Demystifying the Role of Ontologies in XBRL-based Digital Financial Reporting

Understanding the important link between artificial intelligence, XBRL-based structured reports, and machine-readable ontologies

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"AI is taxonomies and ontologies coming to life." *Carol Smith*[1]

Executive summary:

- Artificial intelligence (AI) is poised to have a significant impact on how accounting, reporting, auditing, and analysis tasks are completed[2].
- Machine-readable formats such as XBRL-based structured reports make it possible for machine-based processes to effectively interact and work with financial reports.
- Accounting and financial reporting knowledge stored in the form of machine-readable taxonomies and ontologies will supercharge the capabilities of software applications.
- It is critically important to create high-quality ontologies for financial reporting. What is necessary to create a high-quality ontology is articulated by the ontology spectrum.
- Both the US GAAP and IFRS XBRL taxonomies provide excellent dictionaries. However, neither can considered thesauri or even taxonomies. They are certainly not highly expressive ontologies.
- However, both the US GAAP and IFRS XBRL taxonomies can be supplemented with additional machine-readable information in order to help them achieve a higher level of expressiveness.
- The application for which you are classifying information dictates where you need to be in the ontology spectrum.
- If there is a mismatch between the level that you are using in the ontology spectrum and the application you are creating which will use that ontology; then bad things can happen such as information quality issues, functionality issues, usability issues, and so forth.

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[1] Carol Smith, *AI and Machine Learning Demystified*, slide 12, https://www.slideshare.net/carologic/ai-and-machine-learning-demystified-by-carol-smith-at-midwest-ux-2017/12-AI_and_ML_Demystified_carologic

[2] Jeff Drew, Journal of Accountancy, *What's 'critical' for CPAs to learn in an AI-powered world*, https://www.journalofaccountancy.com/issues/2019/jun/critical-cpa-skills-for-ai-powered-world.html

Computers seem to perform magic. How computers do what they do tends to be a mystery to many people. But computers are really simply machines that follow very specific instructions to get work done. Skilled craftsmen who wield their tools effectively which include providing the appropriate machine-readable instructions enable these machines to perform in mysterious ways and provide the users of these tools with what seems to be magic. If you understand how computers work[3], then you know there is no magic involved.

Engineering is the application of a systematic, disciplined, quantifiable, methodical, rigorous approach to the development, operation, and maintenance of something. When properly engineered; software applications can effectively perform work tasks related to accounting, reporting, auditing, and analysis.

It is machine-readable taxonomies and ontologies that bring artificial intelligence to life within software. Good ontologies can supercharge your software applications. High-quality taxonomies and ontologies for financial reporting are critical to accounting, reporting, auditing, and analysis in a digital environment.

This article was inspired and influenced by an article by Samiul Hasan, *Demystifying the role of ontologies in scientific knowledge management*.[4] What my article tries to do is communicate similar ideas using specific examples from XBRL-based digital financial reporting rather than biology. If you have not done so, I would encourage you to read the document *Computer Empathy*[5] so that you have important background information that will help you incorporate this document into your understanding.

Supercharging Artificial Intelligence

Unless you have been hiding under a rock for the past five years, then it is highly likely that you have heard about the profound impact that artificial intelligence will have on all aspects of society[6]. If you work for a certified public accounting firm the chances are that you have attended meetings where this transformational change was discussed. But in these meetings, were you clear exactly how accounting, reporting, auditing, and analysis would be impacted by artificial intelligence? If this is not clear to you, it is also highly likely that it was not clear to others who attended those same meetings.

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[3] Charles Hoffman, CPA, *Computer Empathy*, http://xbrlsite.azurewebsites.net/2018/Library/ComputerEmpathy.pdf

[4] Samiul Hasan, *Demystifying the role of ontologies in scientific knowledge management*, https://www.linkedin.com/pulse/demystifying-role-ontologies-scientific-knowledge-management-hasan/

[5] Charles Hoffman, CPA, *Computer Empathy*, http://xbrlsite.azurewebsites.net/2018/Library/ComputerEmpathy.pdf

[6] Jeff Drew, Journal of Accountancy, *What's 'critical' for CPAs to learn in an AI-powered world*, https://www.journalofaccountancy.com/issues/2019/jun/critical-cpa-skills-for-ai-powered-world.html

The impact of artificial intelligence will be significant and you and your colleagues should not underestimate the impact of this change. At the same time, you should not let software vendors selling their wares overstate the impact of the changes either.

Key to understanding the impact of artificial intelligence is to understand the power of classification.

Power of Classification

Some people say that data is the new oil. In fact, the Economist declares this in the article, "*The world's most valuable resource is no longer oil, but data.*"[7] Other people say, "*If data is the new oil, then metadata is the new gold*."[8]

If you read this article, *Data Curation: Weaving Raw Data Into Business Gold (Part 1)*[9], the author uses crude oil, refined gasoline, and refined racing fuel as a metaphor to explain the value of metadata.

Metadata is simply data about data. An ontology is basically machine-readable metadata. But, what exactly is metadata and what is an ontology? What is the difference between a taxonomy and an ontology?

We will demystify what an ontology actually is and help you understand why ontologies are important to you and to accounting, reporting, auditing, and analysis in today's digital environment.

"AI is taxonomies and ontologies coming to life.[10]" It was the Greek philosopher Aristotle (384-322 B.C.) that first came up with the idea of classifying plants and animals by type, essentially creating the notion of a hierarchy or taxonomy.

Classification provides three important things. First, you can **describe** the model of something. Second, you can use that description of the model to **verify** an instance of the model of something against that provided description. To the extent that you have machine-readable rules, that verification process can be automated. Third, you **explain** or spell out or tell a software application (software algorithm, AI) knowledge about the *state* of where you are in your *agenda* of tasks necessary to meet some *goal*. To the extent that you have machine-readable rules, software can assist human users of the software in completing the tasks in their

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[7] The Economist, *The world's most valuable resource is no longer oil, but data*, https://www.economist.com/leaders/2017/05/06/the-worlds-most-valuable-resource-is-no-longer-oil-but-data

[8] Julian Ereth, *If data is the new oil, then metadata is the new gold*, https://www.eckerson.com/articles/if-data-is-the-new-oil-metadata-is-the-new-gold

[9] 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

[10] AI is taxonomies and ontologies coming to life, http://xbrl.squarespace.com/journal/2019/5/11/ai-is-taxonomies-and-ontologies-coming-to-life.html

agenda and achieving that goal. That is what is meant by "AI is taxonomies and ontologies coming to life."

If you understand classification[11] and use that understanding to construct appropriate high-quality taxonomies, ontologies, or logical theories you can use those classifications to bring software to life. But consciously understanding what sort of classification system you are creating is important.

Classification Systems

Things in the world are defined by their relations to one another. A classification system is a logical grouping of something based on some similarity or criteria. A classification system is a communications tool. A classification system structures information. A classification system can be informal or formal, more rigorously or less rigorously created, readable and therefore usable by computers, or not.

If you put information into machine-readable form that classification system becomes a knowledge representation model. There tends to be four common categories of classification systems. Although there is not universal agreement as to the definition of each of these classification systems, it is helpful to explain each type of system. Comparing and contrasting the different types of classification systems helps you better understand classifications systems. Classification systems can be categorized as follows:

- **Dictionary**: A dictionary or list is a classification system that tends to provide descriptions without much, or any, structure. Dictionaries or lists simply provide a flat inventory of terms with no relations expressed between the terms.
- **Thesaurus**: A thesaurus is a classification system which is similar to a dictionary of described terms, but adds a bit of structure, indicating that a term might be a “wider” or “narrower” version of some other described term.
- **Taxonomy**: A taxonomy is a classification system which tends to provide descriptions and a limited amount of structure generally in the form of one formal hierarchy into which some list of terms is categorized. Categories are basically formal sets. A taxonomy forms a tree of categories of things with only one relation expressed so terms appear in generally only one location in that hierarchy of categories.
- **Ontology**: An ontology is a classification system which tends to provide descriptions and multiple structures and therefore tends to have more than one hierarchy into which terms are categorized. So an ontology can be thought of as a set of taxonomies. An ontology generally expresses many different types of relations which generally includes traits or qualities of each term. Rather than simply providing one description for formal

[11] Understanding the Power of Classification, http://xbrl.squarespace.com/journal/2019/5/14/understanding-the-power-of-classification.html

relations, an ontology precisely defines the type of relation that exists between two objects. An ontology is less like a tree and more like a graph[12] (network theory). The creator of an ontology essentially describes a model explaining how things in a given ontology are related to one another, the kinds of relationships that exist, the rules of that model.

There are many other types of classification systems. We don't want to confuse you, but it is worth mentioning a handful of others because when you talk about this topic to others, they might use these terms. An *entity relation model*[13] is a type of classification system. A *conceptual model*[14] is a type of classification system. A *logical theory*[15] is a classification system. A *UML model*[16] is a classification system. There are lots of different types of classification systems; there is a spectrum of such classification systems.

Ontology

In simple terms, ontology is about naming parts and processes and grouping those parts and processes together into categories. An ontology is a description of what exists within some field or domain; the parts and the relationship and hierarchy of the parts relative to one another. Why is ontology important? Ontologies help you think about a field or domain. Ontologies help you have precise discussions about challenging questions, to build theories, to construct models, to help you better understand the field or domain represented by the ontology.

Ontologies can be human-readable or they can be machine-readable.

Ontology Spectrum

There are specific and precise differences between a dictionary, a thesaurus, a taxonomy, and an ontology. Knowledge engineering text books refer to these different knowledge classification methods as the *ontology spectrum*. This spectrum is explained in detail by Dr. Leo Obrst in a presentation *The Ontology Spectrum and Semantic Models*[17] and the spectrum is shown graphically by Deborah L. McGuinness, *Ontologies for the Modern Age*, Slide 4[18].

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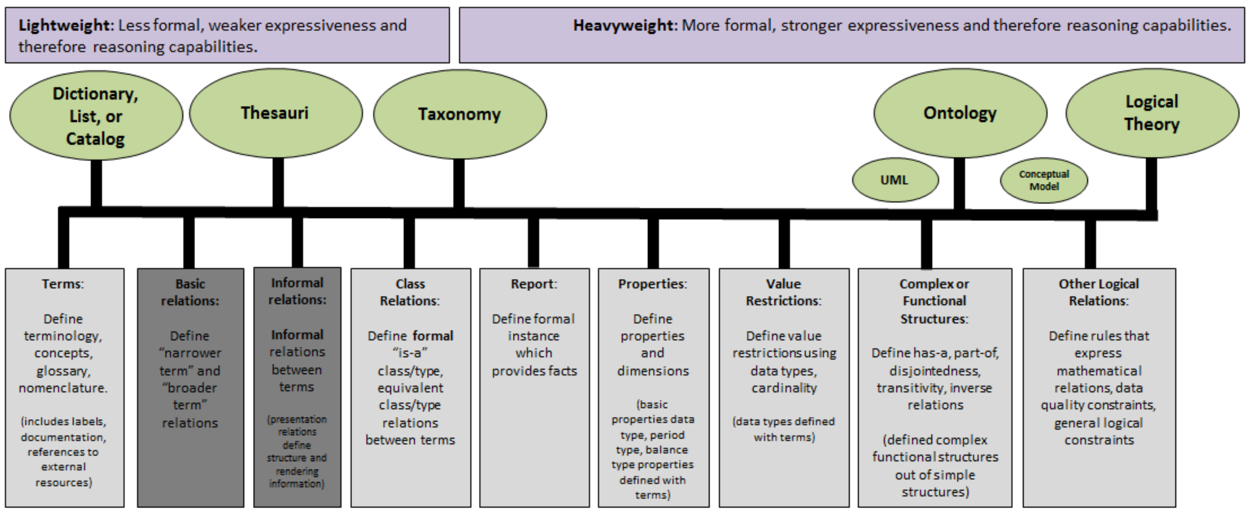
[12] Wikipedia, *Network Theory*, retrieved February 24, 2016; https://en.wikipedia.org/wiki/Network_theory
[13] Wikipedia, Entity-relationship Model, https://en.wikipedia.org/wiki/Entity%E2%80%93relationship_model
[14] Wikipedia, Conceptual Model, https://en.wikipedia.org/wiki/Conceptual_model_(computer_science)
[15] Wikipedia, Theory, https://en.wikipedia.org/wiki/Theory_(mathematical_logic)
[16] Wikipedia, Unified Modeling Language, https://en.wikipedia.org/wiki/Unified_Modeling_Language
[17] Dr. Leo Obrst, *The Ontology Spectrum and Semantic Models*, https://slideplayer.com/slide/697642/
[18] Deborah L. McGuinness, *Ontologies for the Modern Age*, https://www.slideshare.net/deborahmcguinness/ontologies-for-the-modern-age-mcguinness-keynote-at-iswc-2017

Obrst, McGunness, and others tend to use different terms which tends to be confusing. I took information from both of those sources and other information and synthesized the ontology spectrum into the following graphic that I created:



Given this ontology spectrum, I then tried to precisely understand the differences between what is contained in a dictionary, a thesaurus, a taxonomy, an ontology, and a logical theory. This information helps you understand the common components of an ontology.

