deploying continuous auditing solutions for measuring risk to the business and shortening the time to management action.

Brad is an active CPA, certified information systems auditor (CISA), and holds a Certification in Risk Management Assurance® (CRMA®). He has a bachelor of science from LeTourneau University and is a member of the AICPA and Institute of Internal Auditor's Professional Issues Committee.

Carlos Elder Maciel de Aquino

Statutory Director, Diagnostics of America S/A

Carlos Elder Maciel de Aquino is currently statutory director at Diagnostics of America S/A and is currently responsible for the areas of accounting, receivables, accounts payable and corporate registration. He was a partner at KPMG and previously worked at institutions such as Itaú Unibanco and Unibanco, where he held positions such as director of internal auditing, executive director of leasing and managing director of complementary social security. He was also the sector director of Febraban's internal auditing department, was a member of Redecard's, Tecban's and Interbanco's (Paraguay) auditing committees. He earned a degree in accounting from UFPE, a graduate degree in Financial Administration from FESP-PE and in Economic Engineering from Universidade Católica de Pernambuco (UNICAP-PE). He has an Executive MBA in Financing from Instituto Brasileiro de Mercado de Capitais (IBMEC) and a Controller MBA from Universidade de São Paulo (USP) and is an auditing course professor for the MBA in Internal Auditing at Fundação Instituto de Pesquisas Contábeis, Atuariais e Financeiras (FIPECAFI).

María Arthúrsdóttir

Head of Financial Planning and Analysis, Vodafone Iceland

María Arthúrsdóttir is currently a part-time student at Reykjavik University in Management Accounting and Business Intelligence (MABI). She graduated from University of Iceland in Finance, Cand.Oecon, 1996.

María has been employed at Vodafone Iceland since 2006 and has extensive experience in management accounting, business intelligence, revenue assurance, continuous monitoring, planning and analysis. She recently introduced and implemented rolling forecasting and Beyond Budgeting in Vodafone Iceland.

Gerard (Rod) Brennan, CFE, PhD

NA Risk & Internal Control Officer, Siemens Corp.

Rod Brennan is a practitioner, frequent speaker, and published researcher on the topic of continuous auditing and monitoring. He is currently NA risk & internal control officer for Siemens and an adjunct professor in the Rutgers University MBA program teaching Advanced Auditing and Info Technology.

He is a passionate advocate of using technology to audit and monitor and is working with researchers from around the world to develop a continuous auditing and monitoring culture and technology for Siemens. Rod successfully defended his PhD thesis *The Use of Intelligent Software to Enable Continuous Auditing*. The research work included the design and development of a proof of concept ERP continuous auditing software model (using SAP) incorporating some of the latest continuous auditing research concepts. The model was co-developed with Rutgers University's Continuous Auditing Research Laboratory (CAR Lab)—a leading continuous auditing research group.

Rod has been actively involved in the design and implementation of automated auditing and monitoring solutions using a variety of software applications and worked on a centralized risk and internal control solution for Siemens. Siemens operates in diverse business sectors throughout the world in more than 175 countries.

Helen L. Brown-Liburd, PhD, CPA

Assistant Professor, Rutgers University

Helen L. Brown-Liburd received her PhD from the University of Wisconsin-Madison and a bachelor of business administration in accounting from Baruch College. Her research focuses on issues and factors that influence auditors' judgment and decision making related to financial reporting. She has published in *Auditing: A Journal of Practice and Theory*, *Accounting Horizons*, *Journal of Business Ethics*, and *Issues in Accounting Education*. Her teaching experience includes auditing, AIS, and financial accounting.

Helen has more than 16 years of experience in such diverse areas as auditing, financial and operating reporting, and analysis and project management. She has worked for Bristol-Myers Squibb (BMS) as a manager on several company-wide teams established to evaluate and redesign major company-wide processes and she also served as an internal audit manager responsible for supervising and monitoring worldwide audits. She also worked for Pepsi Cola Company as manager of special projects where she researched, developed, and implemented accounting policies and procedures and performed financial reporting for acquisitions. She began her career in public accounting as a staff auditor for Main Hurdman (now KPMG) and later moved to Arthur Young (now EY) where she was promoted to audit manager.

Nancy Bumgarner, CPA

Partner, KPMG

Nancy Bumgarner is an audit partner with KPMG and has served in a number of national, international, and global roles over her career. She is

currently in KPMG's Department of Professional Practice in the audit technical group and has worked in the Houston, Sydney, Tulsa, and Oklahoma City offices and completed a rotation to KPMG's Global Services Centre where she developed new and innovative technologies and audit methodology that facilitate effective and efficient audits in KPMG member firms around the world. While in the global role, Nancy created a new electronic audit tool that harnessed data and analytics with advanced modeling and algorithms that refine risk assessment and audit approaches.

While in Australia, Nancy took a leading role assisting international teams and clients with IFRS and U.S. GAAP differences, U.S. auditing standards, financial reporting, and SEC matters. Nancy is a frequent speaker and panelist at various technical, diversity, and firm-sponsored meetings. Nancy is a member of KPMG's Women's Advisory Board and KPMG's Partner Insight Committee on People.

Nancy is a member of the AICPA Assurance Services Executive Committee and serves on its Continuous Assurance Working Group.

Paul Byrnes, CMA

PhD Student, Rutgers University

Paul Byrnes has an advanced degree in accounting and four-year degrees in accounting, management, and psychology. In addition, he is a Certified Management Accountant with about 15 years of relevant work experience in both the accounting and management fields.

Thomas R. Criste, CPA

Retired Partner, Deloitte & Touche LLP

Tom Criste recently retired as a partner with Deloitte & Touche LLP, with more than 30 years of experience in financial and IT audit, risk management, and internal controls. He served many of the firm's largest multinational clients in a number of industries, including automotive, aerospace, consumer goods, and technology. He also served as the first chief learning officer for Deloitte & Touche LLP, the audit and assurance firm of Deloitte, where he led a successful effort to establish Deloitte University, one of the largest privately-owned learning centers in North America.

Tom is currently a member of the accounting faculty at the Ross School of Business of the University of Michigan in Ann Arbor, MI, with a focus on accounting information systems and auditing. He is also on the Advisory Board of Rutgers' Continuous Auditing and Reporting Laboratory (CAR Lab). He currently serves on an audit data analytics task force of the

AICPA Assurance Services Executive Committee (ASEC) as well as the continuous assurance working group.

**Satyajeet Ghosh, MS, MSE, MBA, CIA, CISA, CFE
SVP, General Auditor and Risk Management, CA
Technologies, NY**

Satyajeet (Saty) Ghosh joined CA Technologies in January of 2011 as the general auditor responsible for assurance, process simplification, Sarbanes-Oxley (SOX) compliance, and enterprise risk management. Prior to joining CA, Satyajeet held numerous management and executive roles in risk management, software development, technology capital management, business transformation, and mergers and acquisitions in various industry verticals. He has worked at AT&T Bell Labs, Dun & Bradstreet, IDT Corporation, Telcordia, Fortent and United Engineers. He is currently on the Advisory Board of CAR Lab and Senior Fellow at Rutgers Graduate School of Business, and was a lecturer at numerous universities. His current interests include predictive analytics, controls monitoring, and risk maturity models.

Satyajeet holds an MBA from Columbia Business School and graduate degrees in computer science and engineering from Drexel University and the University of Pennsylvania, respectively, and an under-graduate degree in engineering from the Indian Institute of Technology, Kanpur (India). He is also a current and past member of various professional organizations that include IIA, ISACA, ACFE, and IEEE.

**Jason A. Gross, CPA, CIA, CFE, CISA, ACDA
Vice President, Controls Management, Siemens
Financial Services, Inc.**

Jason A. Gross is responsible for ensuring an effective and efficient internal control framework, leveraging his seven years of experience as Siemens' vice president, internal audit. In this capacity, Jason and his department focus on the design, implementation, and monitoring of controls via the continuous controls monitoring (CCM) program as well as the management and oversight of various control programs, including the SOX program. Prior to joining Siemens Financial Services, Inc. in 2002, Jason had five years of internal audit experience with AT&T managing internal audit activity of various business units and four years of public accounting experience at the CPA firm of Weiser LLP.

Jason is also an experienced speaker on SOX and internal controls and has presented on several occasions for the Equipment Leasing and Finance Association (ELFA), MIS Training Institute, the Bank

Administration Institute (BAI), and for the Institute of Internal Auditors (IIA) at several IIA conferences. These IIA conferences included the General Audit Management (GAM), Financial Services, the International IIA conference, as well as the 2008 IIA webcast, *Continuous Auditing: What Works Best*. Jason has received the distinction of being named to the list of All-Star speakers for the IIA 2006 All Star Conference. In addition, he has gained recognition in the industry as a subject matter expert on the topics of utilization of audit tools including audit management systems, data analytic tools and methodology, and continuous monitoring and auditing. Jason was featured in the *Best Practices of Highly Successful Auditors* by ACL and has been named to the *2009 100 Most Influential People in Finance of Treasury and Risk*.

In addition to speaking on the topics of internal controls, SOX, and audit tools, Jason has also authored articles in the Internal Auditor publication of the IIA and in the ELT: *The Magazine of Equipment Leasing & Finance* publication of the ELFA.

Benita Gullkvist, DSc

Associate Professor, Hanken School of Economics, Finland

Benita Gullkvist received her DSc degree from Abo Akademi University in 2005. Her research interests include behavioral, social, and organizational issues related to accounting, especially within the field of accounting information systems. She has recently published in journals such as *European Accounting Review* and *Critical Perspectives on Accounting* among others. Funding from the Fulbright Center, Finland made it possible to take part in auditing research at Rutgers Business School, USA in 2011–2012.

Catherine Hardy, PhD

Senior Lecturer, University of Sydney

Catherine Hardy is a senior lecturer at the University of Sydney Business School in the Business Information Systems Discipline. Her research interests focus mainly on the complex and changing relationships between technical innovation, organizational change and governance, and accountability systems. Catherine's current research project is a case-based study on the adoption, implementation, and evaluation of continuous auditing and continuous monitoring in Australian organizations. She has extensive teaching, curriculum development, and program management experience in a wide range of information systems subject areas including information governance, information protection and assurance, accounting information systems, and project

management. Prior to joining academia, Catherine was an accountant in the financial services industry.

Hörður Már Jónsson

Partner, Expectus

Hörður Már Jónsson is a management consultant at Expectus with more than 15 years of experience in information technology focusing on business intelligence, financial planning, and continuous monitoring. Hörður's unique background, combining IT and management consulting, enabled him to develop a unique continuous monitoring solution, exMon. Hörður has a B.Sc. in computer science.

Glen Laslett, CA, CIA

Retired, Metcash Ltd.

Glen Laslett has recently retired as group business assurance manager at Metcash Ltd.

Glen's areas of business expertise include risk, internal audit, continuous assurance, and process management. Glen has a particular interest in continuous monitoring (CM) and, during his 14 years at Metcash, developed an extensive CM framework that delivered substantial benefits to the business. The resulting CM framework comprises more than 100 fully automated routines that deliver evidence of potential control breakdowns and transactional anomalies to the business and subsequently monitors their remediation. Prior to joining Metcash, Glen worked in the financial services and hospitality industries. Glen is a chartered accountant and a certified internal auditor.

Ann Medinets, PhD

Professor, Rutgers University

Ann Medinets received her MBA and PhD from Rutgers University. She teaches courses in managerial accounting, intermediate accounting, cost accounting, and corporate governance at Rutgers. Her research interests include resource allocation, management information systems, and shareholder rights.

Daehyun Moon, CPA

PhD Student, Rutgers University

Daehyun Moon is currently a PhD student in accounting information systems at Rutgers University and teaching accounting courses at University of La Verne. He earned a bachelor's degree in accounting from

Indiana University Bloomington and an MBA in finance from Indiana State University. He holds a CPA certificate in Illinois.

Eduardo Hiroyuki Miyaki, CIA, CCSA, CFSA
Managing Director of Internal Auditing, Itaú
Unibanco Holding

Eduardo Hiroyuki Miyaki is currently the managing director of the Internal Auditing function at Itaú Unibanco Holding, responsible for auditing investment banking, treasury, corporate, and small to mid-sized enterprise operations and its international entities (retail and corporate). He coordinates all continuous auditing initiatives at the bank. Prior to his experience as internal auditor, he coordinated the implementation and managed the Anti-Money Laundering Program at Banco Itaú S.A.

He holds a degree in civil engineering; a specialization in financial management at Fundação Getúlio Vargas; and an MBA in finance and international business at New York University, Leonard Stern School of Business, USA. He also holds CIA, CCSA, and CFSA certifications.

Nilton Sigolo
Research Fellow, Rutgers Business School

Nilton Sigolo is a fellow at the Rutgers Business School's CAR Lab and worked for 35 years at the internal audit of Unibanco and Itaú-Unibanco in Brazil. During the last 13 years, he headed the continuous auditing department. He participated in the Brazilian's Bank Association (FEBRABAN) New Bank Auditing Concepts task force and book in collaboration with Deloitte. He has published in the *Internal Auditor* and has performed recently a set of independent audits of different nature.

Sindri Sigurjónsson
Partner, Expectus

Sindri Sigurjónsson is a management consultant at Expectus. He has worked with some of the largest companies in Iceland focusing on strategy, performance management, financial planning, business intelligence, and business process re-engineering through the use of CM. He has more than 15 years' experience in assisting companies in streamlining their processes and improving their performance. Previously he was the director of business development at Shell Iceland, where he implemented CM, and executive director of production development at Actavis. Sindri has a M.Sc. in operational research and B.Sc. in industrial engineering.

Trevor R. Stewart, CA, PhD

Retired partner, Deloitte & Touche LLP; Senior Research Fellow, Rutgers Business School

Born and educated in South Africa, Trevor Stewart joined Deloitte in Johannesburg, working there and in London before transferring to New York in the early 1980s. In New York, he served in various national and global roles until his retirement in 2009 after 38 years with the firm, 31 as a partner. He is a chartered accountant (South Africa), has a bachelor of science (honors) degree in mathematics from the University of Cape Town and, post retirement, completed a PhD at VU University Amsterdam with a thesis on audit assurance and component materiality in group audits—work that was also published in *The Accounting Review* in a paper with Professor William R. Kinney, Jr.

Trevor started Deloitte’s international audit technology research and development center in Princeton, NJ, which he led for over a decade. He developed, with Kenneth W. Stringer, a technique (STAR) that uses multiple regression and other statistical methods for performing analytical procedures, together with related software, and co-authored *Statistical Techniques for Analytical Review in Auditing* (Wiley, 1996). He served on the firm’s global audit technical policies and methodologies committee until his retirement.

Trevor has served on several AICPA committees and task forces, including the 2008 Audit Sampling Guide task force for which he wrote the companion technical notes. He currently serves on an Audit Data Analytics task force of the Assurance Services Executive Committee (ASEC). He was vice-president, practice, of the Auditing Section of the American Accounting Association, 2006–2008. He currently serves on the advisory board of Rutgers’ CAR Lab.

Ryan Teeter, PhD

Professor, University of Pittsburgh

Ryan Teeter teaches accounting information systems at the University of Pittsburgh. He received his PhD from Rutgers University in New Jersey and has conducted audit research with Siemens and Procter & Gamble. He specializes in remote auditing and audit automation.

Miklos A. Vasarhelyi, PhD

Professor, Rutgers University

Miklos A. Vasarhelyi holds a PhD in MIS from UCLA, an MBA from MIT, and a BS in economics and electrical engineering from the State

University of Guanabara and Catholic University of Rio de Janeiro. Professor Vasarhelyi is currently the KPMG Distinguished Professor of Accounting Information Systems and director of the Rutgers Accounting Research Center (RARC) CAR Lab. He has published more than 200 journal articles, 20 books, and directed over 30 PhD theses. He is the editor of the *Artificial Intelligence in Accounting and Auditing* series and the *Journal of Information Systems*. Professor Vasarhelyi has taught executive programs on electronic commerce to many large international organizations including GE, J&J, Eli Lilly, Baxter, ADL, Volvo, Siemens, Chase Bank, and AT&T. Professor Vasarhelyi is credited with the original continuous audit application and as the leading researcher in this field. The CAR Lab's projects include among others Siemens, KPMG, P&G, AICPA, CA Technologies, and Itau-Unibanco. He was the co-recipient of the AAA outstanding educator of 2013 and ISACA's Wasserman award of 2012.

J. Donald Warren, Jr., PhD

Assistant Professor, University of Hartford

J. Donald Warren, Jr., PhD, is an assistant professor in the Barney School of Business at the University of Hartford. He previously taught in the Rutgers Business School and served as the director of the Masters of Accountancy in Financial Accounting. Professor Warren retired from PricewaterhouseCoopers LLP after a career of 31 years. He served in many capacities with PwC, including being responsible for the direction of the IT audit practice and serving as a national consulting partner on accounting and auditing matters and the firm's liaison to the SEC. Additionally, in that capacity, one of his responsibilities was to review and interpret the AICPA Code of Professional Conduct which contains the ethical standards for CPAs. He co-authored PwC's *SEC Manual* and the third edition of the *Handbook of IT Auditing*. His other work experience includes the US General Accountability Office and FASB. His research interests include continuous audit methodologies and processes and their related technologies.

PART I

Essays

ESSAY 1

Continuous Auditing—A New View

Nancy Bumgarner, CPA
Miklos A. Vasarhelyi, PhD¹

1. INTRODUCTION—CONTINUOUS ASSURANCE THE THEORY²

This volume is intended as an update on the report *Continuous Audit* (also called Red Book) published by the CICA and AICPA in 1999. In that volume, some basic principles and a vision were presented that served as a basis for additional guidance work by the Institute of Internal Auditors (IIA) in 2005 and the Information Systems Audit and Control Association (ISACA) in 2010. Fifteen years after that 1999 report, this volume presents a much different state-of-the-art, and this essay proposes an expanded set of concepts largely adding to Vasarhelyi and Halper (1991) and joining it with an increasing set of experiences and literature from practice and academia. The evolution of IT, the emergence of big data, and the increasing use of analytics have rapidly changed the landscape and profile of continuous assurance and auditing.³ Many of the current audit

¹ The suggestions and contributions of professors Michael Alles and Mr. Shrikant Deshpande are gratefully acknowledged. This essay also substantively benefited from the suggestions of Messrs. Bob Dohrer, Chris Kradjan, Dorothy McQuilken, and Beth Schneider.

² The authors are appreciative for advice and guidance from Professor Michael Alles, the comments of Mr. Shrikant Deshpande, and the research assistance of Ms. Qiao Li.

³ In general the field of assurance incorporates both the traditional audit as well other types of assurance such as SysTrust, WebTrust or assurance on cybersecurity. In this essay *continuous assurance* is also taken as potentially a larger set of topics than providing traditional auditing services but on a more frequent basis. On the other hand, the terms *continuous audit* and *continuous auditing* are used interchangeably.

standards were initially instituted by legislation based on the Securities Act of 1933 and the Securities Exchange Act of 1934 and progressively developed into the current, ever-evolving set of generally accepted auditing standards, or GAAS. This formalization of "generally accepted" has had an enormous effect on business practices and consequently large effects on the social ecosystem.

Within this context, in addition to the external verification of financial statements, many contexts in need of third-party verification have risen. Consequently, organizations developed internal audit departments, consulting firms introduced auditing services, and some of these needs are being satisfied on an ad hoc basis mainly by external audit firms. Vasarhelyi and Alles (2006), in a study for the AICPA's Enhanced Business Reporting (EBR) project, characterized the umbrella of verification services as "assurance," under which falls a set of services such as the "traditional (external) audit," internal audit, and much of what we later in this paper call "audit-like services." Several data analytic and monitoring functions of the expanded set of activities that we hereby call continuous assurance have dual or multiple functions serving assurance, management, and other parties. Guidance on materiality, independence, and required procedures will eventually be needed to adapt to the new tools as the environment evolves. This essay illustrates some of these needs.

Groomer and Murthy (1989) and Vasarhelyi and Halper (1991) have respectively argued for and demonstrated the desirability and possibility of "closer to the event" assurance processes. This approach, reflecting the evolution of technology to online, real-time systems, has had slow but progressive adoption both in practice (Vasarhelyi et al, 2012; ACL 2006; PWC 2006)⁴ and in professional guidance (CICA/AICPA, 1999; IIA, 2005; ISACA, 2010).

1.1 Continuous Process Auditing

Motivating the need for continuous assurance, Vasarhelyi and Halper (1991) state: "There are some key problems in auditing large database systems that traditional auditing (level 1) cannot solve. For example, given that traditional audits are performed only once a year, audit data may be gathered long after economic events are recorded." To deal with these problems, the AICPA/CICA's Red Book (1999) introduced the current definition of continuous auditing:

A continuous audit is a methodology that enables independent auditors to provide written assurance on a subject matter, for which an entity's management is responsible, using a series of

⁴ PricewaterhouseCoopers, Internal Audit Survey; Continuous Audit Gains Momentum, 2006.

auditor's reports issued virtually simultaneously with, or a short period of time after, the occurrence of events underlying the subject matter. (CICA/AICPA, 1999)

Research studies have provided a much broader perspective on how technology is changing auditing. Alles, Kogan, and Vasarhelyi (2002) questioned whether there was an economic demand for continuously provided assurance and suggested that the more likely outcome is audit on demand. Alles, Brennan, Kogan, and Vasarhelyi (2006) expanded the scope of the continuous audit by dividing it into continuous control monitoring (CCM) and continuous data assurance (CDA). It has also been shown that many internal audit procedures can be automated, thus saving costs, allowing for more frequent audits and freeing up the audit staff for tasks that require human judgment (Vasarhelyi, 1983, Vasarhelyi, 1985; Alles, Kogan, and Vasarhelyi, 2002).

In the last decade of the 20th century, many large companies, prompted in part by the Y2K concern, replaced their legacy IT systems with new enterprise resource planning (ERP) systems. These ERP systems are controlled by extensive control settings while data is organized into relational databases that are composed of complex, multi-dimensional tables that are "related" to each other for the creation of reports by common fields. Users, for highly justifiable business reasons, are allowed to override control settings. Consequently, new assurance needs have emerged due to the ever increasing difficulty of direct observation of (1) control structures, (2) control compliance, and (3) data.

Control Structure

The ubiquitous usage of ERPs diminished concerns with the adequacy of control structures as the systems are typically based on best of class implementation and widely used even though each company will determine how the ERP control structure will be adopted for company-specific circumstances. Many questions remain, as the actual control structure does not only involve the ERP systems but also the entire manual and IT set of processes (that include many elements aside from the ERP systems) and their integration. Controls can be overridden or bypassed by the users, or may not exist at the upstream of the process, and transactions will be received as legitimate.

Control Compliance

Control compliance, on the other hand, became a much larger problem as established flexible and widely applicable control structures often entail a very large number of controls and for operational reasons these controls may have to be temporarily re-parameterized. For example, a particular checking account may be allowed to go over its credit limit for

operational reasons. The need to monitor and assure control settings and the nature of overrides generated a new type of audit objective and process.

Data

Data is in general stored in ERPs, in files for legacy systems, or in more recent times in large repositories external to the organization that are called big data (Vasarhelyi, Kogan, and Tuttle; 2015). The access to these data for observation, monitoring, or mass retrieval requires the auditor’s knowledge and extensive use of software tools. This access is not only technically challenging but also organizationally difficult (Vasarhelyi, Romero, Kuenkaikaew, and Littlely; 2012).

1.2 Conceptualizing Various Elements of CA

Table 1-1 illustrates the uses, purposes, and approach of the expanded model of continuous assurance differentiating between internal and external usage and further differentiating between diagnostic, predictive, and historic usage.

Table 1-1: Users, Purpose, and Approach of the Elements of Continuous Assurance

	Data assurance	Controls	Compliance	Risk monitoring and assessment	Operations (monitoring)
Who uses					
• Management	X	X	X	X	X
• Audit (internal or external)	X	X	X		
• Investors	X				
• Regulators	X	X	X		
Purpose					
• Diagnostic		X	X	X	X
• Predictive				X	X
• Historic	X	X	X	X	X
Primarily performed by					
• Automation	X	X	X	X	X
• Manual		X		X	X

Each of these elements is discussed in the following sections.

Continuous assurance (CA) has the potential to benefit a wide variety of users. Management will be interested in all aspects, from data assurance

to monitoring operations. Investors may primarily be interested in data assurance though, depending on the industry, compliance and risk monitoring may be equally as important.

CA is well suited for historic analyses, particularly given the speed with which CA provides information on attributes such as accuracy. Auditors that provide assurance on historic information will likely be primarily interested in the ability of CA to be used for such purpose. Access to sophisticated ERPs and complex data sets create an opportunity for CA to be used for diagnostic purposes. Where an error or anomaly has been identified, CA may perform a retrospective diagnostic of the situation—providing insight and analyses to management. Diagnostically, CA could also be tied to effectively assessing operational and structural strengths and weaknesses of an organization—enabling strategic decisions to be made in a timely manner and with sufficient context.

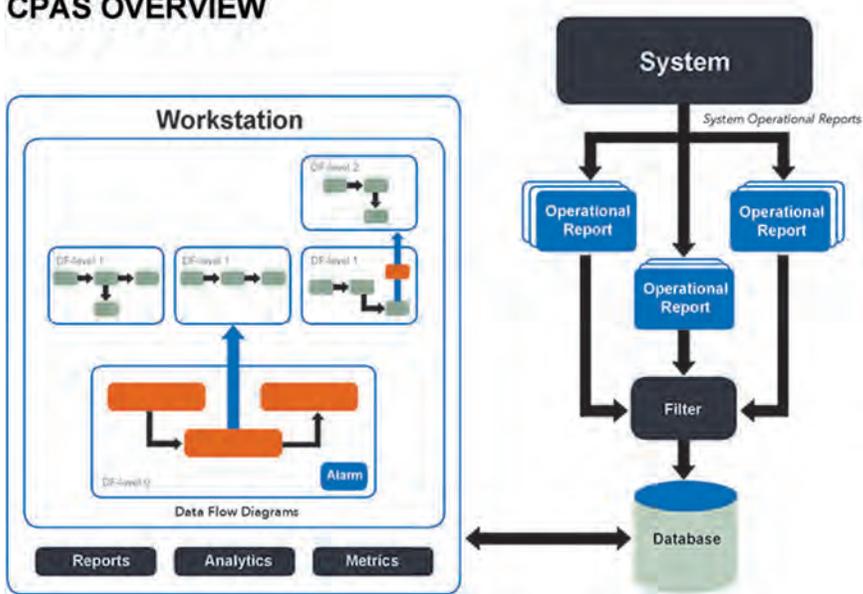
Automation is an essential element to CA, though manual involvement remains important particularly in situations where extensive judgment is required and where anomalies, exceptions, and outliers are identified.

Continuous Data Audit CDA

Vasarhelyi and Halper called the process of monitoring and constantly assuring AT&T's RCAM system continuous audit. The architecture of the system described in figure 1-1 shows data being (1) extracted from pre-existing reports, (2) sent to the business units through the remote job entry network, (3) transferred to an email system, and (4) extracted through individual text mining programs. This technique, analogous to what is called today "screen scrapping," was chosen to avoid interference in the long and complex system process development protocol. All information was collected from existing reports and placed in a relational database. This database drove hypertext graphs that were given to auditors to interact with the system. The several layers of the RCAM system were represented as flowcharts respecting the internal auditors' documentation practices and experience in data analysis. Many of the analytics impounded into the system were drawn from knowledge engineering (Halper, Snively, and Vasarhelyi, 1989) internal auditors and capturing the calculations they made with paper reports. The formalization of these processes allowed for their repetition at repeated frequency, and often reliance on these tests up to the moment that alerts were generated. Although internal auditors started relying on these exception reports, they also requested that the source reports be retained mainly for their traditional audit reports.

Figure 1-1: CPAS as Continuous Data Audit (from Vasarhelyi & Halper, 1991)

CPAS OVERVIEW



Although the idea of a continuous audit was conceptualized initially as a data monitoring and exception system (Vasarhelyi, 1996), its concept was expanded in an implementation at Siemens (Alles et al, 2006) as a reaction to Sarbanes Oxley and the need to issue opinions on the adequacy of internal controls. This expansion was entitled continuous control monitoring (CCM).

Continuous Control Monitoring (CCM)

Siemens had over 150 instances of SAP that were reviewed by technical experts using that narrow guidance of a standardized set of audit action sheets. These were a formalization of the audit plan to review controls and features of a particular SAP implementation and were adapted to each audit instance. Alles et al. (2006) developed a proof of concept tool where a baseline of control settings would be compared with the actual configurable control setting every night and auditors would be alerted of variations. Teeter (2014) extended the original work examining the potential for automation of not only the deterministic settings of SAP but a wider set of controls and parameters in the SAP system.

The...essay...investigates the implementation of a comprehensive continuous controls monitoring (CCM) platform for evaluating

internal controls within a highly formalized and well-controlled enterprise resource planning environment. Utilizing the IT audit plan as a template, auditor expertise as a guide, and manual audit output as a validation tool, this field study examines the process of audit formalization and implementation of CCM at a software division of a large, multinational corporation. (Teeter, 2014)

The results of the applied effort⁵ indicated that 62 percent of the controls arguably could be formalized, creating the possibility of a control certification or assurance layer on top of the SAP instance. Conceptually, this layer could be a part of SAP or an add-on, could be generic in configuration or tailored to the instance, and could be re-thought as a way to increase audit coverage as the original audit plan was applied in an 18- to 24-month cycle, and under this design this layer would be executed every day. Furthermore, the audit plan contained many qualitative questions such as "Is there documentation for XYZ system?"

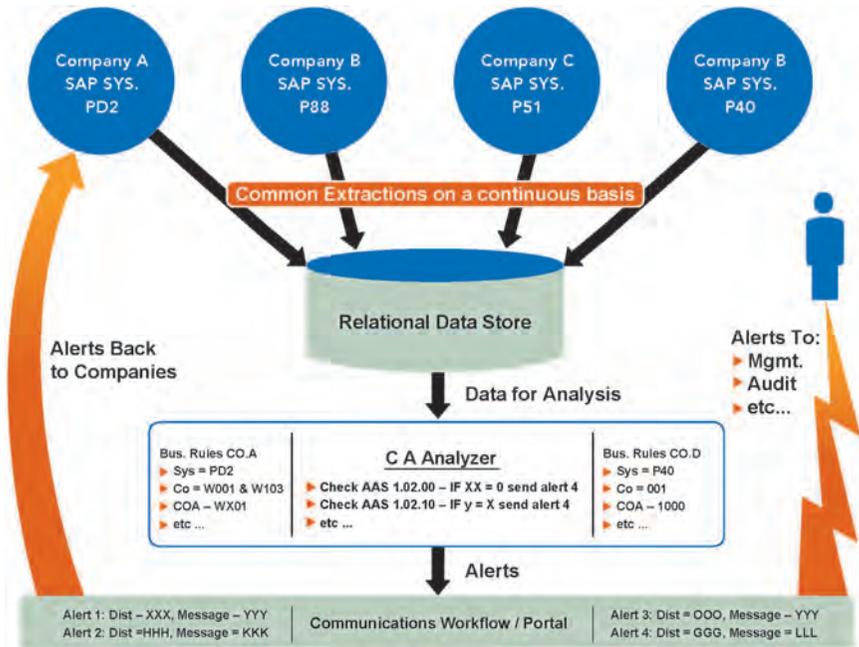
Elder et al. (2013) narrate a continuous monitoring effort at a large South American bank in which internal audit monitored 18 different key performance indicators (KPIs) for over 1400 branches of a bank. Daily extracts of variances were obtained and, on a selective basis, followed up by emails to the regional managers for the branches. These KPIs looked to control overrides such as credit above allowable level or reversal of certain types of transactions.

These examples illustrate (1) situations where auditors were in positions of control over operational controls, which could result in a conflict to the auditor's objectivity or independence and (2) that technology has changed the needs, capabilities, and roles of the assurance function. As suggested earlier, a more flexible set of conceptualizations must evolve, concerning auditor independence in particular. These examples are focused on internal auditors, but a similar monitoring role could be developed for external auditors and an ongoing monitoring opinion could potentially be issued as a new CPA product.

Figure 1-2 describes the vision developed for multi-instances of ERPs and an analytic engine supporting a set of functions. This view, however, could be immediately after the event based on the two experiences described above and would be an ex-post-facto overnight process, which we would describe as retroactive close to the event meta-control or assurance process.

⁵ Private notes Teeter, R.A., Warren, J.D., Brennan, R., and Vasarhelyi, M.A. 2007.

Figure 1-2: Pilot Continuous Monitoring of Business Processes at Siemens, Rutgers CAR-Lab & Siemens Adding Intelligence (from Alles et al, 2006)



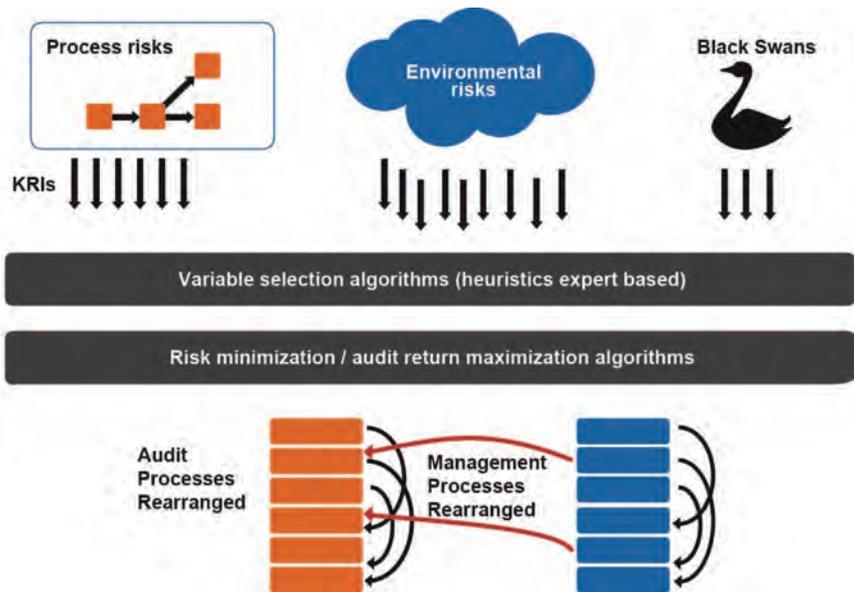
Incorporating the concept of CCM into the original CA conceptualization led to the renaming of the original CA to Continuous Data Audit (CDA) where CA = CDA + CCM.

Continuous Risk Monitoring and Assessment (CRMA)

Vasarhelyi, Alles, and Williams (2010) suggested the addition of Continuous Risk Monitoring and Assessment (CRMA) into the CA schema where: CA = CDA + CCM + CRMA. CRMA is discussed in more detail in essay 6, "Managing Risk and the Audit Process in a World of Instantaneous Change" of this book. The essence of the CRMA concept is displayed in figure 1-3 where risks are divided into three areas: (1) operational, (2) environmental, and (3) black swans (Taleb, 2010). Black swans are very remote risks with strong consequences that could arise, as Taleb predicted the crisis of 2008. Risks are chosen judgmentally by the audit team or management, and key risk indicators (KRIs) are associated with the most important risks in each of the categories. The same basic variance and acceptable variance model can be adapted to detecting significant changes of risk. The model can be parameterized at the initial

audit planning stage with heuristic or otherwise developed weights and optimization procedures applied to determine an audit program. When substantive changes in risk are perceived by the risk monitoring procedures, the algorithm can be rerun, but management must also be informed and joint action by assurance and management must follow. This risk variance activation procedure also confounds the classical audit theory, as many organizations have independent risk management areas often broken down by type of risk or product. New conceptualization of coordinated auditing or coordinated management, audit, and risk areas must follow.

Figure 1-3: Structure for CRMA Effort



Continuous Compliance Monitoring

Very closely related to risk evaluation, and closely linked to the increasingly regulated modern business world, is the area of compliance. Although much of the traditional world of compliance is qualitative, it is progressively being implemented by automated systems. Frequent upgrades in ERPs, for example, at banks and insurance companies reflect the increased regulation, the need to reduce costs of compliance, and the need to obey hundreds of regulations. In this essay, the development of a compliance monitoring (COMO) approach to complement CA is proposed.

The COMO approach would create comprehensive taxonomies of compliance issues and progressive updates for regulatory changes acknowledged by geography, area of activity, and the nature of compliance rule (qualitative, quantitative, mixed, or other). It would restate the CA equation to:

$$CA = CDA + CCM + CRMA + COMO$$

The integration of these views into a closer-to-the-event framework has the advantage of improving assurance coordination, working towards avoiding task repetition, and the potential usage of a conceptual and IT platform. Table 1-2 illustrates one type of (quantitative) compliance objective in relation to the topic of money laundering. As a caveat, if the above functions are united into a joint conceptual view and one platform implementation, the risks of their failure are much larger as a certain degree of redundancy decreases risk but also increases costs.

Table 1-2: Example of Compliance Monitoring Table

Anti-money laundering
<ol style="list-style-type: none"> 1. Compliance Topic: AML 2. Obligation or Compliance issue (for example, not to let over \$10,000 through bank teller deposit without regulatory reporting) 3. Method of compliance: All transactions for a given deposit rule have been captured and reported 4. Frequency capture daily, report quarterly 5. Importance: H M L HIGH

Compliance requirements can be largely qualitative, interpretive especially of legal, regulatory requirements, but its fulfilment (for example, fulfilment of the obligations) needs a degree of formalization in measurement of supporting information, monitoring, and reporting.

Compliance fulfilment data is processed in the complex corporate legacy, ERP, and other sources of big data where the company operates. Traditional methods of extracting and evaluating an assertion of fulfilment of compliance obligations to stakeholders and regulators are anachronistic. Therefore the argument for continuous auditing applies to compliance. Compliance management needs to be design-driven (for example, formal structure for requirement definition, data capture, single view of data bases, data visualization and interpretation from analytics based representation). Continuous assurance and continuous compliance assurance are complementary and can leverage many common design, analytics, and technology components. Their integration is aimed to

alleviate the multiple problems generated by the proliferation of audit-like organizations.

1.3 Guidance on Continuous Auditing

The first guidance on continuous auditing was published jointly by the CICA and AICPA (1999) and is often called the Red Book. This current volume attempts to update the Red Book along several dimensions. Since the publication of the Red Book, the Institute of Internal Auditors published its GTAG 3 *Continuous Auditing: Implications for Assurance, Monitoring, and Risk Assessment* (IIA, 2005) and ISACA its *IT Audit and Assurance Guidelines, G42, Continuous Assurance*, (2010). In 2010, the Australian Institute of Chartered Accountants also published its *Continuous Assurance for the Now Economy*.

Leveraging this statutory work, continuous auditing literature reviews (Brown et al, 2007; Chiu, Liu, & Vasarhelyi, 2014), and literature from practice, this essay will summarize some basic theory postulates for continuous assurance. *Assurance*, for purposes of this essay, is defined as *an umbrella of services that include the traditional audit and other services of a similar or complementary nature that are emerging or being facilitated by new technologies and business needs*. (Vasarhelyi & Alles, 2006)

Considering the new assurance needs in control structure, control compliance, data, and the existing guidance on continuous auditing, a reconsideration and expansion of the elements in the concepts of continuous assurance is needed.

2. THE ELEMENTS OF CONTINUOUS ASSURANCE REVISITED

The advent of new information and analytic technologies has brought about new products as well as new ways to perform business processes. Since the early years of continuous auditing, business has substantially evolved the continuous monitoring processes of production into many other areas of activity including accounting and finance.

2.1 Continuous Auditing Versus Continuous Monitoring

Considerable thought has been given to the problem of overlap between management and assurance processes when they progress in the automation route. KPMG (Littlely and Costello, 2012) described it in operational terms, as shown in table 1-3. Another approach would be to

consider some new type of conceptualization based on the new economics of information, control, and risk.

Table 1-3: CA Versus CM

Continuous Auditing Performed by Internal Audit	Continuous Monitoring Responsibility of Management
<ul style="list-style-type: none"> • Gain audit evidence more effectively and efficiently • React more timely to business risks • Leverage technology to perform more efficient internal audits • Focus audits more specifically • Help monitor compliance with policies, procedures, and regulations 	<ul style="list-style-type: none"> • Improve governance—aligning business/compliance risk to internal controls and remediation • Improve transparency and react more timely to make better day-to-day decisions • Strive to reduce cost of controls and cost of testing/monitoring • Leverage technology to create efficiencies and opportunities for performance improvements

Littlely and Costello (2012), as shown in table 1-1 and the AT&T Bell Laboratories development of Continuous Process Audit System (CPAS) (Vasarhelyi & Halper, 1991) in parallel to management’s Prometheus system (table 4) show a substantive overlap of management and assurance analytics and the potential of the usage of similar systems to support infrastructure. IBM’s⁶ internal audit approach was to commission three monitoring systems for auditees and progressively obtain their agreement to use the system for monitoring by management. Traditional audit thinking argues that if the auditor acts as a "monitorer," in one sense, he or she becomes part of the control system and loses independence. On the other hand, the traditional audit can be viewed as a form of tertiary control acting both as a deterrent as well as an after-the-fact detective control. The progressively increasing set of layers between the auditor and the data, as well as the massive nature of data being used by large corporations, forces the existence of monitoring and reporting layers, not to mention ERP software, web interfaces, legacy systems, and outsourced processes.

