

Accounting in the Fourth Industrial Revolution

Machine readable, structured accounting data constrained by rules providing high quality

By

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"Where there is no order there is confusion." *Luca Pacioli*¹

Executive summary:

- The world is increasingly going digital.
- Financial accounting, reporting, auditing, and analysis is not immune to these changes and will be impacted.
- What will become of human professional accountants in a world where computers play an increasing role in accounting, reporting, auditing, and analysis?
- Accountants who survive and thrive will have an intimate understanding of the limitations of their machine assistants. They will know how to use these new tools with good affect.
- "Digital" opens up new possibilities for how double-entry accounting information systems can function.
- Rather than the more "open" type systems that exist today which pushes work to the end of the month and the grueling, mindless, mechanical process of fixing errors; a new more "closed" or "constrained" approach which leverages accounting knowledge in machine readable form can be implemented.
- Combining artificial intelligence, structured machine-readable information, high-quality curated metadata; accounting, reporting, auditing, and analysis processes can be supercharged. This is analogous to converting crude oil to high-octane racing fuel.
- Leveraging double-entry accounting and the accounting equation the general journal can become a vital and important tool.

¹ Luca Pacioli, *Ancient Double-entry Bookkeeping*, page 33,
<https://books.google.com/books?id=uQ9AAAAAYAAJ&pg=PA33>

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Today, when entries are posted to a general journal the accounts that can be used to post that transaction tend to be unconstrained and specific information related to the change that the transaction will cause tends to be totally absent. Yes, it is true that the accounts used to post general journal entries must exist within the chart of accounts. And yes, there can be additional constraints applied to what information can appear within a specific general journal entry to keep the quality of general journal entries in check. But the truth of the matter is that it is rather easy to post transactions within a general journal incorrectly.

As a result, the month end closing process tends to involve extensive and expensive heroic efforts to rid the month's transactions of errors. Commonly, the accounting principle of materiality is used to blow off the results of a poor process for getting the financial statements out. This is true not only for external financial reports but just as true for internal financial reports.

What if there were a better way? What if the principles and techniques of Lean Six Sigma² could be used to assist in the monitoring and controlling of accounting processes? What if automated machine-based processes which are becoming available as a result of the Fourth Industrial Revolution³ could replace some of the grueling, mindless, mundane and often gruesome and even barbaric processes for keeping the quality of financial reports high?

Professional accountants have better ways to add value to their organization than toiling in the salt mines of the month end close.

This document explores techniques and methods which are coming to light per the past ten years of experimenting with the features offered by the global standard Extensible Business Reporting Language (XBRL)⁴. These observations come from Australia's Standard Business Reporting (SBR) initiative⁵ and XBRL-based financial reporting of public companies to the U.S. Securities and Exchange Commission⁶. We combine the financial reporting perspective and the accounting transaction perspectives into one integrated system for improving accounting, reporting, auditing, and analysis processes.

² Charles Hoffman, CPA, and Rene van Egmond, *Comprehensive Introduction to Lean Six Sigma for Accountants*, http://xbrl.azurewebsites.net/2017/IntelligentDigitalFinancialReporting/Part01_Chapter02.72_LeanSixSigma.pdf

³ *Adapting to Changes Caused by the Fourth Industrial Revolution*, <http://xbrl.squarespace.com/journal/2019/8/4/adapting-to-changes-caused-by-the-fourth-industrial-revoluti.html>

⁴ XBRL International, *Extensible Business Reporting Language*, <https://www.xbrl.org/>

⁵ Commonwealth of Australia, *Standard Business Reporting*, <https://www.sbr.gov.au/>

⁶ U.S. Securities and Exchange Commission, *Structured Disclosure at the SEC: History and Rulemaking*, <https://www.sec.gov/page/osdhistoryandrulemaking>

Transitioning to Digital

What will become of human professional accountants in a world where computers play an increasing role in accounting, reporting, auditing, and analysis? As in many other spheres of knowledge touched by digital; accountants who survive and thrive will have an intimate understanding of the limitations of their machine assistants. These accountants will be part accountant bringing their broad domain knowledge, have good understanding of the real capabilities of their machine-based collaborators, and adept at asking valuable “what if” type questions which are beyond the capabilities of machines. These accountants will have the “know how⁷” to employ digital tools and know what to do with those tools and wield these tools with good affect.

Digital is already on the way. Electronic invoicing⁸ is a good example. The Australian government points out⁹:

Each year, Australian businesses process around 1.2 billion invoices.

Paper and email-based invoicing is manually intensive and prone to human error resulting in increased processing costs and payment times for businesses. Electronic invoicing (or e-Invoicing) is the direct, electronic exchange of invoices between suppliers’ and buyers’ financial systems. e-Invoicing is a clear opportunity to streamline invoice transactions, saving businesses time and money.

e-Invoicing could result in benefits to the Australian economy of \$28 billion over ten years, according to estimates by Deloitte Access Economics.

Smart contract¹⁰ is another excellent example which is defined:

A smart contract is a computer protocol intended to digitally facilitate, verify, or enforce the negotiation or performance of a contract. Smart contracts allow the performance of credible transactions without third parties. These transactions are trackable and irreversible.

The Fourth Industrial Revolution¹¹ is a real thing. As well as providing for precision accounting, this emerging digital transactional reality will facilitate the natural progression of economic decision making into the domain of machines.

⁷ Wikipedia, *Know How*, <https://en.wikipedia.org/wiki/Know-how>

⁸ Wikipedia, *Electronic Invoicing*, https://en.wikipedia.org/wiki/Electronic_invoicing

⁹ Australian Government, The Treasury, *e-Invoicing*, <https://www.treasury.gov.au/consultation/e-invoicing>

¹⁰ Wikipedia, *Smart Contracts*, https://en.wikipedia.org/wiki/Smart_contract

¹¹ Charles Hoffman, CPA, *Adapting to Changes Caused by the Fourth Industrial Revolution*, <http://xbrl.squarespace.com/journal/2019/8/4/adapting-to-changes-caused-by-the-fourth-industrial-revoluti.html>

Human overseers will cede control of more and more of the financial fabric to algorithms. Today we see this emergent behavior in the way enterprises use algorithms to price products and services¹² and designing marketing plans¹³. Others are contemplating the future of assurance; a world of continuous auditing and continuous reporting¹⁴.