Common Components of an Ontology

The best description of the common components of an ontology comes from Shawn Riley's article, *Good Old-Fashioned AI Expert Systems*[19]. In that article, the section "*Components of an Ontology*", Shawn provided a good list of components. I modified the list in order to make the ontology spectrum and the list of components as consistent as possible and I also tried to make the definitions as precise and useful as possible. This is what I came up with:

- **Simple terms**: Defines simple terms that matter from the domain being described by the ontology. Defines the terminology, concepts, nomenclature of the domain represented by the ontology that lets you reliably identify and refer to an object or entity in the ontology. Every simple term is the member of at least one but perhaps many classes. Defining terms might also involve providing labels for the terms, documentation that provides human readable definitions of the terms, and human readable or machine readable references to other resources that provides information about the terms. (ISO 1087 defines the term "definition" as the "representation of a concept by a descriptive statement which serves to differentiate it from related concepts.")

[19] Shawn Riley, *Good Old-Fashioned AI Expert Systems*, https://www.linkedin.com/pulse/good-old-fashioned-ai-expert-systems-shawn-riley/

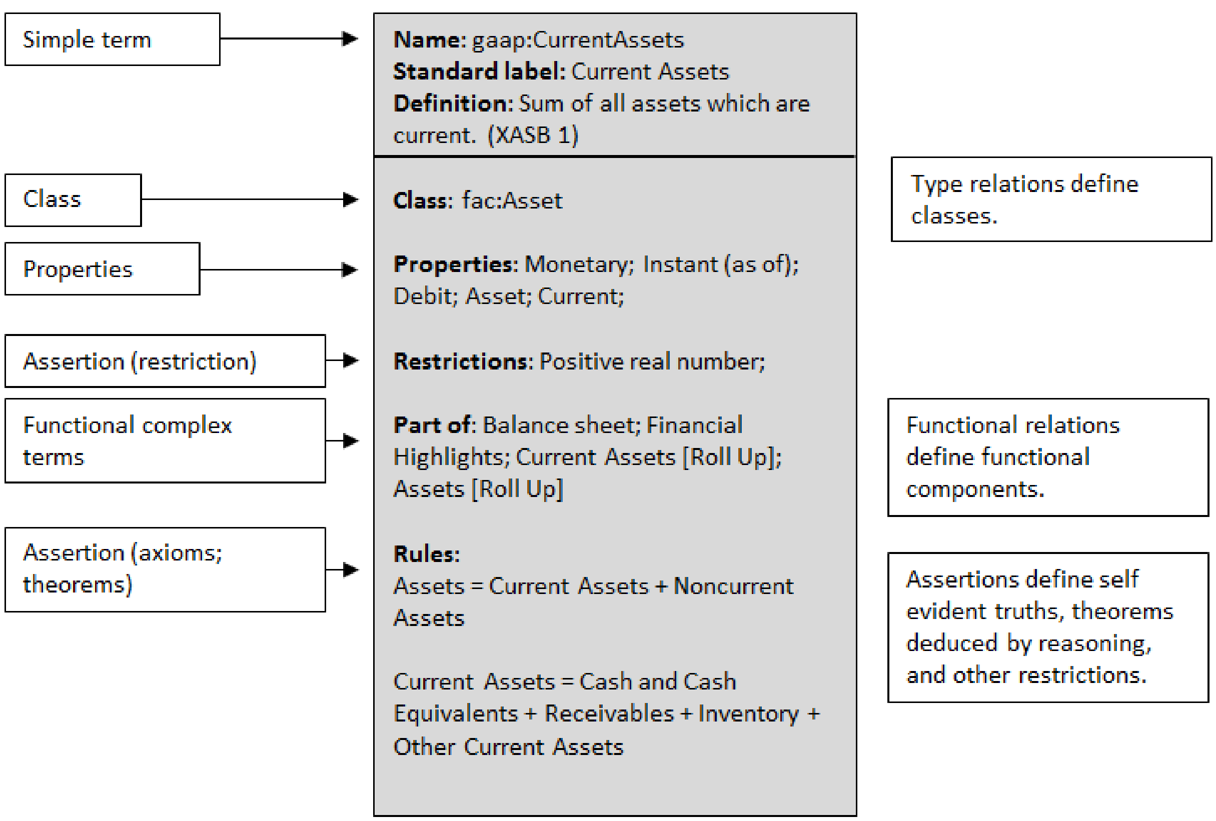
- **Classes**: Defines types or classes of objects or entities that matter and/or kinds of things that allows terms to be put into sets or groups or collections. A superclass is a type of class.
- **Properties**: Defines the qualities, attributes, aspects, features, characteristics, parameters that matter. A property is a type of relation really. (A dimension is a type of property; but not all properties considered dimensions.)
- **Type relations**: Defines the important ways that terms (objects, individuals or facts) or classes of terms are related to one another. These are generally "is-a"[20] or "type-of" or "class-subclass"[21,22] type relations. Used to create functional terms.
- **Functional component terms**: Defines the complex structures that are made up of the combination of simple terms and/or other functional component structures of the ontology that matter. These are also really relations.
- **Functional relations**: Defines functional component. These relations are defined using "has-part"[23] and "part-of" type relations. This includes parts and the wholes they form[24]. These functional terms and the complex structures they form make it easier to work with groups of individual simple terms in assertions and events. Functional component terms can have classes.
- **Assertions**: Describe the set of *restrictions*, *rules*, and *axioms* that matter which describe important aspects of the model or domain. An assertion or logical assertion is a type of relation.
  - **Restrictions**: A type of assertion that formally state descriptions of what must be true in order for some assertion to be accepted as input. Restrictions are ways of constraining class membership. A constraint is a type of a restriction. A value restriction is a type of restriction.
  - **Rules (a.k.a. theorems)**: A type of assertion that is represented in the form of an if-then (antecedent-consequent) statement or sentence that describe the logical inferences that can be drawn from an assertion in a particular form. (non-universal, only true for sets of terms) (Are rules theorems? Theorems are deductions which can be proven by constructing a chain of reasoning by applying axioms in the form of IF…THEN statements.)
  - **Axioms**: A type of assertion in a logical form that together comprise the overall theory that the ontology describes in its domain of application[25]. Axioms

[20] Wikipedia, *Is-a*, https://en.wikipedia.org/wiki/Is-a
[21] Wikipedia, *Class*, https://en.wikipedia.org/wiki/Class_(set_theory)
[22] Wikipedia, *Subclass*, https://en.wikipedia.org/wiki/Subclass_(set_theory)
[23] Wikipedia, *Meronymy*, https://en.wikipedia.org/wiki/Meronymy
[24] Wikipedia, *Merelogy*, https://en.wikipedia.org/wiki/Mereology
[25] W3C, *OWL 2 Web Ontology Language Quick Reference Guide (Second Edition)*, http://www.w3.org/TR/2012/REC-owl2-quick-reference-20121211/#Axioms

describe intrinsic self-evident logical principles that no one would argue with and serve as a starting point for deducing other information. This includes mathematical relations. (This definition differs from that of "axioms" in generative grammar and formal logic. In these disciplines, axioms include only statements asserted as a priori knowledge[26]. As used here, "axioms" also include the theory derived from axiomatic statements.)

- **Events**: Describes the changing of a property, relation, and therefore perhaps a change in an assertion that matter.
- **Instance**: An instance, also sometimes called an individual, represents an object or set of objects that exist in the ontology. Instances are created using the information from the ontology to create an instantiation of the model prescribed by the knowledge in the ontology. (In XBRL, an instance is the facts and also the information model description provided that describes the facts.)

The following provides an example of knowledge provided about a simple term “gaap:CurrentAssets” that is a type of “fac:Asset”, has certain specific properties, is part of specific functional components, and conforms to a number of assertions[27]:



[26] Wikipedia, *A priori and a posteriori*, https://en.wikipedia.org/wiki/A_priori_and_a_posteriori

[27] Example from US GAAP Concepts, http://xbrlsite.azurewebsites.net/2019/Prototype/references/us-gaap/Element-863.html

All the simple terms, classes, properties, type relations, functional component terms, assertions are knowledge (truths) upon which all other knowledge must rest and from which all other knowledge is built up. These formal logical expressions are used in a deduction to yield further results. This forms a complete system of knowledge which instances (or facts) can be used to show that all of its claims can be logically derived.

Ontologies are Rules; Rules Prevent Anarchy

The Merriam-Webster dictionary defines anarchy[28] as “a situation of confusion and wild behavior in which the people in a country, group, organization, etc., are not controlled by rules or laws.”

Essentially, an ontology is a formal set of specific and precise rules. These rules prevent information anarchy. As the term rule is used here we mean assertion; and therefore we mean restriction, rule, or axiom.

Rules enable a knowledge bearer to *describe* information they are providing and *verify* that the information provided is consistent with that description. Rules *explain* knowledge to software applications so that software can perform tasks for the users of the software. Rules enable a knowledge receiver to understand the description of information provided by the knowledge bearer and likewise verify that the information is consistent with that description.

Rules guide, control, suggest, or influence behavior. Rules cause things to happen, prevent things from happening, or suggest that it might be a good idea if something did or did not happen. Rules help shape judgment, help make decisions, help evaluate, help shape behavior, and help reach conclusions.

Rules arise from the best practices of knowledgeable business professionals. A rule describes, defines, guides, controls, suggests, explains, influences or otherwise constrains some aspect of knowledge or structure within some problem domain.

Don't make the mistake of thinking that rules are completely inflexible and that you cannot break rules. Sure, maybe there are some rules that can never be broken. Maybe there are some rules that you can break. It helps to think of breaking rules as penalties in a football game. The point is that the guidance, control, suggestions, and influence offered by rules are a choice of business professionals. The meaning of a rule is separate from the level of enforcement someone might apply to the rule.

A rule states a fact about the world (declarative rule). A rule can provide instructions (production rule). Rules are metadata.

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[28] Anarchy definition, Merriam-Webster, http://www.merriam-webster.com/dictionary/anarchy

Good Old Fashioned Expert System for Constructing Financial Reports

Why go through the trouble of creating an ontology? While it is true that XBRL-based financial reports are machine-readable and analysis of reported information can be easier when using such structured information; but if:

1. Reported financial information is of low quality, leveraging the structured information to improve the efficiency of analysis will be impossible.
2. If you don't have an ontology to assist in the process of analyzing information; then each person attempting to analyze reported information will need to construct their own metadata (ontology) for performing this task.

Creating high-quality reported information is paramount for having usable XBRL-based structured reports. Expert systems for constructing XBRL-based financial reports driven by ontologies are the only way to realize the potential of such XBRL-based structured financial reports. Using Lean Six Sigma[29] strategies, techniques, and philosophies can help you construct high-quality systems.

Assignment: Creating an Ontology

Next, we help you understand ontologies by walking you through the process of creating an ontology. This will also solidify in your mind the difference between a dictionary, a thesaurus, a taxonomy, and an ontology.

We will use a real reporting scheme, *International Public Sector Accounting Standards*[30], to create our ontology to make this as real life as possible. However, we will only create a core portion of the full reporting scheme ontology, just enough to help you understand the important ideas we are trying to convey in this document. For more information about this project, please see the blog post related to creating the IPSAS prototype taxonomy[31]. This process leverages the *Method of Implementing a Standard Digital Financial Report Using the XBRL Syntax*[32]. That can help you understand important details.

Your assignment is to pretend that you want to create an ontology for *International Public Sector Accounting Standards*. All of the accounting standards are freely available online. To get

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[29] *Comprehensive Introduction to Lean Six Sigma for Accountants*, http://xbrlsite.azurewebsites.net/2017/IntelligentDigitalFinancialReporting/Part01_Chapter02.72_LeanSixSigma.pdf

[30] IFAC, *International Public Sector Accounting Standards*, http://www.ifac.org/publications-resources/2018-handbook-international-public-sector-accounting-pronouncements

[31] *International Public Sector Accounting Standards XBRL Taxonomy Prototype Project*, http://xbrl.squarespace.com/journal/2019/1/16/international-public-sector-accounting-standards-xbrl-taxono.html

[32] *Method of Implementing a Standard Digital Financial Report Using the XBRL Syntax*, http://xbrl.squarespace.com/journal/2019/1/11/method-of-implementing-a-standard-digital-financial-report-u.html

the most out of this assignment, actually obtain tools and create the ontology. This section provides a brief overview of the tasks you need to perform. You can look at the answers[33] if you get stuck on any specific task.