Vasarhelyi & Halper (1991) initially developed the CPAS project aimed at creating a meta-understanding of the system being audited and making this system auditor-monitored. It became clear after a certain amount of time that similar monitoring insight and analytics would be also of interest to management and of benefit in the utilization of the system being monitored. Consequently AT&T developed the Prometheus system (Vasarhelyi, Halper, & Esawa, 1995), which used the same technological undercarriage of CPAS but with some unique analytics for both

⁶ As described in annual presentations at the World Continuous Auditing Symposium in Newark (2011, 2012), that can be seen in <http://raw.rutgers.edu/>

management and auditing, as well as a larger common base of analytics and monitoring controls.

Table 1-4 illustrates a series of reports, screens, and data monitoring procedures based on AT&T’s RCAM system where there is examination of data at multiple levels. While analytic 1 examines the overall completion rate of the billing process, analytic 2 works at a much lower and earlier level examining the data collected by the switches. Some analytics are only provided to the audit functions, others are only of interest to management monitoring, while others are to be supplied to both. The CPAS conceptualization involved 4 major elements: (1) actuals, (2) standards (models), (3) analytics and (4) alarms (alerts) in addition to the method of measurement (direct data access or secondary capture). Analytics in CPAS were provided in the form of formulae, rules, and, in most of the instances, with graphic visualization.

Table 1-4: CA and CM at AT&T⁷

Analytic number	Process	CPAS (Continuous Audit)	Prometheus (Continuous Monitoring)
1	Bill Completion Monitoring	Percentage of bills generated that were completed	Percentage of bills generated that were completed
2	Calls recorded	Long-term count of calls adjusted for cycle	Switch billing integrity comparisons
3	Bills missing	Process integrity reconciliation	Process integrity reconciliation
4	Job sequencing in the data center		Examination of CA-7 and CA-11 reports
5	Discrimination of reasons bills not printed		Staged counts
6	Specific Bill content examination	Bill images—content extraction summaries	For accuracy verification
7	Bill sequencing controls	For fictitious bill detection	For production monitoring
8	Continuity Equations	For predictive auditing (Kogan et al, 2014; Kuenkaikaew, 2013)	For error detection and process monitoring

⁷ This table is illustrative in nature. It is loosely based on the actual experience of the monitoring and assurance of the RCAM system in the 1986–1991 period.

Kogan et al. (2014) applied the concept of continuity equations expanding the original suggestion of Vasarhelyi and Halper (1991) including the following:

- Distinguishing exceptions from anomalies
- Introducing time-lagged process measurements that reflected better the actual information flow in the system
- Focusing on transaction-level monitoring with clarification of the different levels of activities
- Introducing the concept of automatic transaction correction into the audit literature

Recent continuous auditing literature (Chiu, Liu, and Vasarhelyi, 2014) has tried to improve the quality of the models that serve as the basic elements of comparison for exception detection.

Table 1-5 compares and expands the original conceptualization of the CPAS effort (Vasarhelyi & Halper, 1991; Halper, Snively, & Vasarhelyi 1988; Vasarhelyi, Halper & Esawa, 1995) with several research efforts performed over the years.

Table 1-5: Expanding Conceptualization in CA/CM⁸

	Vasarhelyi & Halper (1991), Red Book (1999)	Expanded Conceptualization (1999–2014)	Notes
	CPAS/Prometheus effort	Several corporate experimental experiences	Work with P&G, Siemens, Itau Unibanco, and so forth
Measuring	Metrics	Extractions from many different systems and drawing from the Big Data environment	Great potential for increased validation of values including database to database confirmations
Creating a model	Standards	Of comparison	
		Of variance	

⁸ Highlighted items are expansions to the Vasarhelyi and Halper (1991) initial conceptualization.

Table 1-5: Expanding Conceptualization in CA/CM—continued

	Vasarhelyi & Halper (1991), Red Book (1999)	Expanded Conceptualization (1999-2014)	Notes
Relating	Analytics	Representational equations	
		Continuity equations	Kogan et al., 2015
		Visualization	
		Clustering and transaction level continuity equations	For automatic fraud detection and transaction correction
	Alarms (4 levels)		
	Measurement Versus Monitoring	Measurement (indirect data acquisition)	
		Direct data access	
		Introducing external comparative benchmarks	
		Probabilistic data relationships	Linking corporate ERP data to big data in the fringes
Dimension	Data	Continuous data auditing (CDA)	Vasarhelyi & Halper 1991
	Control	Continuous Control Monitoring (CCM)	Vasarhelyi, Halper & Esawa, 1995; Alles et al, 2006
	Risk	Risks (CRMA)	Vasarhelyi, Alles, & Williams, 2010; Essay 6
	Compliance	Compliance (CM)	Essay 1

2.2 The Elements of Continuous Audit

Vasarhelyi, Alles, and Williams (2010) have argued for the inclusion of continuous risk monitoring and assessment (CRMA) in the CA schema: "The audit planning process provides a template for how to make the Continuous Assurance system dynamic: by formally incorporating into it a risk assessment system that encompasses assessment of auditor

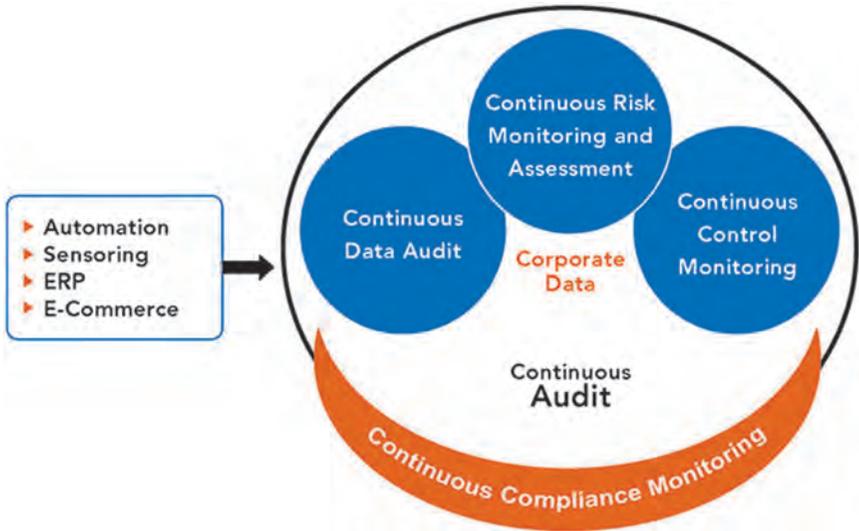
perceptions of risks and allocation of audit resources to risky areas of the audit."

Vasarhelyi, et al. (2012) examined the continuous audit efforts of nine large organizations. It was noteworthy that organizations had a series of "audit-like" organizations (ALO) that competed for resources and presented very different levels of technology use. In its principle 3.5, the King report (Institute of Directors in Southern Africa, 1994, 2009) in South Africa states that "The audit committee should ensure that a combined assurance model is applied to provide a coordinated approach to all assurance activities." A control and assurance automated ecosystem can evolve the audit to create a more reliable and efficient corporation.

All of the interviewed companies have a number of audit-like organizations which perform assurance-like functions in different areas. However, some of the audit areas overlap, and the results of the review are not efficiently shared among them as one manager declared, *"Let me start with my administrative boss. He is the director of risk management for the organization. Underneath is internal audit. Credit examination and our risk management/Sarbanes-Oxley...there is another group that does testing that reports to Chief Legal Counsel. Fraud is handled in our securities group, which is in our service company. They perform investigations on internal and external fraud...We do [received feedback], but not as much as we should."*

One of the interviewed companies had up to seven ALOs, which resulted in substantive differences in the quality of reviews, substantial redundancy, lack of depth in the reviews, and what they called "audit fatigue" where auditees would not cooperate due to the multiplicity of assurance efforts. If the companies had continuous audit in stage 4, a full continuous audit in stage 4, these problems could be eliminated as the monitoring systems would be centralized and integrated. All ALOs could share the systems and information, and their works would not overlap. ALOs in this study included (1) internal audit, (2) compliance, (3) fraud, (4) SOX, and (5) Basel, in most situations, although several other nomenclatures and subdivisions existed. (Vasarhelyi et al, 2012).

Figure 1-4: Expanded Scope of CA including Compliance Monitoring: An evolving continuous auditing framework



The original framework of continuous assurance can be expanded into four elements: data, control, risk, or compliance. Figure 1-4 expands Vasarhelyi, Alles, and Williams (2010) components to add an element of compliance monitoring, expanding the scope of the CA and CM effort. The same considerations of opacity of the data processing environment and the difficulty of access to its information apply to all elements of the auditing framework that evolved since the AT&T CPAS effort.

3. INFORMATION TECHNOLOGY AND THE AUDITOR

Traditional auditing has changed considerably as a result of changes in IT, including more advanced ERP systems, increasing the use of on-line transactions with both customers and suppliers, use of the cloud, and the rapid expansion of data available for use by management and auditors. The continuously evolving IT landscape leads to a variety of audit challenges that compound over time, as summarized in table 1-6 (Adapted from Vasarhelyi and Halper, 1991).

Table 1-6: The Evolution of IT and Associated Audit Challenges (Adapted from Vasarhelyi & Halper, 1991)⁹

Phase	Period	Evolution of IT	Examples	Audit Challenges
1	1945–1955	Input (I) Output (O) Processing (P)	Scientific and military applications	Data transcription Repetitive processing
2	1955–1965	I, O, P Storage (S)	Magnetic tapes Natural applications	Data not visually readable Data that may be changed without trace
3	1965–1975	I, O, P, S Communication (C)	Time-sharing systems Disk storage Expanded operations support	Access to data without physical access
4	1975–1985	I, O, P, S, C Databases (D)	Integrated databases Decision support systems (decision aides) Across-area applications	Different physical and logical data layouts New complexity layer Decisions impounded into software
5	1986–1991	I, O, P, S, C, D Workstations (W)	Networks Decision support systems (non-expert) Mass optical storage	Data distributed among sites Large quantities of data Distributed processing entities Paperless data sources Interconnected systems
6	1991–2000	I, O, P, S, C, D, W Decisions (De)	Decision support systems (expert)	Stochastic decisions impounded into IT systems
7	2000–2010	I, O, P, S, C, D, W, De, Distributed (Di),	Distributed systems Internet based Cloud	Data stored in the cloud and replicated Virtual IT software
8	2010–2020	I, O, P, S, C, D, W, De, Di, Big Data (BD)	Preponderance of data that is applicable in wide array of business, accounting, auditing areas	Big data Multiple sources of automatic data capture
9	2020+	I, O, P, S, C, D, W, De, Di, BD, Artificial Intelligence	Self-improving systems Embedded intelligent modules	Audit activities and reporting are slow and occur too late

⁹ Highlighted items are expansions to the Vasarhelyi & Halper (1991) initial conceptualization.

For example, the challenges that emerged in phase 5 with the decentralization and distribution of data were aggravated with the advent of cloud computing in phase 7. The emergence in phase 8 of big data (Vasarhelyi and Kogan, 2015; Moffitt and Vasarhelyi; 2013) creates a hybrid environment where systems must monitor the boundaries of the broad external data environment, which is too voluminous to be contained within the organization's stores or its outsourced environment (Krahel and Vasarhelyi, 2014). Organizations already scan and extract from big data receptacles (for example, Twitter) and only retain selected pieces or summaries. Although many systems exist that present some degree of decision intelligence and even predictive behavior (Kuenkaikaw, 2013), artificial intelligence applications in business are not yet so prevalent to create an audit challenge.

The evolution of IT also creates opportunities for the introduction of further audit tools and methodologies especially as financial systems have moved towards decentralization, distribution, online posting, continuous (or at least daily) closing of the books, and paperlessness (Vasarhelyi and Yang, 1988).

The CCM application Alles, Brennan, Kogan, and Vasarhelyi (2006) developed is much broader in scope than the Red Book definition, and indeed, subverts its focus on only more timely audits. The point of CCM is to exploit the very structure of the ERP system in order to bring about automation, as opposed to simply doing the same audit procedures more often. In their words, they were reengineering the audit process, not just speeding it up.

Alles, Kogan, and Vasarhelyi (2003) proposed something similar when they used the ability of ERP systems to propose the development of an auditing "black box" that would enable the tertiary monitoring of the audit itself. A decade later, a similar philosophy underlies the use by Jans, Alles, and Vasarhelyi (2014) of event logs to audit business processes.

Alles and Gray (2012) state: "When analyzing the role of big data in auditing it is critical to differentiate between whether what is meant is more of the same kind of data that auditors are already using, or more data of a different kind than what auditors have traditionally relied on to give an audit opinion." The former approach would lead, for example, to continuous auditing where the scope of data is not necessarily expanded, but measurements are taken more frequently in time (Kogan, Alles, Vasarhelyi, and Wu, 2014). By contrast, big data as it is defined below pushes the domain of data far outwards from financial data to non-financial data, from structured to unstructured data, and from inside the organization to outside it.

Over the last two decades, many new analytic and information technologies have become ubiquitous. These technologies also have been progressively applied to accounting and auditing. There have been studies looking at the role of visualizations, exploratory data analysis, process mining, tagging, the remote audit, predictive audits, and so forth.¹⁰

3.1 Evolving Database Audit Conceptualization

The core of traditional systems evolving from the early file-oriented systems to hierarchical and today's relational databases is the structured nature of its data. Vasarhelyi and Halper (1991) pointed out levels of audit complexity in their usage. Table 1-7, "Evolving Database Structures and Their Audit" (expanded from Vasarhelyi and Halper, 1991), expands their view with some of the new considerations of storage and data provenance. Hierarchical data structures of the COBOL days were by and large replaced by the relational databases that are the core of the modern ERPs. With the ubiquity of the internet, there is the emergence of large corpuses of unstructured data from which to draw expanded information. A few facilitating axioms may be useful to introduce:

- There are no reasonable limits of sources of data, but there are great limits on what data an organization can actually store and make useful.
- In general data will tend to exist to support particular decisions or processes, but the great challenge is to anticipate such needs and create software and processes for its examination.
- The costs of system development, improvement, and overlay obey much different rules than the traditional fixed and variable cost managerial accounting model.
- Many IT provisioning economic models are charged on an incremental basis proportional to usage (Siegele, 2014).

Table 1-7 expands the table in Vasarhelyi and Halper (1991) with additional system characteristics and presents the aforementioned opportunities for the introduction of new tools and methodologies.

¹⁰ See <http://raw.rutgers.edu/pcaob>

Table 1-7: Evolving Database Structures and Their Audit (expanded from Vasarhelyi & Halper, 1991)¹¹

System Characteristic	Audit Complexity (level 1)	Audit Complexity (level 2)
Database	Documentation	Data dictionary query
Database size	User query	Auditor query
Transaction flows	Examine levels	Capture sample transactions
Duplicates	Sorting and listing	Logical analysis and indexes
Field analysis	Paper oriented	Software based
Security issues	Physical	Access hierarchies
Restart & Recovery	Plan analysis	Direct access
Database interfaces	Reconciliation	Reconciliation and transaction follow-through
Unstructured data	Linkage to know database elements	Establishment of stochastic relationships between data elements and unstructured data
Cloud storage	Access and privacy evaluation	Tests of system integrity and business continuity
Big Data	Selection of validating parameters	Linkage to data streams and extraction of meaning
		Creation of new forms of evidence
		Integration of new evidence into the traditional audit theory (Hoogduin, Yoon, and Zhang, 2015)

3.2 Incremental Technological Change

The costs of more frequent assurance and its benefits have substantively changed with IT. In the 21st century information technology environment (21CITE), the costs of performing processes has greatly changed with advents in IT and networking as well as the reduction of the human labor component. In essence the following has been noted:

1. Information storage and retrieval is being progressively automated.

¹¹ Highlighted items are expansions to the Vasarhelyi & Halper (1991) initial conceptualization.

2. The cost of creating a report that previously required incremental labor per report now, once established, costs nothing to repeat and is typically developed by the ERP developers.
3. With the modern systems, automatic data collection is changing the schemata of data collection. Data from e-commerce transactions, GPS¹², and RFID¹³ can be captured at defined time intervals contingent on the business need being satisfied. (Moffitt and Vasarhelyi, 2013)
4. Cloud distribution and storage of created/sensed files creates ubiquitous access and much more robust backup. Third party sourcing creates several challenges on assurance but also some degree of professionalism and competence in the data custody function. (Mendelson et al. 2012)
5. A progressive incorporation of some forms of artificial intelligence into several business functions is creating a more stochastic and judgment based set of decision rules. It cannot be assumed any more that a well validated business procedure will respond "correctly" as the rationale in the computer logic is a mix of heuristic rules and complex analytics.
6. Robots are taking a larger and larger role in business processes (Brynjolfsson and McAfee, 2014) and progressively systems with artificial intelligence will be integrated into the manual performance of tasks.
7. The ubiquitous access to information and devices will also be of great import. Two additional sources of internet connection—"The Internet of Things" (Kopetz, 2011) and "Wearables" (Wei, 2014)—will provide further substantive data of particular value for detective and preventive assurance.

These and many other considerations relative to technology and, most importantly, to the economics of business processes are the drivers of evolution on the continuous audit conceptualization.

3.3 The Audit Data Standard

Zhang et al. (2012) discuss the fact the audits are at risk of becoming less relevant if they do not change to meet stakeholder needs, especially for

¹² www8.garmin.com/learningcenter/training/oregon/

¹³ www.aimglobal.org/?page=rfid_faq&hhSearchTerms=%22rfid%22

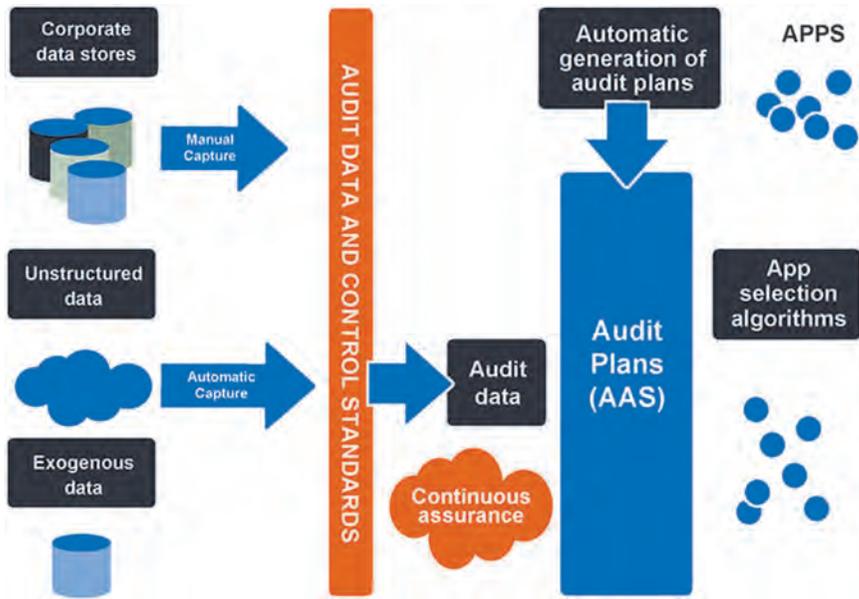
timeliness and scope (for example, process assurance, data-level assurance). Furthermore, they state that audit standards tend to lag behind advances in technology, and many basic audit procedures have not been updated to complement these developments. It also mentioned that the Center for Audit Quality (CAQ) (2011) held roundtable discussions that suggest that investors must act on timely and continuous financial information and it should be explored whether auditor assurance should be provided for financial information disclosed by managers throughout the year.

Furthermore Zhang et al. (2012) argue that "auditors face a challenge in accessing data as there are no standard requirements in place for data availability. Auditors do not have ready access to their clients' accounting data, even when the clients' business operations have become almost entirely digitized. As technology is the major driver of the evolution of the audit process, the AICPA Assurance Services Executive Committee (ASEC) Emerging Assurance Technologies Task Force is trying to pave the way for enhanced use of technology and advanced data analytics in the audit process. The audit data standards, including data standards, data access, audit applications and continuous audit, are formulated to facilitate data acquisition in a standardized fashion and advance the process of audit automation" (Vasarhelyi et al. 2011).

The CAQ initiated an effort to guide the profession towards a set of audit data standards that would guide organizations to make data available to auditors in a standardized format allowing for the homogenization of utilization of data using common auditor oriented applications ("apps"). The AICPA's ASEC took this effort over¹⁴ and is progressively issuing this guidance. Figure 1-5 displays a symbolic view of an automated audit architecture that links: 1) existing corporate IT systems (including outsourced ones and Big Data Links, 2) extractor routines, 3) ADS standards, 4) automatic audit plan generation, 5) apps, 6) app selection routines, and 7) continuous assurance.

¹⁴ www.aicpa.org/InterestAreas/FRC/AssuranceAdvisoryServices/Pages/AuditDataStandardWorkingGroup.aspx

Figure 1-5: ADS Ecosystem Architecture



Zhang et al. (2012) stress that the Audit Data Standard project is an effort to bridge the gap (Kaplan, 2011) between accounting scholarship and practice. "Kaplan (2011) argues that accounting faculty, as scholars in professional schools, have conducted studies that are mostly reactive and put overemphasis on the existing practice instead of advancing the practice. He suggests that accounting scholars should fill the void in academic research and focus on developing knowledge for leading edge practice. The emergence of data standards and audit applications (Apps) is the fruit of academic and practice cooperation."

The AICPA issued initial guidance on the Audit Data Standard in 2013, which included the creation of the following audit data standards: (1) base standard, (2) general ledger standard, and (3) accounts receivable subledger standard. The work continues in extending the standard to other cycles and directions. Currently underway are order-to-cash and procure-to-pay subledger standards.

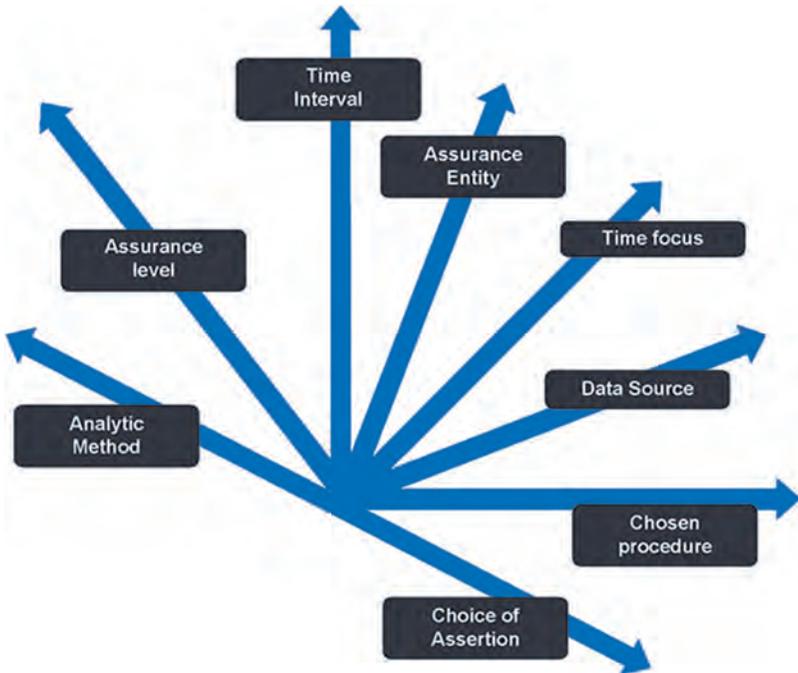
4. THE NEW CONTINUOUS AUDIT

New considerations in continuous audit tie closely to the evolution of information and analytic technologies that grandly expanded the feasible set of monitoring and assurance activities. Many of these activities that could be extremely beneficial are not performed either because of

ignorance of their availability, misconception of their nature, misunderstanding of the costs, or mainly because of the serious costs that may occur in such a litigious society as the United States if substantive corporate reporting problems are detected. Many of the instances where a "material error" was detected, the problem had existed for years in an increasing scope. The problem tends to explode when the adverse business economics that usually causes misrepresentation is too large to be unnoticeable.

Figure 1-6 lists the dimensions of the assurance process that are evolving in the new continuous audit: (1) assurance level, (2) time focus, (3) time interval, (4) data source, (5) chosen procedure, (6) choice of assertion, (7) analytic methods, and (8) assurance entity. Other dimensions may also be of importance in the progressive evolution of audit theory over time.

Figure 1-6: Dimensions of the New Continuous Audit



Halper and Vasarhelyi (1991) recognized the evolving nature of information technology table 1-6, "The Evolution of IT and Associated Audit Challenges" (Adapted from Vasarhelyi and Halper, 1991), and its opportunities in relation to assurance. Here the discussion is expanded to

look at several of the evolving dimensions transforming the panorama of audit (internal and external), control, and management.

The concept and practice of internal control evaluation (design and compliance) has been in the literature for many decades. Sarbanes Oxley expanded its formalization by requiring auditor assurance on management assertions about internal controls. Although the literature of data audits and its methods have evolved for many decades, research on internal control representation formalization (Cash, Bailey, and Whinstone, 1977; Bailey and Meservy, 1986; Bailey et al., 1985) has been sparse. The issues of control representation, assessment, configurable controls, compliance, and verification are to emerge as a major need for professional work and research. The monitoring of controls, the effect of their modification by tailored ERPs or overrides in configurations, and the existence of tens of thousands of controls plus compliance requirements creates a very complex environment both for management and assurers.

4.1 Assurance Level

Kogan et al. (2014) focus on *transaction* level assurance whereby continuity equations are used to monitor transactions through the stages of a hospital supply chain. It utilizes the patterns of delay between processes to improve predictions and to perform automatic transaction correction. It improves the basic quality of data and allows for preventive auditing and automatic transaction correction.

Control level assurance (CCM) has partially replaced the traditional process of internal control evaluation and compliance testing. The ERP environments with pre-set controls have already demonstrated a reliable information structure, but new issues such as configurable controls have appeared to concern management and assurers.

Account level accuracy can be supported and assured at many low, intermediate, and high levels of accuracy. Dashboards (Moharram, 2014) and visualizations (Alawadhi, 2014) are improved with new technology which combines analytic transformation and takes advantage of the attributes of human information process. With the evolution of technology, it is possible to develop and test assertions at a much finer and directed manner.

Statement level assurance allows for combined assessment of accuracy, taking into consideration transaction accuracy, control climate, and all levels of account level accuracy. Each level of assurance actually serves different purposes for both management and auditors.

4.2 Time Focus

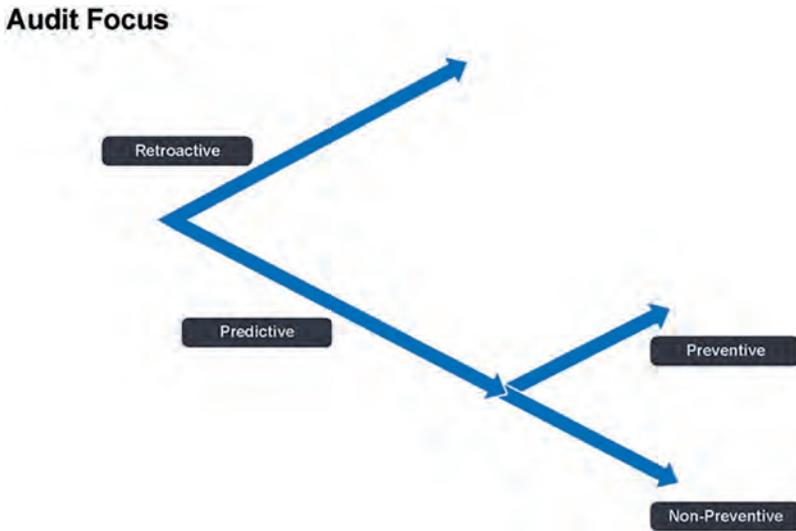
Auditing has been retroactive since its inception. Auditors examined past accounts for accuracy and reported perceived discrepancies. Figure 1-7 illustrates that auditing can both be reactive and predictive (Kuenkaikaew, 2013). When predictive, the auditor (Vasarhelyi and Halper, 1991; Vasarhelyi, Alles & Williams, 2010) will rely on models (standards) to predict results (performance) in an account (transaction) (Kogan, et al., 2014). This prediction is compared with actuals in near-real time to detect substantive variances in monitored processes. Much of the recent research on CA has recently focused on developing better models for actual comparisons (Chiu, Liu, and Vasarhelyi, 2014; Brown et al., 2007). These variances, from improved models, are treated either as an alert to the management and audit function or, if the system has reliable filters, to prevent faults from progressing toward execution. Modern systems combine management action and assurance. Much conceptual work is needed in the re-definition of concepts such as auditor skepticism, independence, materiality, auditor role, audit objectives, and so on. Many of these needs are motivated by the ever-increasing level of automation in corporate business systems and the correspondingly automated nature of tools used by individuals. The advent of a progressively bring-your-own-device (BYOD) environment (Loras et al., 2014) is affecting the locus of the control and assurance. Some of the BYOD tools like smart phones already incorporate predictive algorithms to perform a set of integrative functions for the user. These functions associate typical behavior with data integration to decrease key-strokes by the user. For example if the device detects a request for contact and a telephone number or an address, it may immediately prompt a call or a map to the location.

Auditors will eventually have predictive procedures to drive them to data level prediction (Kuenkaikaew, 2013), procedural prediction (based on the experience of other auditors using the tools and maybe the guidance of the audit plan), and control prediction (where weaknesses in controls or process changes drive the activation or re-parameterization of controls.)

Intelligent *preventive* controls are progressively permeating the corporate IT ecosystem and personal devices. The relationships between processes that have always existed may now be explored analytically and visually for management and assurance purposes. If the predictive ability of models is high and processes modularized and discrete, it may be possible to prevent an error, automatically correct an error, or correct a control deficiency prior to its occurrence. For example an insurance company develops a forensic model to determine if a particular claim

payment is inaccurate (fraudulent or in error). This model is very accurate in generating a number of false positives and false negatives. It can develop a process that once a transaction is ready to order a wire transfer, it is subjected to the same forensic model and, if the level of confidence of accuracy of the transaction (the loading function for the transaction to be further discussed later in this essay) is below a certain threshold, the transaction is blocked and a group of auditors (Elder et al., 2013) proceeds to examine it and release it or not. The economics for this preventive behavior depends on the amounts of the electronic fund transfers, the incidence of erroneous transactions, the losses/costs historically incurred in these (detected and undetected but estimated) errors, and the cost for an auditor or manager to perform this supervisory and assurance action.

Figure 1-7: Time Focus of the Audit Methodology



4.3 Time Interval

The original CA work aimed at using the evolution of technology to replace the work on the annual audits, but the client organization was internal audit. It rapidly became clear that external audit firms do not use CA techniques but consult with internal audit departments on the matter. (See essay 2 in this book.)

As the technological drivers of Continuous Assurance continue to rapidly progress, it has proven difficult to reach consensus on what

Continuous Assurance actually encompasses. There is the need to update the AICPA and CICA definition of continuous assurance to do away with written audit reports, which are redundant in today's world of electronic communication. Even more importantly, the word 'continuous' undoubtedly would not be used today, because it implies a frequency of auditing that is both difficult to achieve technically without impacting the operations of the entity's IT systems, and probably beyond the needs of most users. The different elements of a corporate information system have different pulses and natural rhythms. The assurance process must be coherent with these rhythms to be useful and effective. (Adapted from Vasarhelyi, Alles, and Williams; 2010.)

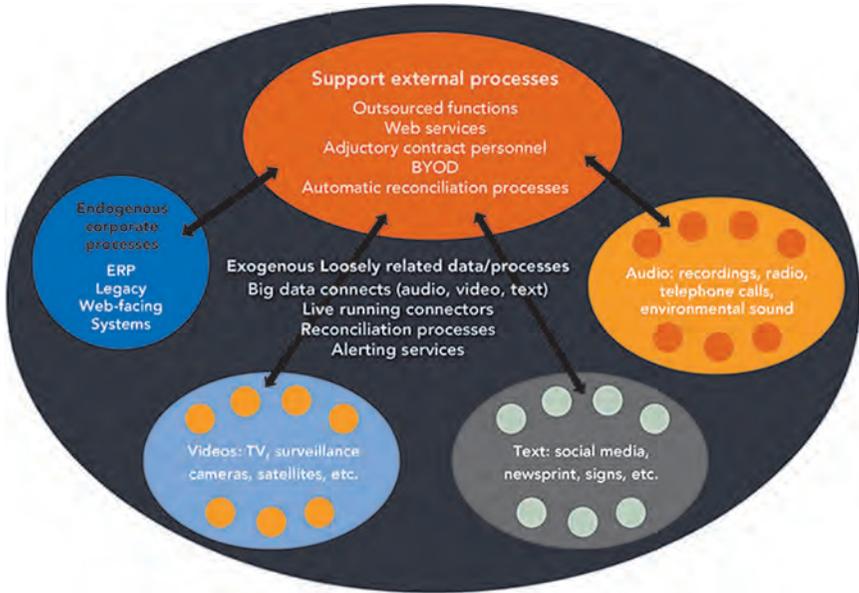
This new view of CA, encompassed in this essay, disagrees with the above statement that the "frequency of auditing that is both difficult to achieve technically without impacting the operations of the entity's IT systems, and probably beyond the needs of most users." Technology is already present to achieve "close to real time assurance." Corporate business ecosystems will be by nature distributed, real-time, and most of all very opaque to the naked eye. Consequently there will be many systems that will be difficult to audit unless a transaction is monitored frequently, predicted in value, prevented if deemed probably erroneous, and so forth. The nomenclature (is this management, control, or auditing?) given to the meta-control and assurance function is of less import than its progression over time and the integrated systems need.

Assurance close to the event allows for inter-process fault blocking and rapid management/auditor intervention into incorrect or unexpected events, which is one factor that was not to be considered in the traditional audit approach.

4.4 Data Source

The new corporate data presents a wider scenario of data sources (Krahel and Vasarhelyi, 2014) internal (endogenous) from ERPs, legacy systems, web-facing systems, and middleware. This data is complemented by associated (outsourced) systems and by bridges to external (exogenous) data of several origins. Data can come from public databases (for example, macroeconomic data, market data such as Compustat and CRSP), from bridges to the larger data environments of video, text, and audio (Moffitt and Vasarhelyi, 2013), and from the many automatic data collection devices that are emerging for multiple purposes. See figure 1-8 for further examples.

Figure 1-8: Sources of Data (adapted from Qi and Vasarhelyi, 2014)



4.5 Chosen Procedure

Audit procedures have been frequently formalized under GAAS in order to create guidelines for verification of financial statements. Unfortunately the standards have not yet explicitly embraced more advanced technological methods that can deal with the emerging challenges of big data, cloud computing, embedded decision making, and the like. In general the audit standards allow for evolution of procedures but do not necessarily facilitate or require such an effort. See table 1-8 for procedures and their evolution.

Table 1-8: Procedures and Their Evolution

	Traditional procedures	Modern procedure
Client acceptance and investigation	Multiple mainly manual methods including investigators	Identical plus extensive text mining of sources like newsprint and social media
Client monitoring		Extensive text mining of sources like newsprint and social media
Population estimate	Statistical or judgmental sampling	Big data population estimation
		Full population measurement

Table 1-8: Procedures and Their Evolution—*continued*

	Traditional procedures	Modern procedure
Confirmation	Manual confirmations or confirmation.com	Close to full population confirmation with database to database confirmatory pings/handshakes
Substantive testing	Manual examination of documents	Electronic documents, process mining
Analytical review	Comparison of end of the month ratios and their trends	A wide selection of analytics procedures at most stages of the audit
Internal control evaluation and compliance testing	Manual tracing, observation, structural evaluation	Reliance on ERP design, CCM

4.6 Choice of Assertion

International auditing standards and U.S. GAAS classify assertions into three categories:

- Assertions about classes of transactions and events for the period under audit
- Assertions about account balances at period end
- Assertions about presentation and disclosure

To which we add the following:

- Assertions about emerging issues of less traditional nature

An assertion basically represents the concern of auditors of particular system faults. Exploratory Data Analysis (EDA) (Liu, 2014) allows for preliminary data examination leading to choice of assertions to be considered in a particular audit. By looking at the data characteristics and distributions and contingencies, the auditor will start with basic assertions and choose additional ones to be considered. EDA will allow for the creation of assertions and the transformation of EDA into confirmatory data analysis.

4.7 Analytic Method

The development of new IT infrastructure, analytic methods, and the expansion of ALOs is changing the potential of continuous audit to a new dimension described in table 1-5: Expanding Conceptualization in CA and CM. The essence of audit automation and the progressive evolution of an audit ecosystem entails synergistic integration of its elements. As has repeatedly been discussed in this essay, systems that support

business processes have become too complex to be efficiently addressed through pure human assurance. Layers of data, software, and the interconnection with upstream and downstream systems (and processes) make observation and evaluation very complex.

In general an entirely new family of audit analytics is emerging¹⁵ that can affect all parts of the audit engagement and can allow the use of an expanded data framework that includes external big data to support audit assertions in an unorthodox manner. Table 1-9 illustrates the number of potential changes and improvements to assurance methodologies. It should be considered together with table 1-10 in which the emphasis is more on procedures.

Table 1-9: Audit Phases and Analytic Methods (modified schema of Cushing and Loebbecke, 1986)

Audit phase	Applicable analytic methods	Observations
Client examination	<ul style="list-style-type: none"> • News media monitoring • Social media monitoring 	A large set of sources allows for environmental scanning of events with directors, their reputation, the behavior of competitors, and events in the industry
Audit Planning	<ul style="list-style-type: none"> • Ex-ante risk assessment a la CRMA • Ratio analysis 	Peer industry group evaluation for performance
Audit risk assessment	<ul style="list-style-type: none"> • CRMA 	The "material" change in the risk situation requires changes in continuous monitoring, management action, and in continuous audit parameters
Internal Control evaluation	<ul style="list-style-type: none"> • Process mining • Analytical modeling 	Much reliance on the "best of class" nature of designed ERP systems but hampered by the fact that most large organizations' data is a mix of ERP based and many other sources
Compliance testing	<ul style="list-style-type: none"> • Process mining • CCM 	Concern about user configurable controls requires monitoring these settings through a CCM methodology

¹⁵ http://raw.rutgers.edu/audit_analytics_certificate

Table 1-9: Audit Phases and Analytic Methods (modified schema of Cushing and Loebbecke, 1986)—continued

Audit phase	Applicable analytic methods	Observations
Substantive testing	<ul style="list-style-type: none"> • Cluster analysis • Database-to-database confirmations • Continuity equations 	The emergence of very large number of transactions, the ability to store them online, the reliance on electronic documents and records, and the usage of XML derivative languages to exchange data from upstream and to downstream systems changed drastically the items to be tested and requires new audit tests that are not yet in the vernacular
Opinion formulation	Formal expert systems for the evaluation of new forms of audit evidence Systems for estimating potential for audit failure based on internal evidence and exogenous variables	With the multitude of data forms and volume, and the lack of direct observability of data, audit systems will have to be substantially automated with a symbiotic process of opinion formulation partially relying on machine observation and opinion formulation

4.8 Assurance Entity

Different ALOs have a mix of complementary, independent, and overlapping objectives. Assurance coordination, as recommended to be implemented in the King report, must take into consideration the evolving variables discussed in this section: (1) assurance level, (2) time focus, (3) data source, (4) chosen procedure, (5) chosen assertion, (6) analytic method, and (7) the specific issues and objectives of the different assurance entities. Organizing a matrix of the above variables, ALOs, and technology platforms can help to create a more efficient assurance function.

5. QUESTIONS REGARDING SOME AUDITING CONCEPTS IN THE MODERN ENVIRONMENT

The speed of technological change is overtaking the ability of business to change and of the multiple lines of defense. The inherent opacity of the layers of technology opens exposures at the same time that it creates

capabilities for business. The same technology that allowed data to be processed rapidly and consistently also allows for consistent errors and their distribution without human observation. The same technology that allows for remote access of computers allows for foreign intrusion and virus diffusion. The same technology that facilitates electronic transactions with credit card magnetic information also allows massive and intrusive capture and leakage of credit card information at reputable organizations such as Target¹⁶ and Home Depot¹⁷. As earlier discussed, the roles of management, internal audit, and external audit are overlapping and use the same tools. Figure 1-10 attempts to integrate some high-level functions that will compose some of the elements of future management and assurance. Prior to its discussion some basic issues in modern assurance are discussed including: (1) progressive implementation of assurance systems, (2) functional migration of roles and tasks, (3) concepts to be evolved in the new audit conceptualization.

