

1.Accounting, Reporting, Auditing and Analysis in a Digital Environment

“It must be remembered that there is nothing more difficult to plan, more doubtful of success, nor more dangerous to manage than a new system. For the initiator has the enmity of all who would profit by the preservation of the old institution and merely lukewarm defenders in those who gain by the new ones.”
Niccolò Machiavelli

We provided you with a 50,000 foot view in the introduction. We pointed out that accounting, reporting, auditing, and analysis are in the midst of what has been called a great upheaval¹. The world is transforming from an analog, industrial economy to a digital, knowledge economy. This type of transformation has not seen in 500 years in accounting, reporting, auditing, and analysis. The transformation is inevitable and is imminent.

Here in this section, we drop down to about 10,000 feet.

Digital financial reporting fits into a larger trend. The purpose of this section is to explain the larger trend into which XBRL-based digital financial reporting fits.

A digital transformation is occurring. Techno-optimists often tend to overstate the impact of technology changes. Business professionals often tend to underestimate such impacts. Reality tends to be somewhere between the optimists and pessimists. Here is one prediction:

“The McKinsey Global Institute estimates that, compared with the Industrial Revolution of the late 18th and early 19th centuries, AI’s disruption of society is happening ten times faster and at 300 times the scale. That means roughly 3000 times the impact².”

This section explains the broader perspective into which XBRL-based digital financial reporting fits. Here is an executive summary of the primary key points:

- The fourth industrial revolution is occurring which is enabling businesses to operate in significantly different ways; enabling technologies include artificial intelligence, internetworked physical devices, cyber-physical systems, nanotechnology, and biotechnology.
- Professional accountants and accounting practices, procedures, and processes will need to adapt. Education and training of professional accountants also needs to adapt.
- Humans augmented by machine capabilities, much like an electronic calculator enabling a human to do math quicker, will empower knowledge workers who know how to leverage the use of those machines.
- Three primary enabling technological innovations are driving this significant change to the current accounting practices, processes, and methods:

¹ The Great Upheaval of Accounting, Reporting, Auditing, and Analysis,
<http://xbrl.squarespace.com/journal/2021/12/17/the-great-upheaval-of-accounting-reporting-auditing-and-anal.html>

² Georgios Petropoulos, *Do we understand the impact of artificial intelligence on employment?*,
<http://bruegel.org/2017/04/do-we-understand-the-impact-of-artificial-intelligence-on-employment/>

structured information such as XBRL-based digital financial reports, knowledge-based systems and other application of artificial intelligence, and blockchain-based distributed ledgers

- While it is difficult to precisely predict the productivity gains which will be realized, initial information is showing the productivity gains will be very, very significant.
- Artificial intelligence, structured information, knowledge graphs, distributed ledgers, machine readable workflow model standards, machine readable decision model standards, and Lean Six Sigma are a match made in heaven and will have a significant impact on accounting, reporting, auditing, and analysis in a digital environment that will prevail during the Fourth Industrial Revolution³.
- These changes to accounting, reporting, auditing, and analysis can be packaged into the larger trend toward computational professional services⁴. Others call this “smart regulation” or “algorithmic regulation” or “rules as code” or “the finance factory” or a “financial transformation” or “modern accounting⁵”.
- Many technologies will be combined to create the semantic spreadsheet⁶ or the computational spreadsheet.

The Fourth Industrial Revolution is here now. Accountants are notoriously resistant to change. But not embracing change has risks and consequences. Again, both overstating and understating the impact can both have detrimental effects. Understanding the moving pieces of this puzzle can help achieve the appropriate balance between optimism and pessimism.

1.1. *The Fourth Industrial Revolution*

What is now commonly referred to as the *Fourth Industrial Revolution*^{7,8} is changing how businesses operate and professional accountants and auditors will need to adapt⁹ to remain relevant and thrive. The training and education of professional accountants also needs to adapt to better prepare new graduates and enable retraining of current professional accountants to adjust to new technologies and the new practices, procedures, and processes that technology will enable.

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-revolution.html>

⁴ Charles Hoffman, CPA, Computational Professional Services, <http://xbrl.azurewebsites.net/2020/library/ComputationalProfessionalServices.pdf>

⁵ Making the Move to Modern Accounting, <http://xbrl.squarespace.com/journal/2021/1/10/making-the-move-to-modern-accounting.html>

⁶ OMG Semantic Workbook, <http://xbrl.squarespace.com/journal/2020/1/16/omg-semantic-workbook-sxml.html>

⁷ Wikipedia, *Fourth Industrial Revolution*, retrieved May 4, 2017, https://en.wikipedia.org/wiki/Fourth_Industrial_Revolution

⁸ Forbes, Bernard Marr, *Why Everyone Must Get Ready For The 4th Industrial Revolution* <https://www.forbes.com/sites/bernardmarr/2016/04/05/why-everyone-must-get-ready-for-4th-industrial-revolution>

⁹ Shelly Palmer, *Digital Transformation in Seven Steps*, <https://www.shellypalmer.com/2017/02/digital-transformation-in-7-brain-busting-steps/>

You might have heard other terms to describe the rapid changes that are occurring. Some call it *The Digital Industrial Revolution*¹⁰. Others refer to the changes as *Industry 4.0*^{11,12}. And others call it the *Artificial Intelligence Revolution*^{13,14}.

The over-arching theme of the change is computers performing more tasks and processes that have historically been performed by humans.

Many say that the **first industrial revolution** resulted from the perfection of the steam engine. The steam engine enabled work to be performed by machines rather than humans, improving productivity tremendously.

The **second industrial revolution** resulted from the harnessing of oil and electricity to create mass production, the assembly line, and the invention of important technologies such as the telephone, the light bulb, the phonograph, and the internal combustion engine. Again, productivity increased significantly.

The **third industrial revolution** resulted from the change from analog electronic and mechanical devices to more effective and efficient digital devices. This era sees the invention of the personal computer, the internet, and significant advances in information and communications technology. Another productivity improvement.

The **fourth industrial revolution** builds on the third and includes advances in artificial intelligence; internetworked physical devices (often referred to as the internet of things¹⁵); cyber-physical systems which are mechanisms controlled or monitored by computer-based algorithms; nanotechnology which is the manipulation of matter on an atomic, molecular, and supramolecular scale; and biotechnology which is the use of organisms and living systems to create products. Even more productivity gains will be realized.

What is common to each of the four revolutions is the use of technology and innovation to enable substantial **productivity gains**. To achieve this, the gap between the problem and the solution must be bridged. Information technology professionals learning accounting and auditing would help bridge the gap. Or, accountants learning a bit about how the technology works so they can have effective conversations with technologists can bridge the gap.

1.2. Pressure to Adapt: increasing workloads, errors, ever increasing complexity

It is easy to understand the impact of the first, second, and third industrial revolutions because they are in our past. The fourth though, because while that change is occurring now most of the change is still in our future, it can be really hard

¹⁰ National Public Radio, TED Radio Hour, *The Industrial Revolution*, retrieved May 4, 2017, <https://www.npr.org/player/embed/524731597/524879464>

¹¹ Cornelius Baur and Dominik Wee, McKinsey & Company, *Manufacturing's Next Act*, <http://www.mckinsey.com/business-functions/operations/our-insights/manufacturings-next-act>

¹² PriceWaterhouseCoopers, *Industry 4.0: Building the digital enterprise*, <http://www.pwc.com/gx/en/industries/industry-4.0.html>

¹³ Steven Levy, Wired, *The AI Revolution is On*, https://www.wired.com/2010/12/ff_ai_essay_airevolution/

¹⁴ Wired, The President in Conversation With MIT's Joi Ito and WIRED's Scott Dadich, *Barack Obama, Neural Nets, Self-driving Cars, and the Future of the World*, <https://www.wired.com/2016/10/president-obama-mit-joi-ito-interview/>

¹⁵ Wikipedia, *Internet of Things*, retrieved May 4, 2017, https://en.wikipedia.org/wiki/Internet_of_things

to separate the science-fact from the science-fiction¹⁶. But not correctly distinguishing the fiction from fact can contribute to leading you down the wrong path. Also, there is risk associated using the strategy of completely ignoring the reality of the changes that are occurring. The past does provide clues as to what might happen in the future.

Oxford University researchers¹⁷ have estimated that 47 percent of U.S. jobs could be displaced by automation within the next two decades. An article, *The Top 5 Jobs Robots Will Take First*,¹⁸ even has accountants listed in the top five jobs that will be automated. That full list is:

1. Middle management
2. Commodity salespeople
3. Report writers, journalists, authors, and announcers
4. Accountants and bookkeepers
5. Doctors

Granted, at times those that report these sorts of change statistics tend to exaggerate the scale of the change and the speed at which the change will occur. But change is inevitable.

While some accountants, bookkeepers, and auditors will likely lose their jobs if they don't tune their skills appropriately; it is better to think about all this not in terms of our jobs but rather to consider the tasks that we perform. What are automated are specific tasks not necessarily entire jobs. Further, the volume and the pace of displacement due to automation is rising.

Also, while some jobs are lost, completely new jobs can be created. For example, the introduction of the automobile led to a decline in horse-related jobs. But entirely new industries emerged which had a significantly positive impact on employment. Not only did the automobile industry grow fast, increasing jobs in that sector, but jobs were also created in the motel and fast-food industries to serve all the motorists and truck drivers who drove those automobiles¹⁹.

Another good example is automated teller machines (ATMs). You might think that ATMs would significantly reduce the number of bank tellers. And, in fact, it did. The average number of bank tellers fell from 20 per branch in 1988 to 13 per branch in 2004. But because the cost of running a bank branch went down because of the ATM, banks were allowed to open more bank branches to better serve customers because of the reduced labor cost of bank tellers. The total number of bank branches increased by 43% over that same period, so the total number of bank tellers actually increased²⁰.

¹⁶ Georgios Petropoulos, *Do we understand the impact of artificial intelligence on employment?*, <http://bruegel.org/2017/04/do-we-understand-the-impact-of-artificial-intelligence-on-employment/>

¹⁷ Carl Benedikt Frey and Michael A. Osborne, *THE FUTURE OF EMPLOYMENT: HOW SUSCEPTIBLE ARE JOBS TO COMPUTERISATION?*, September 17, 2013, http://www.oxfordmartin.ox.ac.uk/downloads/academic/The_Future_of_Employment.pdf

¹⁸ Shelly Palmer, *The 5 Jobs Robots Will Take First*, February 26, 2017, <https://www.shellypalmer.com/2017/02/5-jobs-robots-will-take-first/>

¹⁹ Georgios Petropoulos, *Do we understand the impact of artificial intelligence on employment?*, <http://bruegel.org/2017/04/do-we-understand-the-impact-of-artificial-intelligence-on-employment/>

²⁰ Georgios Petropoulos, *Do we understand the impact of artificial intelligence on employment?*, <http://bruegel.org/2017/04/do-we-understand-the-impact-of-artificial-intelligence-on-employment/>

1.3. *The Rise of the Machines: Enablers of Change*

Computers are machines. There are tasks that machines are good at performing. Likewise, there are tasks that machines are less adept at performing and even some tasks which they cannot perform at all²¹. The same is true for humans. There are some tasks humans are very good at performing and there are tasks where machines are better than humans.