Thinking that accounting, reporting, auditing, and analysis will be immune to the changes caused by technologies such as artificial intelligence¹⁵, structured information formats such as XBRL and RDF¹⁶, and digital distributed ledgers¹⁷ is at best wishful thinking and at worst naïve.

In the near future, say perhaps five or maybe ten years, we doubt many transactions will be initiated without some underlying digital contract. Significant accounting efficiencies cannot be achieved without adapting to this new digital reality.

Adaptation will require a change in accounting software architectures and the behavior of accountants. Accounting software will be designed to “read and understand” smart contracts; filing transactions with lean six-sigma¹⁸ precision and maintaining a constant link to the digital contract. Where today, every enterprise has their own accounting system, tomorrow every enterprise will have the digital encryption keys to their own data but rely on a network of digital services. An accounting digital service network will be comprised of “frames of reference” leveraged mainly by other machines. Today we call these “frames of reference” taxonomies and ontologies. Tomorrow, accounting will be a natural extension of the semantic web¹⁹. Governments and trading consortiums will publish their particular “frames of reference” or data resources that describe their product and or service domain in great detail.

These “frames of reference” are essentially curated metadata²⁰. Data is like crude oil. Creating metadata to help machines better understand the data is like refining the crude oil into

¹² Wikipedia, *Algorithmic Pricing*, https://en.wikipedia.org/wiki/Algorithmic_pricing

¹³ Wikipedia, *Attribution (Marketing)*, [https://en.wikipedia.org/wiki/Attribution_\(marketing\)](https://en.wikipedia.org/wiki/Attribution_(marketing))

¹⁴ DCARPE Alliance, <https://dcarpe.org/>

¹⁵ Charles Hoffman, CPA, *Artificial Intelligence and Knowledge Engineering in a Nutshell*, <http://xbrl.azurewebsites.net/2019/Library/KnowledgeEngineeringInNutShell.pdf>

¹⁶ Charles Hoffman, CPA, *Everything you Need to Know to have an Intelligent Conversation about Digital Financial Reporting*, <http://xbrl.squarespace.com/journal/2019/5/29/everything-you-need-to-know-to-have-an-intelligent-conversat.html>

¹⁷ Charles Hoffman, CPA and Rene van Egmond, *Comprehensive Introduction to Digital Distributed Ledgers*, http://xbrl.azurewebsites.net/2017/IntelligentDigitalFinancialReporting/Part01_Chapter02.71_DistributedLedgers.pdf

¹⁸ Charles Hoffman, CPA, *Comprehensive Introduction to Lean Six Sigma*, http://xbrl.azurewebsites.net/2017/IntelligentDigitalFinancialReporting/Part01_Chapter02.72_LeanSixSigma.pdf

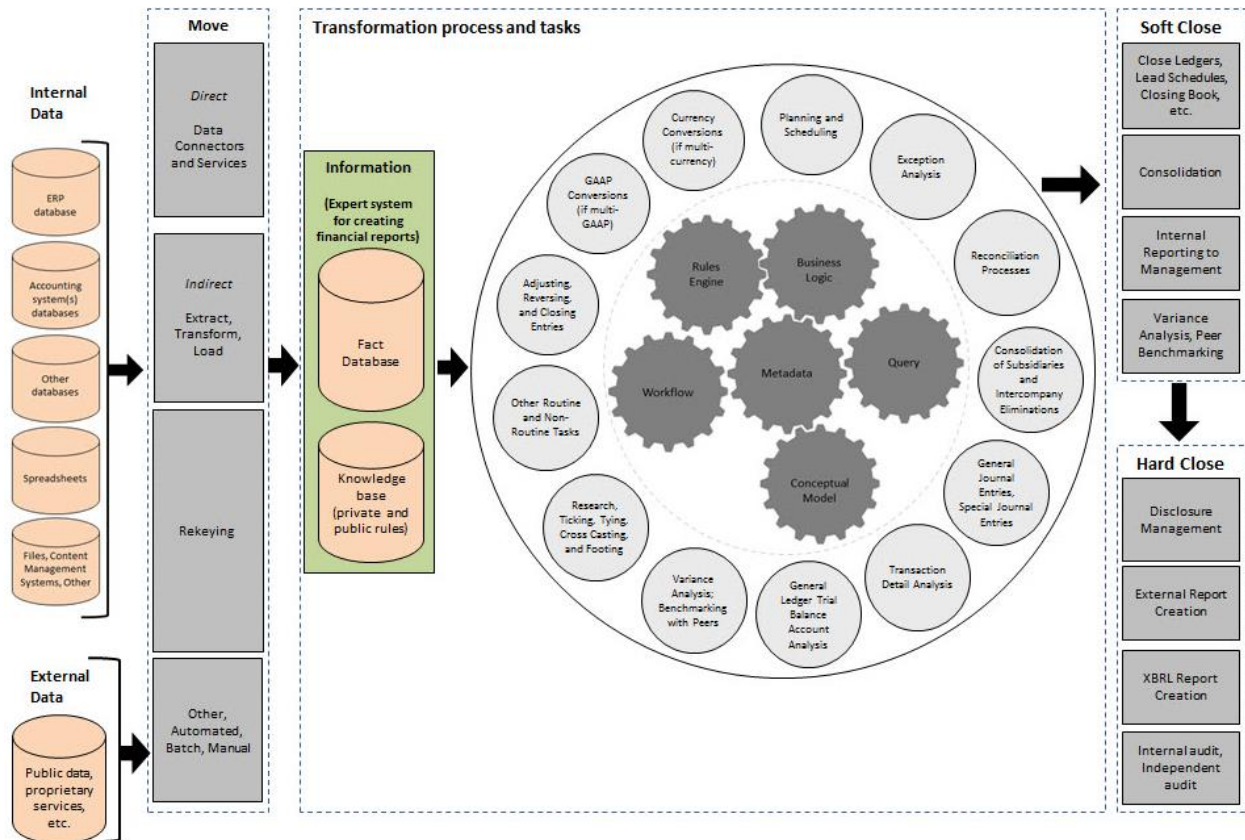
¹⁹ Wikipedia, *Semantic Web*, https://en.wikipedia.org/wiki/Semantic_Web

²⁰ Charles Hoffman, CPA, *Curated Machine-Readable Information (also Human-Readable) is the Future*, <http://xbrl.squarespace.com/journal/2019/6/14/curated-machine-readable-information-also-human-readable-is.html>

gasoline. When done right, some of the gasoline can be further refined into high-performance racing fuel²¹. That high-quality “racing fuel-type metadata” can supercharge an artificial intelligence software application performing work reliably. High quality curated metadata will supercharge accounting, reporting, auditing, and analysis applications. That high-quality curated metadata will be pure gold in a digital environment.