It is expected that the reader is a professional accountant that understands financial reporting concepts and ideas. Note that steps are mentioned could be performed in a different order than the order that I have used.

Domain Information Source

Step 1 is to read the conceptual framework[34] for IPSAS and all of the standards[35] so that you are familiar with the domain for which you are creating an XBRL taxonomy or ontology. We will assume that you are familiar with this reporting scheme. You can become familiar to the extent that you feel you want to understand.

Step 2 is to break the task into bite-sized pieces. You can break up the entire set of IPSAS standards into "Topics". Each topic can be broken down into a set of individual "Disclosures" that are required per each topic.

Here are the completed topics[36]:

IPSAS Topics

IPSASB | Handbook of Pronouncements

Taxonomy scheme (elements) | Presentation relations | Definition relations | Labels | References | XML Infoset | ZIP (Download)

Line	Label	Type	Reference	Name
1	Topics	Network		http://xbrlsite.azurewebsites.net/2019/ipsas/topics/role/Topics
2	**Components of Financial Report**	**Heading**	IPSAS 1 21	topics:ComponentsOfFinancialReport
3	**Face Statements**	**Heading**	IPSAS 1 21	topics:FaceStatements
4	Statement of Financial Position	Topic	IPSAS 1 21 a	topics:StatementOfFinancialPosition
5	Statement of Financial Performance	Topic	IPSAS 1 21 b	topics:StatementOfFinancialPerformance
6	Statement of Changes in Net Assets/Equity	Topic	IPSAS 1 21 c	topics:StatementOfChangesInNetAssetsEquity
7	Cash Flow Statement	Topic	IPSAS 1 21 d	topics:CashFlowStatement
8	**Nature of Economic Entity**	**Heading**	IPSAS 1 150 b	topics:NatureOfEconomicEntity
9	**Basis of Presentation**	**Heading**	IPSAS 1 127 a	topics:BasisOfPresentation
10	**Summary of Significant Accounting Policies**	**Heading**	IPSAS 1 21 f	topics:SummaryOfSignificantAccountingPolicies
11	**Supporting Information for Items Presented in Face Statements**	**Heading**	IPSAS 1 129 c	topics:SupportingInformationForItemsPresentedInFaceStatements
12	Property, Plant and Equipment	Topic	IPSAS 1 88 a	topics:PropertyPlantAndEquipment
13	Investment Property	Topic	IPSAS 1 88 b	topics:InvestmentProperty
14	Intangible Assets	Topic	IPSAS 1 88 c	topics:IntangibleAssets
15	Financial Assets	Topic	IPSAS 1 88 d	topics:FinancialAssets
16	Investments Accountinged for Using Equity Method	Topic	IPSAS 1 88 e	topics:InvestmentsAccountedForUsingEquityMethod
17	Inventories	Topic	IPSAS 1 88 f	topics:Inventories
18	Recoveries from Nonexchange Transactions	Topic	IPSAS 1 88 g	topics:RecoveriesFromNonexchangeTransactions
19	Receivables from Exchange Transactions	Topic	IPSAS 1 88 h	topics:ReceivablesFromExchangeTransactions
20	Cash and Cash Equivalents	Topic	IPSAS 1 88 I	topics:CashAndCashEquivalents
21	Taxes and Transfers Payable	Topic	IPSAS 1 88 j	topics:TaxesAndTransfersPayable
22	Payables Under Exchange Transactions	Topic	IPSAS 1 88 k	topics:PayablesUnderExchangeTransactions

Here is the set of disclosures organized within a topic[37]:

[33] *Method Details*, http://xbrlsite.azurewebsites.net/2019/Library/MethodDetailsOnly.pdf

[34] IFAC, *Conceptual Framework for General Purpose Financial Reporting by Public Sector Entities*, https://www.ifac.org/publications-resources/conceptual-framework-general-purpose-financial-reporting-public-sector-enti-8

[35] IPSAS Pronouncements, http://www.ifac.org/publications-resources/2018-handbook-international-public-sector-accounting-pronouncements

[36] IPSAS Topics, http://xbrlsite.azurewebsites.net/2019/Prototype/ipsas/Metadata/topics_ModelStructure.html

IPSAS Disclosures (with topics)

IPSASB | Handbook of Pronouncements

Taxonomy scheme (elements) | Presentation relations (disclosures and topics) | Definition relations (disclosures and topics) | Labels | References | XML Infoset | ZIP (Download)

Line	Label	Type	Reference	Name
1	Disclosures	Network		http://xbrlsite.azurewebsites.net/2019/ipsas/disclosures/role/Disclosures
2	Components of Financial Report	Heading	IPSAS 1 21	topics:ComponentsOfFinancialReport
3	Face Statements	Heading	IPSAS 1 21	topics:FaceStatements
4	Statement of Financial Position	Topic	IPSAS 1 21 a	topics:StatementOfFinancialPosition
5	**Net Assets/Equity Subclassifications**	**Disclosure**	IPSAS 1 88	disclosures:NetAssetsEquitySubclassifications
6	**Statement of Financial Position, Classified**	**Disclosure**	IPSAS 1 88	disclosures:StatementOfFinancialPositionClassified
7	**Statement of Financial Position, Classified (Alternative)**	**Disclosure**	IPSAS 1 88	disclosures:StatementOfFinancialPositionClassifiedAlternative
8	**Statement of Financial Position, Liquidity**	**Disclosure**	IPSAS 1 88	disclosures:StatementOfFinancialPositionLiquidity
9	Statement of Financial Performance	Topic	IPSAS 1 21 b	topics:StatementOfFinancialPerformance
10	**Statement of Financial Performance, by Function**	**Disclosure**	IPSAS 1 102	disclosures:StatementOfFinancialPerformanceByFunction
11	**Statement of Financial Performance, by Nature**	**Disclosure**	IPSAS 1 102	disclosures:StatementOfFinancialPerformanceByNature
12	**Statement of Financial Performance, Comparison of Budget and Actual Amounts**	**Disclosure**	IPSAS 1 21 e	disclosures:StatementOfFinancialPerformanceComparisonOfBudgetAndActual
13	Statement of Changes in Net Assets/Equity	Topic	IPSAS 1 21 c	topics:StatementOfChangesInNetAssetsEquity
14	**Prior Period Adjustment**	**Disclosure**	IPSAS 1 124	disclosures:PriorPeriodAdjustment
15	**Statement of Changes in Net Assets/Equity**	**Disclosure**	IPSAS 1 118	disclosures:StatementOfChangesInNetAssetsEquity
16	Cash Flow Statement	Topic	IPSAS 1 21 d	topics:CashFlowStatement
17	**Cash Flow Statement, Direct Method**	**Disclosure**	IPSAS 2 18	disclosures:CashFlowStatementDirectMethod
18	Nature of Economic Entity	Heading	IPSAS 1 150 b	topics:NatureOfEconomicEntity
19	**Nature of Entity**	**Disclosure**	IPSAS 1 150	disclosures:NatureOfEntity
20	Basis of Presentation	Heading	IPSAS 1 127 a	topics:BasisOfPresentation
21	**Basis of Presentation**	**Disclosure**	IPSAS 1 132 a	disclosures:BasisOfPresentation
22	Summary of Significant Accounting Policies	Heading	IPSAS 1 21 f	topics:SummaryOfSignificantAccountingPolicies
23	**Significant Accounting Policies**	**Disclosure**	IPSAS 1 132	disclosures:SignificantAccountingPolicies
24	Supporting Information for Items Presented in Face Statements	Heading	IPSAS 1 129 c	topics:SupportingInformationForItemsPresentedInFaceStatements
25	Property, Plant and Equipment	Topic	IPSAS 1 88 a	topics:PropertyPlantAndEquipment
26	**Property, Plant, and Equipment Estimated Useful Lives By Subclassification**	**Disclosure**	IPSAS 17 88 c	disclosures:PropertyPlantAndEquipmentEstimatedUsefulLivesBySubclassification
27	**Property, Plant, and Equipment, Net Reconcilisations**	**Disclosure**	IPSAS 17 88 e	disclosures:PropertyPlantAndEquipmentNetReconciliations

So, by creating the topics for the entire reporting scheme and the disclosures for each topic; the task has been broken down into many smaller tasks.

Defining Terms

The next step is to select one of the disclosures from one of the topics and create the terms necessary for that disclosure. Here is an example from one of the IPSAS disclosures:

Label	Report Element Class	Period	Balance	Name
Property, Plant and Equipment Components [Table]	[Table]			ipsas:PropertyPlantEquipmentComponentsTable
Legal Entity [Axis]	[Axis]			frm:LegalEntityAxis
Consolidated Entity [Member]	[Member]			frm:ConsolidatedEntityMember
Report Date [Axis]	[Axis]			frm:ReportDateAxis
Reported as of March 18, 2020 [Member]	[Member]			company:ReportedAsOfMarch182020Member
Reporting Scenario [Axis]	[Axis]			frm:ReportingScenarioAxis
Actual [Member]	[Member]			frm:ActualMember
Property, Plant and Equipment Components [Line Items]	[LineItems]			ipsas:PropertyPlantEquipmentComponentsLineItems
Property, Plant, and Equipment, Net, Components [Roll Up]	[Abstract]			ipsas:PropertyPlantAndEquipmentNetComponentsRollUp
Land	[Concept] Monetary	As Of	Debit	ipsas:Land
Buildings, Net	[Concept] Monetary	As Of	Debit	ipsas:BuildingsNet
Furniture and Fixtures, Net	[Concept] Monetary	As Of	Debit	ipsas:FurnitureAndFixturesNet
Machinery, Net	[Concept] Monetary	As Of	Debit	ipsas:MachineryNet
Property, Plant and Equipment, Net	[Concept] Monetary	As Of	Debit	ipsas:PropertyPlantAndEquipmentNet

Note that when terms are defined, certain properties and other constraints are created.

37 IPSAS Disclosures, http://xbrlsite.azurewebsites.net/2019/Prototype/ipsas/Metadata/disclosures_ModelStructure.html

Defining Classes

The next step is to formally define classes and subclasses[38]. As an example, below you see that *Current Assets* has a subclass *Cash and Cash Equivalents* which has a subclass *Cash on Hand and Balances with Banks*.

-	Arcrole	Order
Definition View		
BalanceSheetClassifiedSubclassifications (IPSAS)		
Current Assets		0
Cash and Cash Equivalents	http://xbrlsite.azurewebsites.net/2016/conceptual-model/arcrole/class-subClass	1
Cash on Hand and Balances with Banks	http://xbrlsite.azurewebsites.net/2016/conceptual-model/arcrole/class-subClass	25
Short-Term Investments	http://xbrlsite.azurewebsites.net/2016/conceptual-model/arcrole/class-subClass	26
Receivables, Net, Current	http://xbrlsite.azurewebsites.net/2016/conceptual-model/arcrole/class-subClass	2
Inventory	http://xbrlsite.azurewebsites.net/2016/conceptual-model/arcrole/class-subClass	3
Prepaid Expenses	http://xbrlsite.azurewebsites.net/2016/conceptual-model/arcrole/class-subClass	4
Investments, at Cost	http://xbrlsite.azurewebsites.net/2016/conceptual-model/arcrole/class-subClass	5
Other Current Assets	http://xbrlsite.azurewebsites.net/2016/conceptual-model/arcrole/class-subClass	6
Current Liabilities		0
Equity		0
Noncurrent Assets		0
Noncurrent Liabilities		0

Defining Properties

Properties are generally defined when a term is defined, a class is defined, or a relationship is defined, or a rule is defined. Below you see an example of defining properties. For example, Land is a concept that has a data type of monetary, a period of As Of, and a balance of Debit.