5.1 Stochastic Opinion Rendering in a World of Statistics

The nearly "yes" or "no" nature of external audit reporting doesn't provide the types of insights or commentary that stakeholders may find informative. The audit literature has proposed over the years several forms of probabilistic reporting and more explanatory audit opinions. These would give more information to stakeholders, but in general the proposed methods are limited.

Associated with the concept of probabilistic reporting, the modern audit could benefit from a real-time auditor dashboard. The issues related to legal liability, stakeholder needs, and the natural reticence to change will tend to make this evolution challenging. However several commercial products and research efforts are developing these dashboards in internal audit organizations responding to real needs of system monitoring. Internal audits would provide additional value with the issuance of probabilistic reporting.

In general, materiality estimates relate to dollar value in relation to a value on a financial statement. For example, 5 percent of net income is compared with the total value of the account on an account-by-account basis. The audit literature has been linked to the concept of materiality for a long time. Clearly there are decreasing returns in the economics of

¹⁶ www.businessweek.com/articles/2014-03-13/target-missed-alarms-in-epic-hack-of-credit-card-data

¹⁷ www.reuters.com/article/2014/09/09/us-usa-home-depot-databreach-idUSKBN0H327E20140909

data evaluation and review. In the engineering sciences the concept of relative and acceptable errors are common. Unfortunately there are no precise definitions of materiality in the auditing standards literature (Elliott, 1986). Furthermore, information technology has changed the cost structure of both the benefits of an audit as well as the costs of performing audits by making information storage and retrieval very different.

The new environment changes the costs and benefits of assurance. Source documents are indexed and electronic. Analysis activities can be mainly automated. A wide net of automatic document reviews can be communicated to staff and serve as a serious deterrent to malfeasance. If auditor substantive processes can be formalized and support systems evolve towards all electronic processes, full population evaluations may be possible and desirable depending of a set of very different cost-benefit tradeoffs.

A new conceptualization of materiality may be needed now with different considerations of dimensions such as monetary value, volume of transactions, type of usage, and probability of outcome. Furthermore, for the audit to be more informative, it may be desirable to disclose more details of relative expected error and the auditor may create a product that provides a more detailed set of relative error assessments.

Furthermore, there are qualitative and quantitative aspects in audit decision making, as many of the analytic-based monitoring processes will be out of the eyesight of the auditors, there must serious thought given to automatically bringing relevant qualitative evidence to auditors.

5.2 New Audit Products

The creation of new digital products has faced a Cambrian moment (Siegele, 2014) of dramatic change where the cost characteristics of e-products (mainly fixed cost and very low marginal variable costs) are being reflected by the method of provisioning and charging for new products. Auditors need to develop layered monitoring systems with embedded elements such as sensors (for example, RFID, GPS, computer vision), analytic intelligence, and exception detecting and rerouting capabilities in order to provide additional assurance services.

Table 1-10 expands the conceptualization of the audit opinion and table 1-11 adds features that could be parts of the nature of the product. Clearly, unintended consequences and the legal environment would permeate the world of expanded assurances.

Table 1-10: Expanded Opinion Conceptualization

We have	The	For the period	And we found
Examined	Financial statements	Year	Materially correct
Monitored	Account	Month	Reliable to the 99% level
Analyzed	Transactions	Continuously or close to the event or in the appropriate frequency	The enclosed exceptions for the period
Prepared	Controls		The following alerts in the attached URL
Reported	Process		Correct with an acceptable error rate of 1%
Reported and verified	Outsourced process		
Shared examinations	Automated decision settings		The settings to be adequate to perform the continuous assurance function
	Security of user information such as social security numbers and passwords		The system vulnerable to serious attack

5.3 Management, Control, Assurance, and Other Meta-Processes Confusion of Concepts

It may be overambitious to attempt to resolve the confusion generated by the expansion of functions taken over by technology and their effect on the "lines of defense" discussed earlier in this essay. It suffices to understand that internal and external business related functions aim to achieve corporate objectives. The nature of the objective, the characteristic of job functions, the type of technology progressively being used, and the nature of the contractual relationship with vendors, assurers, suppliers, and customers will affect several management controls and assurance functions. The historically evolved set of rules and regulations that permeate the environment rely on definitions that may not be relevant in this age of automation and piggybacking (Siegele, 2014) of technologies and processes. Some examples of concept confusion include the following:

1. If a business has an audit group that reviews and decides on alarms found (Elder et al., 2013), are they performing an audit or a management function? By doing this are they losing their independence but as internal auditors still maintaining their objectivity?
2. If the auditor intervenes in the process when a flag arises, is he/she losing independence but as an internal auditor still maintaining objectivity?
3. If a system flags thousands of exceptions and only the "exceptional exceptions" are being examined by auditors, is this lack of due diligence?

5.4 Independence

Sarbanes Oxley required CPA firms not to perform a wide variety of consulting services for their clients. At first blush, this seemed a good step in light of the egregious aberrations of the Enron and WorldCom nature where the perception was the large audit fees paid for system services to the client blurred the vision and integrity of external auditors.

Likely the need for understanding large systems, partnership with internal organizations, and a dramatic set of environment-changing events¹⁸ may change the view of independence impairment and may revert to some degree of auto-policing and the redefinition of independence conflict. This statement is not aimed to really discuss independence, but it is an illustration of changing conditions that may change concepts in management function as well as the migration of functions to automation and their consequences on organizations, regulations, and social matters.

5.5 Migration of Functions to Automation

The original applications of computers focused on facilitating intensively computational tasks such as the calculation of trajectory tables for cannons in warfare, a task that was being performed manually by a large number of soldiers (Fishman, 1982). With the introduction of magnetic tapes into computer systems, and their sequential data organization, the business purpose of computers became obvious and hundreds of employees manually preparing utility bills were let go and replaced by massive process automation. Once the very obvious large labor replacement tasks were accomplished, demonstrating the economic benefits of automation became more complex. Typically IT solutions at a

¹⁸ Such as breaches in computer systems, cross country mergers, substantive integration of machine intelligence into decision making processes, and the integration of robots into corporate production processes.

more advanced stage improve data quality and processes but are not very closely tied to labor replacement. One of the key lessons from decades of IT and now analytic technology implementation is that to achieve the real benefits of substantially changed technology, processes much be rethought and reengineered (Hammer, 1990; Davenport, 1992, O’Leary, 2000).

Table 1-11: Imagined Automation, Migration of Functions, Technologies, New Processes and Methods

Technology	Automation	Migration of functions	New processes
RFID	Of inventory counts Verification of retail sales Verification or warehouse deliveries	Overlap between management, control and assurance	Inventory counts, inventory tracking, sales, purchases
GPS	Of payroll validation Of travel expenses		Employee work location and existence confirmation
Dashboards	Audit by exception (ABE) Audit plans are complemented by exception activators	Monitoring of alerts, macro process indicators	Auditor close to the event examination of perceived alerts
Cloud storage	Group based work-papers	Some work-paper functionality goes to audit black boxes	Some sharing of auditor files and black boxes between management and auditors
Big data	Process integrity monitoring is included in the audit process	Bots are integrated into process flows instead of human intervention	Creation of monitoring functions relating big data variables and assurance
Clustering	Automatic outlier detection processes are incorporated into the ecosystem	Outlier cluster measurements are automated	
Continuity equations	Process efficiencies are measured through inter-process equations	Process relationship equations are created, disclosed, and used for monitoring	

Table 1-11: Imagined Automation, Migration of Functions, Technologies, New Processes and Methods—*continued*

Technology	Automation	Migration of functions	New processes
Machine learning techniques	Predictive/preventive audits facilitated by better predictions. Predictive technology further expands audit by exceptions		
Process mining		Automatic transaction path analysis and monitoring is implemented	
Text mining	Of client acceptance and engagement renewal		Continuous client investigation examining news-pieces and social media
	Confirmations	Database to database population and value resolution	

Essay 4, "Reimagining Auditing in a Wired World" illustrates the blue sky scenario of a potential imaginary future audit. The ensuing fictitious vignette illustrates the potential prospective evolution of audit automation—progressively embracing different technologies and automating business processes, control methods, and its assurance layer and processes.

AIC auditors serve a large clientele mainly focusing on retailers. In order to improve its efficiencies over the years, AIC has implemented a series of changes in its technological capacity and methods of assurance. Its relation with CL Grocers (CLG) illustrates this fact.

- AIC convinced CLG to make agreements with its larger suppliers, banks, and clients to adopt a transaction and account level confirmatory protocol where, at pre-established intervals, CLG and its partners exchange confirmatory pings. A dashboard manages this process, which is shared between AIC and CLG, although with different reports.

- AIC runs on frequent basis text protocols examining social networks and news pieces for items relevant to CLG, its competitors, directors, managers, and employees.
- AIC has by and large changed to a risk-based audit by exception methodology whereby risk monitoring encompasses external and internal factors and the assurance effort coordinates with management.
- AIC has adopted a commercial system of automated working papers that track auditor keystrokes, phone communications, and several embedded modules in the client system on a constant basis.
- AIC and CLG cooperate on fine tuning a system of predictive analytics that creates forecasts for key accounts and processes of CLG. These are used for process monitoring, preventive monitoring, and for some of CLG's communications with its stakeholders.
- AIC's staff has a wide variety of skills, in particular IT and analytics, and has a very intensive lifelong training program. AIC also monitors its staff through external and internal information sources.
- Larger inventory items have RFID chips and their movement is recorded through the supply chain with the participation of external partners.
- AIC has a wide menu of assurance and advisory services it offers and it contracts not only with CLG but also many of its partners for services such as covenant monitoring, asset existence, process monitoring, financial statement assurance, and so on. The compensation for these services is mainly parameterized on the characteristics of CLG's business, not labor hours. AIC will also perform compensated work for the government relative to tax, ecology, and labor practices. The coordinated audit has many partners.

New protocols, technologies, and standards must cooperate in order to achieve a progressive layering and coordination of management, control, risk, and assurance functions. The following section discusses a symbolic view of what the audit ecosystem would entail.

5.6 The Audit Ecosystem

Businesses are now often described as ecosystems. A logistic supply chain is managed by a multitude of information flows, actors, and IT infrastructures within an evolving timeframe. *The Economist* described practical ecosystems:

Pioneers such as Amazon have built cloud-based "ecosystems" that make content such as its electronic books widely available. Even though the firm has its own e-reader, the Kindle, and has hatched a tablet computer too, it has also created apps and other software that let people get at their digital stuff on all sorts of devices, including PCs.

Other companies are developing their own ecosystems in a bid to make people's mobile-computing experience even more seamless. Google's recent \$12.5 billion acquisition of Motorola Mobility, which makes smartphones, tablets, and other gadgets, will enable it to produce a new crop of devices to show off its cloud services, such as Gmail and Google Docs, to best effect. Apple is stepping up its integration efforts, rolling out an "iCloud" in which people can store up to 5GB of content for nothing, and more if they pay. (Economist, Nov. 4, 2010)

Figure 1-9 represents a potential schemata for an audit ecosystem with a set of elements aimed at dealing with the emerging 21st century information technology environment (21CITA) (Kozlovski and Vasarhelyi, 2014).

Its main elements include the following:

- Examination of transactions and account levels at their entry point in the system, typically with process evaluation apps looking for a variety of generic problems with transactions such as incomplete or incoherent data, high loadings in potential fault discriminant functions, data out of the normal transaction stream, and so on.
- Examination of transactions / account levels using time-series, cross-sectional, and time-series cross-sectional analyses to detect aberrant transactions on a comparative and historical trend basis.
- Constant monitoring of the environment through soft bridges with social media, news pieces, competitor monitoring, and so on.
- Development and monitoring of mixed loading factor equations for exception detection.
- Large audit databases aimed at validation of daily feeds and collection of account-level data for cross-sectional analytics.
- Audit plans that are sensitive to risk levels and variations. The audit plan in a real time audit environment has to be adaptive contingent on changing conditions and rely on continuous monitoring of transactions (and adjustments) entering the system as well as monitoring the time series and cross-sectional trends.
- Hundreds or thousands of apps available in the environment respond by creating tests with the dynamic adaptation of assertions.

- Many of the apps would be autonomous agents either time activated (krons), circumstance activated (daemons), or audit plan activated.

Kozlovski and Vasarhelyi (2014) discuss agents in an audit context as follows:

The various agents presented by Papazoglou (2001) for use in a digital ecosystem are also applicable to an audit ecosystem:

- Application agents: CA/CM agents that are specialized to a single area of expertise and work in cooperation with other agents to solve complex audit problems are but one example of the many application agents that encompass an audit ecosystem
- Personal: (or interface) agent: Work directly with users, primarily client and provider staff, to help support the presentation, organization, requests, and information collections, such as providing user access to audit results
- General business activity agents: Perform a large number of general support activities such as search agents that navigate effectively through fragmented online electronic information in order to provide guidance to the CA/CM agents
 - Information brokering agents: Provide facilities such as locating information on Web sources or other agents that are required to solve a common problem, such as specialized agents to support CA/CM agents in addressing data anomalies, for example
 - Negotiation and contracting agents: Negotiate the terms of a business transaction as regards to exchange and payment, as is required when transacting for audit services
- System-level support agents: Provides objects with access not only to other application objects but also to such facilities as transaction processing when acquiring audit services
 - Planning and scheduling agents: a multi-agent plan is formed that specifies the future actions and interactions for each agent. Typically, an agent may act as the group planner for a cluster of agents surrounding an application agent such as to support multiple CA/CM agents analyzing big data simultaneously, for example

- Interoperation agents: Audit processes may require accessing information from legacy systems and CA/CM agents from separate providers
- Business transaction agents: Can be used to determine new CA/CM product offerings to incorporate in the audit ecosystem
- Security agents: Provide security measures for information, communications and data to or from the audit ecosystem (Based on Papazoglou 2001).

Kozlovski and Vasarhelyi (2014) also discuss the characteristics of an audit ecosystem in figure 1-9. It represents the many characteristics of an audit ecosystem in a single view including attributes, features, and software agents. The schema presented in figure 1-10 complements figure 1-9 as it focuses on the dynamics of transaction processing, rather than on detailed characteristics.

Figure 1-9: Audit Ecosystem Characteristics (Kozlovski and Vasarhelyi, 2014)

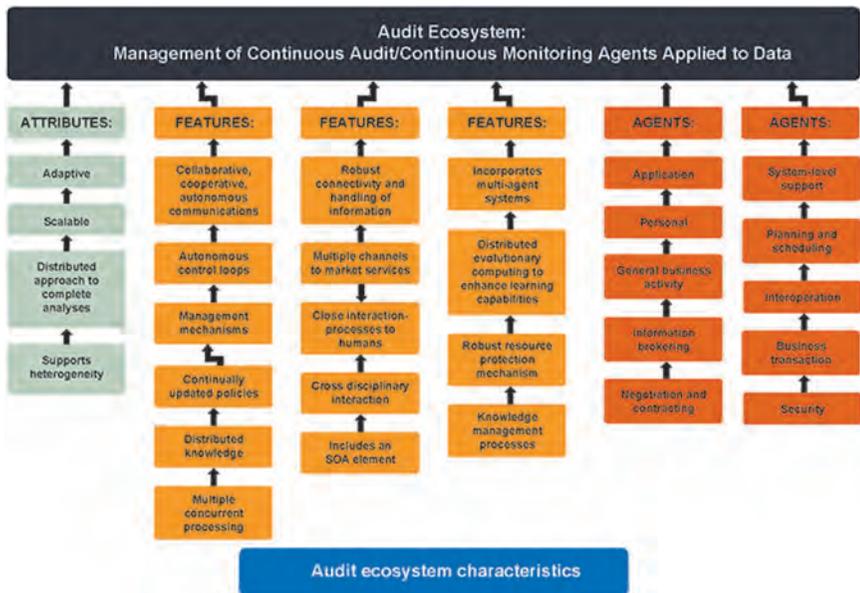
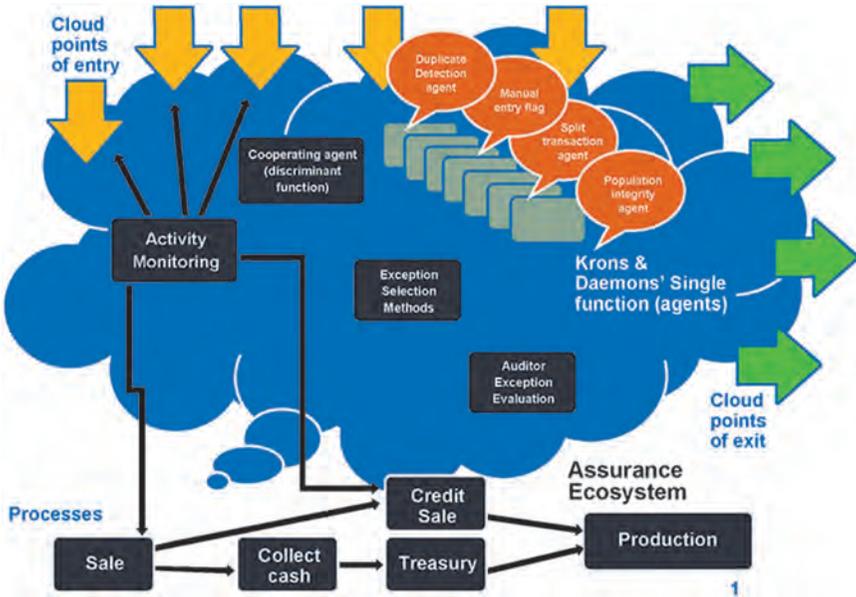


Figure 1-10: The Audit Ecosystem



The 21CITE promises different levels of integration between the organization and its data environment. The data sources to be scrutinized closer are in internal data, and often outsourced data requires reliance on a third party (the auditor of the outsourcer). As experiences with viruses and control structures, new forms of technology, analytic methods, and human inventiveness constantly change the panorama, new forms of fraud, as well as weaknesses in software, are constantly appearing and must be considered.

6. CONCLUSIONS

The rapidly accelerating pace of technological change has created a social drag where socioeconomic systems hold back technological progress. The ubiquity of computers in the performance of business processes brings the need for strict formalization of legal and business rules (Kraheil, 2011) and automation has also resulted in a change in economics. This essay sets the groundwork for the evolution of continuous assurance initially formulated by Groomer and Murthy (1989) and Vasarhelyi and Halper (1991) and divulged by the publication of the CICA and AICPA continuous auditing guidance (Red Book, 1999) later supplemented by the IIA (2003) and ISACA (2010).

The early work on CA focused on using the benefits of automation to perform a more frequent and deeper audit. This essay emphasized a wider frame of thought by considering the effects of technological change on business and the role of a more continuous form of assurance, with different economics, conditions, and processes than are used today.

In this new environment there are no reasonable limits of sources of data, but there are great limits on what data an organization can actually store and make useful. Data will tend to exist to support particular decisions or processes, but the great challenge is to anticipate needs and create software and processes for its examination. The costs of system development, improvement, and overlay obey much different rules than the traditional fixed and variable cost managerial accounting model. The fact that many IT provisioning economic models are charged on an incremental basis proportional to usage will change the profession's usage of technology.

The new environment of audit is a mix of technology (TDA), analytics (ABA), and human (HBA) efforts just as in the past, but the dramatic evolution of TDA and ABA makes it necessary to change business processes, legislation, regulations, and consequently HBA.

The introduction of IT-based analytic monitoring is the introduction of meta-processes, meta-controls, and meta-management functions. These meta functions, such as meta-data providing data about data (for example, in XBRL), meta-control (information about controls being extracted from ERP systems), or meta-control of controls (information about the control of controls), provide increasing conceptual confusion between what auditors and managers should do. The modern IT environment is aggravating this problem. Migration between functions is happening and requires new flexible conceptualizations.

The need for increased verification due to the many layers of technology adding opacity and a more complex society has led to many levels of ALO and the recommendations of the King Commission (Institute of Directors in Southern Africa, 1994, 2009). The new continuous audit model aims to liberate from these shackles, creating a new set of assurance opinions and functions to be provided by the assurance function in a partnership of management, internal control, internal audit, and external audit.

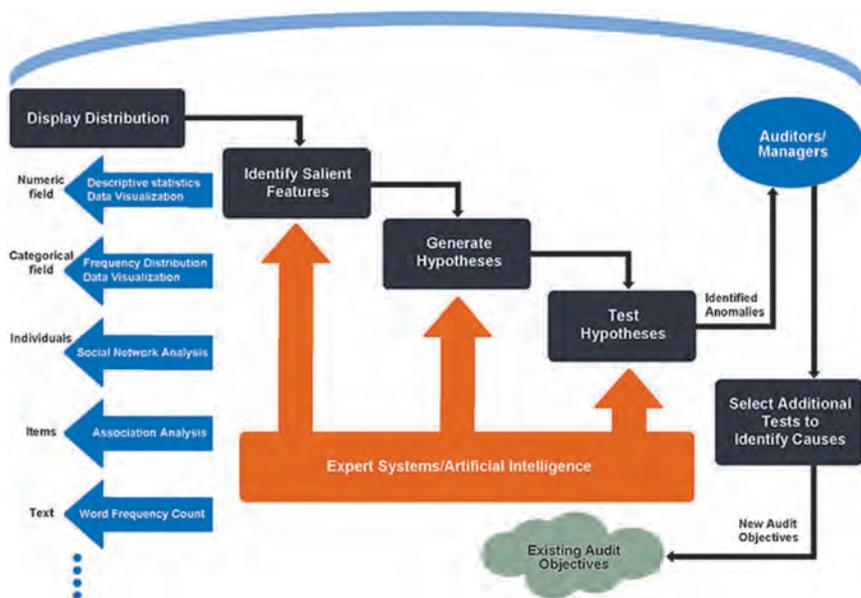
6.1 The New CA

The major changes to CA that are emerging and should be permeating the audit environment, and hopefully standards, are as follows:

- Progressive adoption of a standard data interface to allow for the usage of assertion and analytic based apps.

- The need to incorporate exploratory data analysis into extant audit methodology. Liu (2014) proposes such a step in figure 1-11 where she expects intelligent modules to interface with a wide variety of data sources.
- Progressive impounding of audit apps into the operating environment.
- The evolution of an audit ecosystem with a progressive level of automation over financial and non-financial systems.

Figure 1-11: EDA and CA (from Liu, 2014)



CA Can Be Redefined As

a methodology that enables auditors to provide assurance on a subject matter for which an entity's management is responsible, using a continuous opinion schema issued virtually simultaneously with, or a short period of time after, the occurrence of events underlying the subject matter. The continuous audit may entail predictive modules and may supplement organizational controls. The continuous audit environment will be progressively automated with auditors taking progressively higher judgment functions. The audit will be by analytic, by exception, adaptive, and cover financial and non-financial functions.

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²⁰ CPAS stands for Continuous Process Auditing. CCM stands for Continuous Control Monitoring.

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ESSAY 2

The Current State of Continuous Auditing and Continuous Monitoring¹

Paul Eric Byrnes, CMA
Brad Ames, CPA, CISA, CRMA
Miklos Vasarhelyi, PhD

INTRODUCTION

The AICPA Assurance Services Executive Committee's Emerging Assurance Technologies Task Force is drafting a series of white papers to serve as an update to the 1999 "Red Book" project entitled *Continuous Auditing* (CICA/AICPA 1999). The primary purpose of this introductory white paper is to facilitate an understanding of the extent to which the applications of CA/CM have changed during the previous 12-year period. In addition, this paper is designed to briefly explore related issues and set the stage for associated white papers that will be subsequently developed.

Data for this undertaking was collected using a two-phase approach. First, a comprehensive, open-ended questionnaire was formulated and distributed primarily to the Big 4 accounting firms in an effort to assess variables pertinent to CA/CM usage and perspectives. Second, follow-up interviews were conducted both to clarify survey responses as well as to

¹ First published in October 2012 from the AICPA Assurance Services Executive Committee (ASEC) Emerging Assurance Technologies Task Force.

obtain complementary information. As the project unfolded, four primary questions emerged as the most relevant in addressing established objectives:

1. What are firms doing with CA/CM?
2. What CA/CM products and services could firms provide?
3. What could organizations such as the AICPA or Public Company Auditing Oversight Board (PCAOB) do to facilitate the adoption and use of CA/CM?
4. Do firms have the necessary internal expertise to provide the array of CA/CM options and what is the desired skillset for dispensing such services?

As data was accumulated and analyzed, some trends were observed that ultimately provided a snapshot of where CA/CM exists today. There are major challenges and barriers to achieving widespread adoption and proliferation of CA/CM practices. Interestingly, this is particularly evident in the area of external auditing, although there has been some limited progress in the internal audit area (Vasarhelyi, et al 2012). In presenting the relevant findings, each of the preceding primary questions will be addressed in order of original presentation.

CURRENT ENVIRONMENT

The general view is that not much is currently being done with CA/CM. In reality, this synopsis is not as pessimistic as it appears. Specifically, some positive gains in usage are being noted in the area of internal auditing. For the most part, this entails the collaboration of advisory services divisions of public accounting firms with internal audit clients in implementing CA/CM devices and methods. There are also instances where organizations are outsourcing their internal audit functions and this could conceivably create additional CA/CM opportunities for audit firms. On the other hand, direct CA/CM implementations by external auditors have not noticeably increased and there are specific reasons for this situation. One important consideration is the idea that CA/CM is a costly undertaking and payback period, which is often projected to be quite lengthy. The perceived instability of audit relationships is an element that interacts unfavorably with the cost and payback period variables associated with potential projects. Another impediment exists because many businesses are protective of their data and, therefore, reluctant or unwilling to allow comprehensive and ongoing access to systems by outside parties, including external auditors.

On a positive note, the public accounting arena seems to be encouraging organizations to internally develop and implement CA/CM programs. In

doing so, auditors are ultimately seeking to leverage the use of these devices in conducting external audits. For example, if an audit client has an effective CA/CM system in place, then the external audit team may be positioned to use data generated by this system in order to conduct the external audit in a more efficient and effective manner. In such cases, this has the potential to create beneficial situations for both parties. In other words, the auditing firm would have access to more comprehensive and timely information and would therefore be able to perform a higher quality audit that consumes fewer resources relative to traditional methods. In addition, because of increased efficiency, the audited organization would presumably sacrifice fewer resources in obtaining the external audit services. Clearly as more businesses recognize the value of CA/CM, one might expect to see an increase in this type of behavior, particularly if favorable outcomes are likely to exist for the involved parties. To facilitate an understanding of this collaboration process, the appendix of this white paper presents a recent implementation at Hewlett-Packard Company. At this point, with an understanding of the general state of CA/CM, an exploration of potential CA/CM products and services will now be investigated to provide an appreciation of the manners in which they could affect both the accounting profession and business community.

PRODUCTS AND SERVICES

Initially, CA/CM tool usage might be envisioned as existing on a continuum, from relatively basic monitoring of a particular target area of risk such as accounts payable, to very elaborate auditing systems that yield continuous assurance capabilities such that audit opinions can be maintained in an ongoing manner. Specific CA/CM service opportunities include converting from manual to automated data, controls, and processes; designing controls around processes; formulating tests and monitoring routines; dispensing operational risk management services; and providing full service packages including tools, installation, setup, training, and maintenance.

CA/CM consists of many diverse elements and may be implemented at various levels of sophistication. One of the key features of CA/CM is its ability to provide relevant information in more of a real time context. If a solution is installed, maintained, and utilized as intended, it has the capability to assist in mitigating or even preventing problems in identified risk areas. This is in sharp contrast to the reactionary context in traditional external auditing, whereby annual sampling and testing is conducted to discover whether problems occurred during the fiscal period under investigation.

The traditional approach is suboptimal for at least two reasons. First, the manual audit is based on a sampling of records in identified risk areas and therefore may fail to capture all relevant data. Second, even if problems are uncovered, the lag between event occurrence and detection may be too significant to allow for sufficient remediation and recovery. For example, Company X has an annual audit conducted in January relative to the previous calendar year. An examination of sampled transactions uncovered a material fraud that was successfully perpetrated during the first quarter of the accounting period in question and resulted in a significant diversion of assets. In this case, the damage went completely undetected for an extended period and, as such, the likelihood of the firm fully recovering from the loss is lower than if the issue had been identified sooner. An effective CA/CM mechanism would have uncovered the fraudulent activity in the formative stages and, as a consequence, resource loss could have been minimized or perhaps avoided entirely.

CA/CM has the potential to radically reformulate the manner in which businesses operate. The area shows real promise in contributing to organizational efficiency, effectiveness, and long-term profitability. However, areas of CA/CM appear to be struggling for acceptance and are in a state of tenuous growth. Moving forward, perhaps more advocacy mechanisms are necessary.

PROMOTION EFFORTS

During discussions with survey participants, three items in particular emerged as potential keys for achieving increased implementation of CA/CM practices. First, standards modification by the PCAOB was cited as being important in facilitating a shift away from the old workplace mentality of manual sampling and testing in audits to an automated and comprehensive approach with CA/CM as the foundation. For example, during the external audit, certain actions, such as physical observation of inventories, are required regardless of the robustness of controls in place throughout the organization. The argument against such observation activities holds that, if controls are sufficient, particular verification routines become unnecessary and wasteful of resources. Generally, some believe that auditing standards have not been refined appropriately as changes in technology, processes, and controls have evolved. Consequently, many of the current auditing standards are viewed as antiquated and irrelevant.

Second, many concerns about CA/CM relate to its apparent level of sophistication. As such, another suggestion is that the AICPA could assist with advocacy efforts by periodically issuing guidance or white papers on various topics of relevance. More specifically, such subjects could

include explaining CA/CM in terminology that facilitates enhanced understanding, training relative to implementation and usage, demonstrating application value, and specifying how CA/CM might ultimately transform business operations. Basically, if practitioners are made more aware of CA/CM, understand its concepts and applications, and identify with the overall value proposition, these individuals will be more likely to embrace and pursue CA/CM initiatives. This white paper and the series of ensuing AICPA CA/CM white papers are intended to start addressing this opportunity to educate the market concerning the potential of CA/CM as well as identify with the inclusion of audit data standards within this domain.

Third, it is believed that a formal endorsement of the desirability of CA/CM by standard setting bodies such as the PCAOB would be useful for transitioning organizations from traditional manual auditing methodologies to the more automated domain. However, until a greater level of awareness is achieved, it is probable that CA/CM will continue to struggle for acceptance. Whether or not significant momentum is eventually generated, discussions logically transition to skillset considerations and whether accounting practitioners possess the capabilities necessary to handle CA/CM initiatives.

SKILLS REQUIRED

Preliminary indications are somewhat mixed concerning whether current accounting professionals maintain the competencies to perform CA/CM services. One view is that the present generation of accountants lacks the requisite skillset to sufficiently provide these services. Another perspective contends that the desired expertise is scattered throughout the firm and, as a result, there is no single individual who would typically be regarded as a CA/CM expert. These viewpoints may initially appear somewhat discouraging. However, even if these perceptions are able to be generalized, they still do not pose an insurmountable threat, particularly when one reflects upon the desired skillset elements as defined by accounting firms in this study. The competencies identified by survey participants include the following:

- An audit foundation
- Knowledge of business processes, controls, and inherent risks
- Internal audit experience
- Familiarity with audit planning, audit processes, and forensic accounting
- An understanding of data extraction tools (IDEA, ACL)
- Data analytics background (regression, ANOVA, data mining, SQL, probabilities)

- Knowledge in statistics
- Technical skills (ERP, programming)
- Professional skepticism and judgment

The areas delineated in the preceding list certainly present challenges for many current accounting students and practitioners. Some of the elements are not substantive components of traditional four year accounting programs (for example, technical and analytical areas) and certain items, such as forensic accounting, reflect relatively recent additions to the accounting discipline. Some capabilities would also be primarily developed through relevant and extensive field experience. Consequently, a CA/CM specialist would most likely be a well-seasoned practitioner who has developed extensive audit experience, pertinent technical and analytical expertise, and the ability to employ professional skepticism and judgment as necessary. Such an individual would also need to engage in ongoing education relative to emerging concepts, trends, and technologies in auditing and accounting. Therefore, the combination of diverse attributes needed to be considered a CA/CM expert is such that this designation might be expected to be held by a small minority. Whatever the case, it may actually be more realistic to envision that many CA/CM initiatives of the near future would be handled by cross-functional teams, especially when the scope of activity is substantial. In such cases, perhaps a CA/CM specialist with proven project leader experience could be enlisted to guide the team in completing all necessary objectives.

SUPPLEMENTAL FINDINGS

Respondents also communicated other points of interest concerning CA/CM. The results were generally mixed and suggested that additional efforts are needed relative to the promotion and adoption of CA/CM practices. More specifically, participants provided revealing commentary in areas such as recruitment tactics, client perceptions, and prioritization issues.

Only half of the firms indicated they actively recruit for CA/CM. It is, however, generally larger firms that emphasize hiring individuals with CA/CM backgrounds and skills. Furthermore, audit automation is currently in a state of development and is slowly increasing in terms of application. Taken collectively, this might indicate that smaller firms will eventually be more inclined to recruit for CA/CM as adoption and utilization continue to expand.

Some respondents felt that client understanding of CA/CM was quite limited, particularly at the top management or board levels. This is a disconcerting situation for several reasons. Initially, it is well documented

that tone-at-the-top is a dimension that has a significant influence upon organizational culture and resulting perspectives and behaviors (Merchant and Van der Stede 2007). Furthermore, this tone can be a key factor in determining whether or not certain initiatives are promoted, valued, and explored at lower management and operational levels. If top management maintains an insufficient understanding of CA/CM products and services, there is a reduced likelihood that employees at lower levels of the organization will be poised to actively pursue such solutions. Therefore, if CA/CM is to move forward more fluidly, it is vital that personnel at the board and top management levels better understand and identify with the benefits of CA/CM products and services.

Participants clearly stipulated that a high priority exists relative to improving the use of CA/CM in conducting financial statement audits. Furthermore, it is believed that the accounting profession needs to establish a vision for the future concerning the CA/CM domain. Related to this vision concept, respondents provided three important guidelines. First, they mentioned that audit processes need to be modified as changes occur with respect to technology and information availability. Second, they indicated that a greater utilization of CA/CM products and services is essential. Third, respondents argued that robust CA/CM is ultimately desired such that audit opinions may be available on a continuous basis and removed when substantive negative evidence surfaces. This final viewpoint has been alternatively referred to as the evergreen opinion and might well reflect the optimal state concerning application of CA/CM in practice.

CONCLUSIONS

In summary, organizations are not yet reaping the entire array of benefits that CA/CM could yield. Although some noteworthy gains have been made in internal auditing, there has not been a corresponding increase in external audit applications. In addition, there is an extensive set of products and services that may be provided by practitioners under the CA/CM umbrella. However, these offerings require a diversified skillset for effective implementation and management. At this juncture, there is a level of incongruence between the competencies needed and the skills being acquired by the typical modern accounting professional. CA/CM has also not yet established a fully successful marketing campaign. In response, if the value of this approach can be effectively demonstrated, documented, and disseminated, and if groups such as the AICPA and PCAOB become key players in the education and advocacy efforts, it is plausible to envision that CA/CM will eventually realize its full potential.

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APPENDIX—CONTINUOUS AUDITING AND CONTINUOUS MONITORING IN ACTION

Introduction

An excellent example of how firms are leveraging the use of technology in conducting monitoring and auditing activities may be noted at Hewlett-Packard Company (HP). In this context, HP's internal auditing department has been an instrumental force in devising an automated system to capture, analyze, and communicate key business data, metrics, and transactions to support better decisions regarding risk. Furthermore, HP demonstrates an ongoing commitment to embracing current technologies in conducting business analysis and oversight, giving the organization a definite competitive advantage. One recent implementation example is the Decision Support and Analysis Service Internal Audit (DSAS/IA) Database Project, which comprises several important features. At the onset, it should be noted that all data presented in subsequent figures is completely fictitious and designed only for illustrative purposes.

SAP Key Performance Indicator

Initially, utilizing the SAP environment, the SAP key performance indicator (KPI) solution has been deployed to capture and communicate pertinent KPI measures as needed. This information is then made immediately available to the internal audit staff via Web download and retained in the DSAS/IA Oracle database for future access and usage. This clearly provides for the dissemination of critical data analytics to users such that they are readily positioned to promptly respond to changing business conditions and circumstances.

DSAS/Audit Command Language

SAS/Audit Command Language (ACL) is used for extracting relevant transactional data and files from the DSAS/IA database, as well as accumulating facts from other points such as unstructured data from external feeds. In addition, when an instance of data extraction occurs, the material is presented through a website. From this location, the information is able to be transferred to and accessed by authorized internal audit staff, external audit personnel, and business unit management to assist with oversight or operational activities. Furthermore, the data provided to external audit is prevalidated by the internal audit staff and, therefore, may be readily relied upon. This is an extremely important feature that builds trust in the data and facilitates audit effectiveness and efficiency.

DSAS Database

The DSAS Database Table Content Query Screen enhances query development and processing via a user-friendly point-and-click atmosphere containing convenient drop-down lists, selection windows, selection bubbles, and so forth. In addition, query information is presented in the Standard XML Excel Spreadsheet for Reports environment from which the material may be exported to, analyzed, and evidenced in the Microsoft Excel Spreadsheet context according to an audit data standard. Furthermore, this query building mechanism is often used in providing information to external auditors. These auditors are then able to perform an array of relevant operations with the information, such as benchmarking activities. Overall, the aforementioned functionality greatly simplifies query generation and empowers users to better harness the capabilities that query building offers (figures 2-1 and 2-2).

Figure 2-1

The Decision Support and Analysis Service (DSAS) Database Table Content Query window assists users in the query development process with various prompts, selection options, and drop-down lists. In addition, it allows for providing information in accordance with audit data standards to external auditors.

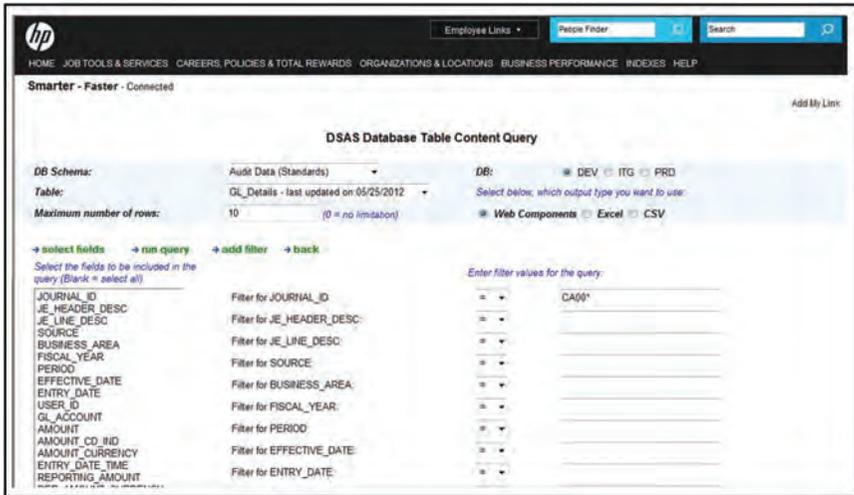


Figure 2-2

According to audit data standards, the following is a query result set as a function of values and options chosen in the Decision Support and Analysis Service (DSAS) Database Table Content Query Window.

Table content:

back to selection new window

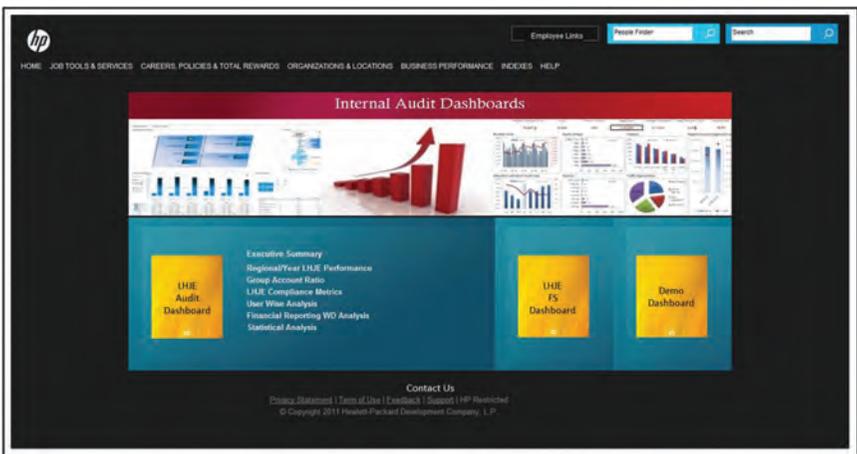
JOURNAL ID	JE HEADER DESC	JE LINE DESC	BUSINESS AREA	FISCAL YEAR	PERIOD	EFFECTIVE DATE	ENTRY DATE	USE
CA00-517679	6424295629	XC16183295/W5231	IA R700-PSG Support	2017	10	01-AUG-17	19-AUG-17	WWW00
CA00-517679	6424295629	XC16183308/W5243	IA R700-PSG Support	2017	10	01-AUG-17	19-AUG-17	WWW00
CA00-517679	6424295629	XC16194766/WR278	IA R700-PSG Support	2017	10	01-AUG-17	19-AUG-17	WWW00
CA00-517679	6424295629	XC16194811/WR277	IA R700-PSG Support	2017	10	01-AUG-17	19-AUG-17	WWW00
CA00-517679	6424295629	XC16195042/WR277	IA R700-PSG Support	2017	10	01-AUG-17	19-AUG-17	WWW00
CA00-517679	6424295629	XC16195108/WR277	IA R700-PSG Support	2017	10	01-AUG-17	19-AUG-17	WWW00
CA00-517679	6424295629	XC16196202/WR278	IA R700-PSG Support	2017	10	01-AUG-17	19-AUG-17	WWW00
CA00-517679	6424295629	XC16205247/W2793	IA R700-PSG Support	2017	10	01-AUG-17	19-AUG-17	WWW00
CA00-517679	6424295629	XC16205387/WRS44	IA R700-PSG Support	2017	10	01-AUG-17	19-AUG-17	WWW00
CA00-517679	6424295629	XC16205506/WRS17	IA R700-PSG Support	2017	10	01-AUG-17	19-AUG-17	WWW00

Dashboard Feature

The system contains an internal audit dashboard feature whereby key metrics and trends are captured and displayed in a variety of graphical and tabular formats that enable users to easily visualize pertinent information and detect problems at a glance. The main internal audit dashboard window also maintains other functionalities including, but not limited to, executive summaries (figure 2-3).