Process Overview

The following graphic²² provides an overview of the processes and tasks that are involved in the creation of internal and external financial reports:



Fundamentally, accounting information systems have two primary parts: (1) the part that flows through a double-entry accounting system, and (2) everything else.

²¹ Digitalist Magazine, Bill Schmarzo, *Data Curation: Weaving Raw Data Into Business Gold (Part 1)*, <https://www.digitalistmag.com/cio-knowledge/2019/04/29/data-curation-weaving-raw-data-into-business-gold-part-1-06197968>

²² Charles Hoffman, CPA, *Internal and External Financial Report Creation Processes and Tasks*, <http://xbrlsite.azurewebsites.net/2018/Library/ProcessesAndTasks.jpg>

This document focuses on the part that flows through the double-entry accounting system. It is not that what does not flow through this part of the accounting information systems is unimportant. It is simply not our focus in this document. If you want additional information helpful related to information that does not flow through the double-entry accounting system, see the document *Introduction to the Fact Ledger*²³.

Logic of Financial Statements

A quick overview of the logic of financial statements will help the reader to put the pieces together effectively.

The basic high-level model of a financial report follows double-entry accounting and is described by the accounting equation which is a logical statement:

$$\text{Assets} = \text{Liabilities} + \text{Equity}$$

Standards setters create financial reporting schemes which provide further details which expand on the accounting equation²⁴. By definition a standards setter cannot violate the accounting equation. The financial reporting scheme essentially defines a core set of *classes* of elements²⁵ used by that financial reporting scheme which reconciles to the accounting equation. The elements of financial statements are the building blocks, or *classes* of defined elements, with which financial statements are constructed by an economic entity reporting per some financial reporting scheme²⁶.

The *items* in the financial statements of a specific economic entity represent in words and numbers certain entity resources, claims against those resources, and the effects of transactions and events, circumstances, and other phenomenon that result in changes in those resources and claims. Those words and numbers are statements the economic entity makes to describe their financial position and financial performance.

These classes of building blocks are **intentionally interrelated mathematically** within the four core statements that make up a financial report; this is called 'articulation'.

²³ Charles Hoffman, CPA and Andrew Noble, PNA, BBus, *Introduction to the Fact Ledger*, <http://xbrlsite.azurewebsites.net/2018/Library/IntroductionToTheFactLedger.pdf>

²⁴ Charles Hoffman, CPA, *Comparison of Elements of Financial Statements*, <http://xbrlsite.azurewebsites.net/2019/Core/ElementsOfFinancialStatements.pdf>

²⁵ Charles Hoffman, CPA, *Comparison of Elements of Financial Statements*, <http://xbrlsite.azurewebsites.net/2019/Core/ElementsOfFinancialStatements.pdf>

²⁶ Financial Accounting Standards Board, *Statement of Financial Accounting Concepts No. 6, Elements of Financial Statements*, page 9, <https://www.fasb.org/pdf/con6.pdf>

Intermediate components, i.e. subtotals, can be used to represent the items of an economic entity within the items that comprise a financial report of the economic entity. However, these intermediate components and the items must fit into the core framework of the classes of elements that are the building blocks of any financial report created using a specific reporting scheme.

The **balance sheet** provides a roll up of assets, a roll up of liabilities and equity, and is bound by the rule “Assets = Liabilities + Equity”. The **income statement** is used to compute the roll up total “Net Income” and there are rules for how the intermediate components (i.e. subtotals) of Net Income roll up. Net income then flows to the **statement of changes in equity** which is a roll forward which reconciles beginning and ending equity on the current and prior balance sheets. The **cash flow statement** is a roll up of Net Cash Flow, rules that specify how the intermediate components (i.e. subtotals) of net cash flow roll up, and a roll forward of the asset Cash and Cash Equivalents which reconciles the beginning and ending balance of that asset on the balance sheet²⁷.

And so, the primary financial statements are explained by:

1. The accounting equation.
2. Some set of elements of the financial statements²⁸ such as those for IFRS²⁹: Assets, Liabilities, Equity, Contributions from Holders of Equity Claims, Distributions to Holders of Equity Claims, Income and Expenses, Income, Expenses.
3. The fundamental relations between the elements where T0 is the beginning balance sheet date, T1 is the ending balance sheet date, and P1 is the current period that reconciles the beginning and ending balance sheet: $0 = \text{Equity}^{T0} + \text{Income}^{P1} - \text{Expenses}^{P1} + \text{ContributionsFromHoldersOfEquityClaims}^{P1} - \text{DistributionsToHoldersOfEquityClaims}^{P1} + \text{Assets}^{T1} - \text{Liabilities}^{T1}$

²⁷ Four statement model, http://xbrlsite.azurewebsites.net/2019/Core/core-ifrs/FourStatements_IFRS.jpg

²⁸ Charles Hoffman, CPA, *Comparison of Elements of Financial Statements*, <http://xbrlsite.azurewebsites.net/2019/Core/ElementsOfFinancialStatements.pdf>

²⁹ Core Elements of Financial Statements (IFRS), <http://xbrlsite.azurewebsites.net/2019/Core/core-ifrs/>

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Balance Sheet [Abstract]		Period [Axis]	
		2020-12-31	2019-12-31
Balance Sheet [Abstract]			
Assets [Roll Up]			
Noncurrent Assets		0	0
Current Assets	Assets	3,500	0
		3,500	0
Liabilities and Equity [Roll Up]			
Liabilities [Roll Up]			
Noncurrent Liabilities		0	0
Current Liabilities	Liabilities	0	0
		0	0
Equity [Roll Up]			
Equity Attributable to Controlling Interest		3,500	0
Equity Attributable to Noncontrolling Interest		0	0
	Equity	3,500	0
	Liabilities and Equity	3,500	0

Cash Flow Statement [Abstract]		Period [Axis]
		2020-01-01 - 2020-12-31
Cash Flow Statement [Abstract]		
Net Cash Flow [Roll Up]		
Net Cash Flow from Operating Activities		3,000
Net Cash Flow from Investing Activities		0
Net Cash Flow from Financing Activities		500
	Net Cash Flow	3,500
Assets [Roll Forward]		
Assets, Beginning		0
	Net Cash Flow	3,500
	Assets, Ending	3,500

Changes in Equity [Abstract]		Period [Axis]
		2020-01-01 - 2020-12-31
Changes in Equity [Abstract]		
Equity [Roll Forward]		
Equity, beginning		0
Income and Expenses		3,000
Contributions from Holders of Equity Claims		1,000
(Distributions to Holders of Equity Claims)		(500)
	Equity, ending	3,500

Comprehensive Income Statement [Abstract]		Period [Axis]
		2020-01-01 - 2020-12-31
Comprehensive Income Statement [Abstract]		
Comprehensive Income [Roll Up]		
Income		8,000
(Expenses)		(5,000)
	Income and Expenses	3,000

While the model shown above which is based on “Assets = Liabilities and Equity”; some economic entities use different sorts of models. For example, some economic entities report using a liquidation basis style balance sheet where “Assets - Liabilities = Net Assets”. “Net Assets” and “Equity” are two different labels for what is the same concept.