Label	Report Element Class	Period	Balance	Name
Property, Plant and Equipment Components [Table]	[Table]			ipsas:PropertyPlantEquipmentComponentsTable
Legal Entity [Axis]	[Axis]			frm:LegalEntityAxis
Consolidated Entity [Member]	[Member]			frm:ConsolidatedEntityMember
Report Date [Axis]	[Axis]			frm:ReportDateAxis
Reported as of March 18, 2020 [Member]	[Member]			company:ReportedAsOfMarch182020Member
Reporting Scenario [Axis]	[Axis]			frm:ReportingScenarioAxis
Actual [Member]	[Member]			frm:ActualMember
Property, Plant and Equipment Components [Line Items]	[LineItems]			ipsas:PropertyPlantEquipmentComponentsLineItems
Property, Plant, and Equipment, Net, Components [Roll Up]	[Abstract]			ipsas:PropertyPlantAndEquipmentNetComponentsRollUp
Land	[Concept] Monetary	As Of	Debit	ipsas:Land
Buildings, Net	[Concept] Monetary	As Of	Debit	ipsas:BuildingsNet
Furniture and Fixtures, Net	[Concept] Monetary	As Of	Debit	ipsas:FurnitureAndFixturesNet
Machinery, Net	[Concept] Monetary	As Of	Debit	ipsas:MachineryNet
Property, Plant and Equipment, Net	[Concept] Monetary	As Of	Debit	ipsas:PropertyPlantAndEquipmentNet

Defining Type Relations

Once the actual classes and subclasses are defined, the relations between a class and its subclasses can be created. For example,

[38] IPSAS Classes and Subclasses, http://xbrlsite.azurewebsites.net/2016/conceptual-model/reporting-scheme/ipsas/classes/classes-ipsas-BalanceSheetClassifiedSubclassifications-rules-def.xml

-	Arcrole	Order
Definition View		
BalanceSheetClassifiedSubclassifications (IPSAS)		
Current Assets		0
Cash and Cash Equivalents	http://xbrlsite.azurewebsites.net/2016/conceptual-model/arcrole/class-subClass	1
Cash on Hand and Balances with Banks	http://xbrlsite.azurewebsites.net/2016/conceptual-model/arcrole/class-subClass	25
Short-Term Investments	http://xbrlsite.azurewebsites.net/2016/conceptual-model/arcrole/class-subClass	26
Receivables, Net, Current	http://xbrlsite.azurewebsites.net/2016/conceptual-model/arcrole/class-subClass	2
Inventory	http://xbrlsite.azurewebsites.net/2016/conceptual-model/arcrole/class-subClass	3
Prepaid Expenses	http://xbrlsite.azurewebsites.net/2016/conceptual-model/arcrole/class-subClass	4
Investments, at Cost	http://xbrlsite.azurewebsites.net/2016/conceptual-model/arcrole/class-subClass	5
Other Current Assets	http://xbrlsite.azurewebsites.net/2016/conceptual-model/arcrole/class-subClass	6
Current Liabilities		0
Equity		0
Noncurrent Assets		0
Noncurrent Liabilities		0

Defining Functional Terms

Functional terms are sets of simple terms or other complex terms that have been defined that work together to create some generally higher level object with which a user can interact. For example, below you see a rendering object that is comprised of information model definition information, instances of facts that have been reported, information that describes a roll up, and other such information to form the human readable rendering that you see:

Component: (Network and Table)	
Network	1110 - Statement - **Statement of Financial Position, Classified**
Table	Statement of Financial Position, Classified [Table]

Reporting Entity [Axis]	1234567890 http://regulator.gov/id
Reporting Scenario [Axis]	Actual [Member]
Report Date [Axis]	Reported as of March 18, 2020 [Member]
Legal Entity [Axis]	Consolidated Entity [Member]
Unit [Axis]	USD

	Period [Axis]	
Statement of Financial Position, Classified [Line Items]	2020-12-31	2019-12-31
Assets [Roll Up]		
Current Assets [Roll Up]		
Cash and Cash Equivalents	1,000 [1]	1,000
Receivables, Net, Current	1,000 [1]	1,000
Inventory	1,000	1,000
Prepaid Expenses	500	500
Investments, at Cost	500	500
Other Current Assets	1,000	1,000
Current Assets, Total	5,000	5,000
Noncurrent Assets [Roll Up]		
Property, Plant, and Equipment, Net, Total	4,000	4,000
Investment in Affiliates	0	0
Receivables, Net, Noncurrent	0	0
Other Noncurrent Assets	3,000	1,000
Noncurrent Assets, Total	7,000	5,000
Assets, Total	12,000	10,000

Defining Assertions

Assertions are defined which could be a rule (if…then statement), a restriction, or an axiom. Here you see the definition of the roll up relations of the facts that you see in the rendering just above.

Label	Report Element Class	Balance	Weight	Name
Statement of Financial Position, Classified [Table]	[Table]		0	ipsas:StatementOfFinancialPositionClassifiedTable
Assets, Total	[Concept] Monetary	Debit	0	ipsas:Assets
Current Assets, Total	[Concept] Monetary	Debit	1	ipsas:CurrentAssets
Cash and Cash Equivalents	[Concept] Monetary	Debit	1	ipsas:CashAndCashEquivalents
Receivables, Net, Current	[Concept] Monetary	Debit	1	ipsas:ReceivablesNetCurrent
Inventory	[Concept] Monetary	Debit	1	ipsas:Inventory
Prepaid Expenses	[Concept] Monetary	Debit	1	ipsas:PrepaidExpenses
Investments, at Cost	[Concept] Monetary	Debit	1	ipsas:InvestmentsAtCost
Other Current Assets	[Concept] Monetary	Debit	1	ipsas:OtherCurrentAssets
Noncurrent Assets, Total	[Concept] Monetary	Debit	1	ipsas:NoncurrentAssets
Property, Plant, and Equipment, Net, Total	[Concept] Monetary	Debit	1	ipsas:PropertyPlantAndEquipmentNet
Investment in Affiliates	[Concept] Monetary	Debit	1	ipsas:InvestmentInAffiliates
Receivables, Net, Noncurrent	[Concept] Monetary	Debit	1	ipsas:ReceivablesNetNoncurrent
Other Noncurrent Assets	[Concept] Monetary	Debit	1	ipsas:OtherNoncurrentAssets

Defining Events

Events are generally defined with respect to an instance that has been created. Below you see a fact that was defined in one report that is being redefined in a subsequent report because of an error event that has occurred.

Component: (Network and Table)	
Network	1300 - Statement - **Changes in Equity, Prior Period Adjustments**
Table	Statement of Changes in Equity, Prior Period Adjustments [Table]

Reporting Entity [Axis]	1234567890 http://regulator.gov/id
Legal Entity [Axis]	Consolidated Entity [Member]
Reporting Scenario [Axis]	Actual [Member]
Unit [Axis]	USD

Statement of Changes in Equity, Prior Priod Adjustments [Li...	Report Date [Axis]	Period [Axis] 2020-01-01/2020-12-31
Accumulated Surpluses (Deficits), Prior Period Adjustments [Adjustment]		
Accumulated Surpluses (Deficits), Originally Stated	Reported as of February 22, 2019 [Member]	2,000
Correction of Prior Period Errors	Reported as of March 18, 2020 [Member]	500
Changes in Accounting Policies	Reported as of March 18, 2020 [Member]	(1,500)
Accumulated Surpluses (Deficits), Restated	Reported as of March 18, 2020 [Member]	1,000

Creating Instances

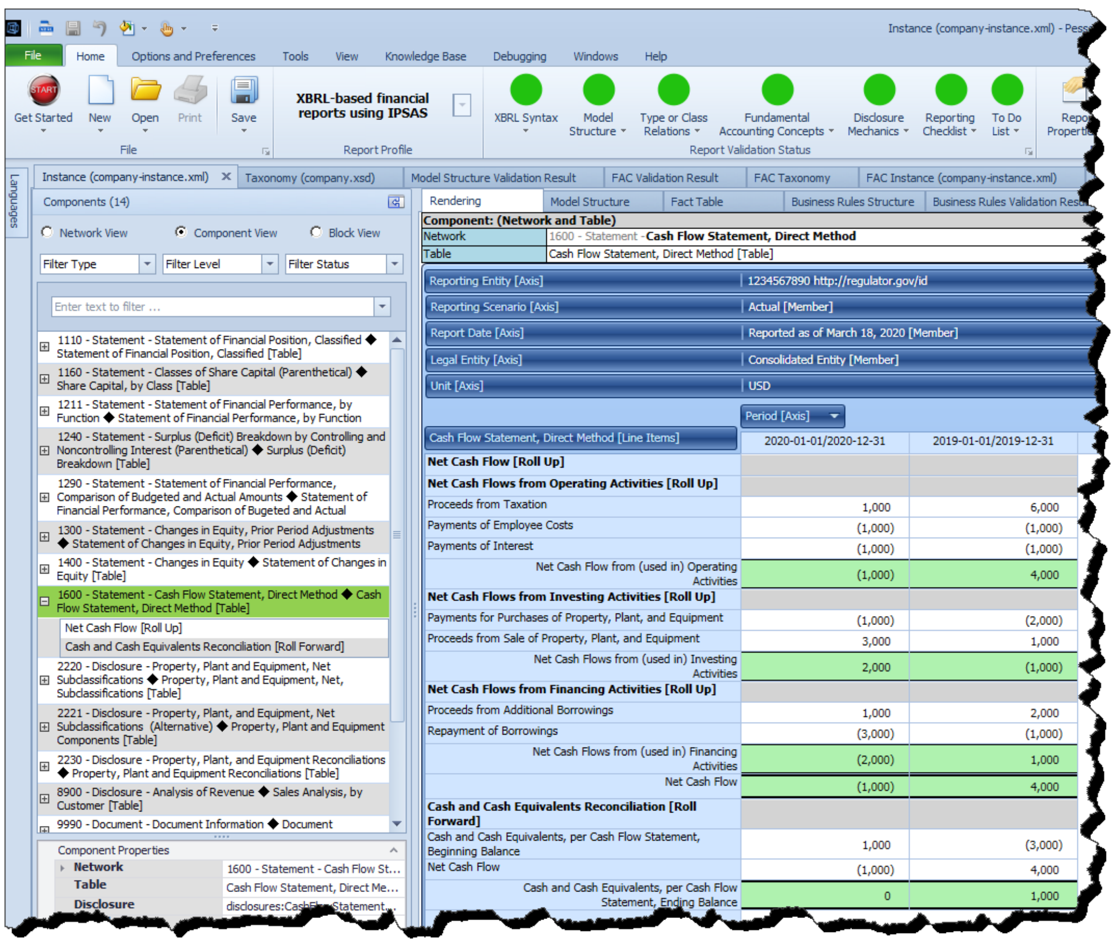
Ultimately, the purpose of an ontology is to define an instance, in the case of an XBRL-based financial report the instance is the actual report that is being created using the ontology which you have defined.

That instance represents the facts (which are also called individuals), the information model definition, and other ontology information to provide an experience to the user of a software application.

Below you see an instance of a report created using the completed IPSAS XBRL taxonomy, which is really an ontology.

If you don't have access to software for using the IPSAS XBRL taxonomy and the instance or report that we are guiding you through the creation of, you can use a version of the report that is provided by a software application that has converted the instance and supporting ontology into HTML files that provide a human readable rendering[39].

Here below you see the same report as shown by a different software application that supports XBRL-based financial reports:



[39] IPSAS report (instance) created using XBRL Cloud, http://xbrlsite.azurewebsites.net/2019/Library/Core/evidence-package/contents/index.html

Notice how both applications provide you feedback as to the consistency of the instance with the rules provided by the ontology. In the screen shot above note the seven green circles which would be red or orange had there been any inconsistencies. Also notice that the software application configures the human readable representation of the report so that you can interact with the report. All of this is complements of the ontology.

Complete Ecosystem

An ontology can provide a complete ecosystem[40]. This is in addition to the basic information model definition[41] and the instance which uses that definition. For example, templates that can be used to create reports, comparisons between periods for a reporting entity, comparisons across reporting entities, examples and samples of a disclosure gleaned from some other report, and other such functionality can be provided using the information provided with the ontology.

If an ontology does not provide the information you need to create the ecosystem that you want, ontology information can be supplemented with additional information.

Existing Financial Reporting Related Ontologies

Today, XBRL-based taxonomies as they are referred to, exist for US GAAP and IFRS financial reports. These existing XBRL taxonomies have specific strengths and weaknesses. They are complete in some areas and incomplete in other areas. This section helps you understand ontologies better by comparing and contrasting ontologies. In addition to the US GAAP and IFRS, I have created two prototype XBRL taxonomies for testing. XASB is a made up reporting scheme and IPSAS is a real reporting scheme, but the taxonomy is a prototype that I created.

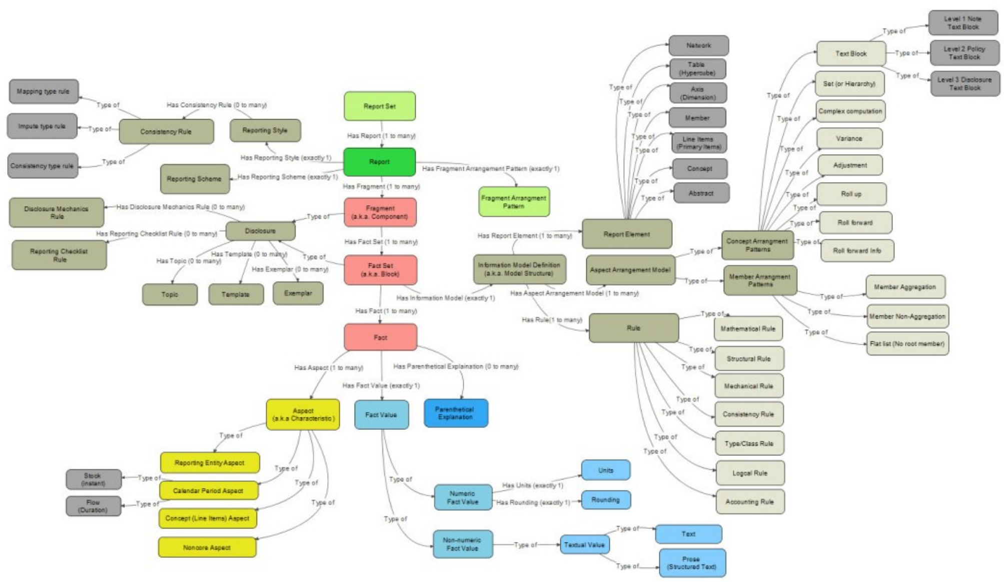
To understand the supplemental information added to the US GAAP and IFRS XBRL taxonomies and my two prototype taxonomies, please refer to the *Method of Implementing a Standard Digital Financial Report Using the XBRL Syntax*[42]. Details are explained in that document.