So, what are computers good at? Here is a list:

- Structured problem solving
- Routine tasks
- Arithmetic and other types of mathematics

Here is what humans are good at and things that computers generally cannot do at all or have a very tough time performing such tasks:

- Unstructured problem solving
- Non-routine tasks
- Creativity
- Innovation
- Intuition
- Improvising
- Exploration
- Imagination
- Judgement (such as making a tough decision from incomplete information)
- Politics
- Identifying and acquiring new relevant information
- Compassion

It has been my observation over the years that technical people have a tendency to overstate the capabilities of technology and that most business professionals have a tendency to under estimate the capabilities of technology.

1.4. *Nine Keys to Digital Financial Reporting Transformation*

As explained in the book *The Great Upheaval*²², the world is in the midst of a “great upheaval” where the world is transitioning from an analog, industrial economy to a digital, knowledge economy.

This section points out nine keys to making this transformation to digital general purpose financial reporting effectively.

²¹ TED Talks, Kevin Kelly, *How AI can bring on a second Industrial Revolution*, https://www.ted.com/talks/kevin_kelly_how_ai_can_bring_on_a_second_industrial_revolution

²² Author Levine and Scott J. van Pelt, *The Great Upheaval*, <https://www.amazon.com/Great-Upheaval-Educations-Present-Uncertain/dp/1421442574>

1.4.1.Key 1: Accounting and Reporting Rules Served by Standards based Machine Readable Declarative Rules

The coming transformation of financial reporting requires some of the rules and regulations related to financial accounting and financial reporting to be represented in a standards-based machine-readable declarative form. However, this does not subordinate accountants, reporting entities, auditors, financial analysts, investors, standards setters or regulators and the rules and regulations to the constraints of computer science. The information communicated by a financial report and the rules and regulations that govern such reports is, and always will be, the legal agreement, not the computer code. The code can only refer to, or facilitate the transmission of, those professional work products that bring a financial instrument into being. It does not seem productive to attempt to translate legal and regulatory technical complexity into code when adjudication, in the case of default, will revert not to code but to the judiciary.

As pointed out by the *Business Rules Manifesto*, Article 4²³;

- Rules should be expressed declaratively in natural-language sentences for the business audience.
- If something cannot be expressed, then it is not a rule.
- A set of statements is declarative only if the set has no implicit sequencing.
- Any statements of rules that require constructs other than terms and facts imply assumptions about a system implementation.
- A rule is distinct from any enforcement defined for it. A rule and its enforcement are separate concerns.
- Rules should be defined independently of responsibility for the who, where, when, or how of their enforcement.
- Exceptions to rules are expressed by other rules.

1.4.2.Key 2: Ease of Use is Required

Digital financial reporting will only emerge if the technology developers allow those market participants that create, read, or otherwise make use of such digital financial reports like accountants, business professionals, investors, auditors, financial analysts, regulators, data aggregators, attorneys, and commercial loan officers, who are not computer scientists or coders, and never want to be computer scientists or coders. Software in support of digital financial reporting must be built around the needs of its users.

Notwithstanding the digitization of the “paper” process or “e-paper” such as PDF, HTML, word processing documents, creating digital financial reports requires that existing workflows, business processes, audits, and financial analysis be maintained in a way that users can accept, understand, and integrate into existing processes. The widespread adoption of blockchain technology in financial reporting requires an expansion of the user base amongst existing practitioners in the marketplace. This will require digitization of these financial reporting related artifacts in a way that is accessible to all participants that are involved in this process.

²³ Business Rules Group, Business Rules Manifesto, Article 4,
<https://www.businessrulesgroup.org/brmanifesto.htm>

Ease of use is required by taking the complexities of digital financial reporting and burying those complexities within software applications or within platforms that serve those software applications and their users. Creative and clever use of explainable rules-based artificial intelligence by software engineers can simplify software use. Simplistic software will not do. Attempting to remove what might be considered a complex or sophisticated task or process from software just in order to make developing such software will never be acceptable. The law of irreducible complexity mandates that all necessary parts of the system exist.

1.4.3.Key 3: Clear, Understandable Accounting and Reporting Logic

The terminology, rules, and other logic used in accounting and financial reporting must be clear and understandable because computers simply cannot work effectively with ambiguity.

Remember, computers are machines. Computers have no intelligence until they are instructed by humans. Computers only appear smart when humans create standards and agree to do things in a similar manner in order to achieve some higher purpose. A machine such as a computer can only mimic what humans tell the machine to do via machine-readable information.

A logical system enables a community of stakeholders trying to achieve a specific goal or objective or a range of goals/objectives to agree on important common models, structures, and statements for capturing meaning or representing a shared understanding of and knowledge in some area of knowledge. Such logical systems can be explained using a logical theory. Logical theories can be tested to prove if the theory described is true or false.

A financial report is a logical system. Financial reports represent economic phenomena in words and numbers. A financial report is a faithful representation of a set of claims made by an economic entity about the financial position and financial performance of an economic entity. Financial reports are not arbitrary, not random, and not illogical.

A logical theory is made up of a set of logical models, logical structures, logical terms, logical associations, logical rules, and logical facts. Such logic must be clear and understandable.

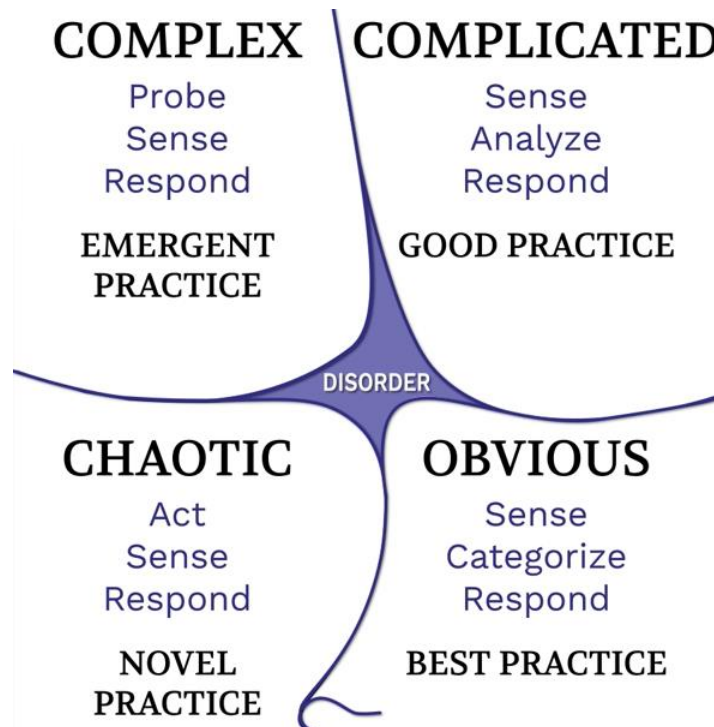
1.4.4.Key 4: Good Practices and Best Practices

An area of knowledge is a highly organized socially constructed aggregation of shared knowledge for a distinct subject matter. An area of knowledge has a specialized insider vocabulary, jargon, underlying assumptions (axioms, theorems, constraints), and persistent open questions that have not necessarily been resolved (i.e. flexibility is necessary).

Accounting is an area of knowledge. You can explain aspects of the accounting area of knowledge, such as the nature of a financial report, using a logical theory which explains a logical model. A logical theory can be tested and proven by providing a proof.

Knowledge can be represented in human-readable form, in machine-readable form, or in a machine-readable form that can be effectively converted into human-readable form.

The knowledge within an area of knowledge can be explained using tools such as the Cynefin Framework²⁴ which is a sensemaking process²⁵.



Some accounting knowledge related to the repetitive, mechanical, mathematical, and logical aspects of accounting, reporting, auditing, and analysis are obvious and can be explained in terms of "best practices" or are complicated and can be analyzed by those with accounting expertise and explained as a set of "good practices". There are other frameworks similar to Cynefin that help one make sense of things²⁶ such as ISO-9000 quality frameworks.

1.4.5.Key 5: Clear, Understandable Terms, Associations, Rules, Facts

Double entry bookkeeping is an ancient best practices technique that is in global use today and commerce and global multinational organizations could not exist without that ancient best practice²⁷. Double entry bookkeeping is a mathematical model²⁸. That double entry bookkeeping mathematical model is the foundation for robust financial reporting schemes such as U.S. Generally Accepted Accounting Principles²⁹ (US GAAP) and International Financial Reporting Standards³⁰ (IFRS) among others³¹.

²⁴ YouTube.com, CognitiveEdge, Cynefin Framework, <https://youtu.be/N7oz366X0-8>

²⁵ Wikipedia, Sensemaking, <https://en.wikipedia.org/wiki/Sensemaking>

²⁶ Tom Graves / Tetradian, And more 'Cynefin-like' cross-maps ('Beyond-Cynefin' series), <http://weblog.tetradian.com/2010/02/28/and-more-crossmaps/>

²⁷ Amazon.com, Jane Gleeson-White, Double Entry: How the Merchants of Venice Created Modern Finance, <https://www.amazon.com/qp/product/B007Q6XKA8/>

²⁸ Mathematics Magazine, David Ellerman, The Mathematics of Double Entry Bookkeeping, https://ellerman.org/wp-content/uploads/2012/12/DEB-Math-Mag.CV_.pdf

²⁹ Wikipedia, Generally Accepted Accounting Principles (United States), [https://en.wikipedia.org/wiki/Generally_Accepted_Accounting_Principles_\(United_States\)](https://en.wikipedia.org/wiki/Generally_Accepted_Accounting_Principles_(United_States))

³⁰ Wikipedia, International Financial Reporting Standards, https://en.wikipedia.org/wiki/International_Financial_Reporting_Standards

Both US GAAP and IFRS are grounded in a version of the accounting equation³². Both US GAAP³³ and IFRS³⁴ define a core set of interrelated elements of financial statements that form a conceptual framework for financial reporting using that financial reporting framework. The semantics of US GAAP has been maturing for almost 100 years and IFRS for almost 50 years.

These interrelated elements of financial statements are the building blocks with which financial statements are constructed. Both US GAAP and IFRS discuss the notions are “articulation” which relates to the intentional interconnectedness of each of the primary financial statements and “intermediate components” which relates to the notion that different reporting entities are permitted to use different subtotals and report line items to represent the financial position and financial performance of an economic entity. This flexibility is intentional, by design, encouraged for specific reasons; and must be considered when creating software applications.