Using the rules of mathematics, the equation “Assets = Liabilities + Equity” can be converted to “Assets - Liabilities = Equity”.

While standards setters do provide an excellent overview of the high-level elements of financial statements, their explanations can be further enhanced and made more complete as I explain in the document *Enhanced US GAAP Financial Statement Elements*³⁰. That document explains the enhancements made to the ten core element definitions provided by the FASB³¹ in three ways. First, it puts these definitions in machine-readable form. Second, it puts the elements in context by showing the associations between the concepts. Third, it adds additional important concepts that are ultimately defined implicitly or explicitly by the FASB to provide a complete set of core high-level financial report elements.

While a financial report is not a static form it is not random either. Financial reports follow patterns and these patterns can be explained using specific models to account for and manage the variability inherent in a financial report. Each set of items in the financial report of an economic entity must follow the accounting equation and the elements of a financial statement defined by some financial reporting scheme.

Double-entry financial accounting works this way by definition. Double-entry accounting was the invention of medieval merchants and was first documented by the Italian mathematician

³⁰ Charles Hoffman, CPA, *Enhanced US GAAP Financial Statement Elements*, <http://xbrlsite.azurewebsites.net/2019/Core/core-usgaap/EnhancedFinancialReportElements.pdf>

³¹ Financial Accounting Standards Board, *Statement of Financial Accounting Concepts No. 6, Elements of Financial Statements*, <https://www.fasb.org/pdf/con6.pdf>

and Franciscan Friar Luca Pacioli³² in 1494. The section related to double-entry accounting was translated into English in 1914³³.

And so, professional accountants tie their internal implementations of a financial reporting scheme, their “items” are reconciled to the “classes” which form the building blocks of a financial report per a specific reporting scheme by creating a chart of accounts. Every financial reporting scheme, be it US GAAP or IFRS or IPSAS or GAS or any other financial reporting scheme works exactly this same way.

Importance of Well-organized Chart of Accounts

Like most things, the capability of a professional accountant to set up a well-organized chart of accounts is a bell-shaped curve. Therefore, some accountants perform this task extremely well, some perform it extremely poorly, but most accountants are average.

A chart of accounts is part of the foundation of an accounting information system. If that foundation is misaligned, you are building on an unstable foundation. The issues of information volume and complexity exacerbate the problem of a poorly organized chart of accounts even more.

As accountants know, if you have a well-organized chart of accounts things work out better than if they you don’t. Having a well-organized chart of accounts is particularly important if you desire to automate accounting and reporting processes. Attempting to automate a poorly organized chart of accounts will tend to lead to failure.

So, what if someone organized, or helped you organize, your chart of accounts? What if you took something like the US GAAP XBRL Taxonomy or IFRS XBRL Taxonomy, further built it out to add missing details³⁴, and then used that as a base to construct a complete taxonomy or ontology-like thing that could be used for your internal reporting purposes?

Three key patterns of information are necessary:

1. The high-level elements of a financial statement which your specific entity uses to report. You can think of these as the “branches” of your report.
2. The low-level chart of accounts that you use to post transactions. You can think of these as the “leaves” of your report.

³² Wikipedia, *Luca Pacioli*, https://en.wikipedia.org/wiki/Luca_Pacioli

³³ J. B. Geijsbeek, *Ancient Double-Entry Bookkeeping*, <https://archive.org/details/ancientdoubleent00geij/page/n3>

³⁴ Charles Hoffman, CPA, *Demystifying the Role of Ontologies in XBRL-based Digital Financial Reporting*, <http://xbrlsite.azurewebsites.net/2019/Library/DemystifyingOntologies.pdf>

- The changes or grouping codes used to reconcile what made the beginning balance of your balance sheet accounts “change” into the ending balances of your balance sheet accounts.

This notion of “branches” and “leaves” is described in the document *Accounting Process Automation Using XBRL*. In another document, *General Ledger Trial Balance to External Financial Report*³⁵, I discuss list item #3 and a step-by-step guide to creating a modern financial statement creation platform for internal and external financial reporting.

Rajib Doogar, an accounting professor at the University of Washington Bothell Campus, explained his notion of looking at the general ledger as “trees”, “branches”, and “leaves” and explaining the matrix algebra model behind these relations. This is very helpful information and significantly helped in organizing these ideas.

Our addition to Doogar’s matrix model is the notion that every real account³⁶ (balance sheet account) has a roll forward associated with it that explains all the changes that occurred between the beginning balance sheet date and the ending balance sheet date. For example, here is the roll forward of the account “Cash and Cash Equivalents”³⁷:

Cash and Cash Equivalents [Roll Forward]	Period [Axis]
	2018-01-01 - 2018-12-31
Cash and Cash Equivalents [Roll Forward]	
Cash and Cash Equivalents, Beginning Balance	3,000
Collection of Receivables	3,000
Payment of Accounts Payable	(2,000)
Additional Long-term Borrowings	6,000
Repayment of Long-term Borrowings	(1,000)
Capital Additions of Property, Plant and Equipment	(5,000)
Proceeds from Sale of Property, Plant, and Equipment	0
Cash and Cash Equivalents, Ending Balance	4,000

Here is the roll forward of “Receivables”³⁸:

³⁵ Charles Hoffman, CPA, *General Ledger Trial Balance to External Financial Report*, <http://xbrlsite.azurewebsites.net/2018/RoboticFinance/TrialBalanceToReport.pdf>

³⁶ Accounting Coach, *What is the difference between a nominal account and a real account?*, <https://www.accountingcoach.com/blog/what-is-the-difference-between-a-nominal-account-and-a-real-account>