Supplementing Financial Reporting Taxonomies with Conceptual Framework

As will be pointed out, the US GAAP and IFRS XBRL taxonomies have limitations. As such, those XBRL taxonomies have been supplemented using other information to create a more complete

[40] Cross Reference (US GAAP 2019), http://xbrlsite.azurewebsites.net/2019/Prototype/references/us-gaap/CrossReference.html
[41] Framework Glossary of Entities - Open Source Framework for Implementing XBRL-based Digital Financial Reporting, http://xbrlsite.azurewebsites.net/2019/Framework/FrameworkEntitiesSummary.html
[42] Method of Implementing a Standard Digital Financial Report Using the XBRL Syntax, http://xbrlsite.azurewebsites.net/2019/Library/MethodForImplementingStandardFinancialReportUsingXBRL.pdf

set of curated metadata that can help those endeavoring to make use of XBRL-based reports. The *Open Source Framework for Implementing XBRL-based Digital Financial Reporting*[43] provides this additional metadata in the form of machine-readable XBRL taxonomies. For example, here is the logical model of the base framework and the supplemental framework provided:



US GAAP and IFRS XBRL Taxonomies are more like Dictionaries

Both the US GAAP XBRL Taxonomy[44] and the IFRS XBRL Taxonomy[45] tend to be little more than dictionaries of terms with some roll up mathematical relations. That said, they tend to be excellent dictionaries and the roll up relations are helpful. Why do I characterize the US GAAP and IFRS XBRL taxonomies in this way? Let me explain.

Both the US GAAP and IFRS XBRL taxonomies define terms, they provide labels for the terms, they provide documentation for the terms, and they provide references to authoritative literature which explains the terms in detail. The IFRS XBRL Taxonomy even provides labels in a multitude of different languages.

Both the US GAAP and IFRS XBRL taxonomies define roll up type relations using XBRL calculation relations. The IFRS XBRL taxonomy provides some additional mathematical relations that cannot be represented using XBRL calculation relations. The US GAAP XBRL taxonomy does not. There are many roll forward relations that are only informally represented in the US GAAP XBRL taxonomy using the informal XBRL presentation relation “parent-child”.

Neither the US GAAP nor the IFRS XBRL taxonomies provide important formal relations information. In terms of relations, both taxonomies are more like human readable “pick lists”.

[43] Open Source Framework for Implementing XBRL-based Digital Financial Reporting, http://xbrlsite.azurewebsites.net/2019/Framework/FrameworkEntitiesSummary.html

[44] FASB, US GAAP XBRL Taxonomy, https://www.fasb.org/jsp/FASB/Page/LandingPage&cid=1176164131053

[45] IFRS Foundation, IFRS XBRL Taxonomy, https://www.ifrs.org/issued-standards/ifrs-taxonomy/

The primary set of relations is XBRL presentation relations which define every relation using the general "parent-child" relation rather than specifically defining relations as an ontology would or as a taxonomy would.

Neither the US GAAP nor IFRS XBRL taxonomies really define classes or properties which can be used to add functionality to the taxonomies. There are very few assertions. There are really no type relations. There are no functional terms defined. As such, the functionality that can be expected from the US GAAP and IFRS XBRL taxonomies is significantly limited from what you might expect. It certainly does not provide what you need to create high-quality XBRL-based reports. The evidence of this is the quality issues[46] of XBRL-based reports that are created.

But those limitations can be overcome by supplementing the US GAAP and/or IFRS XBRL taxonomies. I have created the following supplemental information and 100% of this supplemental information was created using the XBRL technical format.

Classes

To overcome the lack of formally defined classes, I took the information from the US GAAP and IFRS XBRL taxonomies and defined my own prototype set of classes[47]. Below you see an example of IFRS class relations for the class "Assets" and the subclasses of that Assets class.

Don't make the mistake of confusing class relations and roll up relations. While it is true that some roll up relations are similar to the class relations; other roll up relations are not class relations at all. For example, the roll up relation between "Revenues", and "Cost of Revenues" that then totals to "Gross Profit" is not a class relation. And so, you cannot rely on roll up relations to understand the important class relations within the US GAAP or IFRS XBRL taxonomies. So, I created my own class relations.

-	Arcrole	Ord
Definition View		
BalanceSheetByLiquidity (IFRS-FULL)		
Assets		0
Property, plant and equipment	http://xbrlsite.azurewebsites.net/2016/conceptual-model/arcrole/class-subClass	1
Investment property	http://xbrlsite.azurewebsites.net/2016/conceptual-model/arcrole/class-subClass	2
Goodwill	http://xbrlsite.azurewebsites.net/2016/conceptual-model/arcrole/class-subClass	3
Intangible assets other than goodwill	http://xbrlsite.azurewebsites.net/2016/conceptual-model/arcrole/class-subClass	4
Other financial assets	http://xbrlsite.azurewebsites.net/2016/conceptual-model/arcrole/class-subClass	5
Other non-financial assets	http://xbrlsite.azurewebsites.net/2016/conceptual-model/arcrole/class-subClass	6
Investments accounted for using equity method	http://xbrlsite.azurewebsites.net/2016/conceptual-model/arcrole/class-subClass	7
Investments in subsidiaries, joint ventures and associates	http://xbrlsite.azurewebsites.net/2016/conceptual-model/arcrole/class-subClass	8

Properties

Similarly, to overcome the lack of formally defined properties, I defined a prototype set of properties which will ultimately be expanded[48].

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46 *Quarterly XBRL-based Public Company Financial Report Quality Measurement (March 2019)*, http://xbrl.squarespace.com/journal/2019/3/29/quarterly-xbrl-based-public-company-financial-report-quality.html

47 IFRS classes and subclass relations, http://xbrlsite.azurewebsites.net/2016/conceptual-model/reporting-scheme/ifrs/classes/rss.xml

48 US GAAP properties, http://xbrlsite.azurewebsites.net/2016/conceptual-model/reporting-scheme/us-gaap/properties/Properties-us-gaap-rules-def.xml

-	Arcrole	Order
Definition View		
Disjointed Properties (US GAAP)		
[Current]		0
[Noncurrent]	http://xbrlsite.azurewebsites.net/2016/conceptual-model/arcrole/property-disjointedProperty	1
[Operating]		0
[Nonoperating]	http://xbrlsite.azurewebsites.net/2016/conceptual-model/arcrole/property-disjointedProperty	3
[Tangible]		0
[Intangible]	http://xbrlsite.azurewebsites.net/2016/conceptual-model/arcrole/property-disjointedProperty	2

Here are the base set of properties being used for US GAAP: (just a prototype)

-	Arcrole
Definition View	
Disjointed Properties (US GAAP)	
[Current]	
[Noncurrent]	http://xbrlsite.azurewebsites.net/2016/conceptual-model/arcrole/property-disjointedProperty
Extensible Enumeration Domain Members	
Properties (US GAAP)	
[Current]	
[AssetsCurrent]	http://xbrlsite.azurewebsites.net/2016/conceptual-model/arcrole/property-hasProperty
[LiabilitiesCurrent]	http://xbrlsite.azurewebsites.net/2016/conceptual-model/arcrole/property-hasProperty
[Noncurrent]	
[AssetsNoncurrent]	http://xbrlsite.azurewebsites.net/2016/conceptual-model/arcrole/property-hasProperty
[LiabilitiesNoncurrent]	http://xbrlsite.azurewebsites.net/2016/conceptual-model/arcrole/property-hasProperty

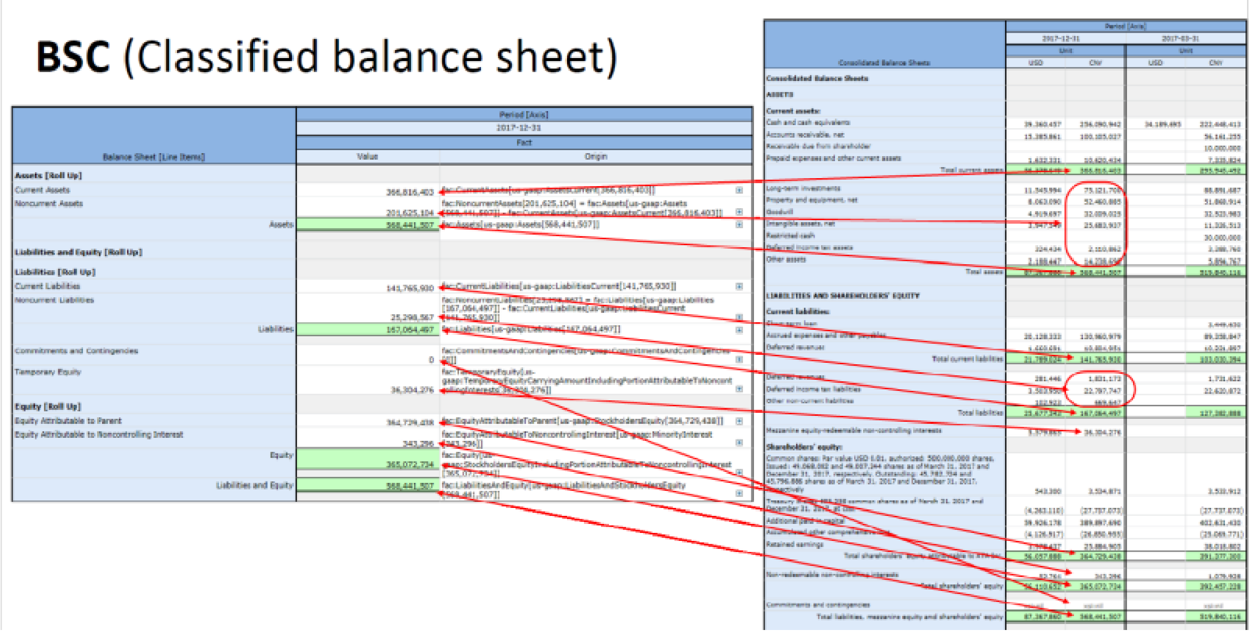
As you can imagine, there are other useful properties that could be useful, most of which are likely defined in the conceptual framework of a reporting scheme.

Reporting Styles (Functional Term)

Both the US GAAP and IFRS financial reporting schemes allow for variability in the way the primary financial statements can be represented. I organized this variability using the notion of reporting styles. A reporting style[49] is functional term. I have reporting style coverage of about 98% of all 6,000 public companies that report using US GAAP to the SEC and for about 80% of the approximately 400 foreign issues that report using IFRS to the SEC.

Here is a human readable example of a US GAAP reporting style for a classified balance sheet:

[49] Making the Case for Reporting Styles, http://xbrlsite.azurewebsites.net/2017/library/MakingTheCaseForReportingStyles.pdf



The reporting style above can be contrast to that of an unclassified balance sheet (or order of liquidity) that might be used by a bank. While the US GAAP and IFRS taxonomies do differentiate a few reporting styles, it is only a few. Here is the balance sheet reporting style information for US GAAP per an analysis of 100% of public companies that report to the SEC:

Code	Count of Reports Using this Style	Percent of Reports Using this Style	Percent of Reports Consistent with Style
BSC	4,637	81%	98%
BSU	883	15%	99%
BSN	111	2%	99%
BSR	15	1%	99%
BSL	?	?%	?%
BSB	3	0%	100%
Unknown/Other	88	1%	??%
Total	5,734	100%	

Fundamental Accounting Concept Relations Continuity Cross Check Supplemental Rules (Assertions)

Neither the US GAAP nor IFRS XBRL taxonomies provide consistency cross check assertions which help make sure there are no inconsistencies or contradictions[50] within XBRL-based financial reports.

[50] Quarterly XBRL-based Public Company Financial Report Quality Measurement (March 2019), http://xbrl.squarespace.com/journal/2019/3/29/quarterly-xbrl-based-public-company-financial-report-quality.html

Today, on a per report basis about 90% of all US GAAP reports and 62% of all IFRS reports submitted to the SEC are consistent with all consistency cross check rules. On a per rule basis, 99.24% of US GAAP and 98.67% of IFRS report related rules are consistent with the existing continuity cross check assertions.