1.4.6.Key 6: Control of Report Model Modifications to Maintain High Report Quality

Financial reporting using both/either US GAAP encourages comparability with consistency. What this means is that financial statements are not, should not, and need not be forms. Rather, within the boundaries of these, and other similar, financial reporting schemes; flexibility is provided to economic entities to create their financial reports to effectively describe their economic entities including important unique aspects of the economic entities. As such, reporting economic entities are permitted to modify their report models within permitted boundaries. As such, software applications that enable the creation of such financial reports must control the software users to help keep those software users within these permitted boundaries.

Control is provided using the machine-readable accounting and reporting rules described previously in Key 1.

Rules are used to articulate allowed variability and “channel” creators of financial reports in the right direction and therefore control variability, keeping the variability within standard limits. That keeps quality where it needs to be. Rules enable things like preventing a user from using a concept meant to represent one thing from unintentionally being used to represent something different.

Further, the discipline of describing something in a form a computer algorithm can understand also assists you in understanding the world better; weeding out flaws in your understanding, myths, and misconceptions about accounting and reporting standards. This helps accountants be better accountants.

³¹ Charles Hoffman, CPA, *Comparison of Elements of Financial Statement*, <http://xbrl.azurewebsites.net/2020/master/ElementsOfFinancialStatements.pdf>

³² Wikipedia, *Accounting Equation*, https://en.wikipedia.org/wiki/Accounting_equation

³³ FASB, *Statement of Financial Accounting Concepts No. 8*, December 2021, *Conceptual Framework for Financial Reporting*, Chapter 4, *Elements of Financial Statements*, https://fasb.org/Page/document?pdf=Concepts_Statement_8-Chapter_4-Elements.pdf

³⁴ IFRS Foundation, *Conceptual Framework*, Chapter 4 *Elements of Financial Statements*, PDF page 25, <https://www.ifrs.org/content/dam/ifrs/publications/pdf-standards/english/2021/issued/part-a/conceptual-framework-for-financial-reporting.pdf>

1.4.7.Key 7: Tamper Proof Audit Trail

Digital financial reporting will involve thousands of machine-readable rules, machine-readable reports models and reports, provided by tens of thousands of economic entities, thousands of auditors, tens of thousands of analysts and investors; you get the point.

How can you be sure rules, reports, and other technical artifacts have not been tampered with? How do you know an inadvertent mistake, or an intention manipulation has not been induced into the system? How can you be sure that software is working correctly and giving you the right answers such that you can rely on automated processes provided by the software?

All of these issues can be effectively handled using immutable digital distributed ledger technologies such as blockchain.

Financial reports can be created at different levels of quality and reliability³⁵. Only reports at levels 5 and above can be proven to actually work effectively. Using the good practices (see Key 4) provided by the *Seattle Method*³⁶, controlled processes (see Key 6) can be created that effectively and provably work. Financial report level 6 adds increased trust that digital artifacts have not been tampered with and a complete audit trail can be provided and dependability of the digital artifacts. Level 7 applies similar techniques at the accounting systems transaction level.

1.4.8.Key 8: Standards Convertible into Multiple Technology Stacks

Standards are necessary for effective digital financial reporting at a global scale. The Extensible Business Reporting Language, XBRL³⁷, is the de facto standard for digital financial reporting and business reporting with over 100 XBRL projects³⁸ in 60 different countries.

Standard methods for implementing XBRL have also emerged including the ISO Data Point Model³⁹ (DPM), Standard Business Reporting⁴⁰ (SBR), OMG's Standard Business Report Model⁴¹ (SBRM), European Single Electronic Format⁴² (ESEF), and the Seattle Method⁴³. There are other approaches to representing XBRL-based digital financial reports.

But enterprises have different preferences for technology stacks that they use to implement technologies within their organizations. The industry standards group RuleML⁴⁴ points out that there tends to be three primary problem solving logic implementation approaches:

³⁵ Auditchain, *Financial Report Levels*,

<http://accounting.auditchain.finance/library/FinancialReportLevels.pdf>

³⁶ Charles Hoffman, CPA, *Seattle Method*, <http://xbrlsite.com/seattlemethod/SeattleMethod.pdf>

³⁷ XBRL International, <https://www.xbrl.org/>

³⁸ XBRL International, *XBRL Project Directory*, <https://www.xbrl.org/the-standard/why/xbrl-project-directory/>

³⁹ ISO, *ISO Datapoint Methodology*, <https://www.iso.org/standard/80873.html>

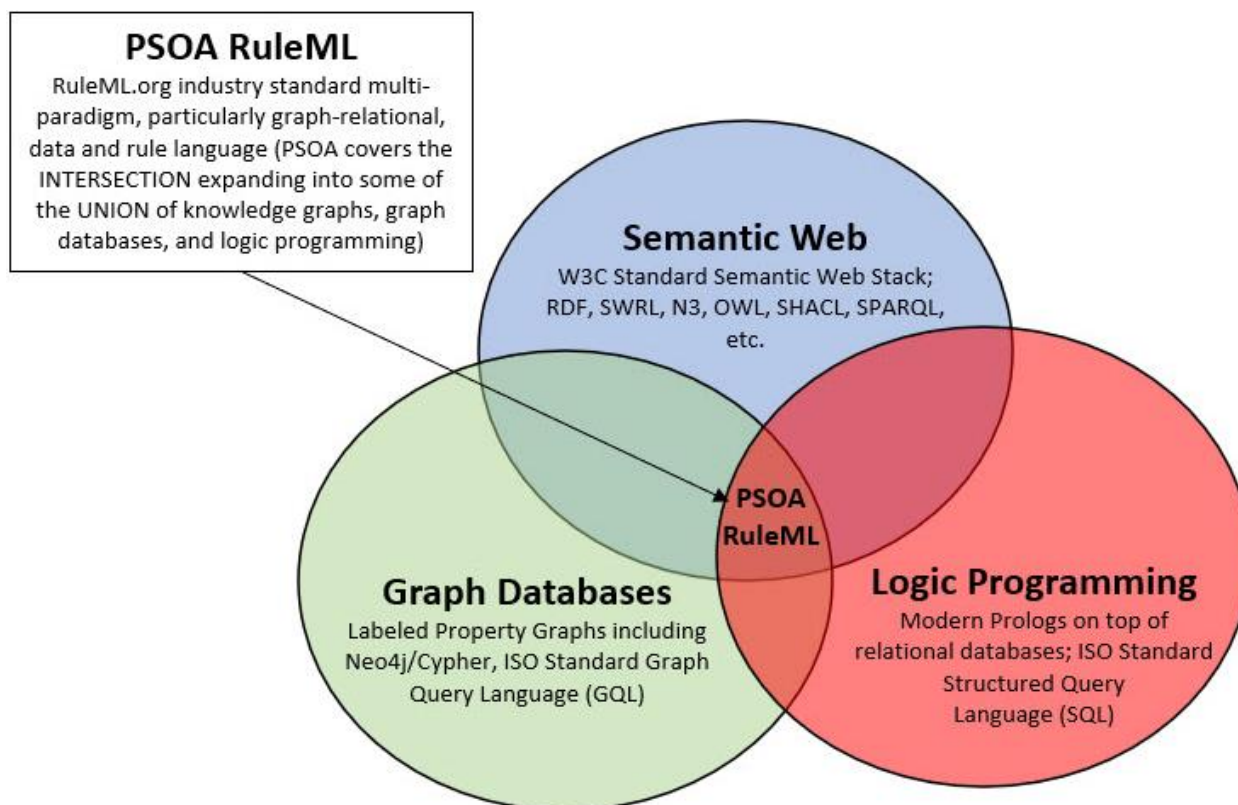
⁴⁰ Wikipedia, *Standard Business Reporting*, https://en.wikipedia.org/wiki/Standard_Business_Reporting

⁴¹ OMG, *Standard Business Report Model (SBRM)*, <https://www.omg.org/intro/SBRM.pdf>

⁴² ESMA, *European Single Electronic Format*, <https://www.esma.europa.eu/policy-activities/corporate-disclosure/european-single-electronic-format>

⁴³ Charles Hoffman, CPA, *Seattle Method*, <http://xbrlsite.com/seattlemethod/>

⁴⁴ RuleML.org, *Graph-Relational Data, Ontologies, and Rules*, http://wiki.ruleml.org/index.php/Graph-Relational_Data,_Ontologies,_and_Rules



RuleML also offers up a very safe “sweet spot”⁴⁵ which is a where each of the three primary problem solving logic approaches can be bi-directionally transferred between implementation technical syntaxes. DATALOG⁴⁶ seems to be the safest logic processor.

1.4.9.Key 9: *Nothing is a “Black Box”*

Accounting is about, well, about accounting for things. As such, any accounting or reporting system must be able to explain and justify everything, every detail. Transparency into how conclusions are reached, what rules where used, lines of reasoning, origin of facts and rules used to reach conclusions, and information about the problem-solving method used for any logical deduction or derivation are non-negotiable; they must be provided to creators of information, consumers of information, and all intermediaries involved in the process.

Explainable artificial intelligence⁴⁷ (XAI) that is rules base is the tool of choice.

⁴⁵ RuleML.org, PSOA RuleML, http://wiki.ruleml.org/index.php/PSOA_RuleML

⁴⁶ Wikipedia, Datalog, <https://en.wikipedia.org/wiki/Datalog>

⁴⁷ ACCA, *Explainable AI: Putting the user at the core*, https://www.accaglobal.com/uk/en/professional-insights/technology/Explainable_AI.html

1.5. Human-machine Teaming

An episode of the NPR program TED Radio Hour, *The Digital Industrial Revolution*⁴⁸, helps you sort through the facts and the fiction to better understand your future which is rapidly arriving. There is one important point that this radio program is getting very right that most people tend to get wrong.

Who is the world chess champion today; a computer or a human? In 1997, IBM's Deep Blue⁴⁹, a machine, was the champion.

Today, a computer is no longer the world chess champion. Neither is a human. Today, a team of computers and humans working together can beat any computer or any human working alone⁵⁰.

That is how the power of computers will be harnessed in the Digital Age; by human and computer teamwork. Humans are good at some tasks; not as good at other tasks. Computers are good at some tasks; not as good at other tasks. Teaming humans and computers together and leveraging the strengths of each is how work will get done in the future. You already team with machines, such as electronic calculators, which can do math faster and with less errors than humans.

In the first industrial revolution, steam engines amplified the power of our muscles. In the fourth industrial revolutions, computers will amplify the power of our brains⁵¹. Human capabilities augmented by computer capabilities are one important way productivity will increase in the fourth industrial revolution. Assisted by computers, humans will spend fewer hours on noncore tasks and more on client service and creative work⁵².