Figure 2-3

The Internal Audit Dashboard window displays pertinent metrics in a convenient fashion.



The internal audit (IA) dashboard also provides critical operational information, group account data and ratios, compliance and performance metrics, business reporting analyses, and so forth. First, the auditors believe that manual journal entries (MJE) applied during the standard closing process carry more risk than other MJEs. With this in mind, the Workday Analysis feature depicts MJE activity occurring during the accounting closing period and is able to display this information for three accounting periods at a glance. In general, MJEs generated during the first day of closing (WD1) represent less risk than those posted on subsequent days. Furthermore, the risk and day attributes maintain a positive relationship such that risk increases as MJEs are applied later in the closing process. As such, periods that have a greater percentage of MJEs applied near the conclusion of closing may be targeted for further investigations. For added utility, the audit tool displays MJE activity by account category to isolate areas where deeper inspections are warranted (figure 2-4).

Figure 2-4

Financial Close Workday Analysis: In the upper charts, closing period manual journal entry (MJE) activity is displayed for each accounting period by workday (WD) using a color coding scheme. In the lower table, MJE metrics are presented by account category. In this example, the account most impacted by post-closing MJEs in each period is Cash. This finding, in addition to the fact that Cash is inherently a high-risk account, suggests that further analyses may be advised in this area.



(Amounts in Billions)

Second, the general ledger (GL) Account Wise Analysis function aggregates information by account type to display various pertinent metrics. In fact, multiple levels of aggregation are available to facilitate drilldown operations. For example, a level 2 view, which is a single drilldown from level 1, results in GL account groupings identical to those shown in figure 2-5. Similar to other IA dashboard tools, emphasis is again placed upon looking at MJE activity. However, additional information is captured relative to trial balance (TB) and manual journal voucher (MJV) values.

Figure 2-5

The GL Account Wise Analysis screen depicts pertinent trial balance (TB), manual journal voucher (MJV), and manual journal entry (MJE) information by account type. As an example, MJE debits in the Cash account group represent 75 percent of the TB debit amount (MJV Debit amount or TB Debit amount). In this example, the MJE information in the Cash and Equities groups is highlighted for further investigation.

GL Group	TB Debit Amount	TB Credit Amount	TB Annual Movement	MJV Debit amount	MJV Credit Amount	MJV Net Amount	% of MJE Amount-Debit	% of MJE Amount-Credit	% of MJE Amount-Net
01 Long Term Assets	423	(405)	17	151	(134)	17	36%	33%	100%
02 Cash	1,239	(1,239)	(1)	927	(925)	2	75%	75%	-311%
03 Inventory	516	(516)	0	28	(34)	(6)	5%	6%	-4982%
04 Receivables	846	(843)	3	272	(321)	(49)	32%	38%	-1586%
05 Other current Assets	274	(275)	(1)	106	(112)	(6)	39%	41%	754%
06 Equities	111	(100)	11	84	(76)	8	76%	76%	76%
07 Long Term Liabilities	54	(58)	(4)	36	(40)	(4)	68%	69%	83%
08 Short Term Liabilities	821	(829)	(8)	278	(229)	49	34%	28%	-638%
09 Revenue	67	(263)	(196)	19	(24)	(5)	29%	9%	3%
10 Contra	331	(230)	102	17	(17)	(0)	5%	7%	0%
11 Cost of Sales	405	(327)	78	42	(37)	4	10%	11%	6%
12 Misc Income	121	(137)	(16)	83	(97)	(15)	68%	71%	91%
13 Expenses	84	(70)	14	32	(28)	3	38%	41%	23%
Grand Total	5,292	(5,292)	0	2,074	(2,074)	(0)	39%	39%	-1%

(Amounts in Billions)

Third, the KPI tool provides specific risk measures, displaying each in terms of percentage of total MJEs and aggregate number of postings. Furthermore, for each attribute, the system divulges the 5 countries that contribute most significantly to the associated KPI value. For example, in figure 2-6 there were 318 MJEs posted by terminated users during the period in question. Also, the 5 countries contributing most to the accumulation of these entries were 34, 59, 213, 106, and 101. Given the high risk associated with this KPI, the entire array of transactions might warrant further analysis. In addition, all or a subset of the 5 identified countries might be subjected to more indepth outlier analysis, particularly those countries demonstrating a pattern of riskiness via other analytical procedures. Country 34, for example, is also reported more frequently in other KPIs and this suggests that this region deserves a closer examination. Taken collectively, the KPI feature contributes to making sampling decisions relative to detailed testing operations as well as identifying locations having the highest risk factors.

Figure 2-6

The Key Performance Indicator (KPI) Performance tool supplies useful metrics for various risk assessments and assists with the coordination of detailed testing routines.

KPI Description	% of Total MJE	No. of Postings	Top 5 countries Contributing to the KPI
1. Amount > \$50MM	0.2%	3,593	Country123, Country34, Country56, Country144, Country2
2. Amount rounded to zero	0.5%	9,518	Country2, Country34, Country209, Country66, Country101
3. Postings on Holidays	5%	87,153	Country2, Country59, Country144, Country87, Country9
4. Amounts with 99 (potential split transactions)	0.05%	860	Country2, Country34, Country74, Country109, Country38
5. Postings by Terminated Users	0.02%	318	Country34, Country59, Country213, Country106, Country101
6. Postings without the Description	32%	594,709	Country2, Country34, Country144, Country96, Country12
7. Posting Date and Document date in different months	2%	37,681	Country2, Country34, Country186, Country94, Country9
8. MEC Postings on first 3 days & last 3 days of the month	47%	870,990	Country56, Country67, Country209, Country101, Country12
9. Fiscal month and Posting month are not Same	0%	-	-
10. JE's Created date beyond WD Calendar	0.004%	65	Country2, Country34
11. JE's Posted with Group Currency only	2%	33,080	Country209, Country101

Fourth, the Business Area Analysis functionality isolates pertinent MJE debit and credit values by business segment and amount range and this contributes to optimizing efficiency relative to auditing processes. For example, for the accounting period depicted in figure 2-7, business segment F generated \$955 million in MJE debit postings wherein each entry was less than \$10,000. Whether this was problematic would depend upon a number of factors, such as recent acquisitions or large accruals. Whatever the case, having the capability to assess MJE activity via the dimensions of business unit and amount grouping offers yet another valuable view when conducting audit activities.

Figure 2-7

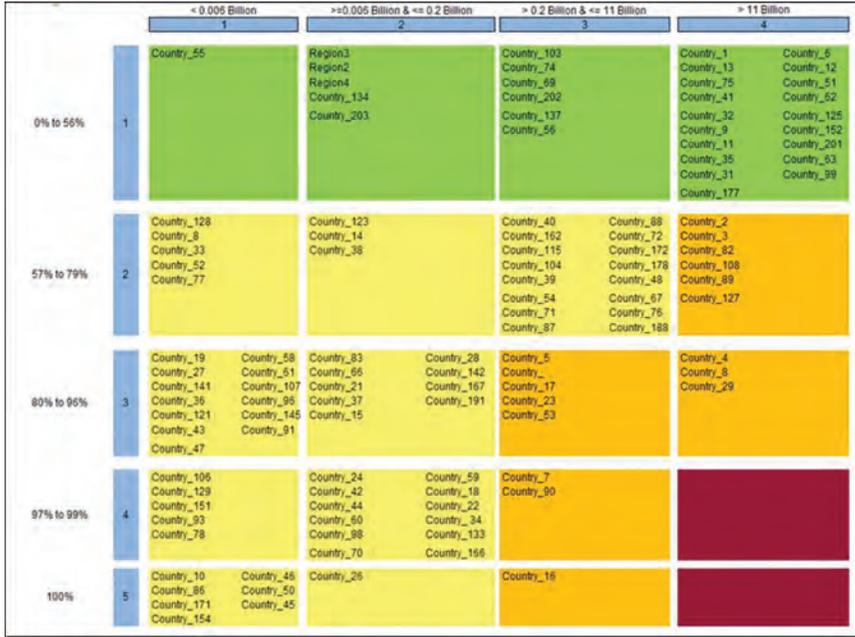
The Business Area Analysis window presents manual journal entry (MJE) debit and credit information by amount range at the business unit level.

Business Segment	DEBIT				CREDIT			
	01. <10K		02. >=\$10K		01. <10K		02. >=\$10K	
	Group Amount	% of Group Amount	Group Amount	% of Group Amount	Group Amount	% of Group Amount	Group Amount	% of Group Amount
A	29	0.77%	56,911	1.89%	(29)	0.76%	(56,711)	1.88%
B	119	3.16%	2,345	0.08%	(119)	3.16%	(2,145)	0.07%
C	1,121	29.83%	80,386	2.67%	(1,129)	30.05%	(79,386)	2.63%
D	772	20.57%	360,560	11.96%	(770)	20.51%	(368,560)	12.23%
E	94	2.51%	99,687	3.31%	(94)	2.51%	(95,687)	3.17%
F	955	25.44%	99,312	3.29%	(954)	25.41%	(97,312)	3.23%
G	643	17.11%	2,290,501	75.98%	(640)	17.04%	(2,290,501)	75.98%
H	23	0.61%	24,870	0.83%	(21)	0.56%	(24,270)	0.81%
Grand Total	3,756	100%	3,014,573	100%	(3,756)	100.00%	(3,014,573)	100%

Last, the Grid Analysis feature classifies countries and regions according to total TB amounts as well as the percentage of total MJVs. More specifically, in figure 2-8 the 5 categories delineated down the left side of the matrix correspond to the percentage of total journal vouchers that are manually created. Similarly, the 4 groups displayed across the top of the grid represent total trial balance dollar values. Essentially, each country or region is ranked along these 2 dimensions such that riskiness may be readily observed. In figure 2-8, Country_55 exclusively occupies the block representing the intersection of row 1 and column 1 (category of least risk). For the period under analysis, this country has less than \$.006 billion in total TB value, generated no more than 56 percent of its journal vouchers manually, and would be perceived as the least risky country via the Grid Analysis operation. In addition to evaluating riskiness, this procedure also facilitates the discovery of better performing countries and regions such that best practices may be identified and disseminated.

Figure 2-8

The Grid Analysis function categorizes countries and regions by total trial balance amounts and manual journal vouchers as a percentage of total journal vouchers.

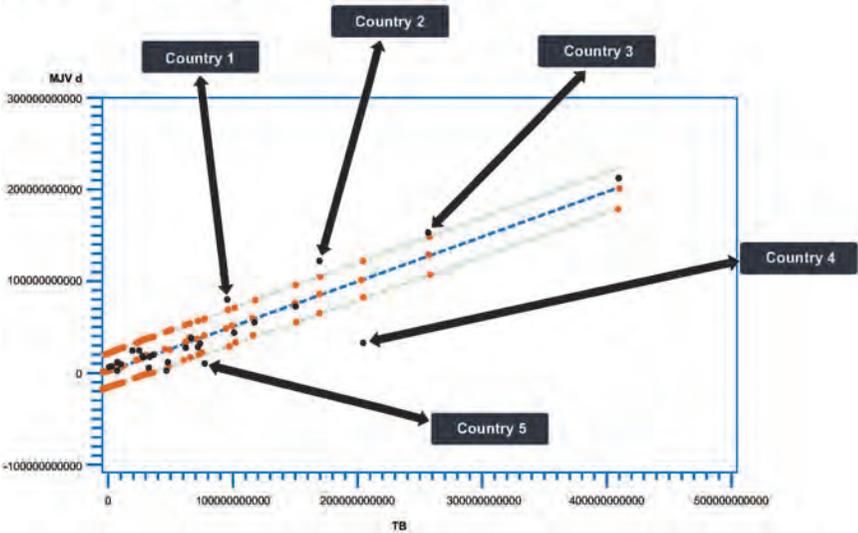


In addition to the preceding capabilities, the continuous auditing and continuous monitoring system is able to perform statistical analyses and employ methods such as Benford’s Law and linear regression. For example, related data of interest may be used to construct a line of best fit via linear regression. A confidence band may then be established for this line and resulting outliers identified. Any points falling outside and above the confidence interval would be regarded as problems requiring closer investigation. Conversely, any points located within or below the confidence band would not be perceived as troublesome. However, such points would likely be explored in an effort to discover and communicate pertinent information relative to best practices. In a specific example illustrated in figure 2-9, a positive relationship has been noted by country between trial balance amounts and number of manual journal entries. As such, a regression equation was constructed that reliably represents this association. Then, a 95 percent confidence interval was created around the regression line. When the line, confidence band, and actual data points were plotted, issues became glaringly apparent.

Figure 2-9

The following figure represents use of linear regression in conducting data analysis. The three points identified outside and above the confidence band pertain to unfavorable outliers that need further investigation (Countries 1, 2, and 3). The two points falling outside and below the confidence band pertain to favorable outliers that would likely be investigated to uncover company best practices information.

95% Confidence Interval



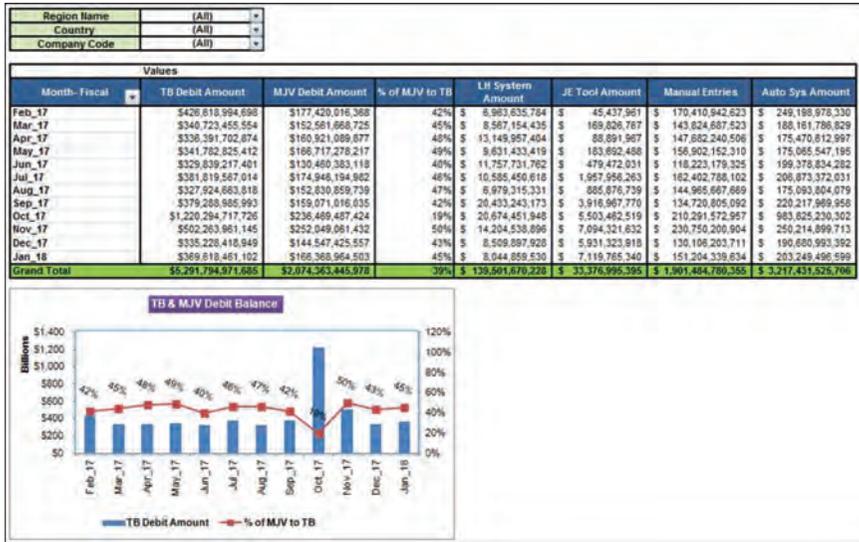
The ability of the preceding regression procedure to assist in the discovery of outliers and exceptions clearly makes the oversight process significantly more efficient.

In addition to the previously noted internal audit dashboard benefits, the module offers other noteworthy strengths:

1. Any of the pertinent data may be readily provided to external audit personnel and other interested parties through an intranet website.
2. Extensive drilldown capabilities facilitate data disaggregation tasks. For example, in conducting global analytics, a user may start with region (for example, the Americas) and proceed to drill down through the layers of geography, business unit, process, and so forth (figure 2-10). Ultimately, the individual could isolate a particular record of interest to obtain detailed information, such as the name of the employee who posted or approved the transaction.

Figure 2-10

The global analytics Monthly Analysis tool contains drilldown functionality for data disaggregation tasks. In the following figure, aggregated monthly accounting period information is displayed that pertains to trial balance amounts and manual journal voucher values and percentages.



As with query reporting, functionality is present in many situations to export information to the Microsoft Excel Spreadsheet environment for further analysis and modeling.

Clearly, the IA dashboard significantly simplifies the management, monitoring, and oversight functions and produces a vast array of useful, reliable, and timely information for decision making purposes.

In summary, the DSAS/IA Database Project is focused on the leveraging of current technologies to automate organizational management, monitoring, and auditing. By accumulating key metrics, statistics, and other relevant information in an ongoing manner, the system positions users to respond to changing business circumstances as associated events and transactions occur. Furthermore, the auditor is optimally positioned to detect issues promptly as they occur, which may ultimately serve a predictive or preemptive purpose. At this point, the auditor is poised to ensure that its business units are appropriately deploying the firm’s scarce resources and, thus, assisting in optimizing profitability and profit growth moving forward.

ESSAY 3

Evolution of Auditing: From the Traditional Approach to the Future Audit¹

Paul Eric Byrnes, CMA
Abdullah Al-Awadhi, PhD
Benita Gullvist, DSc
Helen Brown-Liburd, PhD, CPA
Ryan Teeter, PhD
J. Donald Warren, Jr., PhD
Miklos Vasarhelyi, PhD

INTRODUCTION

Auditing is currently at a critical juncture. Specifically, advances in information technology in conjunction with real-time approaches to conducting business are challenging the auditing profession. As such, the primary purpose of this essay is to examine the extent to which the auditing discipline in the United States has advanced and identify the trajectory it might take if it is to continue to thrive and provide long-run value to society at large.

¹ First published 2012. From the AICPA Assurance Services Executive Committee (ASEC) Emerging Assurance Technologies Task Force.

A BRIEF HISTORY OF AUDITING IN THE UNITED STATES

Although auditing procedures have been relied upon for many years, the formal practice of auditing has been in existence for a relatively short period. In addition, emphasis has historically been placed on a periodic, backward-looking approach whereby key events and activities are often identified long after their occurrence or simply undetected. Given that recent developments and technologies facilitated a movement away from the historical paradigm and toward a more proactive approach, it is essential that auditors understand what the future audit entails and how they might begin to envision a logical progression to such a state. To enhance this comprehension, it is advisable to consider how auditing has evolved from its formal beginnings in the early twentieth century.

The Industrial Revolution and the resulting explosion in growth of business activity led to widespread adoption of auditing methods. The railroads, in their efforts to report and control costs, production, and operating ratios, were major catalysts in the development of the accounting profession within the United States (Chandler 1977). Specifically, firms became aware of the need for mechanisms of fraud detection and financial accountability, and investors increasingly relied upon financial reports as corporations began to participate in the stock market. Although these issues prompted an expansion in the use of accounting and auditing mechanisms, it was after the stock market crash of 1929 that auditing became an obligatory process in the United States.

In particular, the Securities and Exchange Act of 1934 created the Securities and Exchange Commission (SEC). Among other responsibilities, the SEC was initially given authority for the promulgation of accounting standards as well as auditor oversight functions. In addition, the SEC was required to enforce the mandate that publicly traded U.S. companies submit various periodic reports to the agency in a timely fashion. To assist the SEC with ensuring that these reports were created in accordance with generally accepted accounting principles (GAAP), public accounting firms were eventually required to provide certain assurances about the information.

Many of the audit practices existing during the period that immediately followed were not conducted independently and, instead, simply relied upon information from management personnel. Furthermore, refinements of audit standards generally consisted of reactionary measures that occurred in response to significant negative business events. For example, audit tasks such as physical inspection of inventories and confirmation of receivables were optional until fraudulent activities were uncovered at McKesson & Robbins in 1939. As

a result, the AICPA issued Statement on Auditing Procedure (SAP) No. 1 in October 1939 and it required that auditors inspect inventories and confirm receivables. Consequently, auditors became responsible for auditing the business entity itself rather than simply relying upon management verification routines.

Following this, auditing by inspection and observation became the norm. Even as automated accounting systems began to appear in the 1950s, manual auditing procedures continued to be used exclusively. For example, in 1954, UNIVAC was unveiled as one of the first operational electronic accounting systems in the United States. However, auditors only began to seriously consider auditing in the computerized context in the early 1960s; two specific events prompted this transition.

First, in 1961 Felix Kaufman wrote *Electronic Data Processing and Auditing*. The book compares auditing around and through the computer. Historically, auditing "around the computer" entails traditional manual procedures in which the existence of automated equipment is ignored. As such, the computer is treated as a black box. In this context, auditors rely upon physical inputs to and outputs from automated devices and do not concern themselves with how processing actually occurs within the system(s). Conversely, auditing "through the computer" involves actual use of computer systems in testing both controls and transactions. Finally, auditing "with the computer" entails direct evaluation of computer software, hardware, and processes. Consequently, auditing through the computer or with the computer is able to provide a much higher level of assurance when contrasted with auditing around the computer.

Second, International Business Machines (IBM) released its IBM 360 in 1963 and this device made computing more affordable than ever. Clearly, these developments collectively signaled a paradigm shift in terms of how accounting activities were to be conducted in the future and facilitated serious consideration of movement away from the traditional manual audit.

Notwithstanding the progression toward computerized accounting, many auditors continued to audit around the computer and the minority who elected to audit through the computer relied on an array of proprietary programs that were expensive, cumbersome, inefficient, and in need of constant reprogramming. For example, Cangemi and Singleton (2003) mention that in 1967, one firm developed between 150 and 250 unique auditing programs. Furthermore, nearly 80 percent of these programs required significant code modification in the subsequent year because of computer system enhancements and changes in audit requirements. The introduction of AUDITAPE by Haskins & Sells in 1967, a card oriented auditor-friendly computer assisted audit tool (CAAT), encouraged additional auditors to consider moving into the automated

domain. In particular, AUDITAPE allowed nontechnical auditors the increased ability to audit through the computer and facilitated the creation of several general auditing software (GAS) programs from 1968 through the late 1970s. In conjunction with the development of these initial audit programs, Davis (1968) alerted auditors to the idea that they would simply not be able to ignore electronic data processing (EDP) in accounting systems when performing audits. In addition, he explained how and when auditing around the computer might be accomplished, but advised that an evaluation of internal controls as both a review and test of system reliability (audit of the computer) would still need to be performed. Davis had a significant and positive effect on the evolution of audit theory and practice. Moving forward, the 1970s saw 2 major developments that dramatically altered the accounting and auditing landscapes.

First, the Equity Funding Corporation scandal of 1973 is sometimes perceived as the single most significant event in EDP audit history. In particular, the organization committed acts of fraud between 1964 and 1973 (Seidler et al. 1977). Essentially, managers created false insurance policies and commission income to artificially inflate profits and stock price and used a variety of mechanisms to conceal the activities. For example, when auditors attempted to confirm receivables via phone calls to customers, switchboard operators at Equity Funding would simply connect the calls to employees who would subsequently confirm the balance information. When the fraud was eventually unearthed in 1973, Equity Funding had \$2 billion in phony insurance policies and this reflected roughly 67 percent of the total balance in that general ledger account. In reflection, it was determined that an EDP audit would uncover the fraud much sooner. This determination was made primarily because all of the false policies were posted to department number 99, whereas legitimate policies were not applied there.

Whatever the case, the Equity Funding debacle was instrumental in mandating a shift from auditing around the computer. Furthermore, the incident prompted the review of existing audit processes in an effort to address internal controls and audit procedures for information systems. As a consequence, large accounting firms, previously known as the Big 8, established units consisting of EDP specialists to audit information systems. Smaller accounting firms often maintained contracts with information systems professionals to assist in auditing such systems.

Second, the Foreign Corrupt Practices Act (FCPA) of 1977 had substantial implications for accountants. Basically, the FCPA prohibited American companies from bribing foreign officials to obtain business and required these firms to have mechanisms in place to detect such activities. In addition, the FCPA required companies registered with the SEC to maintain their books and records such that transactions were accurately

and fairly reported and consistently employ adequate systems of internal controls. Consequently, U.S. companies were forced to implement significantly more robust accounting systems as well as internal controls within those systems.

During the next 25 years, many of the noteworthy events involving auditing of information systems pertained to the development and refinement of automated vendor offerings designed to increase effectiveness and efficiency in auditing. The advancement and proliferation of technologies, such as the personal computer, led to electronic data processing becoming more widespread within organizations (Davis 1968). As an example, the author shows that the number of computers installed in U.S. based companies increased fourfold between 1962 and 1967. Along with this extensive distribution of computing power and security risk came the increasing demand and need for micro-based computer assisted audit tools (CAATS) designed to aid in automating the audit process. In fact, the flexibility and power of CAATS helped to bring improved audit quality and speed when dealing with the increase in data availability associated with automated systems.

In response to the expanding demand for CAATS, vendor-based solutions began to appear in the marketplace and the need for accounting firms to continue developing proprietary in-house audit tools was greatly diminished. For example, standardized audit tools such as Audit Command Language (ACL) and Interactive Data Extraction and Analysis (IDEA) emerged and offered significant advantages over the COBOL-based programs of the previous period. Moving forward, such tools are periodically refined and continue to provide valuable assistance to those seeking to audit through the computer today. Although CAATS have been instrumental in encouraging a shift away from traditional manual auditing, another fairly recent development has also had a significant effect.

Specifically, passage of the Sarbanes-Oxley Act (SOX) in 2002 imposed sweeping changes on publicly traded companies and the accounting profession. SOX established that assurances about internal control practices and operations as well as financial reporting quality were the responsibility of both management and auditors. Furthermore, SOX caused the accounting discipline to devote more attention to addressing fraud during the course of an audit. For example, Statement on Auditing Standards (SAS) No. 99, *Consideration of Fraud in a Financial Statement Audit* (AICPA, *Professional Standards*, AU-C sec. 240), requires auditors to design audit procedures that provide reasonable assurance of detecting fraud that could have a material effect on the financial statements.

As is evident from the preceding discussion, auditing maintains a very interesting past and refinements have occurred progressively along the

way that ultimately established capabilities for an improved audit experience. However, barriers continue to exist in evolving toward the future audit. For example, the traditional auditing paradigm whereby transactions are sampled based upon risk considerations continues to be prevalent in the auditing profession today. Unfortunately, this process often fails to maximize utility in the information age. Conversely, the future audit that relies upon the leveraging of technologies and processes has the capability to expand analyses of a firm's operating activities and thus provide improved audit quality. As an example, Kuhn and Sutton (2006) examined fraudulent capital expenditures at WorldCom and determined that, where the manual auditing system failed, a properly structured continuous assurance (CA) system would successfully detect suspicious transactions in a timely fashion. Perhaps with effective CA systems in place, the WorldCom disaster and others like it could have been avoided entirely.

In further support of the future audit, it is estimated that total global fraud losses were more than \$2.9 trillion in 2009 (Association of Certified Fraud Examiners 2010). More important, this figure continues to rise. Although some aspects of the traditional audit will continue to hold value, the audit of the future provides opportunities to increase the use of automated tools and remains a key for offering improved assurances relative to the responsible management and utilization of stakeholder assets. Moving on, with rudimentary coverage of audit history achieved, focus will now shift to briefly examining the traditional statutory audit and envisioning how it might ultimately evolve into the future audit.

THE TRADITIONAL AUDIT

Following the initial establishment of a contractual arrangement between the auditor and auditee, an audit engagement typically proceeds with a risk assessment and formulation of an audit plan delineating the scope and objectives of the audit. Following this, auditors collect and analyze audit evidence and form opinions pertaining to internal controls as well as reliability of the information provided by management. At the engagement conclusion, auditors present a formal report expressing their opinion. In fact, this approach reflects the twentieth century methodology whereby there are high costs and significant time delays associated with information collection, processing, and reporting. However, these historical costs and delays are often not the norm today. Most likely, in the current business realm, transactions are often entered and aggregated such that they can provide near immediate feedback to relevant stakeholders. Furthermore, academicians and practitioners alike recognize this information shift and developed numerous solutions that more appropriately reflect the current business environment.

AUTOMATING THE AUDIT

Organizations historically accustomed to manual audit procedures may benefit from pursuing the future audit in an incremental manner. Such an approach would basically result in conducting a pilot study to ascertain the potential benefits of audit automation. Because resistance to change is a universal phenomenon, gradual and careful advancement will likely be a more tractable approach. Moving forward, this might ultimately result in greater subsequent support for expansion of automated audit practices and programs and could significantly improve the chances of success in eventually reaching the future audit.

Lanza (1998) argues that low cost solutions for achieving an initial automated audit experience include introductory CAATS that facilitate data extraction, sorting, and analysis procedures. These programs require little training, have no file size limitations, provide detailed audit logs for use as work paper documentation, and allow for the creation of auditor-specified reports that may be applied to current and future data sets. These tools should be initially used to replace manual audit activities because these are areas where the most substantial benefits might be accrued. For example, the programs could be configured to address tasks such as footing ledgers, choosing statistical samples, generating confirmations, and detecting suspicious transactions. In addition, such tools are capable of testing 100 percent of the records included in a file; this is a marked improvement over the sampling techniques historically found in the traditional manual audit. Through these programs, auditors are able to obtain a better understanding of business operations as well as enhanced levels of expertise and professional skepticism.

In terms of disadvantages, tools in this category do not operate on a truly continuous basis. Specifically, they are batch process programs activated periodically according to the audit plan. As such, although they certainly offer the functionality to improve audit quality, it may eventually be desirable to consider other methods that more closely align with the future audit.

In addition to the preceding software considerations, training issues should be addressed during the process of automating the audit function. For example, Curtis and Payne (2008) argue that although CAATS are capable of improving the efficiency and effectiveness of auditing functions, such tools tend to be underutilized. Accordingly, properly constructed and executed training programs may facilitate more complete adoption and usage of CAATS by practitioners (Janvrin et al. 2008). Adequate training will be an essential component of any audit automation initiative in order to optimize the likelihood that auditing staff will take full advantage of the benefits that automated tools can provide.

A strategically formulated and implemented plan that includes careful consideration about issues of resistance, cost and benefit tradeoffs, project scope, and training should result in more favorable outcomes. At a minimum, CAATS have the potential to serve as a bridging mechanism between the manual audit and the ultimate future audit. If implemented and utilized as intended, significant gains will be realized such that firms should be more open to entertain the notion of venturing further into the arena of automation.

THE FUTURE AUDIT

As previously mentioned, basic CAATS contain capabilities to enhance audit effectiveness and efficiency. However, they do not operate on a 24/7 basis and therefore fail to construct a truly continuous auditing environment whereby exceptions and anomalies may be identified as they occur. Alternatively stated, they do not work with real-time or close to real-time data streams and, thus, are not able to address questionable events such as potential fraud or irregularities in an optimized fashion. Cangemi (2010) argues that, given the recent advances in business technologies, the continuing emphasis on the backward looking audit is simply an outdated philosophy. Instead, he believes that real-time solutions are needed. As such, firms that successfully experiment with the CAATS described previously should give eventual consideration to more advanced programs which contain functionalities resembling the audit of the future and provide a higher level of assurance.

Fortunately, recently proposed solutions better satisfy this vision. In general, the programs in this category contain the capabilities to continuously capture exceptions and outliers in data sets from disparate systems, provide information and alerting mechanisms to relevant personnel in an ongoing manner, and essentially confront issues such as fraud, errors, and misuse of resources in real-time. Furthermore, these programs may assist in optimizing the audit function by analyzing all financial transactions as they occur. As such, this proactive approach increases efficiency and effectiveness in discovering problems and opportunities for business improvement. However, prior to moving into this more elaborate domain, additional considerations relative to business operations are warranted.

In conjunction with this position, Teeter and Vasarhelyi (2011) explain the optimal alignment of enterprise data and audit procedures. For example, they mention that manual data corresponds to manual auditing methods. They also indicate that organizational data that is not strictly manual may be subject to automated audit procedures on some level. Therefore, the more manual data an entity maintains, the less it might initially

benefit from audit automation. In order to determine the potential utility of a robust auditing system, an organization should first consider the extent to which its data is automated. Following this, identified manual enterprise data might reasonably be converted to a more automated state prior to implementation of tools for automating the audit process.

In moving toward the future audit, the extent to which data, controls, and processes are automated must be considered. A company that is overburdened by manual audit processes will need to confront this issue at some point if the objective is to yield optimal benefits from the future audit. Essentially, if the organization automates its data, controls, and processes in a manner that properly aligns with the functionalities of the technology being implemented, the business will likely be in a position to optimize audit quality.

An enterprise that moves toward greater automation relative to data, processes, controls, and monitoring tools begins to naturally structure itself for the coming of the future audit. Given the recent advent of the real-time economy, this positioning is critical. For example, the Continuous Audit Monograph (CICA/AICPA 1999) notes that the development of the digital economy has facilitated a demand from decision makers, such as potential investors and creditors, for more timely notification on a wide array of information topics extending well beyond the traditional financial statements. Therefore, if these decision makers require a more continuous information stream on which to formulate decisions, they will also demand independent assurances about the reliability of that information. Consequently, the need for a 24/7 auditing protocol becomes apparent if firms intend to compete for scarce resources and ultimately succeed in the current and evolving real-time global economy.

With this in mind, one could argue that the traditional manual and retrospective audit is becoming an untenable position. Also, it could be argued that the use of rudimentary CAATS such as those described earlier will eventually be questioned in terms of audit utility. Fortunately, the idea of the future audit is not a recent phenomenon and there are a variety of methodologies that have been proposed to reach this plateau.

Embedded Audit Modules

The embedded audit module (EAM) approach involves the installation of files or code segments within the host system (Groomer and Murthy 1989). For example, in the integrated test facility (ITF) method, a series of auditor-developed "dummy" master files are instantiated in the live client system and test transactions are entered as desired by the auditor. These records are then processed such that only the auditor-created master files

are affected. Another example in the EAM domain involves a block of program code that is created and inserted within the client's system code structure. Under this scenario, the EAM subsequently monitors transactions occurring on the host in accordance with the construction of the code block. When a suspicious item is identified, relevant event information is recorded in a log that the auditor reviews on an ongoing basis. Although these approaches have been proposed for a number of years, several problems have resulted in a lack of acceptance within the auditing community. For example, Groomer and Murthy (1989) point out that the EAM method may reduce client system performance, create excessive data sets relative to the event log, and be subject to code modification by astute programmers. Because of such issues with the embedded approach, it currently exists as primarily an academic topic.

Monitoring and Control Layer

The monitoring and control layer (MCL) architecture is considered a CAAT that may aid in providing continuous monitoring and control of accounting information systems (Debreceeny et al. 2005). Vasarhelyi, Alles, and Kogan (2004) initially introduced the MCL architecture as an alternative to the EAM methodology. In particular, several researchers have pointed out that, in contrast with EAM, MCL has fewer concerns related to software maintenance, legal liability, client independence, and reliance on enterprise personnel (Alles et al. 2006; Kuhn and Sutton 2010).

In terms of functionality, Best, Rikhardsson, and Toleman (2009) indicate that MCL is essentially a self-governing, middleware solution that extracts data from systems and conducts appropriate analyses as desired. The primary function of the MCL method is to continuously analyze and compare data obtained against specific benchmarks or other criteria. When exceptions are noted, alerts are generated and sent to the auditors for review and investigation. Consequently, the MCL approach is preferable to the EAM methodology on many dimensions, including mutual exclusivity of the auditing module and client system(s).

However, although the MCL approach is superior to the EAM techniques, it is still perceived as a suboptimal solution. For example, Sigvaldason and Warren (2004) indicate that many enterprises maintain a variety of disparate systems and this presents substantial difficulties and challenges in establishing the required connections between the MCL and various client systems themselves. Also, given its inherent status as a monitoring and control solution, some might argue that the maintenance of auditor independence in the MCL environment is inherently problematic. Whatever the case, much like EAM, the MCL approach has not yet received widespread acceptance in practice.

Audit Data Warehouse

The audit data warehouse model has been offered as a viable future audit solution. In particular, this approach appears to alleviate the problems and concerns associated with both the EAM and MCL techniques. By definition, a data warehouse is "a big data pool—a single, company-wide data repository—with tools to extract and analyze the data" (David and Steinbart 1999, 30). Essentially, a data warehouse is linked with the various and disparate enterprise systems such that it readily accepts and integrates the pertinent data being generated throughout the organization (Rezaee et al. 2002). In addition, the data warehouse may be incorporated with data marts, which are a set of smaller, focused warehouses in which each addresses a particular functional area such as accounting or marketing. Furthermore, the audit warehouse and data mart(s) may reside on the same audit server.

From an operational perspective, enterprise data is extracted, converted, standardized, and installed in an ongoing manner within the data warehouse context. In addition, each data mart gathers, transforms, and loads appropriate data from the warehouse according to specifications and configurations. Also, each data mart contains various standardized audit tests that operate at stipulated time intervals (for example, continuously, daily, weekly), collect audit evidence, and generate exception reports for auditor review and investigation.

A conceptual model that utilizes the audit warehouse architecture is AuSoftware. According to Sigvaldason and Warren (2004), it accumulates necessary data on a continuous basis in flat file structures from a disparate array of organizational systems (for example, ERP, legacy, outsourced). To minimize processing burden, AuSoftware imports data in read only format into a data warehouse or "audit data mart" that provides for continuous auditing procedures. In addition, as suspicious items are identified, the software is able to communicate control and audit alerts via Web-based interfaces or more direct routes such as cell phones. AuSoftware has the capability to identify anomalies and irregularities on a 24/7 basis and alert auditors in an immediate manner such that interventions may occur in a timely fashion. This is a significant improvement over the traditional audit that simply evaluates a small sample of historical transactions and items on a periodic basis and may either fail to identify problems that exist or detect problems too late for adequate resolutions to be implemented.

Audit Applications Approach

A very recent development entails the usage of specific applications or "apps" in conducting the future audit. The AICPA Assurance Services Executive Committee (Zhang et al. 2012) has promoted the idea that a

standardized set of data² from multiple cycles be used by a series of audit apps that might be constructed and procured in alignment with audit plans and assertions in order to effectively perform the future audit. For example, for the audit activity "evaluate aging of accounts receivable," an audit app could be utilized to query accounts receivable transaction details, compare percentages in all aging categories with prescribed industry standards, and alert auditors when the actual percentages vary significantly from the designated standards. Furthermore, additional apps could be created and otherwise obtained as required for completing remaining audit activities in fulfillment of the organizational audit plan and assertions.

Other Future Audit Considerations

The preceding discussion demonstrates that sophisticated audit technologies are being actively researched and developed to facilitate the future audit. However, many organizations will have much to overcome prior to moving toward that realm. For example, the CICA/AICPA (1999) formulated the following listing of six conditions necessary for advancing to the future audit:

- *Subject matter with suitable characteristics.* Highly automated processes are needed to provide reliable information shortly after occurrence of associated events and transactions.
 - Business has progressed substantially in providing close to real-time information for key processes. Their utilization for audit is still spotty.
- *Reliability of systems providing the subject matter.* Probability the system will operate effectively over a given period of time; reliability optimized when enterprise controls are effective and system provides complete and accurate information in a timely fashion.
 - Although SysTrust has been out for a decade, it is only now that there is more attention given to assurance on system reliability. This attention is also spotty.
- *Audit evidence provided by highly automated procedures.* Auditors must quickly understand causes of all recognized anomalies and errors, determine where they originated, and discuss corrective action with management.
 - We have not yet managed to provide and use real-time audit evidence.

² The audit data standard predicts a series of flat (or tagged) standard files that are to be provided by companies to internal and external auditors. The general ledger and receivables standards were exposed by the AICPA and are under revision as of the publication date of this paper.

- *Reliable means of obtaining results of audit procedures on a timely basis.* The outcomes of automated audit procedures must be efficiently communicated to auditors; this suggests reliable and efficient electronic communication methods with appropriate security measures in effect.
 - As discussed in essay 2, "The Current State of Continuous Auditing and Continuous Monitoring," the external audit profession has not yet adopted "close to the event" audit technologies, although they are in the process of advising internal audit departments on how to do so.
- *Timely availability of and control over audit reports.* Organizational information and associated audit reports must be available in an ongoing manner and easily accessed by legitimate users.
 - Substantive adoption of automated work papers, audit warehouses, and corporate internal report distribution has drastically reduced report distribution challenges.
- *High degree of auditor proficiency in information technology and the audited subject matter.* Auditor must have necessary skill sets to handle the engagement.
 - Pockets of practitioners developed IT skills. Recently there is growing awareness of the need to increase auditor IT and analytic proficiencies.

Therefore, a host of variables and characteristics must be adequately addressed in order to fully realize the benefits of the future audit. Although the system architecture and software components are extremely important considerations, complementary elements such as auditor education, the socio-technical environment of the firm, and tone at the top are fundamental as well. Consequently, comprehensive strategic planning that joins technical issues with human issues is also a necessary ingredient in helping to ensure a successful transition to the future audit.