Below you see a summary of the fundamental accounting concept relations consistency cross check rules measurement results for US GAAP reports.

#	Category	Test Number	Fundamental accounting concept consistency check description	Consistent	Consistent %	Inconsistent	Inconsistent %
1	BS	usfac:BS1	Equity = Equity Attributable to Parent + Equity Attributable to Noncontrolling Interest	5,698	100.00%	18	0.00%
2	BS	usfac:BS2	Assets = Liabilities and Equity	5,706	100.00%	10	0.00%
3	BS	usfac:BS3	Assets = Current Assets + Noncurrent Assets	5,668	99.32%	48	0.68%
4	BS	usfac:BS4	Liabilities = Current Liabilities + Noncurrent Liabilities	5,691	99.81%	25	0.19%
5	BS	usfac:BS5	Liabilities and Equity = Liabilities + Commitments and Contingencies + Temporary Equity + Equity	5,643	99.42%	73	0.58%
6	CF	usfac:CF1	Net Cash Flow = Net Cash Flows, Operating + Net Cash Flows, Investing + Net Cash Flows, Financing + Exchange Gains (Losses)	5,586	97.96%	130	2.04%
7	CF	usfac:CF2	Net Cash Flows, Continuing = Net Cash Flows, Operating, Continuing + Net Cash Flows, Investing, Continuing + Net Cash Flows, Financing, Continuing	5,690	99.71%	26	0.29%
8	CF	usfac:CF3	Net Cash Flows, Discontinued = Net Cash Flows, Operating, Discontinued + Net Cash Flows, Investing, Discontinued + Net Cash Flows, Financing, Discontinued	5,706	99.71%	10	0.29%
9	CF	usfac:CF4	Net Cash Flows, Operating = Net Cash Flows, Operating, Continuing + Net Cash Flows, Operating, Discontinued	5,705	99.81%	11	0.19%
10	CF	usfac:CF5	Net Cash Flows, Investing = Net Cash Flows, Investing, Continuing + Net Cash Flows, Investing, Discontinued	5,697	99.90%	19	0.10%
11	CF	usfac:CF6	Net Cash Flows, Financing = Net Cash Flows, Financing, Continuing + Net Cash Flows, Financing, Discontinued	5,712	99.90%	4	0.10%
12	IS	usfac:IS1	Gross Profit = Revenues - Cost Of Revenue	5,648	98.64%	68	1.36%
13	IS	usfac:IS2	Operating Income (Loss) = Gross Profit - Operating Expenses + Other Operating Income (Expenses)	5,557	98.35%	159	1.65%
14	IS	usfac:IS3	Income (Loss) from Continuing Operations Before Equity Method Investments = Operating Income (Loss) + Nonoperating Income (Loss) - Interest And Debt Expense	5,715	100.00%	1	0.00%
15	IS	usfac:IS4	Income (Loss) from Continuing Operations Before Tax = Income (Loss) from Continuing Operations Before Equity Method Investments + Income (Loss) from Equity Method Investments	5,605	99.03%	111	0.97%
16	IS	usfac:IS5	Income (Loss) from Continuing Operations after Tax = Income (Loss) from Continuing Operations Before Tax - Income Tax Expense (Benefit)	5,635	98.64%	81	1.36%
17	IS	usfac:IS6	Net Income (Loss) = Income (Loss) from Continuing Operations After Tax + Income (Loss) from Discontinued Operations, Net of Tax + Extraordinary Items, Gain (Loss)	5,628	98.54%	88	1.46%
18	IS	usfac:IS7	Net Income (Loss) = Net Income (Loss) Attributable to Parent + Net Income (Loss) Attributable to Noncontrolling Interest	5,536	96.70%	180	3.30%
19	IS	usfac:IS8	Net Income (Loss) Available to Common Stockholders, Basic = Net Income (Loss) Attributable to Parent - Preferred Stock Dividends and Other Adjustments	5,691	99.22%	25	0.78%
20	SCI	usfac:IS9	Comprehensive Income (Loss) = Comprehensive Income (Loss) Attributable to Parent + Comprehensive Income (Loss) Attributable to Noncontrolling Interest	5,672	99.32%	44	0.68%
21	SCI	usfac:IS10	Comprehensive Income (Loss) = Net Income (Loss) + Other Comprehensive Income (Loss)	5,571	97.67%	145	2.33%

Note the very high consistency rates.

Disclosure Mechanics Supplemental Rules (Assertions)

Neither the US GAAP nor IFRS XBRL taxonomies provide important information related to the proper construction of Level 4 Disclosure Details, the relation between Level 4 Disclosure Details and Level 3 Disclosure Text Block, alternative concepts for reporting a line item or disclosure, and other such information. As a result, only about 89% of both US GAAP and IFRS

XBRL-based reports submitted to the SEC on average are created correctly per my measurements[51].

And so, I created supplemental rules for approximately 70 US GAAP disclosures and approximately 15 IFRS disclosures. In addition, I have prototyped complete financial report disclosure sets for a prototype reporting scheme, XASB, and for the IPSAS reporting scheme to more thoroughly test disclosure mechanics validation.

Here is an example of the set of disclosure mechanics rules for the disclosure of the inventory roll up under US GAAP:

Reporting Checklist Supplemental Rules (Assertions)

While both the US GAAP and IFRS financial reporting standards provide information related to when disclosures are required to be reported; neither the US GAAP nor IFRS XBRL taxonomies provide this information.

[51] Disclosure mechanics validation results, http://xbrlsite.azurewebsites.net/2019/Library/DisclosureMechanics_ByDisclosure_2019-03-31.jpg

As such, I created supplemental machine-readable reporting checklist rules that helps financial report creators to understand when specific disclosures are required. These rules exist for the 70 US GAAP disclosures, 15 IFRS disclosures, all the XASB disclosures, and for the IPSAS reporting scheme disclosures.

Below you see the reporting checklist validation results for Microsoft which reports to the SEC using US GAAP[52]:

Disclosure Mechanics and Reporting Checklist

Entity Registrant Name:	MICROSOFT CORPORATION (SEC Filing Page)	Document Type:	10-K
CIK:	0000789019	Fiscal Year / Period:	2017 / FY

Disclosures Found: 48 of 70 (69%)

Disclosures Consistent: 68 of 70 (97%) | Disclosures Inconsistent: 2 of 70 (3%)

Show: All / Only Consistencies / Only Inconsistencies / Only Reported / Only Not Reported

Show Level 1 Note And Policy Concept Columns

#	Disclosure	Category	Level	Pattern	Applicable	Found	Disclosure Consistent	Representation Concept [TEXT BLOCK]	Representation Concept [DETAIL]	Checklist Category	Reason
1	Document Information [Hierarchy]	DOCUMENT	Level4Detail	HIERARCHY	True	True	CONSISTENT	NOT-EXPECTED	Document Fiscal Period Focus	Required disclosure	Disclosure always required
2	Document and Entity Information [Hierarchy]	DOCUMENT	Level4Detail	HIERARCHY	False	True	CONSISTENT	NOT-EXPECTED	Entity Registrant Name	Alternative representation	Not necessary, satisfied by Document Information [Hierarchy] disclosure
3	Entity Information, by Legal Entity [Hierarchy]	DOCUMENT	Level4Detail	HIERARCHY	True	True	CONSISTENT	NOT-EXPECTED	Entity Registrant Name	Required disclosure	Disclosure always required
4	Document and Entity Information [Hierarchy]	DOCUMENT	Level4Detail	HIERARCHY	False	True	CONSISTENT	NOT-EXPECTED	Entity Registrant Name	Alternative representation	Not necessary, satisfied by Entity Information, by Legal Entity [Hierarchy] disclosure
5	Balance Sheet	STATEMENT	Level4Detail	COMPONENT	True	True	CONSISTENT	NOT-EXPECTED	NOT-EXPECTED	Required disclosure	Disclosure always required, satisfied by Assets [Roll Up] and Liabilities and Equity [Roll Up]
6	Assets [Roll Up]	STATEMENT	Level4Detail	ROLL UP	True	True	CONSISTENT	NOT-EXPECTED	Assets	Part of disclosure	Disclosure always required
7	Liabilities and Equity [Roll Up]	STATEMENT	Level4Detail	ROLL UP	True	True	CONSISTENT	NOT-EXPECTED	Liabilities and Equity	Part of disclosure	Disclosure always required
8	Income Statement, by Legal Entity [Roll Up]	STATEMENT	Level4Detail	ROLL UP	True	True	CONSISTENT	NOT-EXPECTED	Net Income (Loss) Attributable to Parent	Required disclosure	Disclosure always required
9	Statement of Income and Comprehensive Income [Roll Up]	DISCLOSURE	Level4Detail	ROLL UP	False	True	CONSISTENT	NOT-EXPECTED	Net Income (Loss) Attributable to Parent	Alternative representation	Not necessary, satisfied by Income Statement, by Legal Entity [Roll Up] disclosure
10	Statement of Comprehensive Income [Roll Up]	STATEMENT	Level4Detail	ROLL UP	True	True	CONSISTENT	NOT-EXPECTED	Comprehensive Income (Loss), Net of Tax, Attributable to Parent	Required disclosure	Disclosure always required
11	Statement of Income and Comprehensive Income [Roll Up]	DISCLOSURE	Level4Detail	ROLL UP	False	True	CONSISTENT	NOT-EXPECTED	Net Income (Loss) Attributable to Parent	Alternative representation	Not necessary, satisfied by Statement of Comprehensive Income [Roll Up] disclosure
12	Cash Flow Statement [Roll Forward]	STATEMENT	Level4Detail	ROLL UP	True	True	CONSISTENT	NOT-EXPECTED	Cash and Cash Equivalents, Period Increase (Decrease)	Required disclosure	Disclosure always required
13	Statement of Changes in Equity [Roll Forward]	STATEMENT	Level4Detail	ROLL FORWARD	True	True	CONSISTENT	NOT-EXPECTED	Stockholders' Equity Attributable to Parent	Required disclosure	Disclosure always required
15	Basis of Reporting Note [Note Level]	DISCLOSURE	Level1TextBlock	LEVEL 1 TEXT BLOCK	True	True	CONSISTENT	Basis of Accounting, Policy [Policy Text Block]	NOT-EXPECTED	Required disclosure	Disclosure always required
16	Significant Accounting ... Note ... Level]	DISCLOSURE	Level1TextBlock	LEVEL 1	True	Tr...	...SISTENT	Significant Acc...	NOT-EXPECTED	...d	...ways required

Disclosures Metadata (Terms)

Neither the US GAAP nor the IFRS XBRL taxonomies provide explicitly for the notion of a disclosure. The closest thing in both of those taxonomies to the notion of a disclosure is the Level 3 Disclosure Text Blocks for which there should be a one-to-one correlation with the accounting standards. However, there appear to be many missing disclosures from both the US

52 Disclosure Mechanics and Reporting Checklist provided by XBRL Cloud for Microsoft, http://xbrlsite.azurewebsites.net/2017/Prototypes/Microsoft2017/Disclosure%20Mechanics%20and%20Reporting%20Checklist.html

GAAP and IFRS XBRL taxonomies. Further, there is no taxonomy metadata that provides for the relation between Level 3 Disclosure Text Blocks and Level 4 Disclosure Detail representations.

Note that neither the US GAAP Accounting Standards Codification nor the IFRS pronouncements actually provide specific and explicit names for actual disclosures. Whereas, in my supplemental ontologies I have provided explicit terms with names and therefore disclosures can be explicitly referenced via software applications.

I have provided for approximately 1,000[53] disclosures for US GAAP and 250 for IFRS. Further, I have about 63 disclosures for the prototype XASB reporting scheme and 35[54] disclosures for the IPSAS reporting scheme.

Topics Metadata (Terms)

While both the US GAAP Accounting Standards Codification and the IFRS pronouncements have the notion of what amounts to topics; neither US GAAP nor IFRS provide actual defined names for those topics or define terms for the topics within the XBRL taxonomies. The closest thing to the notion of topics is the extended link roles that are defined for each XBRL taxonomy network. However, that mechanism is not used particularly well and at best what is provided is a flat list of extended links. Further, as pointed out above, the notion of a disclosure is not used.

I have provided topics for US GAAP[55], IFRS[56], XASB[57], and IPSAS[58] reporting schemes.

Looking to the Future

How XBRL taxonomies are being used today is not necessarily an indication as to how they will be used in the future. Already, people are beginning to recognize the utility of tying the XBRL taxonomies of US GAAP and IFRS to the authoritative literature that defines those standards. But what if the standards setters went further and started defining accounting and financial reporting standards in comprehensive ontologies?