1.6. Increased Productivity from Human-machine Collaboration

How much savings will be realized from this human-machine collaboration? That is hard to say precisely, but one study states how much the federal government might save⁵³:

“At the high end, we estimate within the next 5-7 years, as many as 1.1 billion working hours could be freed up in the federal government every year, saving a whopping \$37 billion annually. Ultimately, AI could potentially free up 30 percent of federal employees’ time. State government savings in time and money could be similar percentages.”

Also, think of something. Who do you want deciding how all these automated processes work? Consider this observation⁵⁴ by then president Barack Obama related to driverless cars,

⁴⁸ National Public Radio, TED Radio Hour, *The Digital Industrial Revolution*, April 21, 2017, <http://www.npr.org/podcasts/510298/ted-radio-hour>

⁴⁹ IBM, Deep Blue, <http://www-03.ibm.com/ibm/history/ibm100/us/en/icons/deepblue/>

⁵⁰ TED Talks, Garry Kasparov, *Don't fear intelligent machines: work with them*, https://www.ted.com/talks/garry_kasparov_don_t_fear_intelligent_machines_work_with_them

⁵¹ Shelley Palmer, *Stop Saying AI Can't Replace Humans*, <https://www.linkedin.com/pulse/stop-saying-ai-cant-replace-humans-shelly-palmer>

⁵² Dr. Peter Viechnicki, William D. Eggers, *How much time and money can AI save government?*, <https://dupress.deloitte.com/dup-us-en/focus/cognitive-technologies/artificial-intelligence-government-analysis.html>

⁵³ *What the future of artificial intelligence in government?*, <http://houseofbots.com/news-detail/504-1-what-the-future-of-artificial-intelligence-in-government>

“There are gonna be a bunch of choices that you have to make, the classic problem being: If the car is driving, you can swerve to avoid hitting a pedestrian, but then you might hit a wall and kill yourself. It’s a moral decision, and who’s setting up those rules?”

Automation, such as autonomous vehicles, is made possible by machine-readable rules that enable the automation. Who do we want writing those rules? Software developers? Probably not. Accounting professionals need to be involved in the creation and maintenance of the rules that drive many of these automated processes that impact them. Auditors need to understand how these processes work, what the rules are, and understand how to test if things are working as expected.

An excellent video documentary helps you understand the possibilities, *In the Age of AI*⁵⁵, produced by Frontline.

1.7. Ready for AI?

But are business professionals prepared? The answer is not really. *The AI Ladder*⁵⁶, by Rob Thomas and published by O'Reilly Media, is by far the best resource that I have run across related to getting your head around artificial intelligence. Here is a summary of why AI projects fail:

- **Lack of understanding.** 81% of business leaders do not understand AI.
- **Bad data.** Not having a handle on your data is completely paralyzing. Your AI is only going to be as good as your data.
- **Lack of the right skills.** The lack of the right skills on part of both business professionals and information technology professionals is problematic.
- **Trust.** Trusting the recommendations made by your artificial intelligence software is a must. AI should not be a black box; business professionals need justification mechanisms that support conclusions.
- **Culture.** *The Technology Fallacy*⁵⁷ points out that digital transformation involves changes to organizational dynamics and how work gets done. AI will enable entirely new business models which were impossible in the past. People tend to believe that change will be due to technology; but the Harvard Business Review points out that change is about talent, not technology⁵⁸.

⁵⁴ Wired, The President in Conversation With MIT’s Joi Ito and WIRED’s Scott Dadich, *Barack Obama, Neural Nets, Self-driving Cars, and the Future of the World*, <https://www.wired.com/2016/10/president-obama-mit-joi-ito-interview/>

⁵⁵ PBS, Frontline, *In the Age of AI*, <http://xbrl.squarespace.com/journal/2019/12/15/frontline-in-the-age-of-ai.html>

⁵⁶ Rob Thomas, O'Reilly Media, *The AI Ladder*, <http://xbrl.squarespace.com/journal/2019/10/19/the-ai-ladder.html>

⁵⁷ *The Technology Fallacy*, <http://xbrl.squarespace.com/journal/2019/5/9/digital-maturity.html>

⁵⁸ HBR: Digital Transformation Is About Talent, Not Technology, <http://xbrl.squarespace.com/journal/2020/5/12/hbr-digital-transformation-is-about-talent-not-technology.html>

1.8. Digital General Purpose Financial Report

The general purpose financial report is currently getting a face lift⁵⁹. XBRL-based digital financial reports provide significant benefits over their paper or e-paper counterparts⁶⁰. While what goes into financial reports is not really changing, how information is conveyed by that report is changing a lot. Paper-based and even electronic versions of financial reports were not understandable by computer processes. But XBRL-based structured digital financial reports⁶¹ are understandable by machines. Public companies have been submitting XBRL-based financial reports to the U.S. Securities and Exchange Commission for over ten years now, perfecting these digital financial reports.

Financial reports are knowledge graphs⁶². Contemporary financial report knowledge graphs were only readable by humans. Going forward, those financial report knowledge graphs will be readable by both humans and machine-based automated processes. It is important to think about that statement and understand that that statement really means. Nobody knows exactly how many tasks and processes can be automated, but it is pretty clear that the answer is more than zero.

Most professional accountants still don't understand how to correctly convey the meaning represented by the complex logical information which makes up a financial report in the machine-readable XBRL structured format. Most professional accountants still don't understand how to create the business rules that help make sure they did not make mistakes in conveying that meaning. Most professional accountants are not leveraging currently available technologies to automate things such as financial reporting and disclosure checklists. Most certified public accountants don't really understand how to audit information conveyed by an XBRL-based structured digital financial report. But all that is slowly changing.

Best practice and good practice based methods such as the *Seattle Method*⁶³ will help professional accountants gain the skills they need.

By all accounts, the process of creating an external financial report is an extremely inefficient process. Here is a list of how some describe that process:

- The CFA Institute calls for "...greater efficiencies within the current inefficient system" [of creating financial reports]⁶⁴.
- The consultancy Gartner points out, "...average Fortune 1000 company used more than 800 spreadsheets to prepare its financial statements"⁶⁵

⁵⁹ Charles Hoffman, *Conceptual Overview of an XBRL-based Structured Digital Financial Report*, http://xbrl.azurewebsites.net/2017/IntelligentDigitalFinancialReporting/Part01_Chapter02.1_ConceptualOverviewOfDigitalFinancialReporting.pdf

⁶⁰ Charles Hoffman, *Case for XBRL-based General Purpose Financial Reporting on One Slide*, <http://xbrl.squarespace.com/journal/2019/2/10/case-for-xbrl-based-general-purpose-financial-reporting-on-o.html>

⁶¹ Mohini Singh and Sandra Peters, CPA, CFA, CFA Institute, *Data and Technology: Transforming the Financial Information Landscape*, <http://www.cfapubs.org/doi/pdf/10.2469/ccb.v2016.n7.1>

⁶² Charles Hoffman, CPA, *Financial Report Knowledge Graphs*, <http://xbrl.azurewebsites.net/2021/Library/FinancialReportKnowledgeGraphs.pdf>

⁶³ Charles Hoffman, CPA, *Seattle Method*, <http://xbrl.azurewebsites.net/SeattleMethod/SeattleMethod.pdf>

⁶⁴ CFA Institute, *DATA AND TECHNOLOGY: TRANSFORMING THE FINANCIAL INFORMATION LANDSCAPE*, June 2016, <http://www.cfapubs.org/doi/pdf/10.2469/ccb.v2016.n7.1>

⁶⁵ Nigel Rayner, Neil Chandler, *XBRL Will Enhance Corporate Disclosure and Corporate Performance Management*, April 23, 2008,

- Ventana Research says, "...for larger companies, assembling the periodic external reports typically is an inefficient and error-prone process."⁶⁶
- PriceWaterhouseCoopers points out, "...old school manual processes..." and "commonly cut and pasted, rekeyed, or manually transferred into word processing and spreadsheet applications used for report assembly and review process steps"⁶⁷

While the process of creating an external financial report might not seem inefficient when being measured against current practices, procedures, processes, and mentalities of those thinking that the way financial reports are created is "the only way" to create such reports; and while it is hard to measure the effectiveness and efficiency of new practices, procedures, and processes because they don't exist yet; when new practices, procedures, and processes do exist the increase in productivity will be measurable and clear, and they will be substantial. Already many organizations are making the move to modern accounting⁶⁸.

1.9. Human-machine Collaboration to Create Financial Reports

How do we know productivity gains will be substantial? For the past five years a software developer and I have worked to create, to the best of our knowledge, the world's first expert system for creating financial reports. We admit that the expertise offered by the system is currently rudimentary but it is effective and it is useful and it does prove the idea. Our current expert system for creating financial reports is somewhat like comparing the first successful airplane created by Orville and Wilbur Wright, Wright Flyer, to say a Boeing 747. Yes, there is a significant amount of room for improvement. But, just like the Wright Flyer proved that sustained controlled flight is possible; our expert system proves that artificial intelligence technology can be leveraged in the process of creating a financial report and it helped to figure out exactly how to make the technology work effectively and more efficiently than current processes. What is more, the entire record-to-report can be automated⁶⁹.

As has been said, "The best way to predict the future is to create it⁷⁰." Yes, it can be hard to separate science-fact and science-fiction. But participating in the creation of new technologies or trying out new technologies before they are ready for commercial use does have its advantages⁷¹. The typical professional accountant is generally too busy working and producing to fiddle around with possible new technologies that might provide productivity improvements. But those that do lift their heads up from the daily grind of using current practices, processes, and procedures; can often see new ways that can be employed to solve those same problems that are more effective and efficient than current approaches.

<http://unstats.un.org/unsd/nationalaccount/workshops/2008/newyork/IG22.PDF>

⁶⁶ Robert Kugel, Ventana Research: Making XBRL Reporting Easy, February 13, 2009, <http://businessfinancemag.com/technology/ventura-research-making-xbrl-reporting-easy>

⁶⁷ Mike Willis, PriceWaterhouseCoopers, Disclosure management: Streamlining the Last Mile, March 2012, <https://www.pwc.com/gx/en/xbrl/pdf/pwc-streamlining-last-mile-report.pdf>

⁶⁸ Making the Move to Modern Accounting, <http://xbrl.squarespace.com/journal/2021/1/10/making-the-move-to-modern-accounting.html>

⁶⁹ Effective Automation of Record to Report (Iteration #4), <http://xbrl.squarespace.com/journal/2021/1/25/effective-automation-of-record-to-report-process-iteration-4.html>

⁷⁰ BarnRaisers, attributed to both Abraham Lincoln and Peter Drucker, <http://barnraisersllc.com/2013/12/12-reasons-predict-future-create/>

⁷¹ Shelly Palmer, *Automate or Die*, <https://www.shellypalmer.com/2017/04/automate-or-die/>

While understanding the big picture is important, the devil is in the details. You need to figure out how to appropriately apply technology to your advantage.