CONCLUSION

Auditing has made great strides in the past decade, but it has not seemingly kept pace with the real-time economy. Some auditing approaches and techniques that were valuable in the past now appear outdated. Also, the auditing evolution has reached a critical juncture whereby auditors may either lead in promoting and adopting the future audit or continue to adhere to the more traditional paradigm in some manner. Future audit approaches would likely require auditors, regulators, and standards setters to make significant adjustments. Such

adjustments might include (1) changes in the timing and frequency of the audit, (2) increased education in technology and analytic methods, (3) adoption of full population examination instead of sampling, (4) re-examination of concepts such as materiality and independence, and (5) mandating the provisioning of the audit data standard. Auditors would need to possess substantial technical and analytical skills that are currently not components of most traditional four year university accounting programs.

SOX introduced the first major change in the mandate of the public company audit. This new prescription focuses on auditor assessment of internal controls, a very important step in the assurance of future systems that will be modular, computerized, and often outsourced. The accounting profession now faces an opportunity to further elevate the audit to a higher level of automation. It is imperative that accountants ultimately lead the way in adoption and implementation of the future audit such that they continue to be the professionals of choice relative to audit engagements of the future.

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ESSAY 4

Reimagining Auditing in a Wired World¹

Paul Eric Byrnes, CMA

Thomas R. Criste, CPA

Trevor R. Stewart, CA, PhD

Miklos Vasarhelyi, PhD

OVERVIEW

How would financial statement audits be designed if auditing were a new service that had just been invented? There can be little doubt but that audit processes would be designed from the get-go to make optimal use of today's amazing technology in order to enable auditors to provide the most effective and efficient service possible within the bounds of economic viability. Instead, for the most part, auditors use legacy processes that are not much different from those of 50 years ago except that they have been computerized. The emphasis has been on improving efficiency, and although effectiveness has improved as well, there has not been the quantum leap that technology can enable.

Our thesis is that the profession needs to achieve that quantum leap. This will involve deconstructing and re-engineering processes; researching how data science and related technologies can be harnessed and tailored into applications for auditors; extending auditing theory to encompass new approaches; modifying auditing standards where necessary and providing plenty of new guidance; and using today's ubiquitous computing and connectivity to transform where and how work gets done and to enable continuous auditing. We use a "blue sky" scenario to describe what future reporting and auditing systems might resemble and we discuss how technology could be used to transform auditing.

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INTRODUCTION: BLUE SKY SCENARIO

It was 7:30 in the morning on Tuesday, June 17, 2020, and Sally was just settling in for another day as the external audit partner of ML Enterprises, Inc. (MLE), a \$12 billion U.S. construction company operating in over 30 countries. As usual, her first task after getting her skinny latte was to sign in to AART, the audit firm's Automated Audit, Reporting, and Tracking system. AART was developed to leverage the widespread availability of information on a 24/7 basis so that technology could continuously monitor MLE's controls, transactions, and account balances. AART had been initially configured and customized for MLE business operations and technology platforms, but was also capable of learning over time. In that sense, AART was able to better understand the client's business. This offered the dual benefits of reducing the number of legitimate events flagged for auditor review (false positives), as well as identifying trends, anomalies, and patterns that Sally and her team had not explicitly addressed or considered.

As she looked at the AART dashboard that she had customized for her use, the majority of her audit status indicators were solid green. However, she noticed a flashing red indicator relating to the Hong Kong Treasury Operations group, and a yellow warning icon associated with the Brazilian operations. She had also been copied on a message that AART sent to her controls team notifying them of a modification to a key control parameter in the centralized SAP system. She clicked on the red indicator, and saw that an unusually large transfer had been executed in Hong Kong last night between the Asian and European regional operations. She then forwarded the pertinent information to her partners in Hong Kong and Munich, and set a flag to remind her to review their responses the following day. In addition, she transmitted the Brazil-related information to one of her managers for follow-up activities.

Sally then examined the Daily Transaction Testing Report from the previous day. This was a randomly generated list of transactions chosen for testing in addition to those specifically identified by the AART system. Of the 12 transactions selected yesterday, 10 had already been reviewed and closed by the audit team, and two remained open. She reviewed the tests performed and resulting conclusions, and was satisfied that the evidence and explanations provided were appropriate and sufficient. She also reviewed the status of the two open items and noted that management had promised to respond by close of business today.

After meeting with the controller, she returned to her office at 11 a.m. She realized that the continuously audited financial statements would be posted on MLE's website at noon, as they were every day, and she wanted to confirm whether there were any significant unresolved issues requiring prior attention. After logging in to AART, she noticed a

message from her controls specialist indicating that the SAP password complexity parameter had been updated to require at least one number and one special character, and he believed this change to be an improvement. He had previously discussed this matter with the chief security officer, who provided evidence of the policy change and the related approvals. Sally then reviewed a number of statistical reports, charts, and graphs produced by AART and concluded that the financial statements could be published and the audit opinion would remain unqualified. Although the Hong Kong transaction had not yet been verified, there was nothing to indicate that it was improper, and, in the worst case, would result in an adjustment the following day.

Sally then recalled that she had a 3:30 p.m. meeting next Monday with representatives from Future Financial (FF) to approve guidelines of an evolving lending arrangement with MLE's U.S. operations. Negotiations were being finalized relative to a line of credit with FF, and part of this final discussion was to involve associated covenant terms. Specifically, FF was looking for regular access to particular information in addition to associated independent assurances. As Sally reflected upon this proposal, she theorized that it would not present any insurmountable challenges. Essentially, MLE was historically proactive, and, as such, recognized long ago that a wider variety of stakeholders were increasingly demanding access to a diverse mixture of real-time information with attached assurances. Among other things, the AART system was designed to facilitate this stakeholder-centric approach. Consequently, she envisioned a rather simple solution. First, a Web-based dashboard would be constructed specifically for FF, and it would contain all of the required information and metrics relative to the lending arrangement. Second, this page would be dynamically refreshed on a daily basis immediately subsequent to the posting of financial statements. Third, FF would be assigned permissions and issued a user name and password combination (or set of combinations) to access, in an ongoing manner, the formulated website, as well as the area(s) containing relevant assurances. Sally actually viewed this as a type of pilot project, because bondholders and other lenders were starting to request information on a similar platform. She knew it was only a matter of time that such provisioning of information would become the norm. Whatever the case, Sally was meeting with her team later today to construct an action plan concerning the issue with FF, and was confident that a suitable solution would be established.

On a more challenging level, rumblings were beginning to be felt on a global basis relative to corporate social responsibility concerns. In particular, environmental groups and community members were placing increasing pressure on MLE to provide relevant information in more of a real-time format. Although Sally felt confident that this could ultimately be accomplished via the AART system, she wondered about the

complexity of maintaining such quantitative and qualitative information on a current basis. Like most companies, MLE presently publishes an annual sustainability report that outlines key initiatives and metrics about social responsibility at MLE, and it is historically a very challenging and time-consuming project. Although she believes that the quantitative portion of reporting could be readily presented on a more frequent basis, she envisions significant coordination barriers in maintaining the independently assured qualitative information in a comparable manner, largely because of MLE's international presence. Not surprisingly, Sally feels fortunate that this is an issue not requiring an immediate resolution. Nevertheless, she has scheduled an initial brainstorming session with her team in an effort to begin articulating potential operational strategies.

On a lighter note, Sally had previously arranged for lunch to be delivered to celebrate the 33rd birthday of one of her team members, Rob, who was her construction accounting specialist. He had 4 years of public accounting experience, including 2 years with the SEC, and was an assistant controller in another construction company for 6 years. Rob's background was indicative of the experience level of her team in general. The junior member was Allison, who had a Ph.D. in statistics as well as 7 years of experience at a major insurance company. The audit specialist, Trevor, was a CPA with 9 years of experience and was responsible for the configuration of the AART system, as well as the design and execution of all substantive audit procedures. Rounding out the team were Subrata, the controls specialist who came to the firm after 8 years in IT and internal audit, and Jorge, who was a construction industry analyst for 17 years at Deutsche Bank. Sally reflected back to the day she was hired directly out of business school, and noted how AART had radically changed the staffing model and audit dynamics. The audit was now being conducted with a handful of highly experienced and well-compensated specialists. In addition, having a skillset that included extensive technical and analytical expertise was no longer optional. Essentially, there was little demand at MLE for an inexperienced, traditionally educated accounting graduate.

Although the preceding anecdote may be perceived as visionary, it is nevertheless a window into what the future audit might entail. As the new economy continues to evolve, and stakeholder groups progressively seek access to more timely information, the audit and reporting models will need to adapt in accommodating this landscape. Given this, the balance of this chapter will be primarily devoted to presenting issues, observations, and potential challenges relevant to audit theory, process, and technology. In doing so, emphasis will be placed upon offering preliminary insight concerning how these items might be addressed to better meet the future needs of stakeholders. In conclusion, future audit

technology considerations will be briefly explored to develop an improved overview of how the audit might evolve in the coming years.

USING TECHNOLOGY TO TRANSFORM AUDITING

Although auditors embrace and make extensive use of information technology, little has been done to consider how auditing might be transformed by it. For the most part, IT has been used to computerize and improve the efficiency of established processes rather than transform or replace them. Consequently, improvements have been incremental rather than transformative. We will discuss some of today's IT enablers and their potential for improving audits.

Technology Enablers

Thanks to the Internet and exponential advances in core technologies, today's auditors practice in a globally connected world of ubiquitous computing and communications devices that collectively provide a platform for transformational applications. Smartphones, tablets, and other mobile computing and communications devices are pervasive and always on, and information workers are no longer tethered to office desks but work from home, coffee shops, public libraries and parks, airport terminals and airplanes, and from rent-by-the-hour office suites (AICPA 2012).

In years past, auditors worked in relatively isolated local teams from the same office, but today's auditors are able to operate more fluidly, connecting to teams from wherever they happen to be, as seamlessly as if they were in the same room, and individual skills can be leveraged globally across many audit engagements. A statistical specialist in Amsterdam can participate in audits conducted in Adelaide or Ankara.

Many audit procedures today can be deconstructed into tasks that can be performed wherever is most effective, whereas in years past, audit procedures had to be performed onsite by vertically integrated audit teams of local office resources. For example, the onsite, client-facing audit team can focus on tasks that only they can perform (such as observing the performance of internal controls or meeting with the CFO), and outsource back-end tasks that may be better performed remotely by teams of specialists or third-party providers. For example, as we will describe later, the mechanics of bank confirmations can be performed by third-party organizations that specialize in that mundane but critical task and can perform at the highest standards of reliability and

security—higher than is likely from the generalist client-facing team. Analytical procedures or journal entry testing for audits in Boston or Budapest can be performed better by a specialist team in Bangalore that performs the procedure day in and day out for dozens of audit engagements. This Internet-enabled deconstruction of tasks into separate processes that are performed wherever it is most effective and is mirrored by similar developments in computing.

Cloud computing is one example of how tasks are deconstructed into separate processes that migrate over the Internet to where they can be performed most effectively. Rather than operate its own IT infrastructure and software, an entity effectively plugs into an IT utility that provides and maintains the necessary software and manages and stores data. End users may need nothing more than browsing software. Thus, the total task is deconstructed into a simple front-end, and a back-end somewhere in the cloud, where a massively equipped provider does the heavy lifting for hundreds of entities.

Data science and related technologies have advanced enormously in recent years, incorporating theories, techniques, and software applications from many fields, including data analysis, business intelligence, mathematics and probability, statistical learning including pattern recognition, data visualization, gamification, big data analytics, and text and process mining. Applications from the world of data science can be applied by auditors to perform more effective audits and to provide new forms of audit evidence not previously available to practitioners (Hoogduin, Yoon, and Zhang 2014). Using new applications effectively requires learning new skills and the support of specialists, which can be enabled by the Internet.

AUDIT OPPORTUNITIES

The technology enablers discussed in the previous section provide opportunities for significantly improving audit effectiveness as well as efficiency. In this section we discuss some of those opportunities and their implications for the profession.

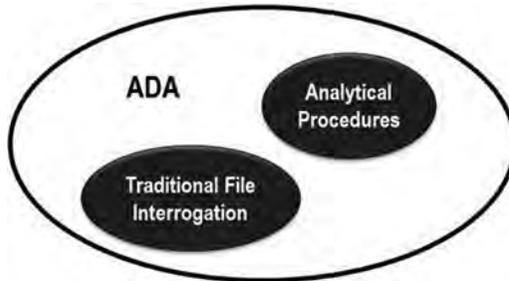
More Effective Audit Data Analytics

Audit data analytics (ADA) is the science and art of discovering and analyzing patterns, identifying anomalies, and extracting other useful information in data underlying or related to the subject matter of an audit through analysis, modeling, and visualization for the purpose of planning or performing the audit. ADA includes methodologies for identifying and analyzing anomalous patterns and outliers in data;

mapping and visualizing financial performance and other data across operating units, systems, products, or other dimensions for the purpose of focusing the audit on risks; building statistical (for example, regression) or other models that explain the data in relation to other factors and identify significant fluctuations from the model; and combining information from disparate analyses and data sources for the purpose of gaining additional insights.

ADA includes, but is not limited to, analytical procedures: preliminary analytical procedures used for planning (AU-C sec. 315); substantive analytical procedures used for substantive testing (par. .05 of AU-C sec. 520); and analytical procedures performed near the end of the audit to assist the auditor when forming an overall conclusion about whether the financial statements are consistent with the auditor’s understanding of the entity (par. .06 of AU-C sec. 520). ADA also includes traditional file interrogation. The scope of ADA is illustrated in figure 4-1.

Figure 4-1: ADA includes but is not limited to traditional analytical procedures and file interrogation.



The data analytics literature distinguishes between two different modes of analysis, exploratory and confirmatory (Tukey 1977), and we continue that distinction here in the context of ADA. Exploratory ADA is bottom-up and inductive. It starts with the data and the auditor asking questions such as, "What does the data suggest is happening? Does the data suggest something might have gone wrong? Where do the risks appear to be? Are there potential fraud indicators? On what assertions should we focus? What models and approaches appear to be optimal for analytical procedures?" Exploratory ADA is most useful in audit planning—understanding the entity and its environment, identifying and assessing the risks of material misstatement, and designing further audit procedures. Confirmatory ADA, on the other hand, is top-down and deductive. It starts with audit objectives and assertions. It tends to be model-driven with the auditor asking questions such as, "Is the subject

matter consistent with my model (that is, with expectations)? Are there deviations that are individually significant or that form a pattern, such that they indicate the potential presence of material misstatement?" Confirmatory ADA is used to provide the auditor with substantive or controls assurance about whether management's assertions are materially correct—ultimately, whether the financial statements are free from material misstatement.²

The use of visual exploratory techniques can help auditors see patterns, trends, and outliers that are otherwise hidden, and reveal relationships between variables that could be the foundation for a confirmatory model. Confirmatory techniques are more formal and tend to be more mathematical and analytical (Behrens 1997); for example, they might utilize multiple regression analysis or the extraction and summarization of transactions meeting certain risk criteria. However, there is no bright line distinction between exploratory and confirmatory ADA, and they tend to be used iteratively. For example, initial exploratory techniques may suggest a fruitful confirmatory model to be used for substantive analytical procedures, but the residuals from that model (actual minus expected) may lead to the discovery of additional factors that can be used to improve the model. Some of the same techniques can be used for exploratory and confirmatory analytics.

In the audit of financial statements in accordance with generally accepted auditing standards, there are numerous potential opportunities for making use of ADA. These include the following:

- Identifying and assessing the risks associated with accepting or continuing an audit engagement (for example, the risks of bankruptcy or high-level management fraud).
- Identifying and assessing the risks of material misstatement through understanding the entity and its environment (AU-C sec. 315). This includes performing preliminary analytical procedures as well as evaluating the design and implementation of internal controls and testing their operating effectiveness.
- Performing substantive analytical procedures in response to the auditor's assessment of the risks of material misstatement (AU-C sec. 520).
- Identifying and assessing the risks of material misstatement of the financial statements due to fraud, and testing for fraud having regard to the assessed risks (AU-C sec. 240).

² Tukey (1977) draws an analogy with the processes of Anglo-Saxon criminal justice where there is a clear divide between the search for evidence, which is the responsibility of the police and other investigative forces, and the evaluation of the strength of evidence and degree of guilt, which is the responsibility of the courts. Exploratory data analysis is detective in character; confirmatory data analysis is judicial or quasi-judicial in character.

- Performing analytical procedures near the end of the audit to assist the auditor when forming an overall conclusion about whether the financial statements are consistent with the auditor's understanding of the entity (AU-C sec. 520).

More Assurance

The auditor's overall objective is to obtain a reasonably high level of assurance about whether the financial statements are free from material misstatement. Reasonably high is not defined, but is commonly understood to mean no less than 95 percent confidence, where degree of confidence is a measure of the auditor's degree of subjective professional belief rather than some objectively calculable probability. Technology can be used to achieve the same level of assurance but more efficiently at a lower cost, or it can be used to achieve a higher level of assurance via a more effective audit at similar cost. Technology also enables statistical techniques (for example, sampling and regression analysis) that can provide objectively quantifiable confidence levels to help build assurance. Economics has driven auditors to focus mostly on improving efficiency (achieving the same level of assurance but at lower cost). Less attention has been paid to increasing assurance at the same cost by improving effectiveness, even though that cost would buy the additional benefits of better meeting client and investor expectations and of reducing audit and reputational risk and liability. In medicine, physicians are expected to use better technologies as they come along if they significantly improve patient outcomes at reasonable cost. In auditing, professional standards should encourage auditors to consider and use technologies that increase assurance beyond the minimum required where economically feasible. Professional standards need to be technology agnostic, but that does not mean that they should not encourage auditors to make the best use of technology to perform the best possible economically viable audits.

An example of where technology can and should be used to increase assurance is in detailed tests of transactions and balances. Traditionally, such tests were performed on a small sample of items. This was the only way to do it when items had to be selected from a printed or hand-written listing. With computerized data and file interrogation audit software, however, many tests can be performed on 100 percent of the population. It is also possible to simultaneously analyze and visualize the complete population in ways that can reveal unexpected patterns and outliers worthy of special investigation. For certain procedures, sampling is still necessary (for example, the physical inspection or third-party confirmation of assets, or the analysis of complex contracts). Nevertheless, even where sampling is necessary for certain essentials, it is often possible to increase audit assurance at little additional cost by analyzing and performing other procedures on the entire population.

Auditing With Big Data³

Big data is the product of a technological environment in which almost anything can be recorded, measured, and captured digitally, and thereby turned into data. The process, often called "datafication," may track thousands of simultaneous events; be performed in real-time; involve numbers, text, images, sound, and video; and require petabytes of storage capacity. Big data has been used in marketing to target potential customers, in political campaigning to study voter demographics, in sports to evaluate teams and players, in national security to identify threats, in biology to study DNA, in law enforcement to identify crime suspects, in public health to identify epidemics, and in securities regulation by the SEC to identify a multitude of behaviors including insider trading and accounting fraud.

Big data analytics is the science and art of improving knowledge about or gaining insights into some field of interest or subject matter by identifying and analyzing related patterns and correlations in big data. In auditing, the basic subject matter consists of the transactions and balances that underlie the financial statements. These usually reside in the entity's enterprise resource planning (ERP) and data warehouse systems and, even if voluminous, do not in themselves constitute big data within the normal meaning of the term. The audit opportunity is to use related big data as an auxiliary to the data actually being audited—to audit with big data, using analytics to identify and analyze patterns and correlations that reveal matters of audit interest.

There are certain characteristics of big data analytics that are causing users to rethink data usage. The first is that it is increasingly possible to analyze the entirety or almost all data rather than just a small, carefully chosen subset or sample. This can lead to more robust models. For example, if an auditor wants to determine what characteristics of journal entries are indicators of risk of error or fraud, it is possible to analyze all the journal entries and use this information to identify current journal entries that are really unusual. In the past, a high degree of care was necessary to eliminate bad data; now when all the data is available, a certain degree of pollution is acceptable for many applications. For example, if a model is based on just a small number of observations, the auditor must take great care to ensure that they are accurate in order not to skew the model. If the model is based on a large number of observations, then the auditor can tolerate some errors because, unless they are systemic, their effect will be insignificant.

³ See Stewart, T., M. Cao, and R. Chychyla, "Big Data Analytics in financial Statement Audits," *Accounting Horizons*, forthcoming 2014.

A second shift in thinking is that instead of trying to understand the fundamental causes of complex phenomena it is increasingly possible to identify and make use of correlations. For example, according to Mayer-Schönberger and Cukier

researchers in Canada are developing a big-data approach to spot infections in premature babies before overt symptoms appear. By converting 16 vital signs, including heartbeat, blood pressure, respiration, and blood-oxygen levels, into an information flow of more than 1,000 data points per second, they have been able to find correlations between very minor changes and more serious problems.

Although these observations may allow doctors to eventually understand fundamental causes, simply knowing that something is likely to occur is more important than understanding exactly the reason. It is analogous to auditing applications in which restatements, accounting fraud, bankruptcy, or going concern issues are correlated with indicators obtained from company filings and sources of data. As stated earlier, the SEC uses big data analytics to identify insider trading and accounting fraud.

Continuous Auditing, Continuous Assurance

It is possible with today's technology to continuously monitor and audit an entity's transactions in close to real-time, or at least at frequent intervals. This ability may be used to monitor and assess the operating effectiveness of automated internal controls, or to perform substantive tests. Although many internal auditors already do continuous auditing, at least for some applications, it is still rare among external auditors. Because internal auditors are part of the entity's internal control system, an ability to detect potential problems as soon as they occur is an enhancement to internal control that should factor into the external auditor's evaluation of internal control.

There are at least two ways in which continuous monitoring and auditing techniques can be directly useful to external auditors. First, such techniques can alert them to potential problems as early as possible, thus giving them more time to respond and adapt plans for the remainder of the audit. This enhances audit quality and client service. Second, continuous monitoring and auditing can help spread the work effort throughout the year. This is not necessarily useful in an environment where the audit team needs to be on the client's premises, as that typically involves travel and setup time. However, in today's connected world it is possible to monitor and audit remotely. To the extent that this can reduce workloads and stress during busy season, it will tend to also

improve audit quality. The ability to use correlation models with big data in order to pinpoint transactions or events of audit interest becomes significantly more useful when applied continuously.

There are many reasons that reporting entities issue audited financial statements only once a year, including the cost and effort of gathering, preparing, auditing, and presenting information. Because ERP systems update general ledger accounts as transactions are initially recorded, it is possible to produce financial statements on a more frequent, almost continuous basis, and Web-based technologies can make such statements almost instantly available online. The use of interactive data reporting standards such as XBRL greatly enhances the appeal and utility of online reporting. As outlined in the MLE story, today a company could, in principle, provide condensed financial statements of some kind on a daily or even close to real-time basis. If stakeholders demand such continuous reporting and are unwilling to accept additional information risk, it is likely that audit assurance will also be required on a continuous basis. Should that occur, continuous auditing will be essential rather than optional.

More Effective Fraud Detection

ADA techniques together with the ability to analyze and correlate vast amounts of data have revolutionized fraud detection. Patterns and connections that might never have been discovered in the past can be much more easily identified, analyzed, and visualized. Network analysis, used to analyze connections and relationships between people or entities, can be used to identify related parties possibly involved in fraudulent activities. The SEC is using data analytics applied to big data to look for inside traders—individual or collusive—and for indications of potential accounting fraud (Financial Times 2014).

Reducing False Positives

When an entire population is analyzed for anomalies and outliers, it is possible for a huge number of false positives to be flagged, and it is the fear of being overwhelmed that often leads auditors not to perform such analyses in the first place. Although false positives can never be eliminated entirely, their incidence can be significantly reduced via statistical learning and other techniques that enable the identification of "exceptional exceptions" (Issa 2013). Credit card companies use such techniques to identify potentially fraudulent transactions without overwhelming cardholders with false alarms.

AUDIT PROCESS RE-ENGINEERING: AN EXAMPLE

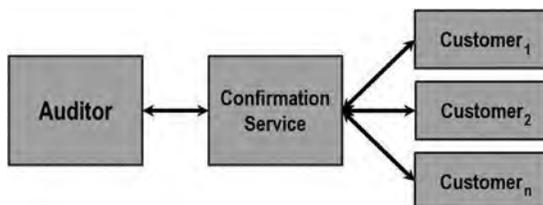
Today, many audit processes are essentially unchanged from those performed decades ago, even though newer technology may be used to perform them more efficiently and opportunities abound for using technology to reengineer processes so they achieve the same objectives more effectively. In this section, we illustrate this with account confirmations—a mundane but critical audit process—that includes confirmations of bank account balances, accounts receivable, and accounts payable.

In a traditional confirmation, the auditor selects a sample of accounts to confirm and then generates and mails letters asking account holders to confirm the amount. If an account holder does not respond then alternative procedures are performed.

Although simple in principle, confirmations must be carefully performed so that the auditor can be sure that the process is not subverted by fraudulent actors and that requests for confirmation are directed at parties who are authorized to respond. One way to improve the process in terms of added security and reduced tedium is to outsource it to an organization that specializes in confirmations. Typically, the auditor provides the confirmation service with a list of accounts to confirm. The service contacts the account and receives the response, and communicates it back to the auditor, as illustrated in figure 4-2. The value added by the service provider is (a) an established secure network including a public key infrastructure that ensures all communications are secured and digitally signed, thus guaranteeing that communications are not intercepted or subverted, and that the parties are who they purport to be; (b) a network of authenticated participating banks or other organizations that sign up and agree to confirm via the service provider; and (c) the performance and administration of a mundane tedious task, thus freeing up audit personnel to focus on higher-level tasks.

When the service provider is asked to confirm an account not in the network, they attempt to authenticate and add it to the network. Because the service provider works for many different audit firms the investment in the network can be leveraged over a large base.

Figure 4-2: Basic connectivity in auditor use of confirmation service in performing the accounts receivable (A/R) confirmation procedure.



When it comes to accounts receivable, Titera (2013) suggests yet another approach that could provide greater assurance than a traditional confirmation in certain businesses. If there is a short average collection cycle, balances outstanding at the date of the accounts receivable audit could be matched with subsequent receipts on the basis that those receipts are confirmation by the customers that the amounts were owed. The auditor would need to ensure, at least on a test basis, that receipts were in fact from the customer and related to the matched invoice. The entire accounts receivable (A/R) population could thus either be confirmed or identified as still outstanding and therefore worthy of special investigation as risks. Confirmation directly with the customer could be focused on the invoices not paid by the test date.

MAKING IT HAPPEN

As indicated earlier, the profession has not realized the full potential of technology to improve audit effectiveness. There are at least three things the profession could do to accelerate the adoption of better technologies:

- Encourage audit research and development
- Provide guidance to practitioners and update auditing standards to encourage the adoption of better technologies
- Encourage and recognize new resource models that bring to bear the new skills required in today's world to complement traditional CPA skills

Encouraging Audit Research and Development

The profession should promote research into how data science and related IT can improve the quality and effectiveness of auditing. Very little such research is being done by universities, which have the capability. Nor is much being done by firms, which mostly do not have much research capability, but certainly have a great deal of auditing expertise. The vehicle for promoting such research could be a consortium

of universities, firms, professional bodies, solutions providers, and experts in related fields such as artificial intelligence, machine learning, statistics, and big data analytics. If successful, such a consortium could lead to a flowering of useful audit research and the development and implementation of solutions that significantly improve audit effectiveness. Funding, governance, and similar issues would need to be worked out.

Providing Guidance and Updating Auditing Standards

An impediment to transformative thinking is that basic auditing standards were set a long time ago and the need to comply with them discourages auditors from considering how to do things better by doing them totally differently; in some cases, available technology-enabled auditing methods would appear to contravene auditing standards (Titera, 2013). Furthermore, there is virtually no professional auditing guidance on the theory and practice of applying new data analytic, continuous auditing, and other techniques and technologies to auditing. For example, auditing standards recognize audit sampling but there is nothing that explains or encourages the types of 100 percent tests and detailed data analyses of entire populations that can significantly increase effectiveness. Auditing standard setters should review current standards and guidance with a view to removing barriers and encouraging the optimal use of technology to improve audit effectiveness.

Encouraging and Recognizing New Resource Models

CPAs are required to lead teams' auditing financial statements because accounting is the indispensable field of knowledge required to perform an audit of financial statements and opine whether they are in accordance with generally accepted accounting principles. However, audits with any degree of complexity usually require the participation of specialists in tax, information technology, valuations, statistics, actuarial science, or other fields, who are not necessarily CPAs. As auditors make increasing use of the technologies described in this essay, they will be obliged to depend even more on professionals who have the skills traditionally-trained auditors lack. In some cases, it will make sense to have these resources within audit firms. In other cases, it will not. Regardless, firms will need to reassess their human resources models and alternative sources to ensure that they strike the right balance.

In the auditing profession as a whole, where there are many auditing firms and tens of thousands of audits, it seems that there should be

opportunities for solution providers to offer auditing applications and skilled resources as a profession-wide service. The advent of cloud computing creates opportunities for such solution providers to offer services that do not require software installation and maintenance. There are clearly confidentiality, privacy, and independence challenges that would need to be overcome, and the profession should take the lead in doing so.

BLUE SKY SCENARIO REVISITED

Sally is now close to retirement and ponders how AART was replaced by Eco-AART that changed not only her assurance role but also the business world where highly automated corporate and audit systems coexist, and regulations are formalized into software and updated in an ongoing manner. The audit is now conducted substantially via automated mechanisms such that an evergreen opinion (AICPA 1999) is dynamically maintained, multiple audit opinions exist continuously for different stakeholders, and a pink system status implies the need for immediate corrective action by members of the audit team. In fact, the audit function is now one of the most expensive components of the business process, as it is not fully automated like many of the other robotic processes at MLE. Furthermore, much of the highly technical competencies are being provided by specialized staff with hybridized employment links to the firm. Sally recognizes that the consistent leveraging of advanced technologies and processes was a key ingredient in the long-term prosperity of MLE. As she prepares for dematerialization and subsequent beaming to Jupiter for a tour of the Galilean moons, she reflects back to 2013, and barely remembers why so many practitioners resisted the paradigm shift in auditing for so many years. How times have changed!

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ESSAY 5

Data Analytics for Financial Statement Audits

Trevor R. Stewart, CA, PhD

ABSTRACT

Data science and supporting technologies have advanced enormously in recent years, incorporating theories, techniques, and technologies from many fields, including mathematics and statistics; computer science; machine learning, including pattern recognition; data visualization; and data, text, and process mining. Data analytics (DA) has the potential to transform the way financial statement audits are conducted making them significantly more effective and possibly more efficient. There is an increasing recognition of this potential in the profession though few if any transformative applications have yet emerged, and there is a chronic shortage of data scientists and very few who understand auditing. There is an opportunity for firms, universities, professional bodies, standards setters, regulators, and solutions providers to collectively bring about transformative change.

THE AUDIT CONTEXT

DA as applied to financial statement auditing is the art and science of discovering and analyzing patterns, identifying anomalies, and extracting other useful information in data underlying or related to the subject matter of an audit through analysis, modeling, and visualization for the purpose of planning or performing the audit. DA includes methodologies for

- identifying and analyzing anomalous patterns and outliers in data;

- mapping and visualizing financial performance and other data across operating units, systems, products, or other dimensions for the purpose of focusing the audit on risks;
- building statistical or other predictive models that explain the data in relation to other factors and identify significant fluctuations from the model; and
- combining information from disparate analyses and data sources for the purpose of gaining additional insights.

DA and Generally Accepted Auditing Standards

DA as just defined is and always has been integral to financial statement audits, pre-dating modern methods and technology. Indeed, it is difficult to imagine an auditor not using DA and still achieving the overall objectives set forth in auditing standards, which, to recap, are to

- a. obtain reasonable assurance about whether the financial statements as a whole are free from material misstatement, whether due to fraud or error, thereby enabling the auditor to express an opinion on whether the financial statements are presented fairly, in all material respects, in accordance with an applicable financial reporting framework; and
- b. report on the financial statements, and communicate as required by generally accepted auditing standards, in accordance with the auditor's findings.

Auditors have historically scanned financial statements and analyzed lists or summaries of transactions and balances; scrutinized journals for anomalous and unusual entries; compared results by month or operating unit; compared entities' operations and results with industry peers and economic expectations; and considered events that might have affected the entity to ensure that they have been properly accounted for. It was ever thus, even in pen and ink days. Over the years, technology—whether it be Excel, ACL, IDEA, or the Internet—has improved the mechanics of how these tasks are performed, though the processes themselves have scarcely changed for decades. The emphasis in introducing technology to the audit process has been on improving both effectiveness and efficiency. While effectiveness has improved, there has not been the quantum leap that technology has the potential to enable. What is different now, in the second decade of the 21st century, is that extraordinary recent advances in fundamental data science, vast increases in computer power, and access to astronomical amounts of data and information have converged to provide an environment ripe for DA

that can and is transforming industries. The time is ripe for transformative thinking in the profession.

DA can contribute to every phase of the audit

- to pre-engagement activities such as deciding whether to accept or continue an engagement;
- to audit planning;
- to understanding the entity and its environment and assessing the risks of material misstatement;
- to evaluating the design and implementation, and testing the operating effectiveness of internal controls;
- to substantive testing, both analytical procedures and tests of details; and
- to concluding and reporting.

DA is relevant to and has the potential to significantly improve audit procedures throughout the audit. Examples include procedures for the following:

- Identifying and assessing fraud risk
- Performing external confirmation procedures, especially the identification of high risk items for confirmation
- Auditing accounting estimates
- Obtaining an understanding of related party relationships and transactions
- Obtaining evidence about the valuation of investments, the existence and condition of inventory, as well as the completeness of litigation, claims, and assessments
- Identifying material subsequent events
- Evaluating whether there is substantial doubt about the entity's ability to continue as a going concern

DA techniques provide leverage by analyzing data and presenting results so that the auditor can more easily make judgments. DA handles the mechanics while real cognition happens in the mind of the auditor. That's as things stand today. But DA is not static and, as described later, recent developments have led to a new breed of computers that are capable of higher-order cognitive processes that until now have been the exclusive preserve of humans. Cognitive computers are destined for an important role in the accounting and auditing profession.

The auditor's overall objective of obtaining reasonable assurance can also be expressed as reducing *audit risk*, the complement of assurance, to an acceptable level. Auditing standards explain that audit risk is a function

of the risks of material misstatement and detection risk; and that the risks of material misstatement consist, in turn, of two components, inherent risk and control risk, which are the entity's risks and exist independently of the audit of the financial statements. DA can be used to identify and assess the risks of material misstatement—both those inherent to the entity and arising from internal control weaknesses—and can be used to reduce detection risk by obtaining or producing substantive evidence.

AUDIT APPLICATIONS OF DA

This section describes types of applications of financial statement audit DA. Two illustrative worked examples with data are included later in the essay.

Understanding the Entity, and Risk Assessment

DA can play a significant role in helping the auditor understand the entity and its environment, and identify and assess risks of material misstatement. Visualization tools and other techniques can help the auditor understand the business, identify anomalous patterns or outliers, and ultimately plan the audit.

In an illustrative example described later, DA is used to understand how the entity compares with its peers across multiple key financial ratios. Frequency distributions are constructed of those distributions such that the entity's ratios can be located relative to those of its peers. Location in a tail of the distribution might be an indicator of strength or risk depending on the ratio and the tail. Locus can be tracked over time as an indicator of improvement or deterioration.

In contrast, it is sometimes useful to take an unstructured approach where the auditor does not start with a pre-specified characteristic, such as financial ratios, but rather approaches the data in an unstructured more open-ended way to discover whether there are natural groupings and, if so, what the determining factors are and whether they have any potential audit significance. *Cluster analysis* is a common technique used for this type of exercise (Provost and Fawcett 2013). For example, a cluster analysis might be applied to a bank with hundreds of branches to discover whether there are natural groupings. The idea is to find clusters where branches within the cluster are similar but significantly different from branches in other clusters. It is also of interest to detect outliers within clusters—that is, branches near the fringe of the cluster to which they belong.

Performing Substantive Analytical Procedures

Analytical procedures consist of evaluations of financial information through analysis of plausible relationships among both financial and nonfinancial data. *Scanning* is a type of analytical procedure involving the auditor's exercise of professional judgment to review accounting data to identify significant or unusual items to test.

DA techniques may help with scanning by, for example, suggesting hypotheses about the relationship between data variables. Regression or visualization software might reveal for a chain of retail stores that sales is strongly correlated with floor area and ZIP code median income. However, in order to use the regression model to obtain substantive audit evidence about sales, the auditor should use professional judgment and knowledge of the business to be satisfied that the apparent relationship is in fact plausible and the regression parameters reasonable. If the auditor is satisfied with the model and recorded sales fall within a reasonable threshold of predicted values, then the auditor will have obtained a degree of substantive audit evidence and may reduce or eliminate further substantive audit procedures. The auditor should investigate the cause and perform additional substantive procedures as necessary for branches with sales outside the acceptable threshold.

Predictive models are represented by one or more equations linking the target variable of audit interest (sometimes known as the dependent variable) to predictor variables (sometimes known as independent variables). *Proof in total*, a form of substantive analytical procedure, is one type of predictive modeling. For example, the auditor might test the reasonableness of wages via a model such as the following:

$$\text{PredictedWages}(\text{Year } 2) = \text{ActualWages}(\text{Year } 1) \times (1 + \text{InflationRate}) \frac{\# \text{ Employees}(\text{Year } 2)}{\# \text{ Employees}(\text{Year } 1)}$$

Whether this model is reasonable or not is a matter for the auditor's professional judgment. If the mix of employees is about the same in both years and the rate of inflation a reasonable proxy for the rate of increase in wages, then it would be expected that the model prediction will not differ by much from recorded total wages for the current year. If the mix of employees has changed or different rates of increase apply to different categories of employee then the model could be extended. Similarly, published interest rates and average balances may be input to a multiplicative model to predict total interest and compare it with the recorded amount; and for some fungible commodities total sales can be predicted if there is reliable data on quantities and prices. In some cases,

a proof in total may be all that is required to audit an account. Of course the validity of the test depends on the reliability of the data used and the expected accuracy of the formula. The model could be more complex than a simple equation and it could incorporate a stochastic element to account for expected random variation. Such applications may also be used in conjunction with population analysis.

In *statistical* predictive modeling, the statistical behavior of "training data," typically audited data from prior periods, is analyzed to identify and parameterize variables in a model and that model is then used to predict using current data. For example, in auditing revenues a regression analysis may be performed on data for 36 prior months for sales and cost of goods sold to establish a model and determine its standard error and other statistics. Provided that there are grounds for believing that the same model should apply in the current period, it may be used by plugging monthly cost of goods sold into the equation to predict sales and determining whether residuals (recorded minus predicted values) are significant. Such applications are typically used for substantive analytical procedures.

Analyzing and Testing Populations of Detailed Transactions and Balances

Performing detailed audit tests on a small sample of items was necessary when items had to be selected from printed or hand-written listings and computations had to be performed manually. With computerized data and file interrogation audit software, however, many tests can be performed on 100 percent of the population. It is also possible to simultaneously analyze and visualize the complete population in ways that can reveal unexpected patterns and outliers worthy of special investigation. Sampling is still necessary for certain procedures—for example, the physical inspection or third-party confirmation of assets, or the analysis of complex contracts. Nevertheless, other procedures may be performed on the entire population, thus increasing audit assurance at little additional cost. Many characteristics that might have required human inspection in the past can be performed automatically—for example, determining whether the vendor or customer is approved, or whether the sale or expenditure is customary. A complete population analysis can also be used to stratify a population so that riskier items can receive increased audit focus. Where the items are complex legal contracts, text analysis might be used to flag potentially problematic clauses across the entire population in order to focus the auditor's inspection.

An *external confirmation* represents audit evidence obtained by the auditor as a direct written response to the auditor from a third party (the confirming party) in paper form or by electronic or other medium. DA software can be used to comprehensively analyze entire populations to identify and focus the confirmation sample on those that are most at risk. For accounts receivable, outstanding invoices at confirmation date may be matched up with payments received subsequently, thus reducing the population to be sampled by eliminating items known to have been paid.¹ For accounts payable, vendors with whom the company does a high volume of business can be selected for confirmation. Bank confirmations can be largely automated using a combination of DA software and a third-party confirmation service.

Recalculation consists of checking the mathematical accuracy of documents or records. Analytical software can often perform recalculations on 100 percent of a population, and ensure also that correct master file data have been used. This is an example of where the evidence that is possible with analytical software is far superior to that obtained when recalculation is limited to a sample.

Considering and Testing for Fraud

Because of the risk that management could override controls and post fraudulent journal entries, auditors are required to test the appropriateness of journal entries recorded in the general ledger and other adjustments made in the preparation of the financial statements, including entries posted directly to financial statement drafts.