³⁷ Roll forward of Cash and Cash Equivalents, <http://xbrlsite.azurewebsites.net/2018/Prototypes/Basic/Basic-XASB-ConsistentRF/evidencepackage/contents/index.html#Rendering-CashAndCashEquivalents-Implied.html>

³⁸ *Roll forward of Receivables*, <http://xbrlsite.azurewebsites.net/2018/Prototypes/Basic/Basic-XASB-ConsistentRF/evidence-package/contents/index.html#Rendering-Receivables-Implied.html>

Receivables [Roll Forward]	Period [Axis]
	2018-01-01 - 2018-12-31
Receivables [Roll Forward]	
Receivables, Beginning Balance	1,000
Sales 2	4,000
Collection of Receivables 2	(3,000)
Additions to Allowance for Bad Debts	0
Bad Debts Written Off	0
Receivables, Ending Balance	2,000

There are three very important items of interest when it comes to the two roll forwards shown above and the roll forward of every other real balance sheet account:

1. 100% of all transactions go through a balance sheet account and the transactions can be grouped into specific categories.
2. The specific categories are different for each balance sheet account.
3. It is the accounts of the chart of accounts (the beginning and ending balances of the roll forward) and the changes in the accounts (the grouping categories) that are used to construct the core quantitative information that ends up in a financial report.

When combined with the elements of a financial report specified by a standards setter the information in #1, #2, and #3 form the core quantitative information that makes up the primary financial statements and the financial account disclosures that provide details of the subclassifications of an account or roll forwards of the changes that are required to be disclosed all organized within the “branches” that are (a) specified by a standards setter and (b) selected by a reporting economic entity because of the industry they are in or the accounting activities that they report and the choices between allowed alternative approaches which they select.

To be crystal clear here, we are NOT saying that every economic entity can have an organization of the elements of a financial statement, chart of accounts, and transaction change grouping thrust upon it that it is required to use for its internal or external financial reporting.

To the contrary. We are saying that every economic entity could create, could have someone else create for them, use some standard industry best practices set of information, or could in some other way define the (a) financial report organization or the “branches”, (b) the chart of accounts that fits into those branches or the “leaves”, and (c) the transaction change grouping codes that would be used to accumulate information about the changes between the beginning balance sheet and the ending balance sheet.

Further, we are not suggesting that every one of the roll forwards would actually be disclosed within an economic entities financial report. That is not required. But we are pointing out that this is an excellent way to manage the internal process of creating either the internal financial report and the external financial report whether the roll forward information is explicitly disclosed or not.

Notion of the Transaction Change Grouping Code

Most accounting systems today do not require or even provide for the notion of a strong set of what we call “transaction change grouping codes” that are used to enter each and every entry that is posted in the general journal. What we are suggesting is that mandating and using such strong transaction change codes would be a very good idea and helpful to accountants and auditors. By “strong” we mean that the transaction change grouping codes play a similar and prominent role as the chart of accounts code in posting transactions.

This is not to say that every transaction change grouping code would be manually assigned. In fact, most would be automatically assigned. For example, all sales transactions that come from the sales/receivables subsystem would have the codes automatically assigned by that subsystem. This would be similarly true for the accounts payable subsystem and other accounting subsystems.

Matrix of Allowed Transaction Possibilities

Another benefit of using a transaction change grouping code on a transaction is that transactions can be proactively controlled to avoid posting errors. As we pointed out, each real chart of accounts account has a specific set of appropriate transaction change grouping codes that are available for that specific account. The set of allowed transaction grouping codes can be leveraged by software applications that enter transactions, a matrix of allowed transaction possibilities for a specific account.

Further, during an audit, software applications can be used to probe general journal transactions for odd chart of account/transaction change grouping code combinations.

Overview of How Transaction Change Grouping Codes Work

We created a very basic prototype³⁹ to help explain how general journal entries flow from the general journal to the financial report.

Step 1 is that an XBRL taxonomy is created that represents the reporting style of the economic entity, a XBRL reporting taxonomy. The chart of accounts is set up and is aligned with the XBRL reporting taxonomy. Accounting systems are modified to require the transaction change grouping code.

Reporting taxonomies could be created by an individual organization, provided by a CPA firm or consultant, provided by an industry group, provided by a software vendor, etc.

Step 2 is that transactions are entered into the accounting system⁴⁰. I have entered a small set of transactions to test this idea. This is what the general journal might look like⁴¹:

JournalEntryID	EconomicEntityIdentifier	TransactionPeriod	GeneralLedgerAccountCode	TransactionDescriptionCode	Amount	Units	Rounding	Balance	EffectiveValue	Sequence	Account	Key	TransactionDescription	DocumentID
JE-1001	308101176587668446	2017-12-31	basic:CashAndCashEquivalents	basic:OpeningBalance	3,000	iso4217:USD	INF	Debit	3,000	1	1,000-1100-00		1 Opening balance.	01
JE-1001	308101176587668446	2017-12-31	basic:Receivables	basic:OpeningBalance	1,000	iso4217:USD	INF	Debit	1,000	2	2,000-1200-00		2 Opening balance.	02
JE-1001	308101176587668446	2017-12-31	basic:Inventories	basic:OpeningBalance	1,000	iso4217:USD	INF	Debit	1,000	3	3,000-1300-00		3 Opening balance.	03
JE-1001	308101176587668446	2017-12-31	basic:PropertyPlantAndEquipment	basic:OpeningBalance	1,000	iso4217:USD	INF	Debit	1,000	4	4,000-1400-00		4 Opening balance.	04
JE-1001	308101176587668446	2017-12-31	basic:AccountsPayable	basic:OpeningBalance	1,000	iso4217:USD	INF	Credit	(1,000)	5	5,000-2150-00		5 Opening balance.	05
JE-1001	308101176587668446	2017-12-31	basic:LongtermDebt	basic:OpeningBalance	1,000	iso4217:USD	INF	Credit	(1,000)	6	6,000-2200-00		6 Opening balance.	06
JE-1001	308101176587668446	2017-12-31	basic:RetainedEarnings	basic:OpeningBalance	4,000	iso4217:USD	INF	Credit	(4,000)	7	7,000-3200-00		7 Opening balance.	07
JE-1002	308101176587668446	2018-01-01	basic:CashAndCashEquivalents	basic:AdditionalLongtermBorrowings2	6,000	iso4217:USD	INF	Debit	6,000	1	1,000-1100-00		8 Additional long-term borrowings for purchase of PPE.	08
JE-1002	308101176587668446	2018-01-01	basic:LongtermDebt	basic:AdditionalLongtermBorrowings	6,000	iso4217:USD	INF	Credit	(6,000)	2	2,000-2200-00		9 Additional long-term borrowings for purchase of PPE.	09
JE-1003	308101176587668446	2018-01-01	basic:PropertyPlantAndEquipment	basic:CapitalAdditionsPropertyPlantAndEquipment	5,000	iso4217:USD	INF	Debit	5,000	1	1,000-1400-00		10 Purchase of PPE using cash from additional borrowings.	10
JE-1003	308101176587668446	2018-01-01	basic:CashAndCashEquivalents	basic:CapitalAdditionsPropertyPlantAndEquipment2	5,000	iso4217:USD	INF	Credit	(5,000)	2	2,000-1100-00		11 Purchase of PPE using cash from additional borrowings.	11
JE-1004	308101176587668446	2018-01-01	basic:Inventories	basic:PurchasesOfInventoryForSale	2,000	iso4217:USD	INF	Debit	2,000	1	1,000-1300-00		12 Purchase inventory on account.	12
JE-1004	308101176587668446	2018-01-01	basic:AccountsPayable	basic:PurchasesOfInventoryForSale2	2,000	iso4217:USD	INF	Credit	(2,000)	2	2,000-1150-00		13 Purchase inventory on account.	13
JE-1005	308101176587668446	2018-01-01	basic:Receivables	basic:Sales2	4,000	iso4217:USD	INF	Debit	4,000	1	1,000-1200-00		14 Sales on account.	14
JE-1005	308101176587668446	2018-01-01	basic:Sales	basic:Sales	4,000	iso4217:USD	INF	Credit	(4,000)	2	2,000-4100-00		15 Sales on account.	15
JE-1005	308101176587668446	2018-01-01	basic:CostOfSales	basic:CostOfSales	2,000	iso4217:USD	INF	Debit	2,000	3	3,000-5100-00		16 Sales on account.	16
JE-1005	308101176587668446	2018-01-01	basic:Inventories	basic:CostOfSales2	2,000	iso4217:USD	INF	Credit	(2,000)	4	4,000-1300-00		17 Sales on account.	17
JE-1006	308101176587668446	2018-01-01	basic:CashAndCashEquivalents	basic:CollectionReceivables	3,000	iso4217:USD	INF	Debit	3,000	1	1,000-1100-00		18 Collection of accounts receivable.	18
JE-1006	308101176587668446	2018-01-01	basic:Receivables	basic:CollectionReceivables2	3,000	iso4217:USD	INF	Credit	(3,000)	2	2,000-1200-00		19 Collection of accounts receivable.	19
JE-1007	308101176587668446	2018-01-01	basic:AccountsPayable	basic:PaymentOfAccountsPayable2	2,000	iso4217:USD	INF	Debit	2,000	1	1,000-2150-00		20 Payment of accounts payable.	20
JE-1007	308101176587668446	2018-01-01	basic:CashAndCashEquivalents	basic:PaymentOfAccountsPayable	2,000	iso4217:USD	INF	Credit	(2,000)	2	2,000-1100-00		21 Payment of accounts payable.	21
JE-1008	308101176587668446	2018-01-01	basic:LongtermDebt	basic:RepaymentLongtermBorrowings	1,000	iso4217:USD	INF	Debit	1,000	1	1,000-2200-00		22 Payment of long term debt.	22
JE-1008	308101176587668446	2018-01-01	basic:CashAndCashEquivalents	basic:RepaymentLongtermBorrowings2	1,000	iso4217:USD	INF	Credit	(1,000)	2	2,000-1100-00		23 Payment of long term debt.	23

You can get the normal looking report of transactions that have been entered into the general ledger⁴².

General Journal by Entry				10/27/2019 3:04:32 PM	
JE	Account	Transaction Description Code	Transaction Date	Amount	
JE-1002	basic:CashAndCashEquivalents	basic:AdditionalLongtermBorrowings2	2018-01-01	6,000.00	
JE-1002	basic:LongtermDebt	basic:AdditionalLongtermBorrowings	2018-01-01	(6,000.00)	
JE-1003	basic:PropertyPlantAndEquipment	basic:CapitalAdditionsPropertyPlantAndEquipment	2018-01-01	5,000.00	
JE-1003	basic:CashAndCashEquivalents	basic:CapitalAdditionsPropertyPlantAndEquipment2	2018-01-01	(5,000.00)	
JE-1004	basic:Inventories	basic:PurchasesOfInventoryForSale	2018-01-01	2,000.00	
JE-1004	basic:AccountsPayable	basic:PurchasesOfInventoryForSale2	2018-01-01	(2,000.00)	
JE-1005	basic:Receivables	basic:Sales2	2018-01-01	4,000.00	
JE-1005	basic:Sales	basic:Sales	2018-01-01	(4,000.00)	

³⁹ Prototype, <http://xbrlsite.azurewebsites.net/2019/Core/core-auditChain/>

⁴⁰ Prototype transaction entry form, <http://xbrlsite-app.azurewebsites.net/MatrixOfPossibleTransactions/GeneralJournalTransactionEntry.aspx>

⁴¹ Prototype general journal, <http://xbrlsite.azurewebsites.net/2019/Core/core-auditChain/GeneralJournal.jpg>

⁴² Report of general journal entries, <http://xbrlsite.azurewebsites.net/2019/Core/core-auditChain/rptGeneralJournalByEntry.pdf>

You can get the typical report of transactions summarized by general ledger chart of accounts⁴³.

General Ledger Trial Balance				10/26/2019 12:43:10 PM	
JE	Account	Transaction Description Code	Balance Date	Account Bal	
000-1100-00	basic:CashAndCashEquivalents				
JE-1001	basic:CashAndCashEquivalents	basic:OpeningBalance	2017-12-31	3,000.00	
JE-1002	basic:CashAndCashEquivalents	basic:AdditionalLongtermBorrowings2	2018-01-01	6,000.00	
JE-1003	basic:CashAndCashEquivalents	basic:CapitalAdditionsPropertyPlantAndEquipment2	2018-01-01	(5,000.00)	
JE-1006	basic:CashAndCashEquivalents	basic:CollectionReceivables	2018-01-01	3,000.00	
JE-1007	basic:CashAndCashEquivalents	basic:PaymentOfAccountsPayable	2018-01-01	(2,000.00)	
JE-1008	basic:CashAndCashEquivalents	basic:RepaymentLongtermBorrowings2	2018-01-01	(1,000.00)	
6					4,000.00
000-1200-00	basic:Receivables				
JE-1001	basic:Receivables	basic:OpeningBalance	2017-12-31	1,000.00	
JE-1005	basic:Receivables	basic:Sales2	2018-01-01	4,000.00	
JE-1006	basic:Receivables	basic:CollectionReceivables2	2018-01-01	(3,000.00)	
					2,000.00

But you can also get a report sorted by transaction change grouping code⁴⁴.