1.10. Audited Without Manual Interference

The conclusion of a paper, *Imagineering Audit 4.0*, written by Jun Dai and Miklos A. Vasarhelyi and published by the *Journal of Emerging Technologies in Accounting*⁷² provides a succinct and in my opinion accurate assessment of where Industry 4.0 and auditing is headed.

“Audit 4.0 utilizes data collection equipment such as sensors, embedded computers, and software modules to collect data across the entire company and its outside entities, such as suppliers and customers, via a network in close-to-real time. Data analytics techniques are employed to build models upon these data for the purposes of monitoring product quality, identifying machine faults, saving costs, and facilitating decision making. Audit by exception is used to bring attention to major issues in a largely automated audit. The audit process strongly relies on a mirror world representation of processes and a strong analytical interlinking of not only financial but especially nonfinancial to financial linkages. Finally, the approach will substantially rebalance the concepts of lines of defense, will be applicable to many types of assurances (external, internal, specialized), and will be mainly automated.”

In another paper, *DATA Act 2022: Changing Technology, Changing Culture*⁷³, published by Deloitte and the DATA Foundation, the authors provide a vision of what is possible to achieve by the year 2022 should *The Digital Accountability and Transparency Act of 2014*⁷⁴ be implemented effectively:

“By 2022, if all goes well, spending information will also be automated: reported, exchanged, and *audited without manual interference*. Systems will deliver reports instantly; grantee and contractor software will communicate automatically with agency and government-wide systems.”

The DATA Act is not an isolated example; it is part of a broader trend referred to as RegTech⁷⁵. Someone, somewhere will begin employing the technologies of the *Fourth Industrial Revolution*. Professional accountants and auditors will then be forced into changing. But these changes will occur and the institution of accountancy may or may not be ready. And these changes will likely occur sooner than you might realize.

The statement “audited without manual interference” implies that manual audit steps are not added value, rather the manual audit steps are unnecessary friction which should be removed from the system.

⁷² Jun Dai and Miklos A. Vasarhelyi (2016) *Imagineering Audit 4.0*. Journal of Emerging Technologies in Accounting: Spring 2016, Vol. 13, No. 1, pp. 1-15., <http://aaajournals.org/doi/abs/10.2308/jeta-10494?code=aaan-site>

⁷³ Deloitte and the DATA Foundation, *DATA Act 2022: Changing Technology, Changing Culture*, <http://www.datafoundation.org/data-act-2022>

⁷⁴ DIGITAL ACCOUNTABILITY AND TRANSPARENCY ACT OF 2014, <https://www.congress.gov/113/plaws/publ101/PLAW-113publ101.pdf>

⁷⁵ R.J. Voster BEng, *RegTech: closing the circle; Will Regulatory Technology (RegTech) digitize regulation?*, <https://www.compact.nl/en/articles/regtech-closing-the-circle/>

In a Fortune article⁷⁶, *Wirecard shows auditing is broken. Here's why—and how to fix it*, Jeremy Kahn holds that auditing is broken. He points out that a POGO study found that when the PCAOB inspected Big 4 audits it found:

- Deloitte botched 20%
- PWC botched 23.6%
- EY botched 27.3%
- KPMG botched 50%

New approaches to auditing are already appearing. The company Mindbridge.ai has created what they call the AI assisted audit⁷⁷. The AICPA is working on the Dynamic Audit Initiative⁷⁸. A PhD student in Brazil is contemplating an XBRL-based machine-readable audit program⁷⁹.

1.11. The Finance Factory

Deloitte is articulating a vision of what they call **The Finance Factory**. I buy into that vision. Here is how Deloitte describes *The Finance Factory*:

The finance factory handles core finance processes, and connects to finance centres of excellence and outsourcing partners in a hub-and-spoke model.

There's no paper, anywhere. Employees use cloud-based apps on mobile devices to transact their business, and highly standardized, simplified, workflow-enabled business processes handle the rest. Automated controls and intelligent process monitoring and analytics keep watch over core, extended and outsourced process performance, exceptions and service levels to help minimize rework. Finance managers receive event-driven, real-time updates thanks to new integration tools and advances in in-memory processing.

The close process is continuous, if not yet real-time. A daily soft close is the new norm, made possible by visual close management tools, integrated sub-ledgers, daily time capture, journal workflows, reconciliation tools, as well as automation of consolidation, foreign exchange, allocation and intercompany transfers. Finance teams now simulate pre-close results and can support the continuous development of the MD&A throughout the close process.

The description of the vision is maturing. Last year I heard the term "lights-out finance" explained in broad brush strokes. Now, I would point you to these Deloitte documents that help paint the details of the vision:

- *Close, Consolidate, Report*⁸⁰
- *The Future of Operational Finance*⁸¹

⁷⁶ Forbes: Auditing is Broken, <http://xbrl.squarespace.com/journal/2020/7/21/fortune-auditing-is-broken.html>

⁷⁷ AI Assisted Audit, <http://xbrl.squarespace.com/journal/2019/6/12/ai-assisted-audits-are-here.html>

⁷⁸ Dynamic Audit Solution Initiative, <http://xbrl.squarespace.com/journal/2019/7/10/dynamic-audit-solution-initiative.html>

⁷⁹ xAudit: Auditing Representation in XBRL Based Documents, <http://xbrl.squarespace.com/journal/2020/1/3/xaudit-auditing-representation-in-xbrl-based-documents.html>

⁸⁰ Deloitte, *Close, Consolidate, Report*, <https://www2.deloitte.com/content/dam/Deloitte/nl/Documents/cfo/deloitte-nl-cfo-point-of-view-close-consolidate-and-report.pdf>

- *Modernizing Finance in Private Companies*⁸²
- *Finance 2025*⁸³

Others⁸⁴ provide insights into the possibilities but refer to the same thing using different terms. "Financial Transformation" and "Finance Digital Transformation" and "The Modern Finance Platform" and "Digital Finance" and "Mirror World" are some of the different terms that are used.

I summarized all of this information in a document that I call *Exploring the Notion of The Finance Factory*⁸⁵. While it is very doubtful that the vision that Deloitte paints for what a finance department will look like in 2025 will be realized in such a short time for all organizations is doubtful, particularly in such a short period of time; what is clear is that change is on its way.

Many aspects of accounting, reporting, auditing, and analysis are painful, monotonous, onerous, gruelling; even barbaric given the tools that are available today for performing these tasks in a digital environment.

While many things might never change, other things will change. No one has a crystal ball that can accurately predict exactly what will change and when. But, thinking that nothing will change is absurd and increasingly risky.

There is always room for improvement in the accounting information systems that keep an organization running or in the supply chain that provides capital via the capital markets.

The Big Four CPA firms are each publishing information that will help their clients adapt to this new paradigm of accounting, reporting, auditing, and analysis⁸⁶.

⁸¹ Deloitte, *The Future of Operational Finance*, <https://www2.deloitte.com/content/dam/Deloitte/nl/Documents/strategy/deloitte-nl-so-the-future-of-operational-finance.pdf>

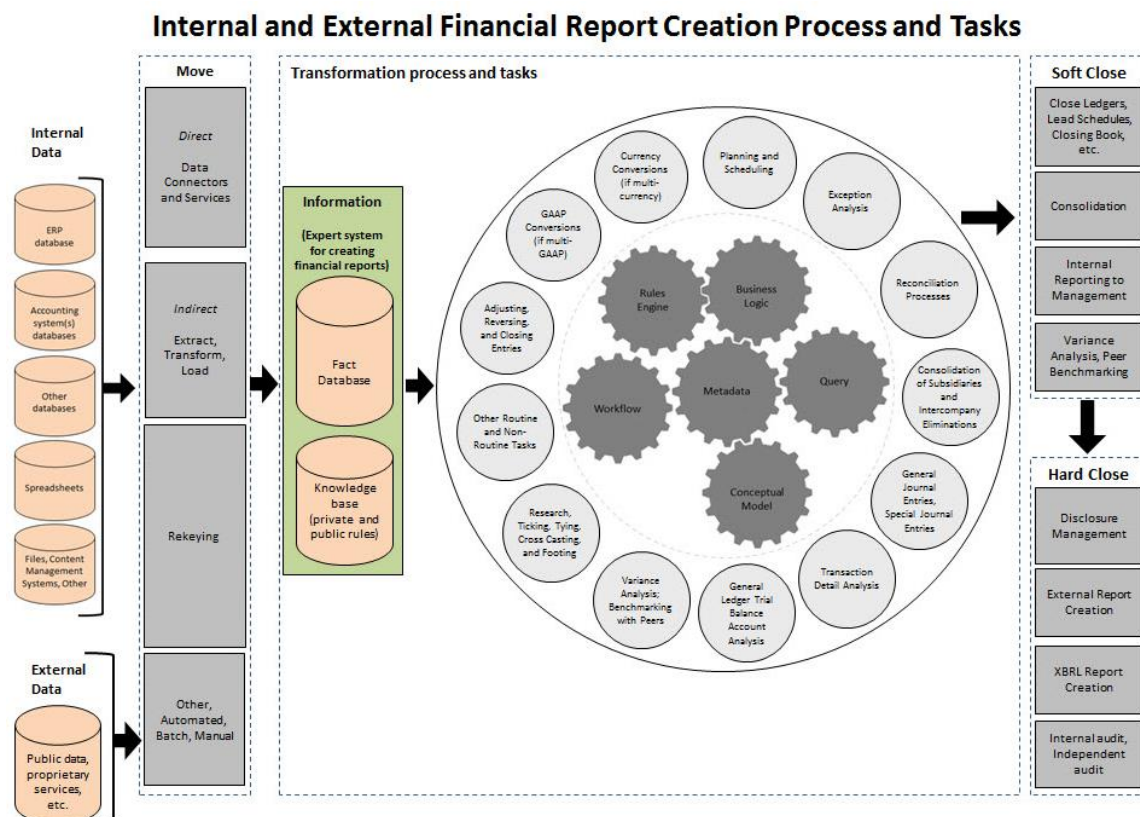
⁸² Deloitte, *Modernizing Finance in Private Companies*, <https://www2.deloitte.com/ca/en/pages/audit/articles/finance-trends.html>

⁸³ Deloitte, *Finance 2025*, <https://www2.deloitte.com/content/dam/Deloitte/us/Documents/finance-transformation/us-ft-crunch-time-V-finance-2025.pdf>

⁸⁴ Deloitte's Vision: *The Finance Factory*, <http://xbrl.squarespace.com/journal/2019/2/20/deloittes-vision-the-finance-factory.html>

⁸⁵ Charles Hoffman, CPA, *Exploring the Notion of The Finance Factory*, <http://xbrl.azurewebsites.net/2019/Library/ExploringNotionOfFinanceFactory.pdf>

⁸⁶ *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>



It is highly unlikely that everything will be automated, but it is very likely that significant automation can be achieved.

1.12. Computational Professional Services

All of these changes and visions can be summarized in the notion of computational professional services⁸⁷.