[53] US GAAP Disclosures, http://www.xbrlsite.com/2015/fro/us-gaap/html/Disclosures/Detail/index.html
[54] IPSAS Disclosures, http://xbrlsite.azurewebsites.net/2016/conceptual-model/reporting-scheme/ipsas/disclosures-topics/disclosures_ModelStructure.html
[55] US GAAP Topics, http://xbrlsite.azurewebsites.net/2016/conceptual-model/reporting-scheme/us-gaap/Disclosures/topics_ModelStructure.html
[56] IFRS Topics, http://xbrlsite.azurewebsites.net/2016/conceptual-model/reporting-scheme/ifrs/disclosures/topics_ModelStructure.html
[57] XASB Topics, http://xbrlsite.azurewebsites.net/2016/conceptual-model/reporting-scheme/xasb/disclosures/topics_ModelStructure.html
[58] IPSAS Topics, http://xbrlsite.azurewebsites.net/2019/Prototype/ipsas/Metadata/topics_ModelStructure.html

Leveraging Ontologies More in Financial Reporting

In a paper, *An analysis of fundamental concepts in the conceptual framework using ontology technologies*[59], written by Marthinus Cornelius Gerber, Aurona Jacoba Gerber, Alta van der Merwe point out:

> The interpretation of financial data obtained from the accounting process for reporting purposes is regulated by financial accounting standards (FAS). The history and mechanisms used for the development of 'The Conceptual Framework for Financial Reporting' (the Conceptual Framework) as well as the financial accounting standards **resulted in impressive volumes of material that guides modern financial reporting practices, but unfortunately, as is often the case with textual manuscripts, it contains descriptions that are vague, inconsistent or ambiguous**. As part of the on-going initiatives to improve International Financial Reporting Standards (IFRS), the International Accounting Standards Board (IASB) promotes the development of principle-based IFRS, which aim to address the problems of vagueness, inconsistency and ambiguity.
>
> This paper reports on the findings of a design science research (DSR) project that, as artefact, developed a first version ontology-based formal language representing the definitions of asset, liability and equity (the fundamental elements of the statement of financial position as defined in the Conceptual Framework) through the application of knowledge representation (ontology) techniques as used within computing. We suggest that this artefact may assist with addressing vagueness, inconsistencies and ambiguities within the definitions of the Conceptual Framework. Based on our findings, we include suggestions for the further development of a formal language and approach to assist the formulation of the Conceptual Framework. The project focuses on the Conceptual Framework for Financial Reporting after the incorporation of Phase A in the convergence project between the Financial Accounting Standards Board (FASB) and IASB.

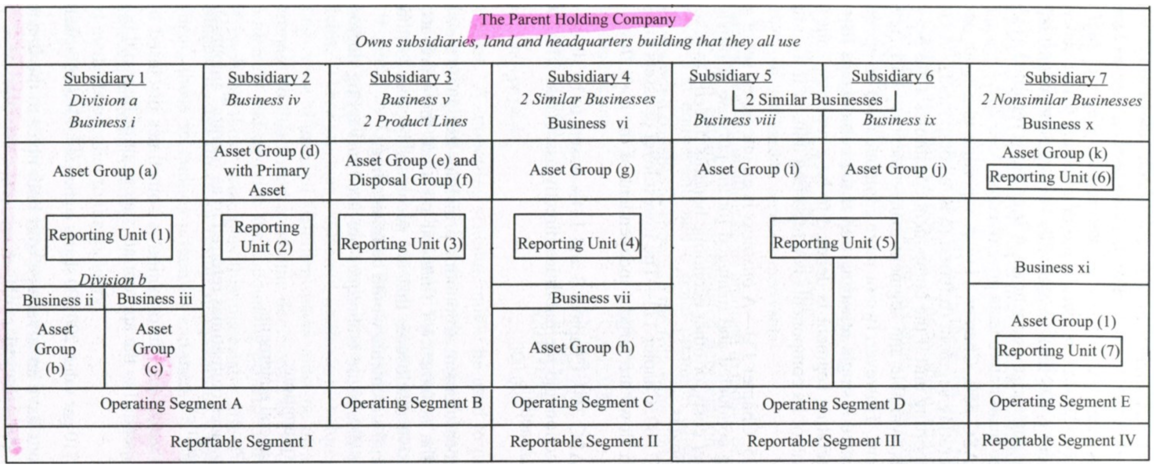
Specific Ambiguities in US GAAP

When humans try and describe complicated things such as financial reporting standards in books it is easy to inadvertently make mistakes which contribute to vagueness, inconsistencies, incoherence, and ambiguities because the only way to check the meaning which is written is manually using humans.

The *Wiley GAAP 2011*[60] (page 46 to 48) points out inconsistencies in the financial position segmentation schemes used within the Accounting Standards Codification (ASC). Different schemes are required for various reporting purposes and depending upon specific circumstances. However, those different schemes use inconsistent and sometimes conflicting

[59] Marthinus Cornelius Gerber, Aurona Jacoba Gerber, Alta van der Merwe; *An analysis of fundamental concepts in the conceptual framework using ontology technologies*, https://sajems.org/index.php/sajems/article/viewArticle/525
[60] Wiley GAAP 2011, page 46 to 48, https://www.ebay.com/p/GAAP-2011-Interpretation-and-Application-of-Generally-Accepted-Accounting-Principles-2011-by-Barry-J/109010794?iid=312496497120

terminology. The *Wiley GAAP 2011* goes as far as providing their own standard taxonomy which organizes and specifically describes these segmentations so that they could do a good job writing their GAAP guide:



Further, the FASB and the IASB define the components of an entity in different ways.

Idiosyncratic Tendencies of Humans

The financial accounting conceptual framework created by the FASB contributes to a clear, consistent, logically coherent, and unambiguous terminology and principles by providing a disciplined framework[61] which can be used to think about financial accounting. A discussion of the framework in a FASB special report states in part:

- Providing a set of common premises as a basis for discussion
- Provide precise terminology
- Helping to ask the right questions
- Limiting areas of judgment and discretion and excluding from consideration potential solutions that are in conflict with it
- Imposing intellectual discipline on what traditionally has been a subjective and ad hoc reasoning process

However, given the idiosyncratic tendencies of humans, interpretations which reflect the arbitrary peculiarities of individuals can sometimes slip in or mistakes can be made when expressing such terminology. Further, parts of our understanding of financial reporting can be incorrect and can evolve and improve and may even simply change over time.

If different groups of professional accountants use different terminology for the same concepts and ideas to express the exact same truths about financial reporting; those professional

[61] Per FASB Special Report, *The Framework of Financial Accounting Concepts and Standards* (1998)

accountants should be able to inquire as to why these arbitrary terms are used, identify the specific reasoning for this, and specifically identify concepts and ideas which are the exact same as other concepts and ideas but use different terminology or labels to describe what is in fact exactly the same thing; and to also understand the subtleties and nuances of concepts and ideas which are truly different from other concepts and ideas. Unjustifiable inconsistencies can be eliminated.

If idiosyncrasies result only in different terms and labels which are used to express the exact same concepts and ideas, then mappings can be created to point out these different terms used to express the same concepts and ideas. Such mappings make dialogue more intelligible and could get groups to accept a single standardized term or set of terminology for the purpose of interacting with common repositories of information, such as XBRL-based financial filings of public companies.

If the difference in terminology and expression are rooted in true and real theoretical differences between professional accountants, and the different terms express and point out important subtleties and nuances between what seemed to be the same terms; then these differences can be made explicit and discussed, in a rigorous and deliberate fashion within the accounting profession once the differences are made explicit.

While accumulating and articulating this information in the form of books and other human readable resources adds to the discipline and rigor of clearly, logically, coherently, unambiguously defining concepts and ideas; articulating this information in machine-readable fashion takes the discipline and rigor to an entirely new level. Further, other new and interesting possibilities and flexibility are opened up because this information is expressed in machine-readable form.

Unjustifiable Inconsistencies

Each reporting scheme has the accounting equation in common[62]. Further, each reporting scheme has many other high-level financial concepts that are the same across all financial reporting schemes[63].

Likewise, many different regulators have unjustifiable inconsistencies between their XBRL architectures and other implementation details[64].

[62] Wikipedia, Accounting Equation, https://en.wikipedia.org/wiki/Accounting_equation

[63] Comparison of Financial Reporting Schemes High Level Concepts, http://xbrlsite.azurewebsites.net/2018/Library/ReportingSchemes-2018-12-30.pdf

[64] XBRL-based Digital Financial Reporting Profiles and General Business Reporting Profile, http://xbrlsite.azurewebsites.net/2018/Library/Profiles-2018-10-22.pdf

Ultimately, these sorts of unjustifiable inconsistencies, that are generally caused by people not talking to one another or the egos of bureaucrats that work for regulators rather than any real technical or business domain related issues or considerations, will disappear.

Conclusion

The application for which you are classifying information dictates where you need to be in the ontology spectrum.

People creating ontologies and applications need to have a conscious understanding of where they are in the ontology spectrum and why they are there. If there is a mismatch between the level that you are using in the ontology spectrum and the application you are creating which will use that ontology; then bad things can happen such as information quality issues, functionality issues, usability issues, and so forth.

If you are too low in the spectrum, what you created must be **supplemented** with additional information if an intended application is not provided for.

What matters is that (a) the people creating an ontology are *conscious* as to what they are creating, (b) that conscious understanding is communicated to the intended user stakeholder community for that ontology and (c) the intended user stakeholder community is aware that if they are not getting the functionality they need from the ontology, they simply need to supplement the ontology so that they do get the functionality they need for their application. Further, unintended users are free to supplement an ontology to meet their needs also.

Supplementing an information classification is natural. You cannot expect an ontology to provide 100% of the functionality that 100% of possible applications to be provided by an ontology. Supplements to ontologies will many times need to be created. Again, this is natural. But, what is important is that business professionals creating ontologies are conscious of what they are doing and why they are doing it.

A complete and properly functioning ontology can supercharge software applications that can be used to create financial reports. While neither the US GAAP or IFRS XBRL Taxonomies are particularly rich in terms of the sorts of metadata you need, those base XBRL taxonomies can be supplemented with additional information to get you where you need to be.

Using the “oil” metaphor; the US GAAP XBRL Taxonomy and the IFRS XBRL Taxonomy are like crude oil. But that raw crude oil can be refined and turned into gasoline or even high octane racing fuel. Artificial intelligence truly does come to life in useful software because of high-quality ontologies.

APPENDIX: Representing Business Domain Knowledge in Ontologies

Skilled craftsmen using the right tools can get the dumb beasts, computers, to perform magic. But it is not really magic that is occurring; it just seems like magic. What is really going on is shared realities are being created in order to leverage to capabilities of these machines in order to make things better, faster, and cheaper. The goal is to increase productivity.

Best Practices

A best practice is a method or technique that has been generally accepted as superior to any other known alternatives because it produces results that are superior to those achieved by other means or because it has become a standard way of doing things.

High-fidelity, High-resolution, High-Quality

As stated, a general purpose financial report provides high-fidelity, high-resolution information that is of very high-quality. Consider this scenario:

> Two public companies, A and B, each have knowledge about their financial position and financial performance. They must communicate their knowledge to an investor who is making investment decisions which will make use of the combined information so as to draw some conclusions. All three parties are using a common set of basic logical principles (facts known to be true, deductive reasoning, inductive reasoning, etc.) and common financial reporting standards (i.e. US GAAP, IFRS, etc.), so they should be able to communicate this information fully, so that any inferences which, say, the investor draws from public company A's input should also be derivable by public company A using basic logical principles and common financial reporting standards, and vice versa; and similarly for the investor and public company B.

Let's be clear about the terms we are using and the need for low to zero tolerance for error. Specifically, let's be clear about the following definitions:

- **Reliability** is about getting consistent results each time an activity is repeated.
- **Accuracy** is about identifying the correct target. Accuracy relates to correctness in all details; conformity or correspondence to fact or given quality, condition; deviating within acceptable limits from a standard. Accuracy means with no loss of resolution or fidelity of what the sender wishes to communicate and no introduction of false knowledge or misinterpretation of communicated information.
- **Precision** is the closeness of repeated measurements to one another. Precision involves choosing the right equipment and using that equipment properly. Precise readings are not necessarily accurate. A faulty piece of equipment or incorrectly used equipment

may give precise readings (all repeated values are close together) but inaccurate (not correct) results.

- **Fidelity** relates to the exactness or loyal adherence facts and details with which something is copied or reproduced. Fidelity relates to the faithful representation of the facts and circumstances represented within a financial report properly reflect, without distortion, reality. High fidelity is when the reproduction (a financial report) with little distortion, provides a result very similar to the original (reality of economic entity and environment in which economic entity operates).
- **Integrity** is the quality or condition of being whole or undivided; completeness, entireness, unbroken state, uncorrupt. Integrity means that not only is each piece of a financial report correct but all the pieces of the financial report fit together correctly, all things considered.
- **Resolution** relates to the amount of detail that you can see. The greater the resolution, the greater the clarity.
- **Completeness** relates to having all necessary or normal parts, components, elements, or steps; entire.
- **Correctness** relates to freedom from error; in accordance with fact or truth; right, proper. Consistency relates to being compatible or in agreement with itself or with some group; coherent, uniform, steady. Holding true in a group, compatible, not contradictory.