General Ledger Trial Balance Changes				10/26/2019 12:42:33 PM	
JE	Transaction Description Code	Account	Balance Date	Account Bal	
JE-1002	basic:AdditionalLongtermBorrowings	basic:LongtermDebt	2018-01-01	(6,000.00)	
1					(6,000.00)
JE-1002	basic:AdditionalLongtermBorrowings2	basic:CashAndCashEquivalents	2018-01-01	6,000.00	
1					6,000.00
JE-1003	basic:CapitalAdditionsPropertyPlantAndEquipment	basic:PropertyPlantAndEquipment	2018-01-01	5,000.00	
1					5,000.00
JE-1003	basic:CapitalAdditionsPropertyPlantAndEquipment2	basic:CashAndCashEquivalents	2018-01-01	(5,000.00)	
1					(5,000.00)
JE-1006	basic:CollectionReceivables	basic:CashAndCashEquivalents	2018-01-01	3,000.00	
1					3,000.00

These general journal entries can be processed within the system and then summarized information can be generated in the form of an XBRL instance⁴⁵ or the detailed transactions can be exported from the system into an XBRL Global Ledger format⁴⁶, XBRL dimensions making use of typed members format⁴⁷, or other format of your choosing and the transactions can be processed into the form of a report using any system you might prefer.

⁴³ Report of general journal entries by account, http://xbrlsite.azurewebsites.net/2019/Core/core-auditChain/rptGeneralLedgerTrialBalance_GroupedByAccount.pdf

⁴⁴ Report of transactions by transaction change grouping code, http://xbrlsite.azurewebsites.net/2019/Core/core-auditChain/rptGeneralLedgerTrialBalance_GroupedByChange.pdf

⁴⁵ Summarized XBRL instance, <http://xbrlsite.azurewebsites.net/2019/Core/core-journal/basic-SampleInstance.xml>

⁴⁶ XBRL Global Ledger format, <http://xbrlsite.azurewebsites.net/2019/Core/core-auditChain/xbrl-gl-JournalEntries-Instance.xml>

⁴⁷ XBRL Dimensions format using typed members, <http://xbrlsite.azurewebsites.net/2019/Core/core-typed/xbrl-typedMembers-JournalEntries-Instance.xml>

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Balance Sheet [Abstract]		Period [Axis]	
		2018-12-31	2017-12-31
Balance Sheet [Abstract]			
Assets [Roll Up]			
Current Assets [Roll Up]			
Cash and Cash Equivalents		4,000	3,000
Receivables		2,000	1,000
Inventories		1,000	1,000
Current Assets		7,000	5,000
Noncurrent Assets [Roll Up]			
Property, Plant and Equipment		6,000	1,000
Noncurrent Assets		6,000	1,000
Assets		13,000	6,000
Liabilities and Equity [Roll Up]			
Liabilities [Roll Up]			
Current Liabilities [Roll Up]			
Accounts Payable		1,000	1,000
Current Liabilities		1,000	1,000
Noncurrent Liabilities [Roll Up]			
Long-term Debt		6,000	1,000
Noncurrent Liabilities		6,000	1,000
Liabilities		7,000	2,000
Equity [Roll Up]			
Retained Earnings		6,000	4,000
Equity		6,000	4,000
Liabilities and Equity		13,000	6,000

Cash Flow Statement [Roll Forward]		Period [Axis]
		2018-01-01 - 2018-12-31
Cash Flow Statement [Roll Forward]		
Net Cash Flow [Roll Up]		
Net Cash Flow Operating Activities [Roll Up]		
Collection of Receivables		3,000
Payment of Accounts Payable		(2,000)
Net Cash Flow Operating Activities		1,000
Net Cash Flow Financing Activities [Roll Up]		
Additional Long-term Borrowings 2		6,000
Repayment of Long-term Borrowings 2		(1,000)
Net Cash Flow Financing Activities		5,000
Net Cash Flow Investing Activities [Roll Up]		
Capital Additions of Property, Plant and Equipment 2		(5,000)
Net Cash Flow Investing Activities		(5,000)
Net Cash Flow		1,000
Cash and Cash Equivalents, Beginning Balance		3,000
Cash and Cash Equivalents, Ending Balance		4,000

Equity [Roll Forward]		Period [Axis]
		2018-01-01 - 2018-12-31
Equity [Roll Forward]		
Equity, Beginning Balance		4,000
Net Income (Loss)		2,000
Equity, Ending Balance		6,000

Net Income (Loss) [Roll Up]		Period [Axis]
		2018-01-01 - 2018-12-31
Net Income (Loss) [Roll Up]		
Income (Loss) from Continuing Operations Before Tax [Roll Up]		
Operating Income (Loss) [Roll Up]		
Gross Profit [Roll Up]		
Sales		4,000
Costs of Sales		(2,000)
Gross Profit (Loss)		2,000
Operating Expenses [Roll Up]		
Depreciation and Amortization		0
Operating Expenses		0
Operating Income (Loss)		2,000
Nonoperating Income (Expenses)		
Income (Loss) from Continuing Operations Before Tax		2,000
Income Tax Expense (Benefit)		0
Net Income (Loss)		2,000

Policies and other nonnumeric disclosures and other information that flows into the financial report from non-double-entry accounting systems can be appended to the report and serialized using the general journal transactions.