Some people call this "smart regulation". Others call it "algorithmic regulation". Still others use the term "rules as code". Some use the term "robo cop". Deloitte uses "the finance factory". "Continuous audit" and "continuous reporting" fit into computational professional services. Another term for all this is "finance transformation".

But whatever you call it; many of the repetitive, monotonous, routine, mechanical, boring tasks and processes related to accounting, reporting, auditing, and analysis will be performed by machines which will free up humans to do more interesting work. This transformation is about talent, not technology.

Professional services is about rearranging abstract symbols that represent information and knowledge. Computers can help perform these tasks and processes much like a calculator helps accountants do math.

⁸⁷ Charles Hoffman, CPA, *Computational Professional Services*, http://www.xbrlsite.com/mastering/Part00_Chapter01.A1_ComputationalProfessionalServices.pdf

1.13. *Be Proactive; Get Retraining, Adapt, and Prosper*

While it has been the case that in the past it has been the tendency for most professional accountants to be reactive rather than proactive; and while it is likely the case that professional accountants and auditors will be reactive to this current round of technology improvements; you don't have to be reactive.

Consider being proactive⁸⁸. Based on what I can tell, in my view the transition of the accounting profession will pick up steam over the next three to five years and will be running on all cylinders by that time.

Unfortunately, the education system used to create the next generation of accounting professionals is not outputting these new leaders with the right skills and is unlikely to change any time soon. In fact, I had one accounting student tell me that their professor told them that the skills they are learning in college were obsolete.

However, there are ways to work around the educational system's current deficiencies. Professional accountants need to learn how computers reason. Don't fall for the "learn to code" hysteria⁸⁹.

Besides, this Wired article, *End of Code*⁹⁰, has the sub title "Soon we won't program computers. We'll train them like dogs." That is a very succinct and accurate statement. But I do disagree with one thing Wired is saying. Business professionals will train software using business rules, not code⁹¹.

Computers reason using the rules of logic. For now, what professional accountants should do as part of their formal education is go to the philosophy department of your university and take a course in formal logic. That is the basis of computer reasoning, the rules of logic. Literacy as to the rules of logic and reasoning used by computers, which can be taught in less than 40 hours, will help you understand the capabilities of computers and how to harness those capabilities.

A little harder to work around is the skill and ability to represent information and convey meaning in machine-readable form and make sure you did so correctly. I have distilled the essence of this skill into 15 succinct principles, *XBRL-base Digital Financial Reporting Principles*⁹². Principles help you think about something thoroughly and consistently.

While this ability tends to be above the capabilities of most professional accountants today, the required knowledge will decrease as software functionality improves. If you think about it, software must improve. There is no way the accounting department is going to rely on the information technology department to get financial reports out. That simply will never happen.

Once you have a base of knowledge then the next step is to help software vendors understand the software you really need. If you don't have the correct understanding of what you need because you don't have the right understanding;

⁸⁸ Shelly Palmer, *Automate or Die*, <https://www.shellypalmer.com/2017/04/automate-or-die/>

⁸⁹ Basel Farag, TechCrunch, *Please don't learn to code*, May 2016, <https://techcrunch.com/2016/05/10/please-dont-learn-to-code/>

⁹⁰ Jason Tanz, Wired, *The End of Code*, <https://www.wired.com/2016/05/the-end-of-code/>

⁹¹ Should Accountants Learn to Code?, <http://xbri.squarespace.com/journal/2020/9/6/should-accountants-learn-to-code.html>

⁹² Charles Hoffman, *XBRL-based Digital Financial Reporting Principles*, <http://xbri.squarespace.com/digital-financial-reporting-pr/>

then you will tend to misdirect software vendors and send them down the wrong software creation path. That is what has happened for software used to create XBRL-based financial reporting by public companies. The quality of XBRL-based public company financial reports is not where it needs to be. Because of quality issues, the use of all that XBRL-based information suffers and the advantages of XBRL are hard to see^{93,94}.

But, if you look at all this correctly⁹⁵, then the possibilities are obvious. A financial report is a logical system⁹⁶. The technology will be hidden deep within software applications, exposing professional accountants to things they understand: accounting and logic. Gaining an understanding the capabilities of computers and how to harness those capabilities is essential⁹⁷.

1.14. Quality Digital Financial Reporting is Paramount

One huge mistake that software vendors make is misunderstanding the quality of a financial report. Financial reports cannot contain mistakes. Period. External financial reporting managers have processes, procedures, and practices of today yield extremely high-quality output. The “high-quality” part simply cannot change. Any new technology or innovation that reduces quality will basically never be adopted by the market.

What can change is the manual effort that goes into creating those high-quality financial reports. The role of technology is to enable the appropriate tasks to be automated and managed by machine-based processes which frees up humans to perform tasks that only they can perform because they are simply not automatable because they require judgement, are non-routine, or are otherwise beyond the capabilities of machine-based processes. Professional accountants understand this distinction. Information technology professionals do not understand this distinction because they do not understand financial reporting and accounting deeply enough.

The accounting profession is leading other business domains into the Digital Age⁹⁸. It may not seem like that, but it is true. This did not start in 1999 when the American Institute of Certified Public Accountants (AICPA) started the process of creating what has become the global standard XBRL⁹⁹. The process started in 1929 with the creation of U.S. Generally Accepted Accounting Principles, the semantics of financial reporting. Those semantics were tuned over a period of nearly 90 years. It

⁹³ *Public Company Quality Continues to Improve, Trend is Good*, <http://xbrl.squarespace.com/journal/2017/6/2/public-company-quality-continues-to-improve-trend-is-good.html>

⁹⁴ Understanding Logical, Mechanical, and Mathematical Accounting Relations in XBRL-based Digital Financial Reports, <http://xbrl.squarespace.com/journal/2016/12/15/understanding-logical-mechanical-and-mathematical-accounting.html>

⁹⁵ XBRL-based Digital Financial Reporting Jump Start, <http://xbrl.squarespace.com/journal/2020/8/6/xbrl-based-digital-financial-reporting-jump-start.html>

⁹⁶ *Special Theory of Machine-based Automated Communication of Semantic Information of Financial Statements*, <http://xbrl.squarespace.com/journal/2019/12/30/special-theory-of-machine-based-automated-communication-of-s.html>

⁹⁷ *Artificial Intelligence and Knowledge Engineering in a Nutshell*, <http://xbrl.azurewebsites.net/2019/Library/KnowledgeEngineeringInNutShell.pdf>

⁹⁸ Wikipedia, *The Information Age*, retrieved June 28, 2017, https://en.wikipedia.org/wiki/Information_Age

⁹⁹ AICPA Publishes History of XBRL, <http://xbrl.squarespace.com/journal/2009/8/3/aicpa-publishes-history-of-xbrl.html>

continued with the creation of International Financial Reporting Standards (IFRS) beginning in about 1975. Getting these financial reporting semantics dialed in is the hard part. Representing those semantics in some technical format is easy as compared to creating the semantics in the first place.

Whether any specific government regulator such as the U.S. Securities and Exchange Commission or ESMA makes this technology work appropriately or not is not really that relevant. The technology, if useful, will likely be adopted because it increases productivity. Until it increases productivity, it will not be adopted broadly. The market would be foolish to adopt something that does not work appropriately.

But when the first software vendor does make this technology work, then the world of accountants and auditors will change dramatically.

1.15. Three Key Technologies Building on Medieval Traditions

Accounting, which has existed for 7,000 years¹⁰⁰, even before the creation of formal number systems, is constantly evolving. Accounting is about to go through another significant phase in that evolution process. Professional accountants who adapt will thrive.

There are three specific new technologies that can be leveraged to significantly improve and modernize accounting and financial reporting. Those technologies will transition into the mainstream over the coming years. Those three technologies are¹⁰¹:

- Structured information such as XBRL-based structured digital financial reports also known as machine-readable knowledge graphs
- Knowledge-based systems and other applications of artificial intelligence
- Digital distributed ledgers using blockchain, hashgraph, hyperledger, or other such technologies

Single-entry bookkeeping¹⁰² is how 'everyone' would do accounting. In fact, that is how accounting was done before double-entry bookkeeping was invented¹⁰³.

Double-entry bookkeeping¹⁰⁴ adds an additional important property to the accounting system, that of a clear strategy to identify errors and to remove the errors from the system. Even better, it has a side effect of clearly firewalling errors as either accident or fraud. This then leads to an audit strategy. Double-entry bookkeeping is how professional accountants do accounting.

Double-entry bookkeeping was the invention of medieval merchants and was first documented by the Italian mathematician and Franciscan Friar Luca Pacioli¹⁰⁵.

¹⁰⁰ Wikipedia, History of Accounting, retrieved June 10, 2017, https://en.wikipedia.org/wiki/History_of_accounting

¹⁰¹ Charles Hoffman, *Modernizing Accounting and Auditing: Three Technology Trends*, <http://xbri.squarespace.com/journal/2017/5/27/modernizing-accounting-and-auditing-three-technology-trends.html>

¹⁰² Wikipedia, *Single-entry Bookkeeping System*, retrieved August 30, 2016, https://en.wikipedia.org/wiki/Single-entry_bookkeeping_system

¹⁰³ Essence of Accounting, <http://xbri.squarespace.com/journal/2020/5/12/essence-of-accounting.html>

¹⁰⁴ Wikipedia, *Double-entry Bookkeeping System*, retrieved August 30, 2016, https://en.wikipedia.org/wiki/Double-entry_bookkeeping_system

¹⁰⁵ Wikipedia, *Luca Pacioli*, retrieved August 30, 2016, https://en.wikipedia.org/wiki/Luca_Pacioli

Pacioli documented a good practices approach to double entry bookkeeping that was referred to as the *Venetian Method*¹⁰⁶.

Double-entry bookkeeping is one of the greatest discoveries of commerce and its significance is difficult to overstate. Which came first, double-entry bookkeeping or the enterprise¹⁰⁷? Was it double-entry bookkeeping and what it offered that enable the large enterprise to exist; or did the large enterprise create the need for double-entry bookkeeping?

Accountants think differently than non-accountants, it is part of their training. Non-accountants tend to not realize this and accountants tend to forget or take this for granted. XBRL-based structured digital financial reports, knowledge-based systems and other such applications of artificial intelligence, and machine-readable digital global ledgers will enhance the invention of the medieval merchants.

Accountants, don't under estimate the value of double-entry bookkeeping and the other processes, procedures, and techniques employed to make sure that everything "ticks and ties" and "cross casts and foots". These useful techniques, even perhaps better referred to as ingrained medieval traditions, should make their way into these new modern accounting techniques. These successful and important medieval techniques are still very relevant even in the digital age.