Shared View of Reality to Achieve a Specific Purpose

In his book[65] *Data and Reality*, William Kent provides an excellent summary that discusses the realities of sharing information. In Chapter 9: *Philosophy* in the Third Edition and Chapter 12: *Philosophy* in the first edition (which is available online) he paints a picture of why you want to go through the trouble of sharing information using machine-based processes and the realities of what that takes. This is what William Kent points out which I have paraphrased as it relates to financial reporting:

> To create a shared reality to achieve a specific purpose: To arrive at a shared common enough view of "true and fair representation of financial information" such that most of our working purposes, so that reality does appear to be objective and stable so that you can query information reliably, predictably, repeatedly, safely.

Meaningful information exchange that is reliable, repeatable, predictable, safe, cost effective, easy to use, robust, scalable, secure when necessary, auditable (track provenance) when necessary.

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[65] William Kent, *Data and Reality*, Technics Publications, (See this resource which has CHAPTER 12: Philosophy from the first version of this book, http://www.bkent.net/Doc/darxrp.htm)

Prudence dictates that using the information contained in a digital financial report should not be a guessing game. Safe, reliable, repeatable, predictable, reuse of reported financial information using automated machine-based processes is obviously preferable to a guessing game.

The effective meaningful exchange of information is created by skilled craftsmen that know their craft well. The craftsmen balance the system, bringing the system into equilibrium to achieve some specific purpose. Creating this shared view of reality which allows this specific purpose to be achieved has benefit to the financial reporting supply chain.

That purpose should be clearly defined so that everyone understands the objective and exactly what the system can, and cannot, deliver.

Principles help you think about something thoroughly and consistently. Overcoming disagreements between stakeholders and even within groups of stakeholders is important. Agreement between stakeholder groups and within stakeholder groups contributes to harmony. Lack of agreement contributes to dissonance. Principles help in the communications process.

I would argue that a first step, if not the first step, of arriving at harmony is outlining the interests, perceptions, positions, and risks of each constituency/stakeholder group.

A "stakeholder" is anyone that has a vested interest. Another term for stakeholder is "constituent". A "constituent" is a component part of something.

Foundational to arriving at harmony is having a common conceptual framework including a set of consistent principles or assumptions or world view for thinking about the system. For example, accounting and financial reporting have such a conceptual framework including principles/assumptions such as "materiality" and "going concern" and "conservatism".

This "framework for agreeing" helps the communications process which increases harmony and decreases dissonance. This is about bringing the system into balance, consciously creating the appropriate equilibrium/balance.

Named Entities

A named entity[66] uniquely identifies something that exists in reality. Named entities are usually proper nouns. A named entity can be abstract or actually physically exist. A named entity is a specific, named instance of a particular entity type. Another words used to describe named

[66] Wikipedia, *Named entity*, https://en.wikipedia.org/wiki/Named_entity

entities are term, concept, object, and thing. Nomenclature[67] is a system for naming entities in a domain of knowledge.

Differentiating a Notion/Idea/Phenomenon, a Name, and a Preferred label

It is important to understand and properly differentiate between the following three things:

- **Notion, idea, phenomenon**: something that exists in reality that needs to be represented
- **Name**: helps computers uniquely identify some notion/idea/phenomenon that is a representation of reality within some machine-readable conceptual model
- **Preferred label**: alternative ways used to refer to name

Confusing these three things can cause problems when trying to create a conceptual model. Two things that are genuinely different should have two different names. However, if one thing is given two names when the one thing really is two different preferred labels problems can occur.

Differentiating the Important from the Unimportant

The following terms help one understand the difference between an important nuance and an unimportant negligible difference.

- **Nuance**: a subtle but important difference in or shade of meaning, expression, or sound; a subtle but important distinction or variation
- **Subtle**: so delicate or precise as to be difficult to analyze or describe but important; hard to notice or see but important; not obvious but important
- **Negligible**: so small or unimportant as to be not worth considering; insignificant; so small or unimportant or of so little consequence as to warrant little or no attention

Business professionals can best differentiate important nuances from unimportant negligible differences. They do not do it perfectly and the only real way to make sure things are right is testing and experimentation.

Conceptual models, ontologies, and theories are about getting the salient aspects of a problem domain right. One needs to take a pragmatic view of the world because it is impossible to describe every single aspect of the real world. Such frameworks only need to represent the important things and serve as a “wireframe” or a “substrate” of reality. Getting bogged down in unimportant, insignificant, or inconsequential details at best serves no purpose, at worst can cause unnecessary complexity.

[67] Wikipedia, *Nomenclature*, https://en.wikipedia.org/wiki/Nomenclature

Difference between a Requirement and a Policy

Sometimes things are required, other times things are a choice. Yet in other times setting some policy eliminates certain options which could have been previously considered.

- **Policy**: a course or principle of action adopted or proposed by a government, party, business, or individual; definite course or method of action selected from among alternatives and in light of given conditions to guide and determine present and future decisions
- **Requirement**: a thing that is needed or wanted; something that is essential or that must be done
- **Choice**: an act of selecting or making a decision when faced with two or more possibilities; the act of choosing; the act of picking or deciding between two or more possibilities
- **Option**: a thing that is or may be chosen; the opportunity or ability to choose something or to choose between two or more things

Any time a business professional is presented with an alternative complexity increases because the business professional then must choose between the available alternatives. As the number of choices increases, complexity increases. Choices must be managed. Flexibility when it is not necessary is not a feature, it is a bug.

Relations

The concept of relation[68] as a term used in general philosophy to describe a relation between one thing and some other thing (i.e. things are a named entity). Another important part of understanding relations is the different types of relations that can exist between named entities. While entities tend to be nouns, relations tend to be verbs[69]. Some general relationship types include "is-a" or "class-of" or "type-of"; "has-a" or "has-part", "part-of", "part-whole", etc. Those relations tend to be more formal or specific. A relation such as "parent-child" tends to be more general or an informal description of a relation.

Differentiating between Objective and Subjective

There is a difference between something that is objective and something that is subjective.

- **Objective**: not influenced by personal feelings or opinions in considering and representing facts; based on facts rather than feelings or opinions; not influenced by feelings; facts are objective.

[68] Wikipedia, *Relation*, https://en.wikipedia.org/wiki/Relation_(history_of_concept)

[69] Wikipedia, Entity Relationship Model, Mapping Relation Types, https://en.wikipedia.org/wiki/Entity%E2%80%93relationship_model#Mapping_natural_language

- **Subjective**: based on or influenced by personal feelings, tastes, preferences, or opinions; based on feelings or opinions rather than facts; relating to the way a person experiences things in his or her own mind; opinions are subjective.
- **Judgment**: the ability to make considered decisions or come to sensible conclusions; an opinion or decision that is based on careful thought; judgment is subjective.

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. It is easy to agree on things that tend to be objective. It is harder to agree where there is subjectivity. It is extremely difficult to impossible to get a machine to exercise judgment. A machine such as a computer can only mimic what humans tell the machine to do via machine-readable information.

Difference between Explicit and Implicit

In the process of agreeing, it is important to understand the difference between what is important and what is unimportant in that process of agreeing. It is likewise important to understand the difference between telling a machine something and requiring the machine to figure something out:

- **Explicit**: Stated clearly and in detail, leaving no room for confusion or doubt; very clear and complete; leaving no doubt about the meaning.
- **Implicit**: Implied though not plainly expressed; understood though not clearly or directly stated.
- **Ambiguous**: Open to more than one interpretation; having a double meaning; able to be understood in more than one way; having more than one possible meaning; not expressed or understood clearly.
- **Derive or Impute**: Assign (a value) to something by inference from the value of the products or processes to which it contributes; to deduce a conclusion about some fact using some other fact or facts and logical reasoning.

Machines do well with information which is explicitly provided. When information is not explicitly provided, software developers either make a choice or have to figure out ways to allow a business professional making use of the software to make a choice. Every time a software developer or business professional has to make an interpretation because something is ambiguous, there is the possibility that some unexpected or incorrect interpretation can be made. Not being explicit causes confusion and turns using ambiguous information into a guessing game.

Business Rules Should Be Controlled and Maintained by Business Professionals

Business professionals create and maintain business rules. As Article 9 of the *Business Rules Manifesto*[70] states, business rules are of, by, and for business people; not information technology people.

- 9.1. Rules should arise from knowledgeable business people.
- 9.2. Business people should have tools available to help them formulate, validate, and manage rules.
- 9.3. Business people should have tools available to help them verify business rules against each other for consistency.

Rather than creating tools that only information technology professionals can use because the tools are so complicated; business professionals need to demand software tools that properly expose functionality that exposes business rules to business users such that business users are working with business domain knowledge, not technical details that should have been buried deeply within the software applications.

Business professionals need to understand the *Law of Conservation of Complexity*[71] which states that complexity can never be removed from a system, but complexity can be moved. The *Law of Conservation of Complexity* states: "Every application has an inherent amount of irreducible complexity. The only question is: Who will have to deal with it - the user, the application developer, or the platform developer?"

Categories of Business Rules

At their essence, business rules articulate information about something or about the relationship between one thing and some other thing. Some examples that can help you better understand exactly what business rules are:

- **Assertions**: For example asserting that the balance sheet balances or "Assets = Liabilities + Equity".
- **Computations**: For example, calculating things, such as "Total Property, Plant and Equipment = Land + Buildings + Fixtures + IT Equipment + Other Property, Plant, and Equipment".
- **Constraints**: For example, specific behavioral constraints that control when it is appropriate to create, update, or remove information.

[70] *Business Rules Manifesto*, http://www.businessrulesgroup.org/brmanifesto.htm
[71] Understanding the Law of Conservation of Complexity, http://xbrl.squarespace.com/journal/2015/5/24/understanding-the-law-of-conservation-of-complexity.html

- **Continuity cross-checks**: For example, if a fact is use that fact does not conflict with or contradict other facts.
- **Process-oriented rules**: For example, the disclosure checklist commonly used to create a financial statement which might have a rule, "If the line item Property, Plant, and Equipment exists on the balance sheet, then a Property, Plant and Equipment policies and disclosures must exist."
- **Regulations**: Another type of rule is a regulation which must be complied with, such as "The following is the set of ten things that must be reported if you have Property, Plant and Equipment on your balance sheet: depreciation method by class, useful life by class, amount under capital leases by class ..." and so on. Many people refer to these as reportability rules or statutory and regulatory compliance requirements.
- **Instructions or documentation**: Rules can document relations or provide instructions, such as "Cash flow types must be either operating, financing, or investing."
- **Relations**: How things can be related, such as whole-part relations. For example, how the business segments of an economic entity are related.

Scaling Business Rules

Managing business rules becomes more complex as the number of rules increase. Scaling business rules is important. Using a decision model based approach can help manage large sets of business rules. The article, *How DMN Allows Business Rules to Scale*[72] points out four primary problems that you run into:

- **The 'Rush to Detail'**: Business rule development encourages policy makers to focus on rule implementation prematurely, before they have considered the broader goals and structure of their business decisions and to what extent they will be automated. This approach is like starting to build a house by laying bricks, rather than drawing plans and establishing foundations.
- **Poor Dependency Management**: A growing and poorly understood set of inter-dependencies between rules causing changes to have unintended consequences—making the rule set brittle and reducing its agility.
- **Insufficient Transparency**: The bewildering size of a rule set, use of technical (rather than business) terms and style for expressing rules and a poor connection between rules and their business context (their rationale and place in the business process)—making the meaning and motivation of rules more obscure.

[72] Jan Purchase, *How DMN Allows Business Rules to Scale*, November 19, 2015, http://blog.luxmagi.com/2015/11/how-dmn-allows-business-rules-to-scale/

- **Lack of Growth Management**: Poor discipline about the scope, quality and placement of rules that are added to the rule set—making it hard to find rules and leading to 'stale' rules and duplicates.

Separating Business Rules from Code

Historically, business logic and application logic have been intermingled in software algorithms. Whenever business logic changed, it took a programmer to make the change in business logic in software algorithms. To do that, business professionals had to explain the new business logic to programmers then programmers would need to make the change in algorithms.

But that is changing. Business logic and application logic should be separated. Business professionals should be able to control business logic and change aspects of how software works by changing the business logic as business needs dictate.

Separating business logic from application logic is achieved by representing business rules that control the business logic of software in machine-readable form that is understandable by and under the control of business professionals. Then, a different type of software can be created and used; a business rules engine.