There are numerous journal entry-testing software systems used in practice, developed either by individual firms or commercial solutions providers. Because of the volume of journal entries processed by today's ERP systems, many of the testing systems in use today produce too many false positives, leaving it up to the auditor to figure out which "positives" are genuinely problematic and how to deal with the rest. There is a need for software that does a better job of filtering—just as credit card companies tend to do a good job of alerting customers to potential fraud without overwhelming them with false alerts.

Collusive fraud can be particularly difficult to detect. One detective technique, used in forensic work, is to analyze social networks via software that maps networks of people who interact. This type of analysis can be used to look for related parties and collusive fraud, and to analyze and evaluate separation of duties for internal control purposes.

¹ The validity of this depends on the accuracy and reliability of the subsequent receipts data and on ensuring that receipts actually relate to the balances being tested.

Testing the Operating Effectiveness of Internal Control

Reperformance involves the independent execution of procedures or controls that were originally performed as part of the entity's internal control.

Internal control procedures such as ensuring that prices on an invoice come from an approved price list, performing account reconciliations, or ensuring via batch totals that information is correctly transferred from one system to another can often be reperfomed on a 100 percent basis rather than for a sample and can be performed continuously.

Observation consists of looking at a process or procedure being performed by others (for example, the auditor's observation of inventory counting by the entity's personnel or the performance of control activities). As high-performing computer systems take over processes and procedures that previously required human involvement, the nature of audit observation changes. Further, when a computer performs a control activity, it can be monitored around the clock and any lapses immediately reported.

Process mining of event logs is a technique that can identify internal control deficiencies such as payments made without approval, violations of segregation of duty controls, and violations of entity-specific internal procedures (Jans, et al. 2014).

Inquiry

Inquiry consists of seeking information of knowledgeable persons, both financial and nonfinancial, within the entity or outside the entity.

Statistical analysis, relationship analysis, and the summarized results lists of anomalies provided by population analysis can all provide significant material for client discussions (and often provide insights that clients find valuable).

A LOOK AHEAD: COGNITIVE COMPUTING IN THE AGE OF BIG DATA

Utilizing Big Data

Big data is the product of a technological environment in which almost anything can be recorded, measured, and captured digitally, and thereby turned into data. Big data is important in machine learning, where

computers are trained in a subject by ingesting a vast number of examples and other information. As the next section will explain, it's a key to cognitive computing. Essay 4, "Reimagining Auditing in a Wired World," discusses big data in more detail.

Cognitive Computing

In 2011, IBM's Watson computing system became the world's best Jeopardy! player. Jeopardy!, a TV quiz show, is known for its complex, tricky questions and very smart human champions. Playing it requires not only acquiring the general knowledge needed by humans to play but the ability to answer questions posed in nuanced natural language, including puns, synonyms and homonyms, slang, and jargon (Friedman 2014)—something that humans are very good at and computers have historically been very bad at. The same cognitive technology is being applied to medicine and other fields, and some think that "Dr. Watson" may soon become the world's best diagnostician. Google's self-driving car is another example of how cognitive computers can learn to perform "human" tasks with relentlessly super-human skill.

Enabling all this are recently developed deep learning algorithms that augment and enhance AI algorithms developed over decades since the 1950s; big data, which provide the raw material that learning algorithms ingest and "understand" as the basis for their knowledge; and inexpensive graphical processing chips originally designed for video games but repurposed for machine learning via clever new techniques (Kelly 2014). Useful AI—once an oxymoron—is now a reality.

Cognitive computers combine AI and machine-learning algorithms, in an approach that attempts to reproduce the behavior of the human brain (Mohda 2014, 28-29). Instead of being programmed in a traditional way, cognitive computers learn, as do humans, by seeing many instances of what they are learning about. Just as a child learns to distinguish between dogs and cats, a cognitive computer is trained by being fed countless examples from a world of big data together with human intervention where required ("No, that's not a dog. It's a kitty.").

Dr. Watson has learned medicine by "reading" dozens of textbooks and medical journals, and thousands of patient records from Memorial Sloan Kettering (Friedman 2014). Writing for *Forbes* Bruce Upbin (2013) reported, "Watson has analyzed 605,000 pieces of medical evidence, 2 million pages of text, 25,000 training cases and had the assist of 14,700 clinician hours fine-tuning its decision accuracy." And of course Dr. Watson continues to learn, to keep up to date, and to improve: more CPE than would be possible for any human doctor.

According to the *Financial Times* (Alloway and Massoudi 2014), *Kensho* is an analytics platform being designed to instantly answer millions of

complex financial questions by automating previously human-intensive research, for example, "What happens to US homebuilder stocks if a category three hurricane makes landfall?" Goldman Sachs and Google are investors. Most of the data that move markets are inherently unstructured—central bank announcements; geopolitical developments; product releases; research breakthroughs; droughts, hurricanes, and other weather-related phenomena; and natural disasters. To advise its human handler, a cognitive computer, like a Watson or a Kensho must apply heuristics learned from analyzing and making sense of vast amounts of mostly unstructured textual data plus a (usually much smaller) corpus of structured quantitative data.

If cognitive computers can be trained to be superb medical or financial assistants there is no reason they could not be superb CPA assistants. The cognitive CPA could ingest and "understand" all available accounting and auditing knowledge that exists in the form of professional standards, interpretations, guidance, journal articles, and other literature; and SEC and other regulatory rules, rulings, pronouncements, and millions of filings. No human CPA could possibly absorb, retain, and constantly update this amount of information. It is no longer unreasonable to predict that before too long a computer will be able to review a set of financial statements, including disclosures and management's discussion and analysis, and identify problems as effectively as the most experienced CPAs. Unlike humans, the cognitive CPA would be consistent—always giving the same answer to the same question (unless its knowledge has been updated)—and would never be grumpy or sleep-deprived. While expensive to develop and train, the cognitive CPA's marginal cost per enquiry would be essentially zero; and the cognitive CPA would operate in the cloud and be available to any user with a smartphone regardless of time or location.

UPPING OUR GAME

The essay "Reimagining Auditing in a Wired World" suggests steps the profession should take to realize the full potential of technology to improve audit effectiveness. Those steps are especially important if DA is to be used to transform the way audits are performed. In particular, normative research is required into how DA can be integrated into the audit so that it replaces current procedures where appropriate and results in significantly greater effectiveness, not simply an incremental improvement. Specific methodologies and techniques need to be developed that can be rolled out widely and effectively implemented in the field. There are also many practical issues that require research such as determining the proper role of DA in risk assessment and internal control evaluation; how to ensure high quality results by focusing on

data quality, and documentation and review issues; exploring the assurance implications of 100 percent population tests as well as practical impediments such as dealing with false positives; reliance on internal auditor’s use of DA; how to interpret DA findings; and the efficiency and effectiveness consequences of DA (Wang and Cuthbertson 2015).

ILLUSTRATIVE EXAMPLES

This section includes two examples of audit DA. The first shows how the use of some simple graphics can enhance understanding.² The second illustrates the use of peer data.

Example 1: Simple DA Visualization

The AICPA Audit Guide *Analytical Procedures* (2012) illustrates the use of analytical procedures in both planning and substantive testing using a case study for a chain of convenience stores, called *On the Go Stores*. In the case study, trend analysis, ratio analysis, reasonableness tests, and regression analysis are demonstrated. Here we will use the case study data to illustrate the use of graphics in DA as a way to better understand the entity’s business and identify risks of material misstatement. On the Go Stores has 23 convenience stores located in the Southeast United States. The data are shown in table 5-1.

Table 5-1: On the Go Stores, Case Study Data

Store	Prior-Year Sales (Audited) (\$)	Current-Year Sales (\$)	Current-Year Inventory (\$)	Square Feet	Average Number Full-Time Employees	Sells Gas (1)
1		781,793	48,725	2,500	11.00	0
2	1,165,221	1,146,438	44,171	2,500	11.31	0
3	1,147,430	1,195,004	45,714	2,500	12.46	0
4		951,784	37,218	4,000	11.86	0
5	2,037,463	1,981,409	45,826	4,000	10.06	1
6	2,257,920	2,300,671	53,862	4,000	11.10	1
7	1,850,354	1,956,481	49,883	4,000	10.71	1
8	1,916,884	1,799,713	47,016	4,000	7.50	1
9	1,833,209	1,820,641	59,726	4,000	14.00	0
10		774,954	35,882	2,500	11.20	0
11	980,484	1,159,004	37,664	2,500	11.60	0

² The charts in this section were all prepared in Excel.

Table 5-1: On the Go Stores, Case Study Data—continued

Store	Prior-Year Sales (Audited) (\$)	Current-Year Sales (\$)	Current-Year Inventory (\$)	Square Feet	Average Number Full-Time Employees	Sells Gas (1)
12	1,069,652	1,139,475	34,662	2,500	12.70	0
13		948,522	44,782	4,000	11.86	0
14	1,795,123	1,984,777	38,774	4,000	12.20	1
15	2,119,015	2,293,847	55,423	4,000	11.10	1
16	1,947,303	1,984,722	52,884	4,000	10.40	1
17	1,705,789	1,798,336	46,834	4,000	8.84	1
18	2,396,971	2,484,503	53,772	4,000	12.10	1
19	1,901,631	1,837,400	43,982	4,000	9.70	1
20	1,514,798	1,609,385	44,893	4,000	7.20	1
21	1,886,587	1,874,229	37,665	4,000	10.50	1
22		698,333	33,826	2,500	10.50	0
23	1,092,908	1,198,229	44,857	2,500	10.90	0
Total	<u>30,618,742</u>	<u>35,719,650</u>	<u>1,038,041</u>	<u>80,000</u>	<u>250.80</u>	<u>12</u>

Source: AICPA, Audit Guide: *Analytical Procedures*, March 2012

Five of the 23 stores (stores 1, 4, 10, 13, and 22) opened during the year. Operations vary by geographic location and the mix of products sold. The location of a store is based on several factors, such as competition and the economic environment of the location. Typically, a store's operations do not change much unless a new product line is introduced, such as selling gas, offering check-cashing services, or selling lottery tickets. The mix of products and services can vary, and the most important factor is whether the store sells gasoline. (Stores 5, 6, 7, 8, 14, 15, 16, 17, 18, 19, 20, and 21 sell gasoline.) These additional product lines typically affect the volume of customers as well as the number of full time employees.

One could stare at table 5-1 for some time without easily seeing patterns and correlations. For most people, data comes to life when it is presented graphically. One could start by simply charting sales for the two years as it is presented in the table. Figure 5-1 does this as a dot plot, with store ID on the horizontal category axis, sales on the vertical value axis, with current sales indicated by an empty circle and prior sales by a solid circle.

First, it is interesting that the stores appear to comprise several clusters: {#1–#4}, {#5–#9}, {#10–#13}, {#14–#21}, and {#22–#23}. The apparent clustering may have to do with location or some other factor correlated with store ID, or it could just be a spurious pattern thrown up by coincidence. It might be worth finding out.

Figure 5-1: On the Go Stores, Current and Prior Year Sales in Store ID Order as Presented

Store Sales, Current and Prior Years

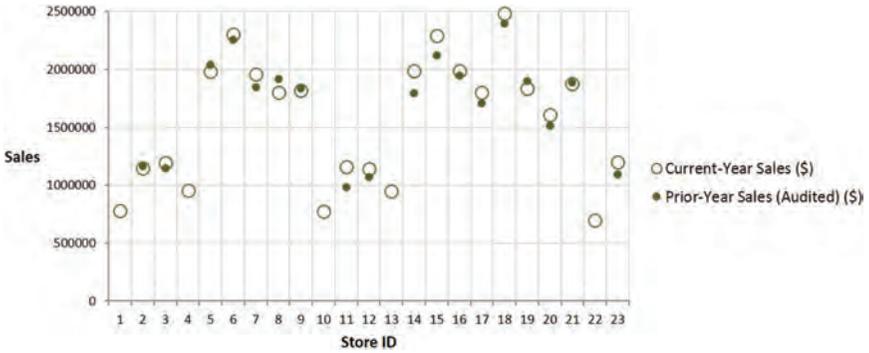


Figure 5-1 can be changed to reveal new information in at least two ways. First, rather than plotting the numbers in store ID order, plotting them in order of store sales shows the distribution of the stores from lowest sales to highest sales. Second, because we know that it makes a significant difference whether or not the store sells gas, it makes sense to distinguish between those that sell gas and those that don't. The result is in figure 5-2.

Certain things are immediately apparent, for example:

- The five new stores that opened in the current year have the lowest sales, confirming something one might expect.
- Stores that sell gas have significantly higher sales than those that don't. The one exception is Store #9, which appears to be performing as well as the stores that sell gas. The auditor might want to check whether the store has been correctly classified as a no-gas store, and, if it has, enquire as to why it appears to have done so much better than the others.

The case study discusses reviewing sales per square foot compared to the benchmark amount of \$490 provided by National Association of Convenience Stores (NACS) as a reasonableness test. The results are plotted in figure 5-3. Once again the five recently opened stores have the lowest sales per square foot. Stores that don't sell gas are all performing at below the industry benchmark; three of those that do sell gas are operating well above the benchmark.

Figure 5-4 shows that inventory turnover ($\text{Sales} \div \text{Inventory}$) is significantly greater for stores selling gas (36 to 50 times) than for stores not selling gas (16 to 33 times).

Figure 5-2: On the Go Stores, Current and Prior Year Sales in Store Sales Order Showing Stores Selling and Not Selling Gas as Separate Series
Store Sales, Current and Prior Years, in Sales Order

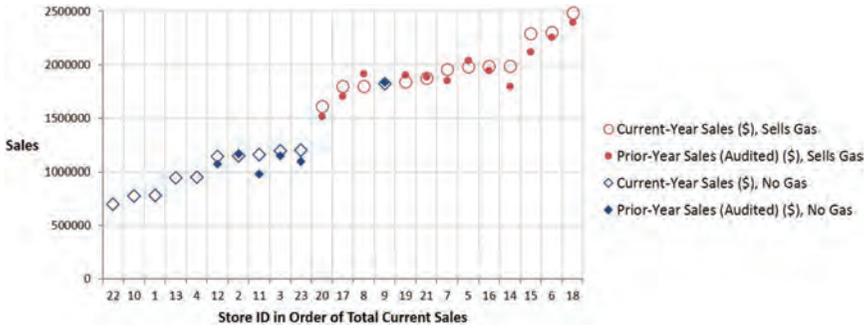


Figure 5-3: On the Go Stores, Sales per Square Foot by Store Compared with NACS Benchmark

Sales per Square Foot Compared with NACS Benchmark (\$490)

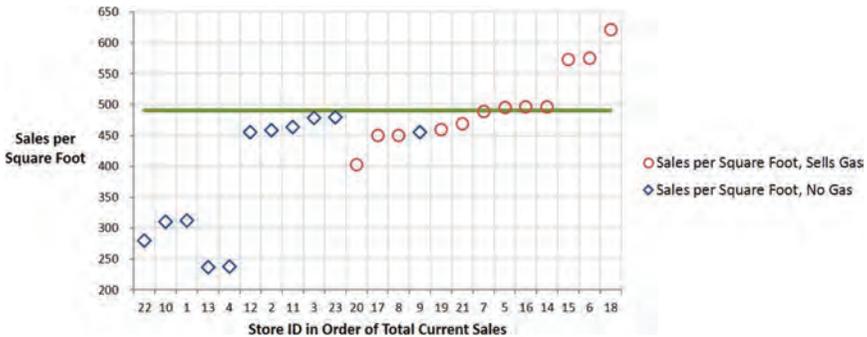


Figure 5-4: On the Go Stores, Inventory Turnover by Store
Inventory Turnover

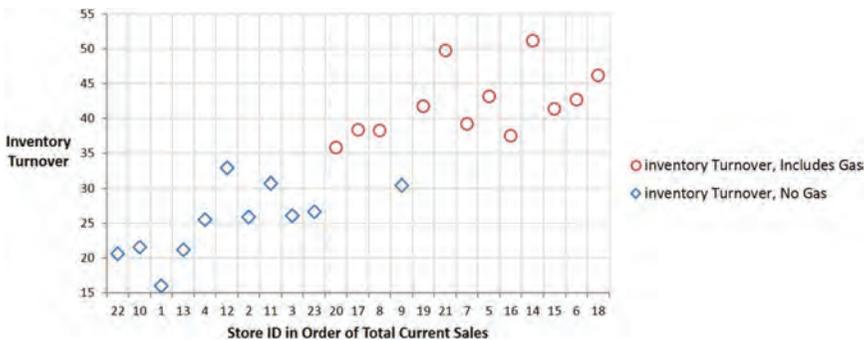
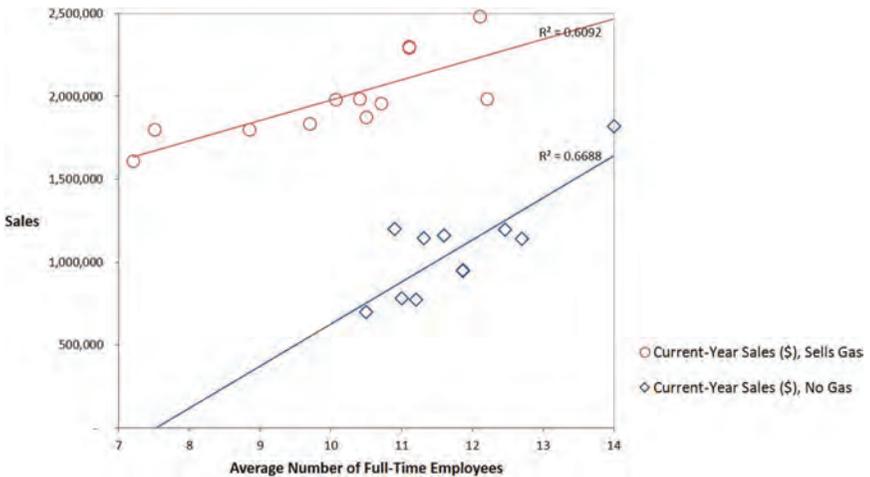


Figure 5-5 is a scatter plot of sales against number of employees, a different type of chart from the dot plots depicted, which all have horizontal category (store ID) rather than value axes. When the data are broken out as two series depending on whether or not the store sells gas there is a strong correlation, approximately 80 percent in each case, and it is clear that stores selling gas have significantly higher sales per employee than those not selling gas. If the data were not broken out into two series, the regression line would not be a good fit and the correlation would be only 15 percent. It would be inappropriate for the auditor to develop a single regression model for the data as a whole without allowing for the difference between the two sets of stores. This serves to make the point that auditors should use DA to understand the data before attempting to model it.

Figure 5-5: On the Go Stores, Scatterplot of Sales Versus Average Number of Employees

Correlation between Sales and Number of Employees



Source: *Compustat* 2013

The conclusions and insights that the auditor of On the Go Stores would draw from this DA would depend on the specifics of the entity, including the auditor’s expectations. The visualizations help the auditor see patterns and relationships and possibly unexpected results. It is up to the auditor to decide, based on other knowledge of the business, what is important and what, if anything, requires additional audit focus.

Example 2: Financial Ratio Peer Analysis³

An important indicator of financial health or lack thereof and thus of interest to an auditor trying to understand the entity and assess risk is how the entity's key financial ratios compare with those of its industry peers. In this example, we show frequency distributions of several key ratios for the wholesale and retail sector (SIC codes 5000 to 5999) against which the ratios of any audit client in that sector can be compared. If a particular ratio is located in the tail end of the distribution it indicates a deviation from the industry norm, which may be good or bad depending on the ratio, which tail, and how far out. A visualization of the complete distribution allows the auditor to make a judgment based on a complete picture of the sector; the client ratios can all be viewed juxtaposed against the relevant distributions and viewed together dashboard-style; and the ratios and their relative positions tracked year to year for signs of improvement or deterioration.

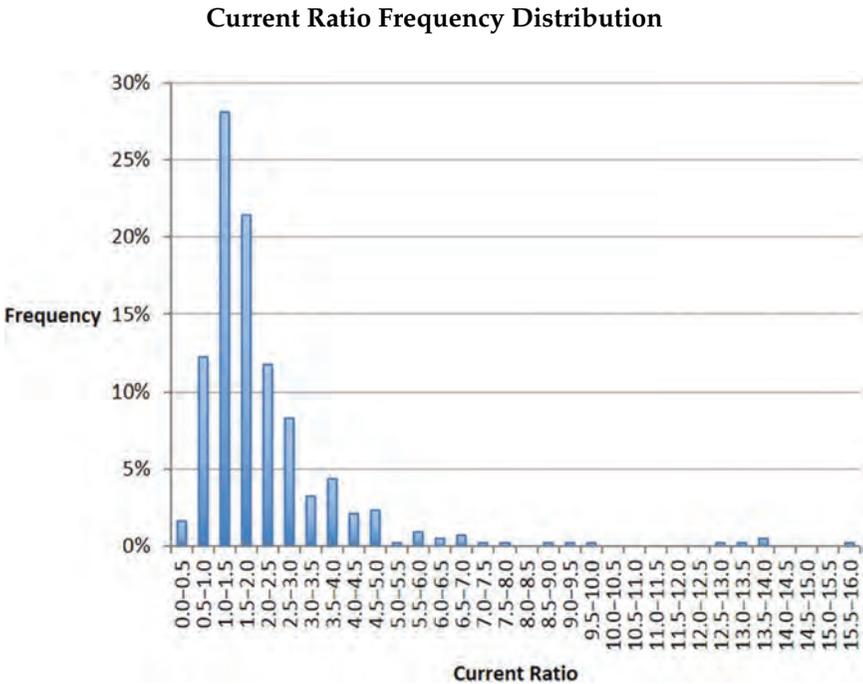
The Compustat database, which includes approximately 430 companies in the SIC 5000-5999 sector, was used to develop the distributions from 2013 data. For example, figure 5-6 shows the distribution of the current ratio (current assets divided by current liabilities). It can be seen that the distribution is very highly skewed. Just looking at the distribution it would seem that current ratios between 1 and 3 are the norm, ratios less than 1 are potentially worrisome, and a very high ratio (the highest in the database is nearly 16) might indicate a potential problem with the data, possibly a misclassification of current assets or current liabilities.

While it is helpful to visualize the shape of the distribution, *cumulative* frequency distributions are generally more useful because percentiles can be read directly. Cumulative frequency distributions for several ratios derived from the Compustat database are displayed in figure 5-7. The first chart is the cumulative distribution for the current ratio and corresponds to the frequency distribution in figure 5-6. Additional ratios presented include inventory turnover, return on assets (ROA), and long-term debt to equity. A table of statistics is included to the right of each chart. It can be seen from the cumulative distribution, for example, that the median current ratio, the 50th percentile, is approximately 1.7. It's the point on the horizontal axis corresponding to 50 percent on the vertical axis. The table gives it more accurately as 1.657. It can be seen that only 5 percent of this peer group have current ratios of 0.740 or less, so the auditor who considers a low ratio to be a risk might have concerns if the entity's ratio is that low.

³ I thank Paul E. Byrnes of Rutgers Business School for providing me with an unpublished paper on which the examples and data in this section are based.

The conclusions and insights that the auditor of an entity in the wholesale and retail sector would draw from this DA would depend on the specifics of the entity, including the auditor’s expectations. The visualizations help the auditor locate the entity’s ratios relative to the entire universe of peers, but it is up to the auditor to decide, based on other knowledge of the business, what is important and what, if anything, requires additional audit focus. This is an example of DA applied to an industry segment, the results of which could be leveraged across multiple audits in that segment.

Figure 5-6: Current Ratios in the Wholesale and Retail Sector



Source: *Compustat* 2013

Figure 5-7: Cumulative Frequency Distributions for Various Ratios

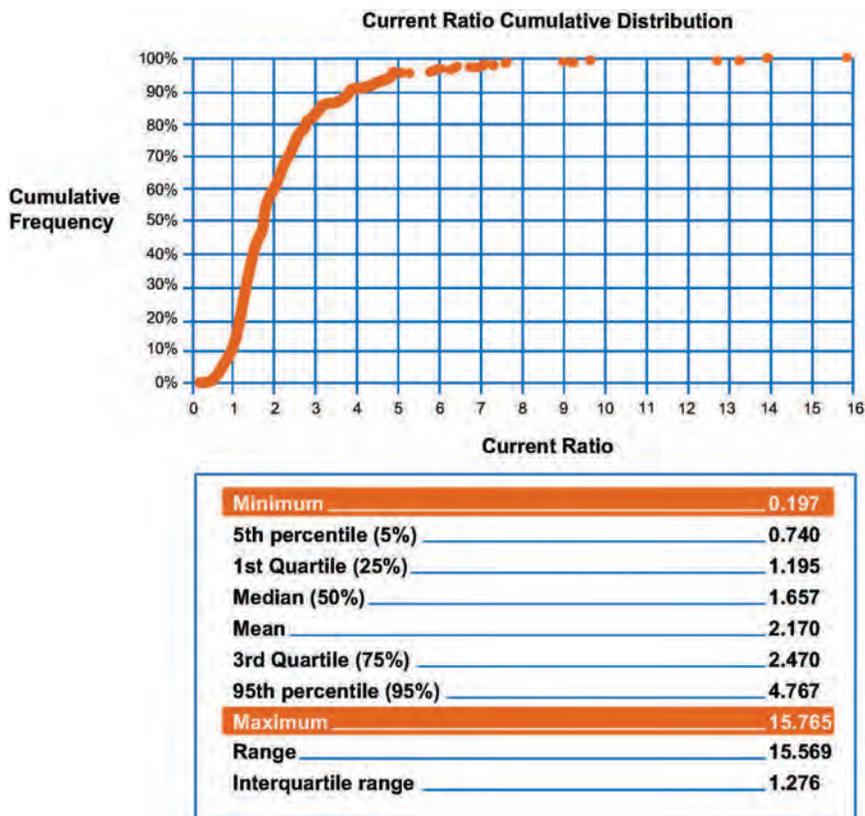


Figure 5-7: Cumulative Frequency Distributions for Various Ratios—*continued*

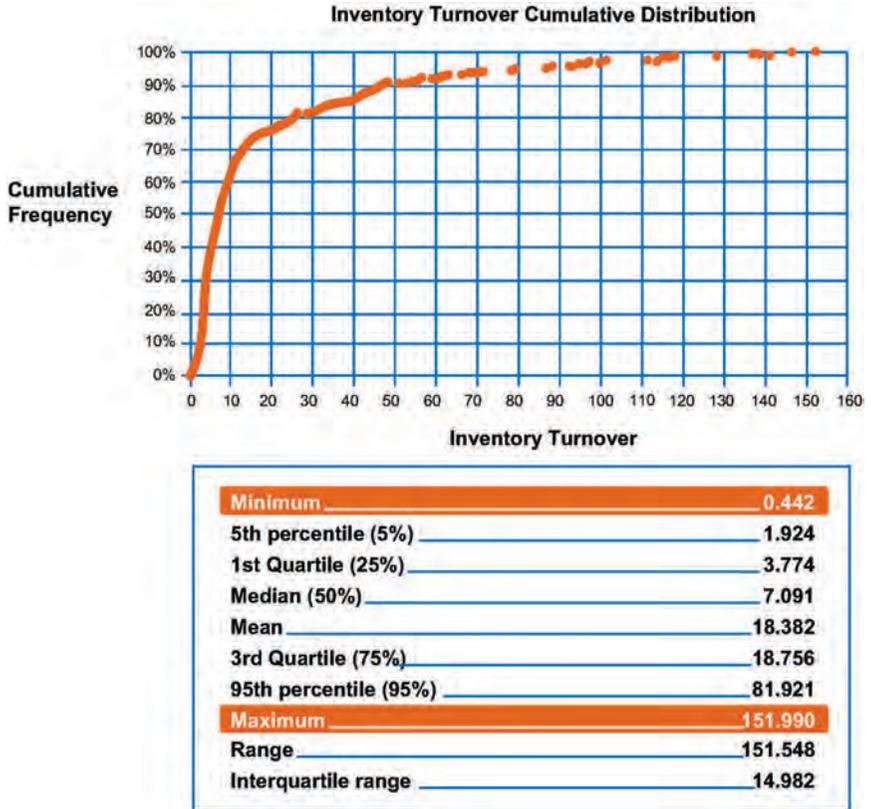


Figure 5-7: Cumulative Frequency Distributions for Various Ratios—*continued*

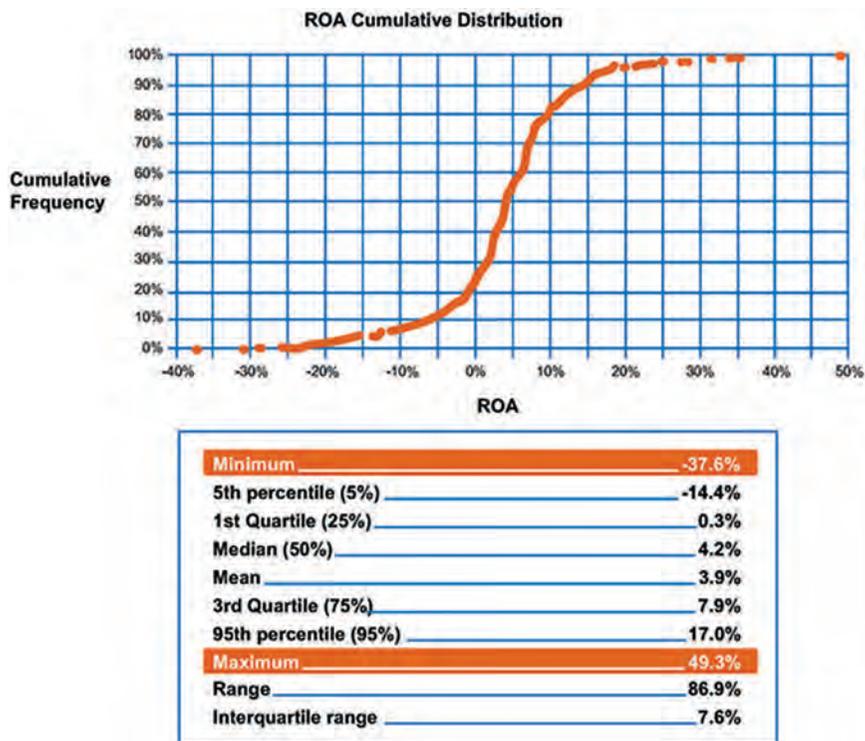
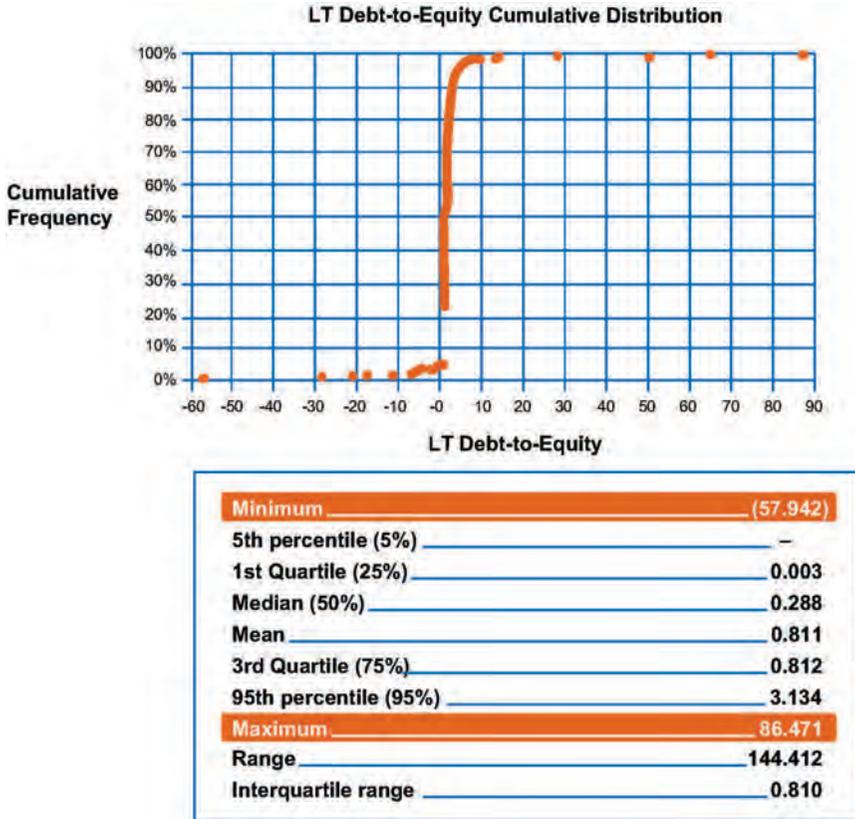


Figure 5-7: Cumulative Frequency Distributions for Various Ratios—*continued*



Multivariate Ratio Analysis

The charts in figure 5-7 allow individual ratios to be benchmarked. While such a piecemeal technique has value, it may fail to identify relationships exhibited via the combination or synthesis of all examined ratios. Because outliers in univariate space are often not found to be multivariate outliers (Starkweather 2013), if one is looking for true outliers, it may be useful to benchmark several key ratios simultaneously. Thus, instead of reviewing $Ratio_1, Ratio_2, \dots,$ and $Ratio_n,$ separately, one might consider the n -tuple $(Ratio_1, Ratio_2, \dots, Ratio_n)$ as a point in multidimensional space to be compared with the industry benchmark point of median ratios.

If there are only two ratios, say current ratio and ROA, a scatter plot shows how the point pairs (Current Ratio, ROA) are dispersed. Figure 5-8 illustrates this using the Compustat-derived data for these two ratios summarized in figure 5-7. For comparability, scales have been changed so that 0 is the lowest for each ratio and 1 is the highest, with the relative measurement retained. Outliers are those points that lie a significant distance from the median. In figure 5-8, X marks the median point and the farthest outlier is circled. To use this chart in practice the auditor would compute the entity's current ratio and ROA and compare the pair to the points in figure 5-8, and would typically be concerned if the point is in the "weak" lower left. figure 5-9 shows the distribution of the distances of the points depicted in figure 5-8 from the median point marked with an X.

If there were three ratios, the scatter of points ($Ratio_1, Ratio_2, Ratio_3$) would occupy a three-dimensional "box" chart rather than the flat sheet occupied by figure 5-8. For more than three dimensions we lose the ability to depict the points graphically though they can be handled just as easily mathematically. The equivalent of figure 5-9 works regardless of the number of dimensions.

Figure 5-8: Dispersion of the Ratio Pair (Current Ratio, ROA)

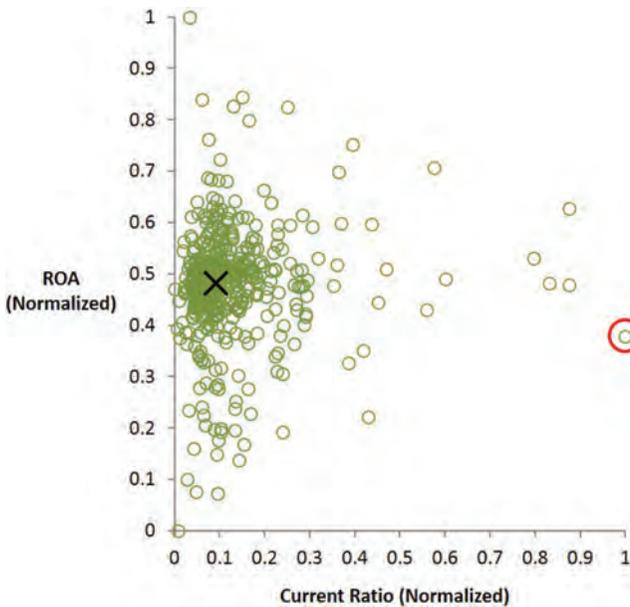
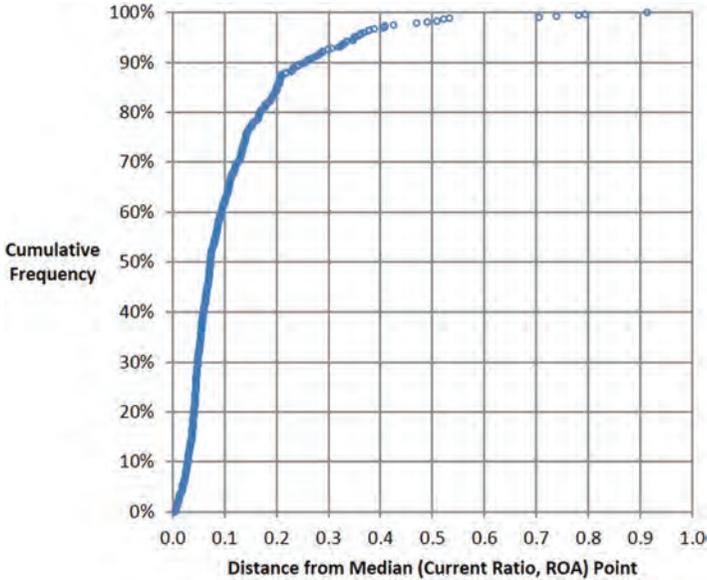


Figure 5-9: Distribution of (Current Ratio, ROA) Distances from the Median Point

Distribution of (Current Ratio, ROA) Distances from Median



Where multivariate ratio analysis is used, the DA software would compute distance of the entity’s multivariate ratio point from the median point and the auditor would compare that distance with the distribution of distances (for example, figure 5-9) to determine the extent to which the entity is an outlier. Distance as measured in this multivariate example accords with our everyday notion of distance—the length of the straight line joining two points. Data science also recognizes other distance metrics as well (Starkweather 2013; Tan, et al. 2006). Because ensembles of multiple approaches have been shown to be particularly effective in identifying true outliers (Zimek et al. 2014), DA applications seeking true outliers in a multivariate ratio analysis might compute distance from the median in several different ways and then calculate a composite outlier score. For example, if four different measures are calculated, they can be normalized to lie between 0 and 1 so that the composite outlier score lies between 0 and 4, with 0 indicating that the point coincides exactly with the median and 4 indicating that the point is a maximal outlier. Scores might also be weighted in the construction of the composite.

The literature on multivariate ratio analysis in auditing is thin to non-existent (Google hits: zero) and the discussion in the preceding paragraph is speculative. The distance measures of data science are principally used in applications such as text analysis, and the extent to

which they would be useful in multivariate ratio analysis in auditing and how one would interpret results is an open question that would benefit from theoretical and applied research. Questions such as what ratios in what industries are of most audit interest and how they can best be used would also benefit from such research.

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ESSAY 6

Managing Risk and the Audit Process in a World of Instantaneous Change

Paul Byrnes, CMA

Gerard Brennan, CFE, PhD

Miklos Vasarhelyi, PhD

Daehyun Moon, CPA

Satyajeet Ghosh, MS, MSE, MBA, CIA, CISA, CFE

ABSTRACT

We live in a world in which business circumstances change and risks evolve in a very rapid manner. Within this context, traditionally-developed annual audit plans may not be able to account for the constantly changing landscape and associated modifications to business risk. Consequently, an approach for regularly monitoring, assessing, and reporting on all pertinent risk factors should be implemented. In this setting, auditors would benefit by keeping audit plans current, thus facilitating adjustment of audit procedures and tests so as to help ensure that a high level of assurance can be provided in a timely manner.

In this essay, the concept of continuous risk monitoring and assessment (CRMA) is described as a method for simultaneously conducting effective audits and managing business operations in the evolving real-time

global economy. Discussion includes a general overview of CRMA as well as more specific considerations such as identification of risk, development and maintenance of key risk indicators, and responses to changing risk levels by both auditors and management. In summary, CRMA offers promise in accommodating auditing and business needs of the future.

INTRODUCTION

In the traditional auditing and managerial environments, risk assessment is viewed as a discrete activity that occurs periodically at a point in time. For example, in the external auditing context, risk assessment would historically occur during the planning stage of the annual audit. The accumulated evidence would then contribute to deciding pertinent characteristics of the corresponding audit plan, such as scope, procedures, and tests, as well as accounts and balances to be emphasized. However, problems can arise when a client's risk profile experiences significant change between the risk assessment phase and completion of the associated audit engagement. In this setting, dynamic adjustment of the audit plan is warranted, but if risk assessment is not a fluid activity, this will not transpire. Problems associated with the untimely identification of changes in the risk landscape will also affect the management and internal audit areas.

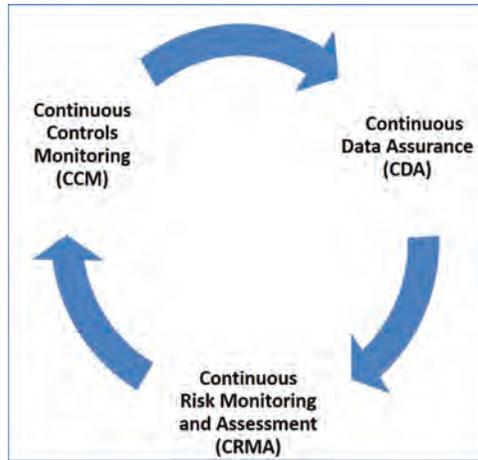
Increasingly, we live in a society where business circumstances and risk factors can and do change very abruptly, thus substantially reducing the lead time for effectively responding to changing conditions. Simultaneously, stakeholders' needs and expectations are expanding (NACD 2009). Within this environment, the traditional method of risk assessment becomes untenable. Alternatively, a more agile, real-time approach for monitoring and assessing risks is necessary such that the audit plan and enterprise risk management protocols are both able to be updated in real time based upon changing risk levels. Audit and risk management procedures may then be refined accordingly, thus improving both audit quality and business productivity. CRMA demonstrates the potential to facilitate this process.