Note that the renderings that you see are created automatically using software algorithms that understand how to render XBRL-based financial reports⁴⁸. In addition to an auto-generated application being generated; auto-generated Inline XBRL can be generated⁴⁹ or more pixel perfect representations⁵⁰ can be created using either automated or manual processes:

⁴⁸ Example human-readable rendering generated, <http://xbrlsite.azurewebsites.net/2019/Core/core-trialbalance/evidence-package/contents/index.html#Rendering-BalanceSheet-Implied.html>

⁴⁹ Auto-generated Inline XBRL, <http://xbrlsite.azurewebsites.net/2019/Core/core-trialbalance/basic-SampleInstance.html>

⁵⁰ More pixel perfect rendering, http://xbrlsite.azurewebsites.net/2018/RoboticFinance/basic-SampleInstance-InlineXBRL2b_FormattedTables.html

Balance Sheet Roll Ups

<i>(in US Dollars)</i>	As of December 31, 2018	As of December 31, 2017
ASSETS		
Current Assets:		
Cash and cash equivalents	\$ 4,000	\$ 3,000
Receivables	2,000	1,000
Inventories	1,000	1,000
Total current assets	<u>7,000</u>	<u>5,000</u>
Noncurrent Assets:		
Property, plant, and equipment	6,000	1,000
Total noncurrent assets	<u>6,000</u>	<u>1,000</u>
Total assets	<u>\$ 13,000</u>	<u>\$ 6,000</u>
LIABILITIES AND EQUITY		
LIABILITIES		
Current Liabilities:		
Accounts payable	\$ 1,000	\$ 1,000
Total current liabilities	<u>1,000</u>	<u>1,000</u>
Noncurrent Liabilities:		
Long-term debt	6,000	1,000
Total noncurrent liabilities	<u>6,000</u>	<u>1,000</u>
Total liabilities	<u>7,000</u>	<u>2,000</u>
EQUITY		
Retained earnings	\$ 6,000	\$ 4,000
Total equity	<u>6,000</u>	<u>4,000</u>
Total liabilities and equity	<u>\$ 13,000</u>	<u>\$ 6,000</u>

But what is even more interesting is being able to interact with a financial report using a software application that understands financial reports. Such applications work more like pivot table which let you reconfigure the report for your preferences.

The pivot table functionality and the drilldown capabilities enabled by the transaction change grouping code are hard to show in a static image. So, I created this video⁵¹ which demonstrates the sort of functionality you might expect from software applications in the very near future. Such features will only get better over time.

⁵¹ YouTube, *Drill Down and the Transaction Change-type Code*, <https://www.youtube.com/watch?v=aEoNcDYzT2g&feature=youtu.be>

The screenshot displays the XBRL software interface. On the left, a 'Components (40)' pane shows a list of components, with '1110 - Statement - Balance Sheet' selected. The main area shows a 'Component: (Network and Table)' view for '1110 - Statement - Balance Sheet'. It includes a table with columns for 'Reporting Entity [Axis]', 'Unit [Axis]', and 'Period [Axis]'. The table data is as follows:

Reporting Entity [Axis]	Unit [Axis]	Period [Axis]	2018-12-31	2017-12-31
30810137d58f76b84afd http://standards.iso.org/iso/17442	USD			
Balance Sheet [Abstract]				
Assets [Roll Up]				
Current Assets [Roll Up]				
Cash and Cash Equivalents			4,000	3,000
Receivables			2,000	1,000
Inventories			1,000	1,000
Current Assets			7,000	5,000
Noncurrent Assets [Roll Up]				
Property, Plant and Equipment			6,000	1,000
Noncurrent Assets			6,000	1,000
Assets			13,000	6,000
Liabilities and Equity [Roll Up]				
Liabilities [Roll Up]				
Current Liabilities [Roll Up]				
Accounts Payable			1,000	1,000
Current Liabilities			1,000	1,000
current Liabilities			6,000	1,000
Liabilities			7,000	2,000
Liabilities			6,000	4,000
Equity			6,000	4,000
Equity			6,000	4,000
Liabilities and Equity			13,000	6,000

A 'Fact Characteristics and Properties' dialog is open, showing details for the selected component: Reporting Entity (30810137d58f76b84afd), Period (2018-12-31), Concept (Liabilities), Fact Value (7000), Units (iso4217:USD), and Decimals (rounding) (0).

Retrofitting to Existing Systems

While existing accounting systems that don't provide a place to enter a transaction change grouping code, some of this sort of functionality can still be enabled. Using artificial intelligence type software algorithms software can be used to sort out transactions and get those transactions into an internal or external financial report.

Although, this "bolt on" type of an approach provides minimal leverage and benefits of the XBRL-based metadata in processing your transactions within an accounting system.

Considering the Impact of What is Needed from Base Financial Reporting Taxonomies

Neither the US GAAP XBRL Taxonomy nor the IFRS XBRL Taxonomy have the metadata necessary to enable the sort of processing we are trying to demonstrate here. As explained in the document *Demystifying the Role of Ontologies in XBRL-based Digital Financial Reporting*⁵², financial reporting XBRL taxonomies created by regulators and standards setters today tend to be little more than human-

⁵² Demystifying the Role of Ontologies in XBRL-based Digital Financial Reporting, <http://xbrl.azurewebsites.net/2019/Library/DemystifyingOntologies.pdf>

readable “pick lists” that are somewhat usable by machine-based processes. Over time, as others provide additional metadata that enables enhanced capabilities and as standards setters and regulators learn to harness the true power of XBRL-based digital financial reporting, these large base taxonomies could improve. On the other hand, they might never improve as standards setters and regulators leave it to the market to provide enhancements.

Changes are Inevitable and are Not Dependent on XBRL

XBRL is only a technical syntax. There are many other technical syntaxes that could be used to enable the sort of functionality we are describing in this document. Another is RDF and OWL or what is referred to as the semantic web stack of technologies.

Each technology approach has pros and cons. Efforts such as the Object Management Group (OMG) effort to create *Standard Business Report Model (SBRM)*⁵³ will help professional accountants understand the real power of these sorts of technologies and better harness those powers.

SBRM formally documents a logical conceptualization of a business report in both human-readable and machine-readable models. Once software engineers understand the logical model of a report, they will be able to create easier to use software that is far more functional. The current evolution of software applications tends to make it harder to understand the real possibilities that technology has to offer.

Conclusion

“Digital” opens up new possibilities for how double-entry accounting information systems can function. Rather than the more “open” type systems that exist today which pushes work to the end of the month and the grueling, mindless, mechanical process of fixing errors; a new more “closed” or “guided” approach which leverages accounting knowledge in machine readable form can be implemented which leverages lean six sigma techniques and philosophies to managing accounting system transaction quality. Combining artificial intelligence, structured machine-readable information, high-quality curated metadata; accounting, reporting, auditing, and analysis processes can be supercharged.

⁵³ OMG, *Standard Business Report Model (SBRM)*, <https://omgwiki.org/SBRM/doku.php>