1.16. Financial Reports are Logical Systems

It is worth pointing out that financial reporting schemes have five things in common that can be leveraged in the communication of financial statement information and are unique to financial reporting schemes:

- First, at the foundation of every financial reporting scheme is the double-entry accounting model¹⁰⁸. Simply stated, that model is: **DEBITS = CREDITS**. It is a mathematical model. (If you don't understand this model, this video is helpful¹⁰⁹!)
- Second, building on the double-entry accounting model is the accounting equation¹¹⁰: **Assets = Liabilities + Equity**.
- Third, every financial reporting scheme defines a **core set of interrelated elements of a financial statement** that are fundamentally grounded in some form of the accounting equation. For example, the Financial Accounting Standards Board (FASB) defines these ten elements of a financial statement in SFAC 6¹¹¹; Assets, Liabilities, Equity, Comprehensive Income, Investments by Owners, Distributions to Owners, Revenues, Expenses, Gains, Losses. Then, additional elements are defined based on that core set.

¹⁰⁶ *Be the Accountant who Changed the World*, <http://xbrl.squarespace.com/journal/2021/10/20/be-the-accountant-who-changed-the-world.html>

¹⁰⁷ Ian Grigg, *Triple Entry Accounting, A Very Brief History of Accounting, Which Came First - Double Entry or the Enterprise?*, http://iang.org/papers/triple_entry.html

¹⁰⁸ David P. Ellerman, *The Mathematics of Double Entry Bookkeeping*, Mathematics Magazine, http://www.ellerman.org/wp-content/uploads/2012/12/DEB-Math-Mag.CV_.pdf

¹⁰⁹ YouTube, *2016 Debit Credit Theory Accounting Rap Song from O'Neill High School*, https://www.youtube.com/watch?v=PHanSCcMb_I

¹¹⁰ Wikipedia, *Accounting Equation*, https://en.wikipedia.org/wiki/Accounting_equation

¹¹¹ *ibid*, page 23.

- Fourth, every financial reporting scheme has what is called "articulation". **Articulation** is the notion that the elements of a financial statement are mathematically interrelated and therefore depend on one another and so the four core statements; the balance sheet, the income statement, the changes in equity and the cash flow statement are all mathematically interrelated. Articulation is explained very methodically by the FASB in SFAC 6¹¹².
- Fifth, every financial report has inherent variability that is the result of explicitly allowing intermediate components of a financial report (i.e. subtotals) to be combined in appropriate but perhaps different ways depending on the needs of the reporting economic entity. Again, this is explained in detail within SFAC 6¹¹³.

These five special characteristics of a financial reporting scheme and therefore of a financial statement created using such a financial reporting scheme offers benefits above and beyond the general communication of words and numbers¹¹⁴. For more information see *Essence of Accounting*¹¹⁵.

1.17. Accountants are Knowledge Workers

Knowledge workers such as professional accountants, whose jobs seem secure, are perhaps feeling threatened by technology. This threat by artificial intelligence and other technologies, perhaps, generates fear, uncertainty, doubt and maybe even dread within many different job categories. However, as long as professional accountants are willing and able to adapt to these changes¹¹⁶, most professional accountants should be well-positioned to create more value than ever, augmented by machines that they understand how to work with and leverage.

The tremendous potential of the use of technologies to increase productivity in this Fourth Industrial Revolution to liberate resources offers tremendous opportunity to professional accountants faced with limited resources, more things being put on their plate, increasing information complexity, and expanding backlogs of work. It is highly-likely that new tasks for knowledge workers such as professional accountants will arise, many of which can only be performed by humans; making humans with the right skills even more valuable.

Managers can use these new technologies as a way to increase innovation among those they manage; encouraging their employees to create new ways to use liberated work hours to improve the services they provide to clients. The most forward-thinking managers will see these technologies as an opportunity to reimagine the nature of what and how professional accountants work, increasing the value they provide to their clients.

¹¹² *ibid*, page 21 – 22, "Interrelation of Elements-Articulation"

¹¹³ *ibid*, page 47, paragraph 77.

¹¹⁴ *Special Theory of Machine-based Automated Communication of Semantic Information of Financial Statements*, <http://xbrl.squarespace.com/journal/2019/12/30/special-theory-of-machine-based-automated-communication-of-s.html>

¹¹⁵ Charles Hoffman, CPA, *Essence of Accounting*, http://www.xbrlsite.com/mastering/Part00_Chapter01.D_EssenceOfAccounting.pdf

¹¹⁶ Charles Hoffman, *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>

"I skate to where the puck is going to be, not where it has been." Wayne Gretzky, legendary Canadian hockey star.

Don't skate to where the puck is. Understand where the puck will be and go there.

Keep in the back of your mind that the changes that are occurring are transformational, not incremental. Entire industries will be transformed, accounting, reporting, auditing, and analysis included.

Start your journey by getting the correct map for your journey¹¹⁷.

1.18. Trends in Financial Reporting

Forbes published an article, *3 Important Ways Artificial Intelligence Will Transform Your Business and Turbocharge Success*¹¹⁸, which explains that organizations are already leveraging AI in three common ways:

- Creating more intelligent products;
- Offering a more intelligent service;
- Improving internal business processes

Financial reporting will be different in the fourth industrial revolution¹¹⁹. There seems to be a number of trends that are interacting with one another in the realm of financial reporting. This is a summary of what I see:

- **Machine-based digital reporting:** Machine-based digital financial reporting¹²⁰ will likely prevail over the historically prevalent exchange of paper or e-paper by humans. Both general purpose and special purpose financial reporting will be impacted.
- **Integrated reporting:** Sometimes called "triple-bottom line" or sustainability reporting¹²¹ or ESG¹²² as contrast to simply financial reporting.
- **Push-reporting:** Push reporting¹²³ as contrast to pull-based reporting.
- **Continuous reporting:** Continuous reporting enabled by continuous accounting¹²⁴, as contrast to the historical "batch" oriented mode of reporting.

¹¹⁷ Charles Hoffman, CPA, *Computer Empathy*, <http://xbrlsite.azurewebsites.net/2018/Library/ComputerEmpathy.pdf>

¹¹⁸ Bernard Marr, Forbes, *3 Important Ways Artificial Intelligence Will Transform Your Business and Turbocharge Success*, <https://www.forbes.com/sites/bernardmarr/2020/08/03/3-important-ways-artificial-intelligence-will-transform-your-business-and-turbocharge-success/#d6dea16620fa>

¹¹⁹ *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>

¹²⁰ *Case for XBRL-based Digital Financial Reporting on One Slide*, <http://xbrl.squarespace.com/journal/2019/2/10/case-for-xbrl-based-general-purpose-financial-reporting-on-o.html>

¹²¹ *ESMA Publishes its Strategy on Sustainable Finance*, <http://xbrl.squarespace.com/journal/2020/2/10/esma-publishes-its-strategy-on-sustainable-finance.html>

¹²² Wikipedia, *Environmental, Social, and Corporate Governance*, https://en.wikipedia.org/wiki/Environmental,_social_and_corporate_governance

¹²³ *Push Reporting*, <https://www.push-reporting.com/>

¹²⁴ Wikipedia, *Continuous Accounting*, https://en.wikipedia.org/wiki/Continuous_accounting

- **Continuous auditing:** Continuous auditing¹²⁵ and AI assisted auditing¹²⁶ using things like the dynamic audit solution¹²⁷ as contrast to older audit approaches.
- **Triple-entry accounting:** Triple-entry accounting¹²⁸ leveraging machine-readable digital distributed ledgers as contrast to double-entry accounting which is internally focused.
- **Algorithmic analysis/regulation:** Algorithmic regulation¹²⁹ or "smart regulation"¹³⁰ as contrast to older approaches which tended to be more manual.

Center to all of this is the financial report logical model¹³¹, enabling a new modern approach to financial reporting, compliance, and regulation. Software interacts with that standard model to put things into a report, make sure the report is right, extract information from the report for analysis, etc. Machine-readable metadata glues everything together logically, enabling very significant automation. This graphic¹³² created by the Data Coalition describes smart regulation:

¹²⁵ *Logic's Role in Digital Mirror Worlds Representing Reality*, <http://xbrl.squarespace.com/journal/2018/4/14/logics-role-in-digital-mirror-worlds-representing-reality.html>

¹²⁶ *AI Assisted Audit*, <http://xbrl.squarespace.com/journal/2019/6/12/ai-assisted-audits-are-here.html>

¹²⁷ *Dynamic Audit Solution Initiative*, <http://xbrl.squarespace.com/journal/2019/7/10/dynamic-audit-solution-initiative.html>

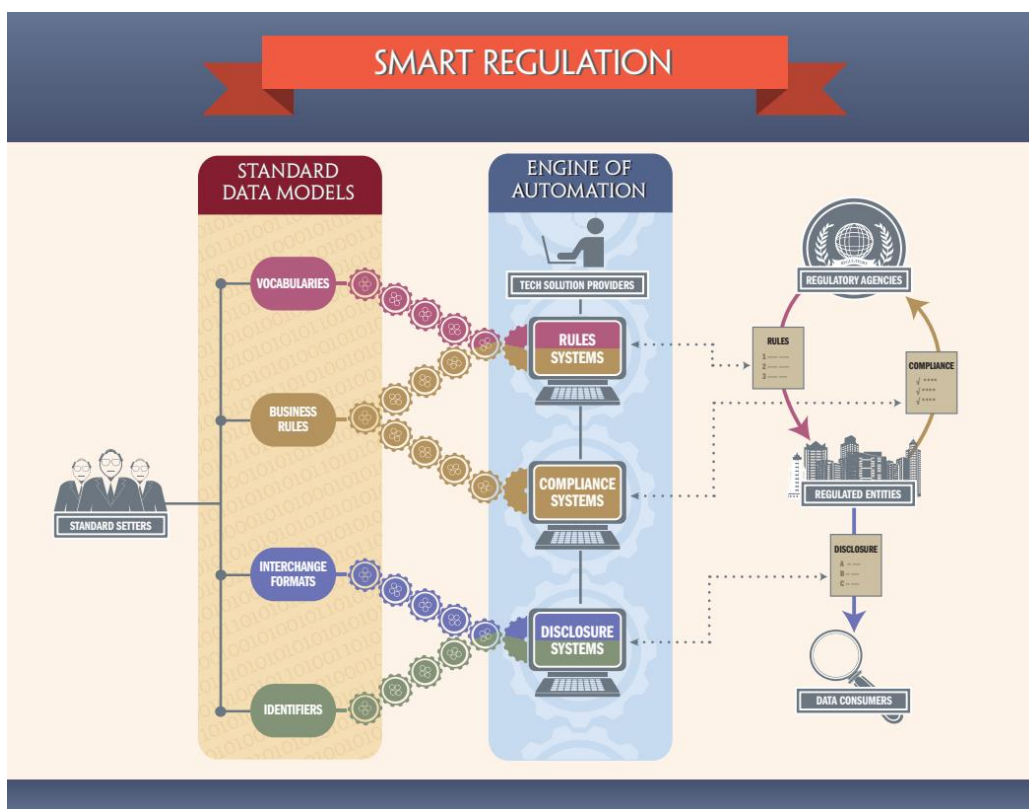
¹²⁸ *Triple-Entry Accounting; Most important invention in 500 years*, <http://xbrl.squarespace.com/journal/2018/5/4/triple-entry-accounting-most-important-invention-in-500-year.html>

¹²⁹ Tim O'Reilly, *Open Data and Algorithmic Regulation*, <https://beyondtransparency.org/chapters/part-5/open-data-and-algorithmic-regulation/>

¹³⁰ *Smart Regulation Graphic Shows Big Picture*, <http://xbrl.squarespace.com/journal/2012/11/12/smart-regulation-graphic-shows-the-big-picture.html>

¹³¹ Charles Hoffman, CPA, *Special Theory of Machine-based Automated Communication of Semantic Information of Financial Statements*, <http://xbrl.squarespace.com/journal/2019/12/30/special-theory-of-machine-based-automated-communication-of-s.html>

¹³² Data Coalition, *Smart Regulation*, <http://www.datacoalition.org/wp-content/uploads/archivedfiles/smart-regulation-rough-draft-infographic.pdf>



Enterprise internal financial reporting systems will work in a similar manner. The notion of computational professional services “packages” all these changes.