CRMA ARCHITECTURE—OVERVIEW

Vasarhelyi, Alles, and Williams (2010) initially envisioned CRMA as a vehicle for monitoring the risk landscape, measuring pertinent indicators, and providing meaningful input to the audit plan, so that it may be reformulated dynamically in response to modifications in an entity's risk

profile. The authors also contend that CRMA should ideally be fully integrated within a structure that includes both Continuous Controls Monitoring (CCM) and Continuous Data Assurance (CDA) such that a robust system of continuous auditing is ultimately achieved (figure 6-1).

Figure 6-1: Integrated Components in Continuous Auditing (Vasarhelyi, Teeter, Krahel 2010)

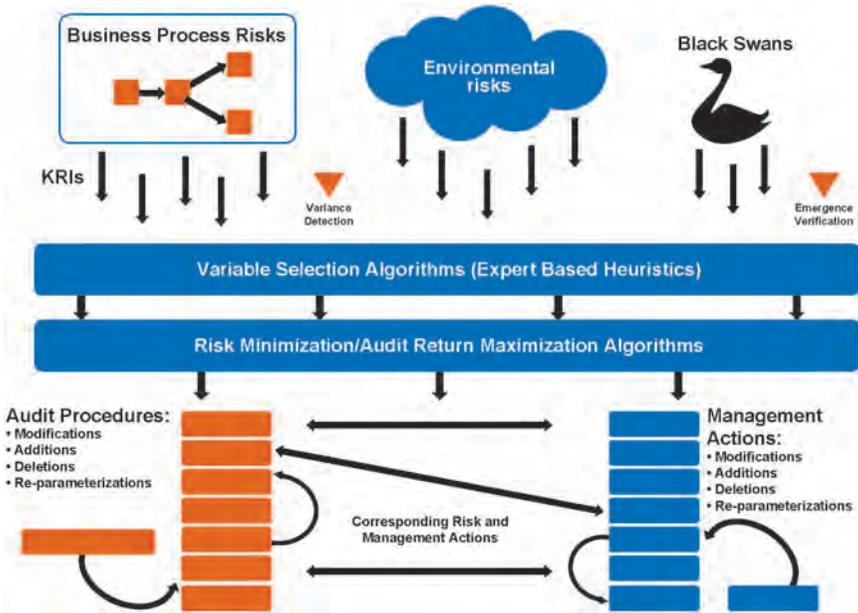


In practice, there might be an initial tendency to implement one or more of the modules in a mutually exclusive manner. For instance, an organization might elect to adopt CRMA as part of a risk management initiative but not incorporate it with CCM or CDA at that point. While this will certainly be beneficial, eventual integration of all three components will produce synergistic effects. For example, as the CCM module identifies internal control failures and other issues, this information can be provided as input to the CRMA program, thus potentially impacting one or more of the risk measures being monitored, as well as offering evidence pertaining to whether revision of the risk profile and corresponding metrics (for example, key risk indicators) is advisable. Furthermore, as risk measures fluctuate in the CRMA system, this information can serve as input to the CCM module, allowing it to proactively address changes in business risk (Moon 2014a). While the CRMA architecture can add value by itself, it can be fully leveraged when combined with CCM and CDA to provide a complete system of continuous auditing and monitoring.

CRMA—GENERAL PROCESS

Vasarhelyi (2011) further describes the CRMA architecture by elaborating on and discussing its various components and functionalities (figure 6-2).

Figure 6-2: Schemata of CRMA Process (Adapted from Vasarhelyi 2011)



In the proposed CRMA framework, three general types of risks are identified and monitored. These include business process or operational risks, environmental risks, and black swans (Taleb 2010). Business process risks are largely inherent and attributable to the business itself as well as its industry. Environmental risks include other forces in the internal environment such as infrastructure and information security issues, and risks in the macro-environment including those residing in the political, competitor, and economic arenas (Kuenkaikaw and Vasarhelyi 2013; Hill 2008). A black swan is a risk that has a very low probability of transpiring, but would likely carry substantial costs if materialized. A black swan is formally defined as "an event or occurrence that deviates beyond what is normally expected of a situation and that would be extremely difficult to predict." (Financial Times 2014). Furthermore, the emergence of a black swan can have catastrophic and unpredictable outcomes. Consequently, although this type of event is problematic to anticipate, it is vital that monitoring mechanisms are established to accumulate and maintain information about these

potential risks. For example, in the airline industry, a possible black swan might be the sudden and prolonged unavailability of jet fuel arising from shipment sabotage and hijacking as well as ongoing civil unrest. Obviously, this set of circumstances could have devastating ramifications and, therefore, should be contemplated to the extent feasible.

For each risk identified, a key risk indicator (KRI) or a set of KRIs is constructed along with an associated benchmark or collection of benchmarks so that effective monitoring of the risk profile can be performed in a systematic and continuous manner. As KRI measures (or combinations of them) are found to be indicative of emerging problems, vulnerable business process areas and associated accounts and transactions are identified, the audit plan is updated, and a revised set of audit procedures and tests is compiled for execution. In addition, the process facilitates revisions to enterprise risk management procedures. To complete the CRMA framework, a method for maintaining the set of KRIs is developed whereby new measures are added, existing metrics are refined, and stale KRIs are deleted as risk profile modifications dictate. Specific considerations in implementing and using CRMA are explored in the next section.

CRMA—MORE DETAILED CONSIDERATIONS

Initial construction of the risk profile will be a prerequisite to creation of a functional CRMA program. In seeking preliminary guidance and direction, one might initially consult with the Committee of Sponsoring Organizations (COSO) 2013 Internal Control Integrated Framework. For an established entity, it will also be beneficial to refer to existing documentation, such as the most recently formulated risk assessment, risk profile information, or organizational quarterly and annual reports, and subsequently revise the risk profile as warranted. In achieving this, the CEB Risk Management Leadership Council (2013) recommends working closely with all identified risk owners and subject matter experts. The finalized risk profile will become instrumental in developing a comprehensive set of KRIs for use in monitoring and assessment routines.

Risk Identification and Analysis

Scandizzo (2005) outlines a system for managing operational risk and indicates that mapping is a critical component of the risk identification and management process. Generally speaking, mapping involves decomposing and examining a given business process by activity to identify all pertinent risk drivers (that is, people, processes, systems, and external dependencies) and associated risk factors. A useful question to

ask of each activity during this phase is "What can go wrong?" because this will enhance discovery of relevant task characteristics such as how an activity can fail, how much risk exists, and the probability of occurrence and impact of potential risk exposure. Once all risks are identified and a profile is constructed, efforts gravitate toward the formulation and implementation of a meaningful set of KRIs able to productively monitor the risk environment.

KRI Development and Implementation

Key risk indicators are "metrics used by an organization to provide an early signal of increasing risk exposures in various areas of the enterprise" (CEB 2013). Each KRI should be a root cause identifier or a leading indicator of risk, such that a proactive response can be made in addressing detected problems. However, achieving this in practice is a non-trivial task. In a recent ERM function survey, 56 percent of respondents indicated the greatest difficulty in KRI development is establishing metrics that are leading indicators of risk (CEB 2013). Therefore, serious attention must be devoted to KRI construction. For example, if the inability to settle current liabilities is an identified risk, several potential KRIs might be envisioned, but many would be suboptimal. The current ratio might initially be suggested as a potential KRI in this situation, but at the point when this measure is indicative of a problem, it could be too late to prevent occurrence of the underlying risk event. Conversely, customer financial health trend information is a leading and more suitable KRI. In this case, if significant financial deterioration in the customer base is detected, then more effective corrective measures could be enacted to avoid having insufficient liquidity in clearing current liabilities as they mature.

Moon (2014a) argues each KRI must possess two fundamental characteristics. First, it has to be measurable, but need not be purely objective. A KRI can be relatively subjective provided it is independently quantifiable and verifiable (Scandizzo 2005). For instance, information arising via text mining and sentiment analysis of news feeds and other electronic media could be synthesized in generating an effective KRI. In an application of this approach, relevant textual information is regularly analyzed, and variables such as information source quality, frequency and timing of news, and severity level of content are all determined and aggregated in computing an entity's reputation risk score (RepRisk 2014). On the other hand, for the identified risk of manipulative earnings management, one might view tone-at-the-top as a potential KRI. The underlying rationale might be that this variable is highly correlated with organizational culture as well as the propensity for unethical behavior. However, evaluating tone-at-the-top would prove extremely challenging from the standpoint of measurability, and if the proposed KRI is not

objectively quantifiable and verifiable, it would be an unsatisfactory indicator.

Second, a KRI must be relevant, meaning that changes in the measure must result in corresponding alterations in the probability of target risk event emergence. For instance, employee turnover rate might be considered as a proxy for risk of having material errors in the financial statements. While this seems a reasonable assumption, if the measure is not found to be highly predictive of the risk event, then it would not be a useful KRI in this context.

Beyond being measurable and relevant, KRIs should also be non-redundant, easy to monitor, and auditable (Scandizzo 2005). To meet the first of these criteria, if two or more KRIs are highly correlated, then only one of the metrics is needed. Presumably, the retained KRI would be that which provides the greatest benefit in terms of risk monitoring and assessment quality. In fulfilling the second criterion, each KRI should be relatively easy and cost-effective to measure and report. To meet the final requirement, complete documentation of all indicators and corresponding data sources used for measurement should be consistently maintained. Table 6-1 provides some theoretical KRIs and associated applications so as to facilitate initial thinking about risk measure development.

Table 6-1: Subset of Potential Key Risk Indicators

Key Risk Indicator	To monitor risk of problems relative to:
Segregation of duty violations	Internal control failures and misappropriation of assets
Percent of uncollected sales	Estimation quality and manipulative earnings management
Customer financial health	Cash flows, collections, and debt covenants
Customer complaints	Sales and customer base; product, labor, and process quality
Accounting employee turnover	Error, fraud, and earnings management
Password reset requests	Control failure, fraud, data integrity or loss
Ratio of book value to fair value for depreciable assets	Estimation quality, errors, and manipulative earnings management
Customer attrition	Revenues and debt obligations
Research and development spending	Innovation, vision, organizational health, and management
Tone of media coverage	Corporate governance; management policies and practices
Phishing incidents	Controls, external fraud, and data compromise

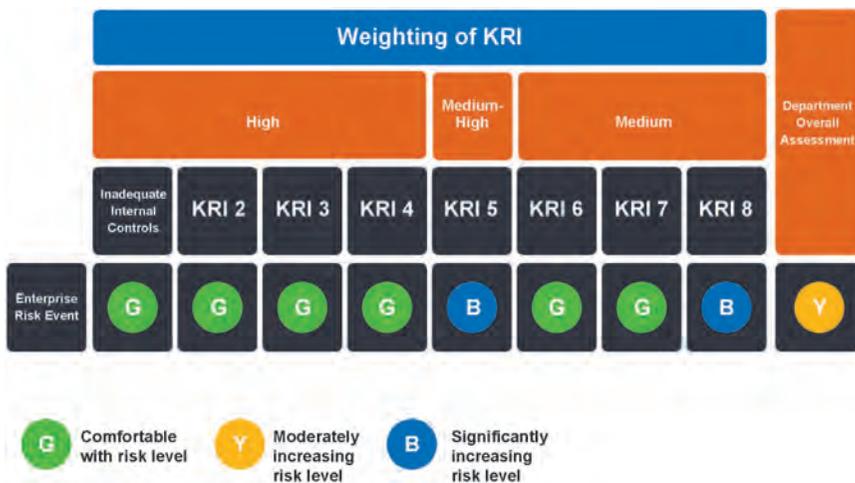
In addition to formulating a comprehensive set of KRIs that are leading, meaningful measures of associated risk events, benchmarks must also be incorporated as reference mechanisms. Moon (2014a) indicates that such threshold values or ranges can be established in two ways. First, historical data can be explored to determine the appropriate threshold or tolerance limits for a given KRI. For example, if prior data reveals that late product deliveries of 1 percent or less is normal behavior from a customer service perspective, then 1 percent might be used as the benchmark in this case. Second, there are standardized KRIs and thresholds established for certain industries. For instance, risk consultancy firms have emerged in the marketplace that, among other things, specialize in the development and provisioning of KRI measures and associated benchmark information to their client bases.

In summary, it is critical that a comprehensive and leading set of KRIs and corresponding thresholds or tolerance limits be developed and maintained so the CRMA program reliably informs auditors and management about the changing risk landscape. In this way, audit plans, audit procedures and tests, and organizational risk management policies and activities can all be addressed and revised in a proactive manner.

Auditor Response to Changing Risk Levels

The CEB Risk Management Council (2013) recommends the design and implementation of a KRI dashboard system for the reporting of risk information. A generic and simplified example of this is presented in figure 6-3.

Figure 6-3: KRI Reporting Dashboard (taken from CEB 2013)



Source Consolidated Edison, Inc.

In practice, the dashboard array might also include a variety of visualizations, such as charts, graphs, and tables. Irrespective of content and sophistication level, it is most important that both management and auditors are provided with relevant, comprehensive, and up-to-date risk information at a glance that is easy to interpret and able to be employed in productively responding to changing risk patterns.

In the audit context, risk information would provide input for the existing audit plan and potentially lead to a reformulation of audit procedures and tests to be conducted. Vasarhelyi, Teeter, and Krahel (2010) indicate that this dynamic approach will present problems for the traditional auditor who tends to be resistant to change and demonstrate rigidity relative to application of auditing standards. To be productive in this new setting, auditors will need to be open to change, inclined to incorporate new methods and technologies into the audit process as warranted, and maintain a principles-oriented stance concerning application of auditing standards.

Moon (2014a) proposes that the CRMA process be substantially automated within the continuous auditing (CA) environment. In this way, as KRI measures change and new significant business risks are identified, they are mapped by the CA system to corresponding audit items and accounts vulnerable to material misstatement. Based upon the outcomes, appropriate audit procedures are then executed to mitigate audit risk. This would result in a real-time CA program equipped to regularly update its settings and routines in accordance with information generated by the CRMA module.

Management Response to Changing Risk Levels

In CRMA, changes to KRI levels and significant business risks also serve as inputs to the organization's risk management procedures and processes. As such, the resulting information is instrumental in updating the risk management plan. Incidentally, Moon (2014a) proposes that this process should also become fully automated in a manner analogous to the audit setting previously mentioned. Specifically, as significant business risks are detected by the CRMA module, these items are linked to the associated risk management protocols, and the set of risk management procedures and processes are revised and implemented.

At this point, the primary features and mechanisms of CRMA have been highlighted. As a complement to this discussion, it is useful to now consider a simplified example of how such a system might function in practice.

HYPOTHETICAL ILLUSTRATION OF CRMA IN USE

Moxy Motors, Inc., an automobile manufacturer, maintains a robust CRMA system. One noteworthy aspect entails continuous monitoring of the regulatory environment relative to the risk that auto emissions standards will become excessively stringent. In addition, given the growing momentum concerning sustainability, social responsibility, and "green" initiatives in general, mechanisms have been implemented to monitor these areas as well. Consequently, there is a combined set of risk indicators to report on the phenomena as they pertain to the automotive industry. Although the overall reporting measure was in a normal state at 11:30 a.m., it suddenly spiked at noon so as to translate into a significant business risk. Fortunately, the operational managers and audit teams were alerted to this problem immediately by the CRMA dashboard reporting module, and promptly initiated investigations.

Management used the information primarily to revisit organizational risk management protocols. A strategic response for addressing this severe regulatory risk involved allocating additional research and development (R&D) efforts toward the design and production of more environmentally friendly vehicles such as hybrid fuel, electric, and hydrogen-based cars and trucks. Furthermore, R&D emphasis regarding traditional vehicle design and development was to be diminished by 25 percent. While these rearrangements would substantially increase costs in the short-run, the estimated long-run benefits provided more than adequate justification for change.

Meanwhile, the auditors were simultaneously processing the current CRMA information to refine the audit plan and adjust audit actions accordingly. The growing concerns suggested that added audit procedures and testing routines to mitigate audit risk should be enacted and more explicitly emphasize accounts, balances, and transactions potentially affected by R&D activities, discretionary accruals, and revenue-related items. Because Moxy had relied predominantly on production of fossil fuel burning cars and trucks, the burden placed on the organization via restructured R&D investments could enhance the probability of questionable accounting practices appearing in that area. Furthermore, because of rising operating costs and resulting issues relative to management's concerns about meeting various short-term earnings targets, there could be immediate pressure to manage earnings.

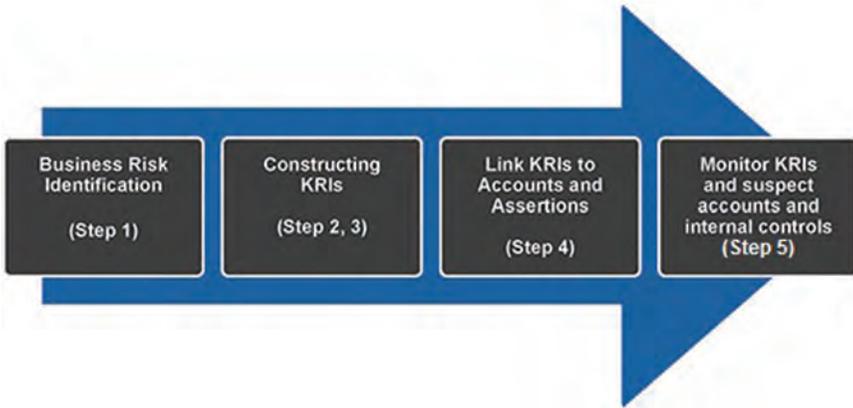
By proactively responding to the identified business risks, managers productively implemented an action plan for addressing the emerging problems. In addition, auditors were able to adjust the audit plan in

real-time, thus improving confidence that a high-quality audit could ultimately be performed.

Systematic Implementation of Risk Management and Assessment in a Process

Moon (2014b) outlines a formalized approach for the development and implementation of a continuous risk monitoring and assessment program. The corresponding framework is shown in figure 6-4, and provides guidance in establishment of CRMA for a given process.

Figure 6-4: Framework for CRMA implementation (Moon, 2014b)



The diagram flow is essentially from left to right. However, pertinent activities in the areas of communication, consulting, monitoring, and reviewing will be ongoing during all phases of both system development and usage (VMIA 2014). This facilitates continuous acquisition of information and knowledge beneficial for responding to identified issues and refining the CRMA module as warranted.

When initially seeking to monitor and assess risk in a particular process, a fundamental preliminary task is to identify relevant parties. More specifically, all internal and external stakeholders (that is, process owners, subject matter experts, and auditors) should be identified by the project team and included in the initiative so as to ensure program functionality and success. Furthermore, the inclusion and involvement of these stakeholders should be ongoing throughout development and implementation phases of the CRMA initiative (VMIA 2014).

According to figure 6-4, business risk identification is the first formal step, and involves a comprehensive evaluation of the internal and

external environments. Initially, gaining a sufficient understanding of the business is required, and entails considering organizational objectives within the context of each target process. For example, if a risk-monitoring and assessment routine is being established for the manufacturing process, it would be necessary to envision how it contributes to organizational objectives and the ways in which risks might impact their achievement. Such an assessment will yield several insights, including but not limited to process importance, extent of and tolerance for associated risks, project scope, and resources likely required for implementation of the risk monitoring initiative.

Following this, all relevant risks must be identified. According to the VMIA (2014), this involves the creation of an exhaustive listing of items that could affect the fulfillment of organizational objectives. Referring to historical documentation and consulting with pertinent stakeholder groups will be a useful starting point. In addition, brainstorming, interviews, surveys, and focus groups could produce supplemental input for risk identification purposes. In documenting risks, it is also important to specify how and why each risk might occur, take note of any existing controls that mitigate risk realization, and consider associated consequences of risk materialization. The emphasis in this stage should be not only on documenting all possible risks, but also understanding the root causes and outcomes of each risk event. For example, consider the risk of information technology (IT) failure. One cause might be network intrusion by an unauthorized external party. Among other things, one consequence might be loss of sensitive customer data leading to customer dissatisfaction and reputational damage. Certainly, management would want to proactively anticipate and address such problems. From an auditing perspective, risk of IT failure would be perceived as increasing the probability of subsequent fraud. Therefore, audit efforts would be appropriately modified in response to emergence of this risk event.

Once a complete listing of business risks is generated, emphasis is placed upon generating KRIs to effectively monitor the risk environment. Obtaining a firm understanding of risks and associated causes and consequences in the previous stage should greatly assist with discovery of a comprehensive and leading set of KRIs for subsequent monitoring and assessment routines. Returning to the previous IT example, the number of phishing attempts might be established as one KRI for risk of IT failure. In addition, other metrics might be identified such that a set of KRIs is meaningfully combined to collectively measure IT failure risk.

It is also imperative that, for each KRI, a suitable threshold or tolerance range is determined. Otherwise, the implemented system will fail to provide timely, relevant, and reliable warning signals concerning emergence of business risks. To assist with this activity, prior experience and documented industry KRI information can be relied upon. For

instance, if historical findings suggest that a product specifications conformity rate of 99.999 percent is minimally acceptable from both product quality and customer satisfaction standpoints, then this might be perceived as a legitimate threshold value. Performing this type of analysis for each risk indicator will help ensure that functional threshold values are structured so that management, internal auditors, and external auditors are all able to proactively monitor and respond to the changing risk environment.

Once KRIs and associated thresholds have been created and compiled by the project team and relevant stakeholders, auditors begin linking each KRI with the related subset of accounts and assertions to be tested (Moon 2014b). Objectives in this phase pertain mainly to understanding KRI impacts on financial statement information and, consequently, how audit activities should be modified in response to changing KRI levels when significant business risks are detected. As an example, one important audit assertion relates to valuation of assets. In an embedded component of testing this assertion, the auditor will seek to determine the reasonableness of any pertinent estimates such as depreciation, amortization, and allowances. For instance, imagine that a KRI and related set of tolerance limits based upon historical experience are implemented to monitor depreciation levels on fixed assets. When the KRI moves near or outside the acceptable boundary, auditors are alerted about an emerging risk relative to the valuation assertion for fixed assets. The accounts primarily affected in this case are non-current assets of a depreciable nature. In addition, an income statement account (that is, depreciation expense) is also affected, thus impacting net income in a potentially questionable manner. In response to increasing risk in this area, auditors would adjust the audit plan and testing activities so as to more heavily emphasize examination of depreciable assets as well as the reasonableness of depreciation amounts currently being recognized. If problems of a material nature are unearthed, then timely remedies can be proposed and implemented. In so doing, the auditor is positioned to productively modify the audit plan and related testing routines dynamically as changes in the risk landscape are reported by the CRMA system.

The final step in figure 6-4 encapsulates the implementation phase for CRMA. In the auditing domain, the entire set of KRIs are continuously measured and reported by the CRMA system. When emerging risks are detected, auditors use this information to adjust the audit plan so that appropriate emphasis is placed on examining and testing the assertions, accounts, and controls that are most likely to be impacted.

To ensure ongoing system relevance and reliability, KRIs are regularly maintained so that new measures are created, existing metrics are modified, and obsolete KRIs are eliminated as the risk profile dictates.

Furthermore, associated threshold values and tolerance limits are addressed in a comparable manner. This requires continuous communication and vigilance by process owners, subject matter experts, management, and auditors, and is key to the long-run success of risk monitoring and assessment. Given that the risk landscape is dynamic, an effective monitoring system must be agile, and the CRMA approach can provide for this capability.

CONCLUSION

We live in an interconnected world where the risk landscape and business circumstances can and do change abruptly and unexpectedly. The traditional risk identification setting, wherein risk assessment is done as a discrete task and the risk landscape is not comprehensively monitored in an ongoing manner, is increasingly untenable in our evolving real-time global economy. Instead, a more fluid approach is necessary to monitor risks and facilitate modification of audit procedures and testing routines, thus resulting in higher quality audits with assurances that optimize the value added to corresponding information. Although CRMA is admittedly in a formative stage, it offers genuine promise in helping to achieving this vision.

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PART II

Case Studies

CASE STUDY A

Developing Continuous Assurance at Siemens

Ann F. Medinets, MBA, PhD
Jason A. Gross, CPA, CIA, CFE, CISA, ACDA
Gerard (Rod) Brennan, CFE, PhD

Siemens Financial Services (SFS)¹ helps organizations in the energy, construction, manufacturing, and healthcare industries to finance their equipment and software, generate working capital, and manage their portfolios and projects. SFS also provides financing so that municipalities may achieve their transportation and infrastructure goals. In order to help clients reach their financial targets, data integrity is critical at SFS. Both internal managers and external customers need assurance that the data used to make and evaluate strategic financial decisions is correct.

¹ According to a recent press release,

Siemens Financial Services, Inc. (SFS) is the U.S. arm of the global Financial Services unit of Siemens, which is an international provider of business-to-business financial solutions. SFS helps facilitate investments, providing commercial finance, project and structured finance with specific asset expertise in the energy, healthcare, industry, and infrastructure and cities markets. Employing more than 2,900 employees worldwide, SFS supports Siemens as well as other companies with their capital needs and acts as an expert manager of financial risks within the Siemens Company. By leveraging our financing expertise and our industrial know-how we create value for our customers and help them strengthen their competitiveness. Beyond that, financing is key in creating trust for technological solutions—and acts as a key enabler when it comes to the market launch. As of September 30, 2014, the total assets amounted to €21.97 billion. For more information, visit: www.usa.siemens.com/finance.

TRADITIONAL INTERNAL AUDIT

In the past, SFS followed a traditional internal audit regime. Generally, internal auditors act as an interface between the Board of Directors' Audit Committee and the external auditors, so their responsibilities relate primarily to the areas of internal control, risk management, and governance.

Internal control: All organizations are supposed to maintain a system of internal controls to accomplish four key goals: (1) to monitor the efficiency and effectiveness of the organization's operations; (2) to safeguard the organization's assets; (3) to prevent errors that might impair the reliability of the organization's financial and managerial reporting, or to detect and correct such errors once they occur; and (4) to ensure the organization's compliance with relevant laws and regulations. Although organizations may choose different methodologies for specific tasks, the internal auditors or the internal control functions typically monitor, evaluate, and make recommendations to management in order to improve the network of internal control policies and procedures designed to accomplish these goals.

Risk management: In the area of risk management, internal auditors work with managers to assess and mitigate risks that might impair the organization's business strategy under the COSO (Committee of Sponsoring Organizations of the Treadway Commission) enterprise risk management (ERM) framework. In addition, as part of the organization's compliance with Section 404 of the Sarbanes-Oxley Act (SOX), internal auditors report to management on any weaknesses in the organization's internal controls that might create a potential risk of a material misstatement in the organization's financial reporting.

Governance: The COSO ERM framework broadly defines governance to include all activities related to directing the organization's operations in order to achieve its operational goals and protect stakeholders' interests. The governance aspect of the internal auditor's job is to work with the audit committee on control issues and to facilitate the flow of information between the external auditor and the audit committee.

CONTINUOUS CONTROLS MONITORING

The skills and techniques used in internal audit can also be applied to continuous controls monitoring (CCM) programs. The vice president of internal audit started at SFS in 2002, but starting in 2009, the company leveraged his years of knowledge of its internal business processes and control framework to develop the company's CCM program. In his new

role as vice president of controls management at SFS, he observed that many of the company's internal audit programs, such as audit checklists, are mechanical and repetitive in nature, so he wanted to automate these processes by moving to a CCM program as an independent control assurance function that would be separate from internal audit.

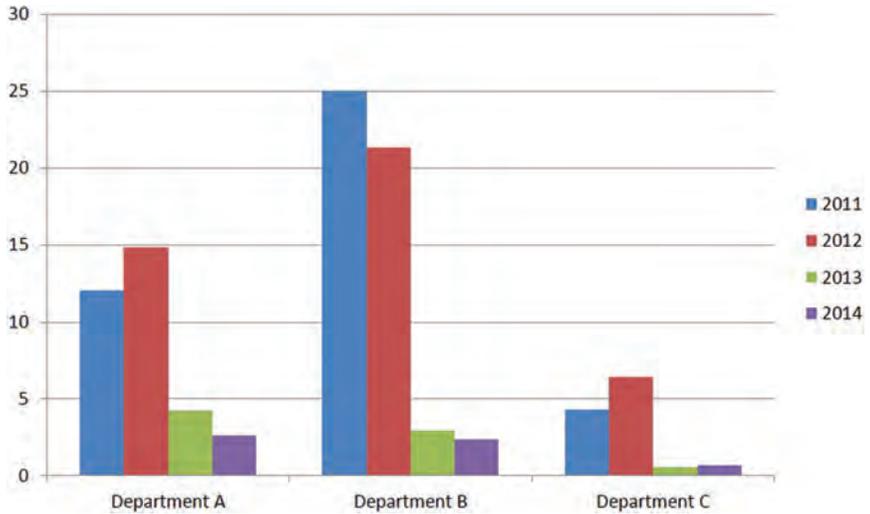
Recognizing that organizations are often resistant to change, he decided to start with small, achievable targets to demonstrate that the program has merit, and then expand beyond financial reporting into operational components once the business unit and support unit managers at SFS had become accustomed to the continuous monitoring methodology.

In the first phase of the project, the new vice president of controls management focused on financial reporting rules compliance and data integrity. Personnel at SFS manage data and make decisions within a framework of company policies expressed as a set of rules. Because SFS relies on communicating rules and assessing compliance with those rules in providing services to its clients, the first part of the project was to develop a system that could notify key people within the company about "exceptions" and "alerts." An exception demands immediate research and resolution because it means that a rule was not followed. Depending on the explanation that is given for the exception, it might also require a correcting entry in the SFS accounting records. By contrast, an alert flags any transaction that might be of interest to the owners of that information, such as a change in a transaction, so that SFS can take immediate action to verify the information and be proactive in monitoring the business.

Implementing a CCM program would enhance business processes at SFS by immediately identifying any exceptions to the company's system of rules and policies by internal decision-makers, notifying them of these exceptions, and demanding resolution. The CCM system would also improve the company's financial assurance processes, such as SOX requirements, by monitoring the entire data population, instead of relying on the types of sample testing used in traditional SOX or internal audit methodologies. According to the vice president of controls management, "Exceptions in the data pool are like fish in the lake. Just because they are there doesn't mean you will catch any." Continuously assessing 100 percent of data attributes (validity, authorization, completeness, valuation, time period, and disclosure) for exceptions gives far greater assurance that the data represents the company's underlying economic position than periodic sampling ever could. In addition, the immediacy of the CCM's feedback raises decision-makers' cultural and behavioral awareness of rules at SFS, which further enhances its value as a tool and a methodology.

Designing and instituting a CCM program requires finding a balance between complexity and flexibility. It must be simple enough for all personnel to use it correctly, but capable of being tailored to the needs of customized data sets, disparate system platforms, and unique business rules. For the CCM program at SFS, the vice president of controls management chose the ACL Analytics Exchange (AX) platform, including AX Exception and ACL Analytics. At the most basic level, this system recursively tests 100 percent of transactional data in the company's sub-ledger system for anomalies and control failures, and notifies the owners of the data about any alerts or exceptions within their area of responsibility. As a result, process owners would get a higher level of assurance on data integrity. In addition, process owners and members of the controls management team can be freed from repetitious manual tasks and time constraints. Therefore, they can refocus their skills and energy on specifically flagged areas, and skip information in parts of the business processes that do not need immediate attention. As an added benefit, the number of exceptions detected was expected to decrease over time. Many exceptions come simply from habit, so better communication of the rules and mechanisms should reduce or eliminate repetitive problems, resulting in overall consistency and process improvement.

The data analytics manager at SFS provided a sample of three of the company's departments, covering approximately 60 of the 150 exception-type testing algorithms (commonly referred to as "analytics") in the scope of the CCM program. He noted the substantial improvements in the average percentage exception rate from the program's inception to the present. These analytics cover various attributes including data input checks, validity checks, and compliance with regulations and internal policies. As shown in figure A-1, the consistent reduction in the average exception rates demonstrates an adherence to controls driven by the continuous monitoring program. For instance, Department A showed a reduction in percentage exception rate from 12–14 percent in 2011 and 2012 to 2–4 percent in 2013 and 2014. Even more strikingly, Department B improved from an exception rate of 21–25 percent in 2011 and 2012 to 2–3 percent in 2013 and 2014, and Department C improved from an exception rate of 4–6 percent in 2011 and 2012 to less than 1 percent in 2013 and 2014.

Figure A-1: Change in Departmental Exception Rates at SFS (2011–2014)

SFS currently runs approximately 250 exception-type and alert-type analytics on a daily basis. The results of this sample indicate that the exception rates have significantly improved and remained consistent since the implementation of the CCM program into production in February 2010. The vice president of controls management has observed that departments are starting to request that new analytics be added to the CCM program as the business unit and support unit managers at SFS recognize the system's value.

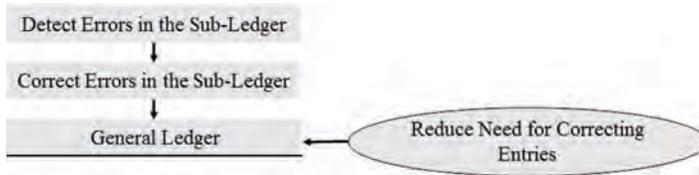
In addition to the analytics, the vice president of controls management made some design choices to customize the ACL AX system to specific needs and workflows at SFS. He decided to have the system report an aging of exceptions. This forces the owner of each exception to deal with the problem in a timely fashion. He also chose to implement closed-loop escalated alerting. One of the most powerful features of the system, these alerts operate like traffic cameras at red lights, sending a "ticket" up the company's hierarchy if the owner of the exception fails to address the issue. Finally, he determined that there should be no unilateral closing of unfixed problems. Each exception must either be fixed or explained by the owner and then reviewed and verified by someone else. In terms of data integrity, this means that if the owner closes an exception on the web-based system, it must also be validated by the CCM system. Thus, the exception must be resolved fully in the sub-ledgers because the owner of the data cannot simply make the problem disappear. Otherwise, the exception will be republished the next day, and the CCM program

will also notify higher-ups. The goal of this procedure is to ensure that all exceptions are corrected, but this design choice also has managerial implications. It helps supervisors to see the types and frequencies of exceptions that are occurring so that they can consider whether their subordinates are taking too many liberties with the rules, or whether the rules themselves might need to be changed. Alternatively, particular patterns of exceptions might indicate that specific processes may need to be improved.

In 2013, the vice president of controls management instituted a valuable innovation to the CCM program. Because the CCM program already automatically identifies new exceptions daily, he realized that the same approach can be applied to notify the owners of the analytics, on a daily basis, when their previously flagged analytic exceptions have been fully corrected and resolved in the sub-ledger. Therefore, noteworthy efficiencies in the CCM process became achievable. This drove the creation of a CCM functionality that the vice president of controls management refers to as "Auto Close." The Auto Close feature eliminates the requirement for the owner of an analytic to update the status of a corrected and closed exception manually on the website. The benefits of Auto Close include avoiding the manual step of closing the items on the AX Exception website, typing comments, and/or uploading supporting documentation. In addition, this new process ensures a real-time status of corrected items on the website for improved transparency of unresolved items because, at times, the step of updating the AX Exception website manually may not be timely or fully maintained. The Auto Close feature also ensures strong change management through logging of the data corrections on a before-and-after view and archives this information as an attachment in the history audit trail in the AX Exception website. Auto Close confirmations are automatically emailed to the analytic owners as they are identified by the CCM Program.

The vice president of controls management indicates that, although most people think of a CCM program as a detective control, the benefits of the CCM program reach further if planned and incorporated carefully. The program can also be a preventative control because it monitors transactions as they occur during the month, and identifies exceptions daily (or in real-time) and corrects them immediately (or at least before the end of the month). Therefore, the exceptions are corrected in the sub-ledger prior to the month-end closing process. As shown in the following diagram, this eliminates the need for the accounting function to book correcting journal entries manually and results in a clean general ledger without manual adjustments. The vice president of controls management says, "It's a win-win for the business operations and the accounting function. We can target common sources of correcting journal entries as analytic targets in the CCM program."

Figure A-2: CCM as a Preventive Control to Improve the Closing Process



Of course, the way that the CCM functions within an organization's internal control system depends on the specific structure of the organization's bookkeeping system. For example, if an organization posts to the general ledger monthly, then the CCM operates as a preventive control because it catches errors before they are posted. Alternatively, if transactions are posted daily, then the CCM serves as a detective and corrective control because it fixes errors after they are posted.

To a large extent, internal control specialists are the architects of an organization's analytic tools because they have a unique awareness of the risks and controls, as well as the kinds of information and the information formats that will be needed by managers for decision-making and by internal and external auditors for risk assessment and assurance purposes. For example, the AX system has a naturally auditable log function that constantly tracks actions performed in the CCM program to provide a solid trail in one direction to the way that exceptions were derived, and in the other direction to subordinate clean results that may be relied upon by both internal and external auditors. This creates an audit trail that facilitates both internal and external audit activities. Thus, the AX log not only finds exceptions and monitors their resolution, but also reports on exceptions and keeps a log of clean results that serve as evidence on the correctness of the residual data. As an added benefit, this is a tool that the external auditors easily understand and trust because they already use this software application in their work. AX has also streamlined the processes necessary to comply with requirements for internal controls over financial reporting under SOX and ICFR (internal control over financial reporting). SFS no longer needs to sample the functionality of selected internal controls that have already been migrated to CCM for Section 404 reporting because the system has already tested 100 percent of the population, giving the external auditors a high level of reliance on the data as they plan the timing, nature, and scope of the audit. It also eases the client's burden to provide sample-based data to the auditors and streamlines or eliminates the need for management assurance testing.

The vice president of controls management sees the CCM system primarily as a tool of management. For each managerial decision, the

system enables managers to prepare the accounting for that decision, tracks ownership of the data related to that decision, and provides a check on whether the company's rules were followed for each attribute of that decision. In addition, the system helps owners to do spot checks and flag potential issues.

At SFS, the controls management department owns and controls the ability to modify or add new analytics to the ACL CCM program, and the company's managers own the results and resolutions to exceptions, but the rules are the core of the system. They need to be expressed in a way that is system-compatible, and must be monitored to ensure that they are operating as intended. The ACL Analytics Exchange is a highly flexible system that can include components such as automated fraud detection and forward-looking data analytics. Its only limitations are an organization's available resources.

Another potential area for expansion is strategic data analysis. Specific identification is the most granular level of data, but it is not always the most useful for planning the future. The North America risk and internal control officer at Siemens points out that the ACL Analytics Exchange is compatible with systems like SAP HANA, a powerful platform that offers the capability of running analytics for the CCM system (or any process) much faster because it optimizes data management so that the data is, in effect, stored in random access memory (RAM). This allows "in-memory" analytics to be run instantly with real time results. Users no longer need to search remote databases to find and transport data, improving the latency and response time of analytics. This is breakthrough technology in the world of accounting, auditing, and monitoring because it allows for the fast and efficient use of analytics across multiple databases on structured and unstructured "big data" with a significant reduction in complexity and with instant results.

CCM is a focus for Siemens across many corporate functions, business units, products, and processes. Analytics, as a key support for CCM, is an important enabler of the company's future vision for control, but it also helps to drive the use of more automated common process in all business areas. This technology can be used to help ensure that people are following defined processes and strategies, to prevent or detect fraud, to improve project management, to monitor key risk indicators and opportunities, and as an early warning system to prevent problems before they happen. According to the North America risk and internal control officer, "We have made good progress in some areas and are just conceptualizing opportunities in others. For the future, we need a clear, integrated enterprise strategy around continuous monitoring and common, easy-to-use tools across all business units and regions to best leverage the power of this technology to improve business processes and reduce costs. Continuous monitoring and the use of analytics is a

'disruptive change' that can and will have a significant impact on improving products and improving business and operational processes in the future."

The vice president of controls management believes that the system developed at SFS can be leveraged into a scalable, sustainable, replicable application for other parts of the Siemens organization. Ultimately, his goal is to move the company from computerized, continuous, internal monitoring to a fully integrated, real-time, continuous assurance system for internal control.