1.19. Accounting, Reporting, Auditing, and Analysis in a Digital Environment

Imagine accounting, reporting, auditing, and analysis related tasks and processes that are connected using machine-readable information expressed in a global standard format where one process feeds another process. Imagine that the meaning was created using one shared curated knowledge graph¹³³.

¹³³ Enterprise Knowledge Graph Principles, <http://xbrl.squarespace.com/journal/2020/6/15/enterprise-knowledge-graph-principles.html>



The machine-readable curated knowledge graph is how accounting knowledge is stored, shared, and used by machines that augment the knowledge of humans to perform work.

Imagine accountants curating machine-readable information and being compensated for the machine-readable information they create and pay for the machine-readable information that they consume¹³⁴. Digital economics are governed by different rules than industrial era economics¹³⁵.

1.20. Curated Models, Metadata, Rules

The old industrial economy and the new information economy will not work the same. We all need to grasp the dynamics of information. This will be covered in detail in forthcoming sections of this resource. But we do want to give you the big picture now.

Economist said, "The world's most valuable resource is no longer oil, but data¹³⁶." But others go on to say, "If data is the new oil, then metadata is the new gold.¹³⁷" And then this article points out that data curation is how you weave raw data into

¹³⁴ The Economics of Digital for CPAs, <http://xbrl.squarespace.com/journal/2021/3/22/the-economics-of-digital-for-cpas.html>

¹³⁵ New Rules for a New Economy, <http://xbrl.squarespace.com/journal/2021/4/5/new-rules-for-the-new-economy.html>

¹³⁶ Behold the Power of Metadata, <http://xbrl.squarespace.com/journal/2019/5/23/behold-the-power-of-metadata.html>

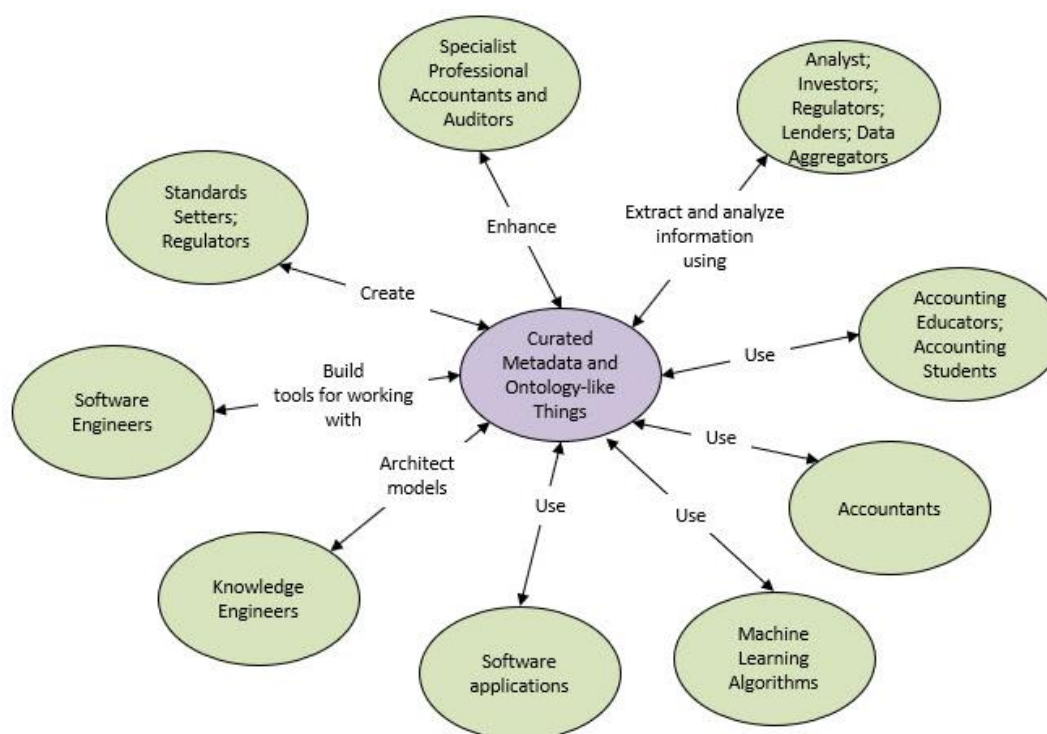
¹³⁷ Eckerson Group, *If Data is the New Oil, Metadata is the New Gold*, <https://www.eckerson.com/articles/if-data-is-the-new-oil-metadata-is-the-new-gold>

"business gold"¹³⁸. This article uses the following metaphor which I paraphrase to explain value:

A barrel of raw crude oil costs \$62 per barrel; there are 42 barrels in a gallon so that is about \$1.47 per gallon. Refined gasoline is about \$3.89 per gallon. High-octane racing fuel goes for about \$25 per gallon.

High-quality curated models and metadata will supercharge artificial intelligence applications, enabling software to augment the skills of an accountant much like a calculator augments one's ability to do math. Storing information in a digital distributed ledger improves transparency and trust.

Now, the metaphor is not perfect. Clearly refinement costs come into play and you cannot get 42 gallons of high-octane racing fuel from 42 gallons of raw crude oil. But, this does help to understand the notion of value and that you can transform something and change value. But hopefully you grasp that metadata is important.



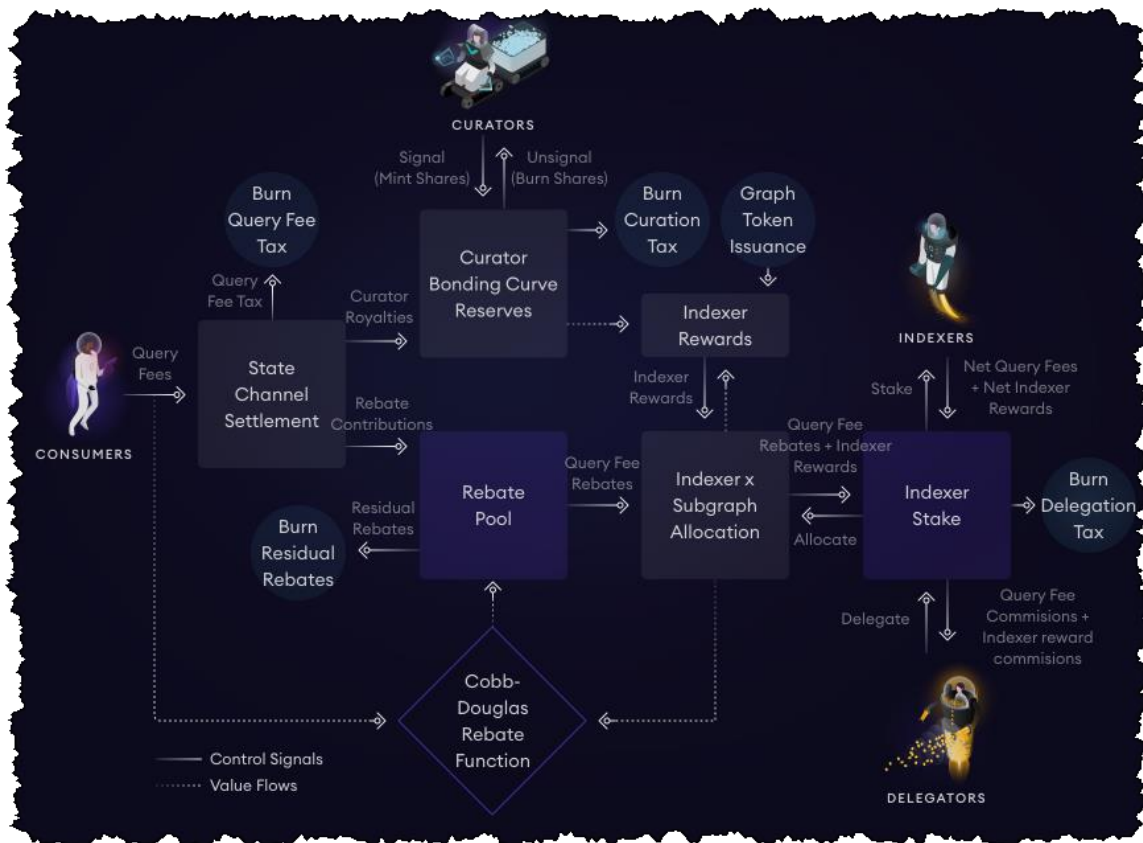
In the new information economics, professional accountants will be both creators and consumers of machine-readable information¹³⁹.

An article by Brandon Ramirez; *The Graph Network In Depth, Part 1*¹⁴⁰; provides a detailed description of how digital economics works. From this you can get an idea of where professional accountants will interact with information in this new information economy.

¹³⁸ D!igitalist Magazine, 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/>

¹³⁹ The Economics of Digital for CPAs, <http://xbri.squarespace.com/journal/2021/3/22/the-economics-of-digital-for-cpas.html>

¹⁴⁰ Brandon Ramirez; The Graph Network In Depth, Part 1, <https://thegraph.com/blog/the-graph-network-in-depth-part-1>



No one knows exactly how everything will unfold. But this is certain: change is underway now.

Auditchain¹⁴¹ is pushing for an entirely new approach for accounting, reporting, auditing, and analysis¹⁴². Will Auditchain, or someone like Auditchain, succeed? Time will reveal the answer to that question.

¹⁴¹ Auditchain Explained in Simple Terms, <http://xbrlsite.azurewebsites.net/2022/library/AuditchainExplained.pdf>

¹⁴² Auditchain Protocol Launches on Testnet, <http://xbrl.squarespace.com/journal/2021/10/21/auditchain-protocol-launches-on-testnet.html>