CASE STUDY B

Implementing Continuous Auditing and Continuous Monitoring in Metcash—Change, Capabilities, and Culture

Glen Laslett, CA, CIA
Catherine Hardy, PhD

INTRODUCTION

Developing continuous auditing (CA) and continuous monitoring (CM) capabilities are consistently recognized in industry surveys as a top priority for not only improving internal audit effectiveness and efficiency but also for adding value in increasingly complex and changing business environments (KPMG 2012a; Protiviti 2014; PwC 2014). While the benefits and business imperative for CA/CM are widely accepted, uncertainty remains as to how this can be effectively accomplished (Hardy 2014). Building a sustainable CA/CM system requires far more than a business-as-usual type approach and "adding some tactical and

technical data analytic capabilities" (KPMG 2013, 1). A number of papers have referred to the challenges in being able to effectively leverage data analytics and CA/CM techniques (PwC 2014) and then successfully integrating them into the audit process (KPMG 2013). We argue that the principal challenge is more fundamental. A major issue facing internal audit functions is developing an architecture that facilitates the regular capture and management of data from various systems, as well as the development and reliable delivery of continuous monitoring routines (CMRs) that efficiently test controls and data as well as mechanisms that allow the tracking and analysis of exceptions.

We draw on the Metcash case, an Australian-based company that has reached an advanced maturity stage over a decade of development in using CA/CM (Hardy and Laslett, forthcoming). Key issues and challenges faced by the internal audit group when implementing and using CA/CM are described, as well as the lessons learned. More importantly, the case also reveals how CA/CM is being used to transform internal auditing and future directions. Our discussion commences with the value proposition for adopting CA/CM in Metcash. A description of the architecture follows. The types of CA/CM applications used are outlined, giving detailed attention to one specific CMR due to its relative uniqueness as well as its coverage of the core elements of value-added CMR development: multiple data sources, complex algorithms, and accountable exception delivery. The implication for implementing CA/CM and internal audit more broadly concludes the case discussion.

VALUE PROPOSITION: IDENTIFYING THE NEED AND ADDRESSING THE BUSINESS CHALLENGE

The value of CA/CM for Metcash needs to be placed in the context of the company's history and overall strategy. Metcash operates in four market areas: food and grocery, liquor, hardware, and automotive. The vision of the company is to grow its markets and deliver value to its stakeholders, provide excellence in distribution and merchandise, be retailer and consumer champions, and be a place of choice to work. The company has had a long history of growth through acquisitions over a 40-year period. This was a period of significant change, resulting in organizational restructures, a new senior management group and diverse systems. Investments in enterprise platforms relating to warehousing and financial systems have occurred over the past decade.

There were clear benefits to be accrued by implementing a CA/CM system. Metcash processes high volumes of transactions. For example, the accounts payable department processes approximately 760,000

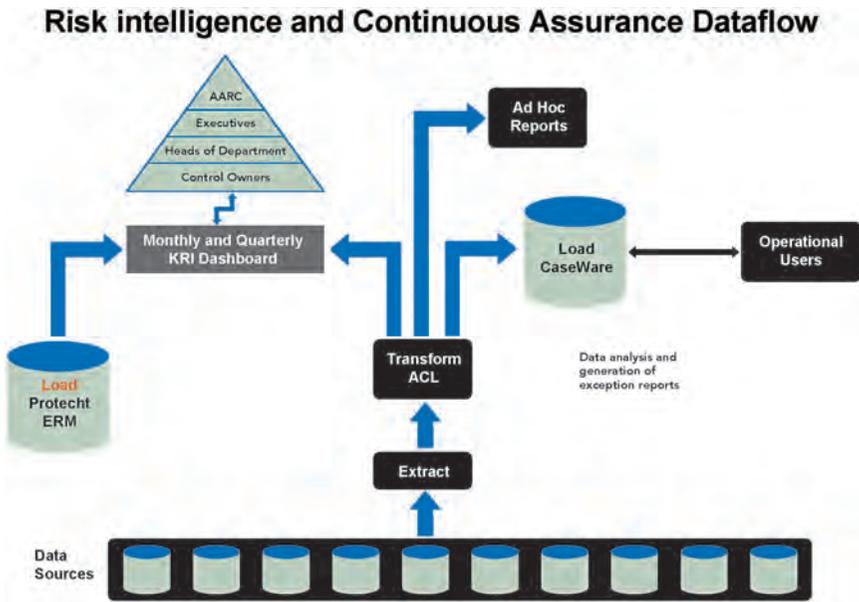
invoices annually, with a further 1,500,000 processed for direct deliveries to customer stores. Accounts Receivable processes nearly 700,000 transactions each month (Hardy and Laslett, forthcoming). An automated environment for testing 100 percent of controls and transactions on a near real-time basis was always going to bring value to the business if executed appropriately. However, the benefits to be gained were far more than simply automating manual tasks. Closer alignment with management needs, reduction of audit costs, improved focus in audit planning and development of a superior data analytics capability provided added value in terms of cost, competencies, and relationships. There was not an explicit focus on these value adding activities in the early stages of implementing CA/CM. Rather, they emerged over time, building on incremental successes of rolling out applications of CA/CM commencing with routine tasks such as duplicate invoices and progressing to more sophisticated applications that are discussed later.

The benefits delivered so far have exceeded the cost of achieving them. However, the implementation of CA/AM was not without challenges. Long lead times, complex technical environments and a commitment of resources meant that the range of benefits were not easily recognizable in the early stages. However, savings from automating routine audit procedures, (for example, potentially duplicated invoice processing), provided an "early win" for demonstrating value to management. In the earlier stages of developing and operating the automated testing there was political resistance from some business owners about the value of adopting the CA/CM system. Active leadership was required from the internal audit group to manage not only the technical issues, but also the change process in terms of managing varying perceptions and expectations about how exceptions would be identified and managed; impact on work routines; and the need for collaborative efforts in designing scripts and using technologies that would best assist in providing greater insights into business activities. Extensive consultation was needed to ensure user engagement and that the benefits were meaningful to the business owners. This transformative approach assisted in focusing attention on business improvement outcomes, thus, changing behaviours and demonstrating the value that internal audit can bring to the business.

THE IMPORTANCE OF ARCHITECTURE

The CA/CM solution resembles data warehouse solutions in that data is "extracted, transformed, and loaded" into the CA/CM applications.

Figure B-1: The Architecture



(Source: Hardy and Laslett, forthcoming)

Commercially available software is used, incorporating ACL, CaseWare Monitor™, ACL Direct Link™ for SAP, Windows Scheduler, and Excel spreadsheets, each serving different purposes (Hardy and Laslett, forthcoming). A CA/CM system based on spreadsheets is not sustainable. A robust architecture is required that supports the identification of exceptions, and provides assurances that the exceptions have been actioned by relevant parties and that the exception data is retained and secured appropriately. The need for a "robust" database to manage and store large and growing amounts of data is not new (Alles, et al. 2008, 150). However, it was a challenge for the internal audit group as they were responsible for the acquisition, maintenance, and security of the CA/CM infrastructure. The IT department viewed this as an end-user responsibility.

The architecture consists of three component areas: (1) data extraction; (2) data transformation; and (3) loading of exception data into user accessible exception management software. This is broadly based on a monitoring and control layer (MCL) type of approach (Vasarhelyi et al. 2004). As shown in figure B-1, ACL Direct Link™ is used to extract data from the ERP (SAP) system. Non-SAP data requires other extraction techniques. ACL™ is used to transform different native file formats and execute the scripts. Experience has shown that vendor pre-written scripts

cannot be universally applied because business units have unique business rules. Exceptions are managed using the CaseWare Monitor™ software. The software supports notifications of exceptions, the person responsible, actions taken, the required time frame and when it has been resolved. Movement and pending reports have been developed out of CaseWare Monitor™ to better analyse the queues. By having greater visibility over the resolution process, the internal audit group is able to focus its attention on higher level oversight.

DEFINITIONS AND APPLICATIONS OF CA/CM IN METCASH

There is a range of definitions used for CA/CM (Hardy 2014). While some distinctions are based on roles, this was not a significant issue in the early stages of development in Metcash. The internal audit group led the development of the CM system. Responsibility for the CM system was handed over to the business owners after it was fully functioning. At this stage, the internal audit department played more of an oversight role, examining trends and reviewing whether business owners were using the system as intended. This approach supports the view that neither CA or CM needs "to be present for the other to be implemented" (KPMG 2012b, 3), but by combining them there is a more efficient use of technical and human resources through coordinated efforts (KPMG 2012b, 3). However, similar to Vasarhelyi et al. (2012, 275), findings, the monitoring systems shared between audit and management at the full continuous audit stage were not being fully used by management. Internal audit was generating exception reports and monitoring results that were being passed on to management. There was a degree of uncertainty as to when and how these exceptions were being acted on. Metcash developed a complete exception management system to monitor and determine how exceptions are being actioned by management using the CaseWare Monitor™ workflow application. The architecture is discussed in the following.

Definitions of CM that emphasise how weaknesses in control designs or operations can be identified may also cause some level of confusion. It is challenging to monitor controls directly. For example, a review of segregation of duties (SOD) violations may reveal conflicts, but it does not address mistakes or possible fraud of authorised users. The continuous review of master data and transaction exceptions allows inferences to be drawn regarding the effectiveness of the controls and where gaps may exist. For example, Metcash policy requires staff to declare related party interests. In order to confirm that this policy is effective, a CMR compares changes to the vendor master file to the employee master file on a daily basis. Matches between the master files on

sensitive data elements (address, telephone numbers, and the like) trigger exceptions for the review of the Group Security function. Multiple dimensions need to be considered when integrating CA/CM and analytics, incorporating transactions, controls and a "macro-analytic" aspect such as differences in metrics and patterns within a business unit or across an organization (KPMG 2012b, 6).

An Example Application: The Leave Continuous Monitoring Routine (CMR)

Metcash currently has more than 100 applications in a range of areas (see Hardy and Laslett, forthcoming for a list). One of these CMRs is relatively unique. All business entities struggle with ensuring that all leave (that is, compensated absences including sick, vacation, and other) is properly accounted for. Failures to complete compensated absence applications, particularly in large organizations, may lead to overstated compensated absence liabilities and adverse effects on cash flow and operations as staff leave the business or take compensated absences to which they are unentitled.

A brief description of the leave CMR algorithm follows:

- Log-in data is captured from all sources across the business.
- Any staff member who has not logged in for two or more business days is identified and the exception is cross-matched to the human resources leave records.
- If no leave record is found, the exception is flagged, and the CMR continues to check the leave records for the next 14 days.
- If no leave record is processed during the 14-day window, the exception is processed to the exception management workflow system.
- An automated email (in the name of the responsible HR manager) is sent to the employee's manager alerting him or her to the gap in the log-in records and asking him or her to review the exception and advise the human resources team.
- Once a response is received, the exception is closed in Caseware Monitor™ including a reason and action code for further analysis and reporting.
- If the exception remains unclosed, the CMR continues to produce follow-up emails asking the manager to review the exception and respond accordingly.
- For those exceptions closed as "leave owing" in Caseware Monitor™, the CMR subsequently checks to ensure that the leave

has actually been processed as promised. Exceptions are passed to Human Resources for further review.

- The CMR also examines cases where exceptions have been closed as "no leave owing," but leave is processed nonetheless (as a test of integrity).
- The CMR produces weekly activity and status summaries for executive management.

The leave CMR is complex. We argue that it tests the boundaries of CA/CM and thus provides an illustration of developments in an environment with multiple data sources and a complex software and data ecosystem. Specifically, the CMR:

- accesses several systems to assemble and cross match the data;
- applies relatively complex algorithms to reduce the number of false positives; and
- uses multiple platforms to deliver and monitor the exceptions including ensuring that the exceptions are being actioned as advised.

The value of CA/CM is diluted unless there is a robust mechanism to track and resolve exceptions. Further, the value of CA/CM is also reduced if the algorithms do not effectively address the suppression of false positives. Experience suggests that external auditors tend to find techniques of this sort to be uneconomical due to the need to incorporate the business rules of differing clients in the algorithms. For example, tools such as ACL can easily check for potential duplicate invoicing; however, ACL will potentially produce large numbers of potential exceptions unless scripts are developed to, for example, identify matching reversals. The experience at Metcash has been that multiple iterations of the algorithms are required to minimise false positives.

Moving Forward—Key Risk Indicators

Metcash has moved away from the AS/NZS ISO 31000 Risk Management Standard risk profiling approach, as published by the International Standards Organization. A static 5×5 matrix that builds on likelihood and consequences is not consistently of practical use to management. Monitoring and assessing key risks through data driven risk indicators provides a greater benefit to management. The increasing availability of data and sophisticated analytics has facilitated a more accurate identification of problems in critical areas such as Food Safety and Human Resources. The use of dashboards (see figure B-2 for example) has enabled the risk indicator data to be effectively communicated to management via various media including tablet devices.

Figure B-2: Example of a KRI Dashboard: Dummy Data



CHALLENGES AND LESSONS LEARNED

Eight key challenges were encountered and lessons were learned:

- Implementing a CA/CM system is not a trivial exercise. While CA/CM has a high payback, there are long lead times and a significant investment of time and effort is required.
- Data management is critical in ensuring that the right data is accessible on a timely basis. However, data accessibility and quality issues were major inhibitors in the early stages of implementing CA/CM at Metcash.
- CA/CM needs to be robust, sustainable, and deliverable. This outcome involves the development of adequate physical architecture, data coding standards, documentation, exception management, and backup. As an end-user development, the CA/CM system requires a range of controls around it to ensure that it continues to operate properly and maintain its integrity. More than 100 fully automated scripts run on a daily basis, some of which are quite complex. It is vital that these applications are properly managed.

- In-house development requires ongoing focus over at least two to three years. Outsourcing may be a viable option to build a CA/CM system in the short-term and particularly so with respect to architecture development. A third-party developer may be able to build CA/CM applications within a "green field" site relatively quickly and may be able to provide this service as a "cloud" based service.
- Implementation does not tend to progress in discrete linear steps as normally represented in current guidance. Rather, the CA/CM environment tends to unfold through an iterative and incremental process with key learnings being acquired in layers.
- "Meta" CM routines may be specified, but it is rare that a high value-add can be derived from generic CM routines due to different business rules and data formats. Caution should be taken with "potted solutions" offered by third parties, as large volumes of false positives can arise. The case of those opposing the development of CA/CM for whatever purposes will be strengthened by the delivery of unusable volumes of exceptions, most of which prove to be false positives. Metcash's experience is that much of the coding surrounding the CMRs is dedicated to removing false positives so as to ensure that the output is largely composed of "high probability exceptions."
- The downside of success with a CA/CM system is that it may result in it becoming a de facto production system. CA/CM tends to become part of the production landscape as users begin to rely on the output. Internal audit begins to interact closely with the business and responds to their demands for further development. In that context, particularly from a CM perspective, the environment must be adequately controlled. Examples include controls to report failed CMRs, complete data capture as well as regular back-ups, coding standards, and periodic manual review of output to ensure that the output continues to be complete and reliable. For example, Metcash has written several hundred thousand lines of code in the context of its CA/CM system. The loss of this code would be catastrophic. Rigorous backup procedures are followed. The operation of a powerful set of CM applications may be viewed by some as potentially eroding the independence and objectivity of the internal auditors. It is our view that "objectivity" is a state of mind and, provided that the internal auditors do not subordinate their judgment to that of the end users, any potential conflicts can be effectively mitigated.
- Exceptions must be delivered reliably and effectively followed up. The value of CA/CM would be seriously diluted if there is a lack of comfort that control breakdowns are remedied and transactional exceptions are investigated and corrected as

necessary (for example, duplicate invoice processing). A failure to properly manage exceptions will adversely affect stakeholder engagement, the opportunity to change behaviors, and the realisation of benefits.

CONCLUSION

CA/CM has evolved into a valuable system in Metcash. Its success depends on having the right talent, technologies, and culture. Data management, technical expertise (for example, analytics, enterprise systems, and audit knowledge and capabilities), and managing change and culture were the main elements in building Metcash's capability. The CA/CM system grew organically for more than a decade. The head of the internal audit group played an ongoing and significant role in building this capability. The immediate value of CA/CM may not be entirely evident to the business owners in the early stages of implementation. Further, CA/CM presents new ways of doing things, challenging existing practices. An experienced and senior audit professional is required to enlist senior management support in managing the transition. In addition, internal audit needs to invest significant effort in collaborating with business owners to work towards a common goal and use insights garnered along the way to guide future development. The Metcash culture was open to new ideas and approaches, having experienced significant organizational change over a long period. These "norms" and values assisted with internal audit's efforts in implementing CA/CM. The advances made through CA/CM are transforming the way internal audit is conducted in Metcash as well as how it is perceived. By successfully leveraging technology, internal audit is able to contribute far beyond reviewing past activities, additionally providing insights for business performance and value-added activities. In uncertain and complex business environments, this presents an opportunity for internal audit to become a key partner in managing risk and guiding success.

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CASE STUDY C

Increasing Audit Efficiency Through Continuous Branch KPI Monitoring¹

Carlos Elder de Aquino

Eduardo Miyaki, CIA, CCSA, CFSA

Nilton Sigolo

Miklos A. Vasarhelyi, PhD

Paul E. Byrnes, CMA

ABSTRACT

Over the last decade, a large South American bank (SAB) has monitored over 1,400 retail branches and been involved in a remarkable leading-edge transformation of the nature of its audit process. Historically, an annual 160-hour audit was performed for each branch, and the associated work was either conducted by the internal audit staff or outsourced to one of the large audit firms. During the previous five years, this process was reengineered to perform daily continuous monitoring in conjunction with an annual potential 40-hour surprise audit of each branch. The banking system in this country is progressive in that it maintains overnight clearing processes and superior information technology (IT) and internal controls. This case study can provide U.S. corporations with unique and valuable insight regarding how a nimbler and more advanced set of audit processes can be implemented.

¹ <http://raw.rutgers.edu>

INTRODUCTION

The audit profession has accelerated adoption of continuous auditing and assurance mechanisms now that attention to Sarbanes Oxley and other compliance activities have been embedded into existing processes. Since 1999 (CICA/AICPA 1999), additional guidance has been issued by the Institute of Internal Auditors (IIA 2005) and ISACA (ISACA 2012), but substantial conceptual confusion nevertheless persists in this domain. This case study uses an actual implementation example to illustrate and clarify the conceptual issues as well as suggest some plausible solutions.

Country regulations and internal policies obligate the bank to perform a yearly branch audit for each of its more than 1,400 locations. Each branch audit historically entails about 160 hours of audit work, requiring the outsourcing of many of these engagements to external auditors at substantial expense and with nontrivial logistical challenges. A productive solution to this problem involved overnight monitoring of each branch using 18 indexes as well as the adoption of an annual potential 40-hour surprise audit of each branch. Monitoring in this case was performed by a "continuous audit" process in which variances from standards were regularly measured and reviewed. When a variance was deemed to be outside the range of acceptability, an email message prompting review and explanation of the event was sent to regional managers (to whom branch managers reported). This strategy has proven to be cost effective and provides for process improvements and enhanced allocation of scarce resources. The solution is also estimated to be generating substantial savings for the bank.

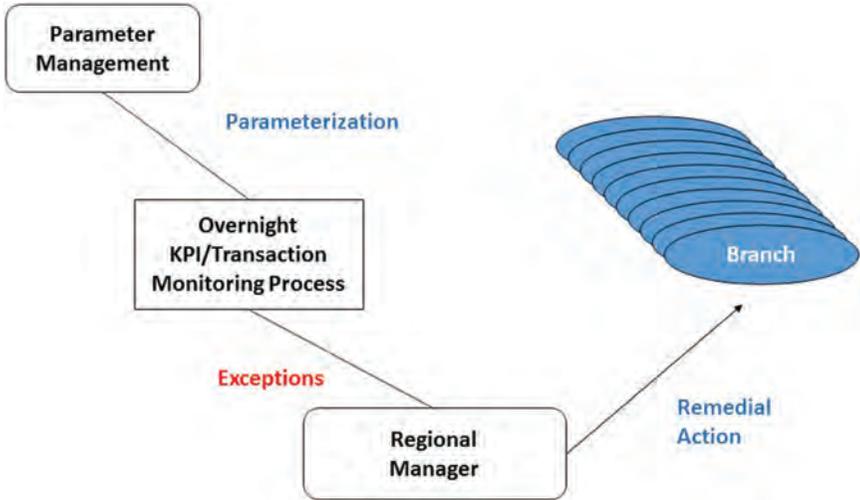
THE PROCESS AT SAB

Continuous monitoring and assurance at SAB follows the generic outline displayed in figure C-1. More specifically, a nightly extraction routine is executed and captures 18 overall process key performance indicators (KPIs) and relevant transaction dimensions such as amount, timing, nature, and branch. Accumulated values are then compared to historical data, company standards, and master files containing client characteristics, parameters, and other factors. In general, the standards employed create an average of about 800 exceptions per week that are subject to initial screening on an individual basis. Of these, about half are ultimately sent for further action to a regional manager who supervises individual branch managers. To allow for proactive system optimization relative to the generation of false positives and false negatives, the internal audit "continuous audit" manager has the authority to change filter parameterizations as needed. This feedback loop facilitates continuous process improvement whereby the quality of issued

exceptions improves over time. To ensure system effectiveness, a comprehensive set of procedures and ratios are relied upon.

In particular, there are 18 procedures or ratios that address detection, deterrence, financial losses, and compliance issues.

Figure C-1: Branch Monitoring Process



Some specific procedures examined are check advances, excess in accounts, overdrafts, cashier out-of-balance situations, federal tax payment cancelations, and electronic fund transfers.

The success of the SAB branch monitoring initiative demonstrates the value proposition of continuous auditing. In addition, it offers some insight relative to the interplay that naturally exists between continuous monitoring and continuous auditing, and this raises important questions about CA/CM. For example, CM is historically viewed as a managerial responsibility whereas continuous auditing is perceived as an auditing function. However, a single system can be implemented to perform both CA and CM simultaneously. In this setting, questions might arise relative to issues such as independence.

POTENTIAL ENHANCEMENTS

SAB's audit alerts can be integrated into a discriminant function with weights for the various alerts, thus creating a daily "grade" for each branch. These grades can then be ranked and used to direct "surprise audits" for branches with higher perceived risk, and process risks could

be reflected in the weights given to each discriminant variable. The branches with higher risk weights would likely be audited immediately while others would be lower in terms of audit priority.

KPIs and/or the variables that comprise them can be changed, and a communications program can be established to warn and educate employees about these modifications. In addition, evolving risk profiles can be linked with the appropriate sets of audit activities and efforts. Although this may somewhat reduce the efficiency of process monitoring, it could substantially improve overall process performance in terms of effectiveness.

CONCLUSIONS

The tradeoffs that created the current audit model have changed with the advent of business information technology. The costs of information processing and benefits of error detection and value confirmation have also evolved. The SAB example allows for the verification of values, value ranges, and ratios for the entire data population. Benefits include much stronger confidence relative to the accuracy of values as well as improvements in overall business operations.

The SAB implementation is an extremely useful CA system that provides a glimpse of things to come both in corporate business processing systems as well as the assurance function of the 21st century. Substantial flexibility can be designed into this methodology, and a new set of systems, analytics, auditor structures, functions, and competencies will result.

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CASE STUDY D

Implementing Continuous Monitoring at Vodafone Iceland

María Arthúrsdóttir
Hörður Már Jónsson
Sindri Sigurjónsson

INTRODUCTION

Vodafone is one of the world's largest telecommunications companies. It provides a range of communications services including voice, messaging, data, and fixed communications. With revenue of GBP 43.6 billion at the end of the 2013–14 financial year,¹ Vodafone has mobile operations in 26 countries, partners with mobile networks in 53 more, and fixed broadband operations in 17 markets. As of September 30, 2014, Vodafone has 438 million mobile customers and 11 million fixed broadband customers.

Vodafone Iceland, registered on NASDAQ OMX Nordic stock exchange, is a quad-play service provider with mobile and fixed voice, broadband Internet access, and IPTV services. Vodafone Iceland was established in 2003 following the merger of three telecom companies. In 2006, Vodafone Iceland became the first single brand partner at Vodafone Global, with full access to the latter's know-how, ready to market products, marketing assistance, procurement, and consultancy in networking.

¹ http://vodafone.com/content/dam/vodafone/investors/financial_results_feeds/preliminary_results_31march2014/p_prelim2014.pdf

María Arthúrsdóttir, head of financial planning and analysis (FP&A) at Vodafone Iceland, is responsible for the company's financial analysis, budgeting, business intelligence (BI), management reporting, revenue assurance, billing, and structuring. Arthúrsdóttir is also the main driver in Vodafone Iceland's project of implementing BI solutions and continuous monitoring (CM) within the company.

In the often complex telecom business, correct flow of data and data quality is vital to both employees and customers alike. Employees must be able to evaluate and make correct decisions on short notice even if systems and networks don't work according to plan; it is therefore crucial that information about Vodafone Iceland's customers and its services is correct at all times. Customers in the telecom industry are known to have limited loyalty to their operators, and because it is relatively easy to change providers, customer churn is quite high. It is therefore critical for service providers like Vodafone Iceland to know about errors and/or discrepancies in the customer relations data processes as soon as they arise. This enables Vodafone Iceland to resolve these errors quickly and even proactively suggest new and altered services when appropriate. Vodafone Iceland's main focus is to maximize customer satisfaction, as Arthúrsdóttir stresses the following:

We want to keep our customers content and happy. We need to be sure all customer data records are delivered from the user, through our network, into our billing gateway and ensure this data ends up on the customer invoice, correctly and in a timely fashion.

CONTINUOUS MONITORING IN VODAFONE ICELAND

In 2009, Vodafone Iceland embarked upon a project of designing and implementing a new business intelligence solution. The company wanted to improve the efficiency of the financial closing process and at the same time make financial information more easily available to the management team. The company soon discovered that it had too little control over the quality of the data in the management reports delivered. The reasons for the low quality of information provided varied between months; in some instances data got lost on the way, while in others attributes such as new departments or account numbers were not mapped in a consistent manner as products and services had been incorrectly set up within internal systems before they reached the financial ledger.

Arthúrsdóttir observed that many of the internal processes, such as the preparation of the financial statements, included a lot of manual work and re-work (thus increasing the potential for error), resulting in delayed monthly closing, with work around the clock at the end of every month

to discover and repair errors that had occurred during the period. Arthúrsdóttir saw the potential benefit of automating the process further, including continuously detecting and repairing errors as soon as they occurred, thus shortening the financial closing cycle, as well as avoiding peaks of intense work at the end of every month.

Other potential areas of benefit using CM were defined by Arthúrsdóttir and her team, such as identifying possible revenue leakage, improving customer relationship management, streamlining processes such as the billing process, and monitoring the quality of data flowing between different internal systems and even external third-party systems.

"At Vodafone Iceland we are rating millions of Call Detail Records (CDRs) per day, for hundreds of thousands of customer services. The CDRs are being received from dozens of different network elements and systems. We need to ensure that all these events are handled correctly and quickly, and validate the integrity of all customer services. We also have to spot and stop potential fraud in our network," says the company's revenue assurance project manager. Consulting with Vodafone Iceland's BI service provider, Arthúrsdóttir and her colleagues decided to begin using some new CM software, exMon.² The producer of exMon, Expectus Software, is the only CM technology vendor with a local presence in Iceland.

Revenue Leakage

In the first phase of the project, Arthúrsdóttir and her team implemented exMon for revenue assurance. Revenue leakage is a known issue in the telecom industry. According to TM Forum, "Convergence and lack of visibility across an ever-expanding value chain are causing growing revenue losses for Service Providers, as evidenced in a one-of-a-kind benchmark study conducted by The TM Forum. The most surprising breakthrough was the tangible proof that Service Providers incur an average of one-percent revenue leakage with a maximum recovery of 50 percent."³ The study's authors also note, however, that collected data across five continents indicates that prevention really works and that service providers that validate a large percentage of their data see significantly lower revenue leakage.

This was also the case with Vodafone Iceland. The company tries to minimize revenue leakage where possible, but because it is not a large organization, operating a dedicated revenue assurance department is not financially feasible. The company evaluated the risk involved and used automated CM for situations where the stakes were assessed as high, gradually working their way down the list to less important items.

² <http://exmon.com/cm/#home>

³ www.tmforum.org/TMForumPressReleases/RevenueAssuranceStudy/36002/article.html

One example of revenue leakage identified involved blocked accounts due to debt. When a customer is terminated or blocked (that is, his or her account sent to a debt collection agency), it is important that he or she is no longer able to use the service, and blocking the account requires actions in many systems. Blocked accounts are now under continuous monitoring and if something in the closing process has failed, the system will flag usage on the terminated telephone number.

Another example showed certain Internet connections or fixed lines not being charged to the retail customer, yet being charged to Vodafone Iceland by their backbone supplier. By analyzing the exceptions, the origin of the problem in the workflow was identified—in this case a software bug—and that information was delivered to software engineers who fixed the problem. The process owner continues to monitor this via CM, should a similar exception arise again.

If not managed correctly, the complexity of discount business rules and price changes can also result in revenue leakage. Vodafone Iceland therefore also uses CM to detect failing discount rules in the systems that result in missing discounts and/or illegal discounts being issued by employees. The execution of price changes is also being monitored closely, ensuring that tariff price changes are always correct. The system regularly compares (daily or monthly) all price changes against the "golden copy" owned by the company's marketing department to monitor and verify all price changes implemented on the billing system.

Process of Monthly Financial Closing

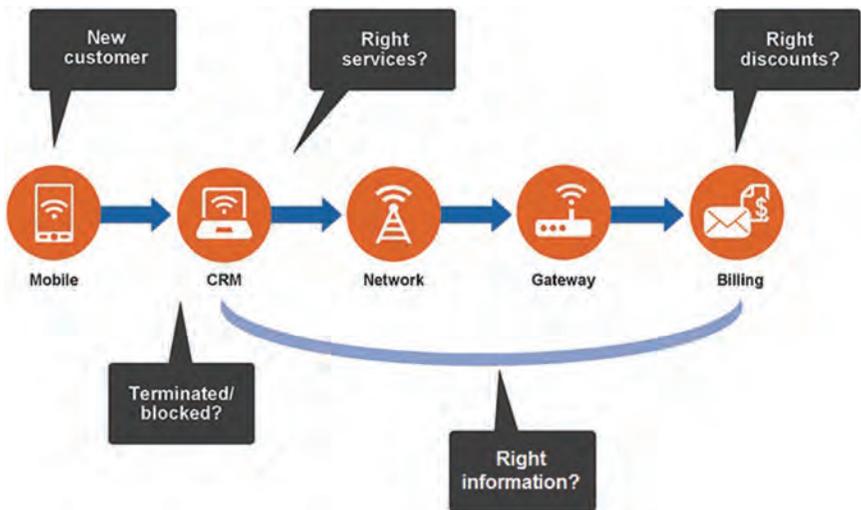
As previously mentioned, the initial goal Arthúrsdóttir and her team decided to address early on in the project was to decrease the time required to process the financial closing each month. This challenge was resolved through two key initiatives—improved BI capabilities using Microsoft Business Intelligence solutions and implementing CM checks with exMon at various points in the closing cycle. Using these two methods, both management and analysts were able to analyze their financial information in a much more comprehensive manner, as automated checks were performing their detective work behind the scenes at all times, ensuring accuracy throughout the process.

After several months of trial and error and fine-tuning of monitoring check points, the Vodafone Iceland team was experiencing exceptions being detected and fixed on a daily basis. This dual approach of addressing management reporting requirements through state-of-the-art BI solutions and ensuring underlying data quality through means of CM resulted in the financial closing process now being finalized within hours instead of days.

The Billing Process

An example of the data flow monitored by exMon is that of customer data, from first entry through networks and IT systems, into correct invoices being sent out from the billing system (figure 1). To facilitate this, a mobile user is registered in the customer relationship management (CRM) system along with the chosen product and tariff plan. This registration needs to be delivered to the home location register (HLR) in the mobile network, giving the customer access to the services he or she should be able to use (make and receive calls, send SMSs, use data via Internet, and use data roaming abroad). The customer also needs to be registered correctly in the billing system, with the same tariff plan and potential value-added services and discounts.

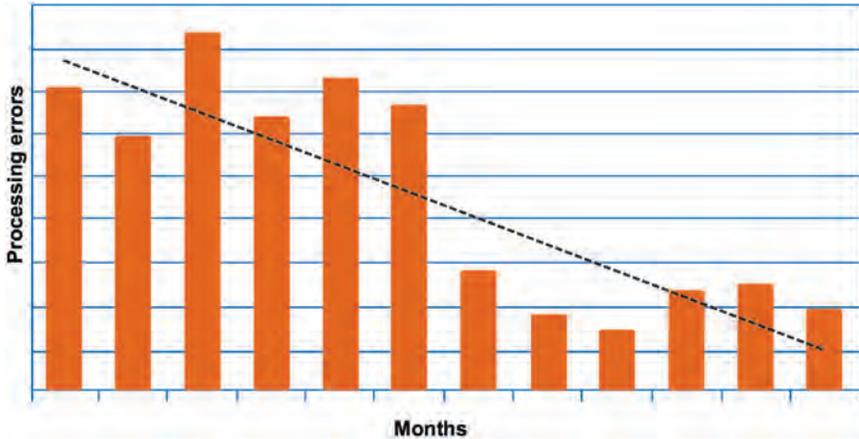
Figure D-1. Example of How Customer Data Flow Is Checked Within and Between Many Systems to Ensure Correct Billing



Customer charging records can fail, rendering the billing system unable to process the records correctly for them to be billed to the customer. Such errors may include a missing link between the customer's IP address and the customer usage data, or traffic on a cell phone number not recognized by the billing system. By monitoring these and other similar issues in an organized manner, receiving lists every week with errors, spending time analyzing and trying to find out the root cause instead of focusing on the symptoms, the billing department at Vodafone Iceland observed a 74

percent drop of billing data processing errors within a period of 12 months (figure 2).

Figure D-2. Monitoring Exceptions in the Billing Process Resulted in a 74 percent Drop in Billing Data Processing Errors Within 12 Months



Other CM checks implemented to ensure end-to-end reconciliation of CDRs from network elements to billing include

- ensuring that all CDR files have been delivered from network elements to the billing system;
- reconciling that the all CDRs within each file have been rated in to the billing system;
- ensuring that all CDR files are being delivered in a timely fashion;
- reporting on potential mediation or rating errors in CDR-based erred events;
- reporting on missing subscribers or subscriber services based on erred events; and
- reconciling all rated records against the customer bill.

All exceptions identified the exMon CM system enables easy follow-up and handling through a web user interface. Within this portal, cases are assigned to the responsible parties, who can actually fix the root cause of the problem as soon as it is identified and prevent exceptions from reoccurring. The follow-up function immediately gives the relevant teams and employees a clear overview, enabling them to fix the problem without having to look into other systems or databases. The system logs all actions and escalations, and the responsible person can assess the age of exception cases, status, and level of severity at a glance.

Fraud Monitoring

Fraud detection was a high priority in the process of implementing CM. Fraud cases can be of different origin and can cost both the customer and the service provider a lot of money. Fraud can arise within companies through various means, such as by employee abuse of access to systems or financial resources. Fraud can also originate from outside the company. A common example in the telecom sector is abuse of SIM cards from stolen cell phones, where they are used to generate usage to premium numbers and produce revenues to third parties. Another example of external fraud is a break-in into a customer's IP network to generate high traffic to servers in some foreign countries. It is vital to be able to detect and stop fraud being committed in the company's systems as quickly as possible. Investment in an expensive specific fraud management system has not been an option for small- to medium-sized enterprises (SME) like Vodafone Iceland, so they use exMon to monitor certain patterns of behavior for potential fraud. Examples of potential fraud monitored continuously include break-ins into business telephone systems, roaming fraud, SMS spam, fraudulent use of all inclusive packages, and credit card fraud.

Customer Relationship Management

After the initial phases in the project of focusing on the revenue leakage, fraud, and billing process errors, Arthúrsdóttir and her colleagues turned their attention toward how they could use the CM process to enhance the quality of their CRM. According to the head of customer care at Vodafone Iceland, CM of customer relations has enabled her team not only to reactively repair things that go wrong, but also to proactively contact their customers with specific advice on how to get more value out of their service plans. This use of CM checks to detect cross-selling opportunities and areas where the company can add real value to its customers' usage of communication services is extremely innovative.

First, some examples of reactive repair results of monitoring the customer relationship and use of their services:

- If the mobile subscriber has a family subscription, then every family member needs to be linked to and registered to the same account so that each will receive the right benefits and discounts they have been promised. This process is now being monitored and a discount check made on the billing data.
- If a mobile subscription is paid by a subscriber's employee, then it is vital that the subscriber is set up in the correct customer user group, because usually subscribers within a company are allowed

to make free calls within a defined group of users. Today, the correctness of this process is secured by an automated check.

- Vodafone Iceland used to have a problem with sometimes overcharging customers who were switching from fiber optic cable Internet price plans to "Fiber to the Home" (FTTH) price plans. The company had to issue credit notes every month because customers were being double billed, sometimes even for months. Vodafone Iceland therefore introduced CM checks. These identified the problem as system failure within the termination process. The problem was handed over to the software engineers, and the system was fixed. The company thus saved significant time on reactive corrections and reduced customer calls and, most importantly, saved the customer from irritation and inconvenience.

Vodafone Iceland's customer care department is now able to take proactive measures, including that of informing the customer in almost real time when he or she is getting close to his or her maximum amount of data, SMSs, and voice minutes included in his or her price plan. The message directed at each customer then includes information about either how to block further usage, like when a parent wants to prevent a child from further downloading from the Internet, or how to economically buy additional download or minutes to keep using the service. Customers' usage of mobile voice and Internet services abroad is also being monitored continuously to prevent "bill shock" when they roam into expensive international rating zones.

These customer-related measures in CM are very important to Vodafone Iceland, for which the main focus area is customer satisfaction. Thanks to closer monitoring of customer-focused processes, the company can now report tangible results in that area.

Culture Change and Enhanced Quality of Work Flow

The project of implementing CM within different departments and units has resulted in significant positive changes throughout Vodafone Iceland. There is a growing culture of proactively implementing checks in different areas when developing and deploying new processes and services. People are more amenable to and proactive about checking their own work, which results in a culture that is more proactive and preventive. The process has also resulted in an enhanced visibility of internal processes. More people think about the entire process, instead of just their part of it, and are now used to drawing up process maps, discussing them and internalizing them. Responsibilities in every step of these processes are more visible than before and the process of finding the root cause(s) behind each failure is now much shorter.

This enhanced sense of initiative has spread to customer relationship management and the culture of proactive customer care is now quite visible. Customer care agents are more conscious about preemptively detecting errors before they reach the customer and then proactively giving advice to their customers about better and more economical ways to use the service they are paying for.

Today, Vodafone Iceland employees really see and appreciate the value of CM as it has enabled them to prioritize in a more correct manner and focus their energy, time, and skills on the right issues by reducing or eliminating repetitive manual work on problems that used to repeat themselves daily.

CHALLENGES AND LEARNING

There were some challenges associated with implementing CM in Vodafone Iceland. One of these was unclear ownership of processes in the early phases of CM implementation. Implementing CM has helped Vodafone to map and assign ownership to various processes and work flows. Another challenge was to correctly assess the value of each check created. The subsequent alarm and analysis cycle can easily become an unnecessary distraction instead of a benefit if the initial assessment of the check is not thoroughly completed. It has also been important to align the frequency of alarms and exception lists with the human resources available and the time required to analyze and fix the problems. Working with the system for several months has also demonstrated that it is important to remove checks that are no longer relevant and keep the overall set up of checks up to date.

THE FUTURE

The goal of Vodafone Iceland is to expand the use of CM across the entire organization. There are still departments and areas of operation that have not been introduced to the system. Arthúrsdóttir sees opportunities in enhancing and optimizing the use of the system, and in extracting and analyzing statistics from the use of CM, discovering patterns and new dimensions of potential value. PM is taking over an increasingly greater portion of external audit of the company. Several manual checks completed in previous years through computer security audit, have now been canceled and are instead performed automatically on an on-going basis. A process of presenting an overview of checks to external auditors has been in operation for two years. The external auditors then audited selected checks in the CM process. This development will continue and is

expected to increase trust in the quality and flow of data within the company.

CONCLUSION

Overall, Vodafone Iceland's experience with CM has been a good one. The company operates within a complex set-up of networks, systems and services, as is usual with quad-play communication service providers. Their conclusion is that CM is of great benefit to complex operational environments like those in the telecom sector, and that the journey of using the system is just beginning. Arthúrsdóttir states:

We have high expectations about expanding the use of the CM system. Today, the main emphasis of the company is to build a trustworthy long-time relationship with our customers. Companies are increasingly realizing that investment in customer care pays off, whereas ever increasing acquisition cost per customer doesn't. We see opportunities in using CM in different ways within analyzing customer behavior and customer account data. We still have a long way to go to map up possible ways to use exMon to increase the mutual value of the relationship with the customer, and we expect to discover new areas of usability in the future. Our goal is to steadily enhance the quality of our business processes and establish a positive cycle of renewing the set of checks.

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- ▶ developing assurance guidance by creating suitable criteria when necessary, and/or performance guidance, as appropriate;
- ▶ communicating new assurance methodologies, guidance, and opportunities to our members and the profession on a global basis; and
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