Redefining 'Useful Life' – An Energy Consumption Method Emerges from the CC/DS Environment

Stanley X. Lewis
Troy University

James Scott Magruder
The University of Southern Mississippi

Dena S. Mitchell
Troy University

Carl Smolinski
Louisiana State University-Shreveport

Eddy J. Burks
Consultant

A redefining of the underlying concept of "useful life" in the depreciation and costing is a result of the changes driven by advancements in the application of technology emerging from the Cloud Computing and data storage environment. Cloud Computing has found success in being an integral structural improvement used in business to improve efficiency and effectiveness as well as to manage costs. Data Storage has proven an equally successful tool in managing the expanding data captured and used in data analytics by companies. Beyond these influences a new approach to existing accounting methods can become a fundamental change which will lead to improved actions in decision making and external reporting for financial and taxation purposes.

The Environment & Change Agent (Technology)

A simple scenario shows that traditionally, decisions by a company result in the acquisition of needed assets in manufacturing, office operations, information systems, etc. Capital assets are acquired and related operating expenses are incurred and accounted for by a business using existing, long-standing accounting concepts. One cost which will be highlighted in this scenario is that of utility costs for the energy to run the equipment and manage the company infrastructure. The infrastructure is the technology and all equipment used by the company. Under existing assumptions or concepts capitalized costs are depreciated over an estimated useful life based upon the anticipated life of the asset measured in years and months of productive service. If the estimated useful life changes methods are used to re-calculate

depreciate expenses. As equipment is used, a decline in efficiency occurs through our recognition of depreciation.

One could argue that a decline in efficiency over usage of the infrastructure further leads to an increase in the energy consumption and thus, – higher utility costs. Businesses will use trend and usage analysis including variance analysis to understanding the relationship between declining efficiency as the equipment ages versus the increasing costs of energy consumption due to that inefficiency.

Suppose there is a way to significantly make better decisions, improve financial reporting and even better match expenses to revenues for determining taxable income while improving our effort to correctly match revenues with expenses. The change factor is "usage." Perhaps energy consumption is a better measure of usage than the historical assumptions based upon a calendar.

The Enabler – Advancements in Cloud Computing & Data Storage

An examination of Cloud Computing and its impact on traditional methods used in both accounting and taxation permits a reconsideration of underlying assumptions such as "useful life" concepts due to advancements in the application of technology to business. A general working definition of Cloud Computing (CC) is that it is the technology which provides online/Internet hardware, software, and network infrastructure as a substitute for the traditional acquisition of these items by a business. Data Storage (DS) can generally be defined as a related application which enables a business to capture and store data and perform data analytics through the CC environment.

The question to be identified and addressed is 'what impact does CC have on accounting?' Let's begin with one vendor's definition. Microsoft describes the CC environment in the following definition as "the delivery of computing services-servers, storage, databases, networking, software, analytics, and more- over the internet (the cloud)." [Microsoft]

The cloud provider can allocate and thus "spread out" the cost for the technology (servers, etc.) and of electricity over all clients. The costs are charged to cloud clients but an economy of scale results by all costs being incurred through a collective acquisition of energy. We know this traditionally as volume buying to receive price discounts. The alternative is that individual company costs could be higher if the company acquires lower quantities of energy and does not receive the same volume price discounts. The logic applies also to the acquisition of equipment for use internally in the business.

In the cloud environment a business establishes a contract with the cloud provider to obtain services which are the same as a traditional networked system maintained by the company. The contract generally includes: cloud availability 24/7 and 365 days a year, penalties if the cloud goes down, and a purchased level of data storage (DS) capacity with the cloud services.

From the resulting usage of CC/DS the company reduces its dependency upon the internal network system infrastructure replacing it with operating in the cloud. What happens if more computing capacity/storage amounts are needed (on-demand); how much does the contract change? In general terms more services result in the contractual price increasing. This change is described in terms of changes (and price) of capacity, operating speed, security, etc. For our scenario we could assume that security issues should be addressed by new (different) contractual terms. Is this based upon full knowledge of the improved security services? Does the user of CC/DS know or understand what technologies are used in the cloud? They don't need to as long as they have access to their data (and computing availability) and the data are secure.

While migrating to the CC/DS environment may reduce some of the company's costs, it may also increase other costs. This is why CC/DS usage analytics are useful. The analytics/monitoring allow the organization to continuously monitor their cloud account, the organization may also want to have more than one cloud provider. [Teevity,1] One issue is that cost savings may not occur when using a specific provider. A company's usage level is such that higher costs are passed along through the contract and while the operating environment has changed there is no actual change in costs. Thus, by monitoring and measuring costs of the "unused-capacity" a better decision can be made. [Teevity, 2] Energy consumption monitoring has been part of our regulatory environment since 2010. Guidelines for

monitoring consumption exist and have led to tax incentives (discussed below) but also to an awareness of the importance of monitoring and analysis of energy consumption. [Energy]

Comparative Capital Decision Considerations

There may also be a way to use some of this monitored information as a depreciation-type measurement comparative method, much like a comparison of purchase versus rent of equipment or acquisition and internal operation of assets versus the outsourcing of services. For instance, if the CC/DS contract has a built-in pass-through clause to bill energy cost increases without additional technology services being added or a change in usage then comparative monitoring is necessary to a business. Rate increases by electric providers occur in our society. This is simply an awareness that even if we operate in the CC/DS environment electric rates can increase and be passed along to a company under contractual agreements. However, rate increases might be an indicator that some of the CC/DS provider's technology is becoming inefficient. In the CC/DS environment the contractual obligations guide decisions. Are the increased energy costs to be passed-through to the business or will they be absorbed under a contract by the CC/DS provider? In essence, do we have valid electric cost increases due to increases between the electric company and the CC/DS provider or do we have an increase in costs due to inefficiency in the CC/DS provider's infrastructure? As with any outsourcing activity, the business, both through its technology department or internal audit staff, should investigate the source of cost increases and determine any contractual cost allocations and/or eventual contract modifications upon a renewal for services. This type of monitoring and measurement should apply to a CC/DS, a separate DS host for data storage for the company, and should extend beyond the contractual partner to sub-contractors for either the CC or DS or a set of providers.

Let's turn to our hypothetical business and start with how efficiency is achieved if a business operates outside the CC/DS environment. In the past, a business would often use one server for one task. Through the accountant's eye each server was a capitalized asset to be depreciated and used over its useful life measured in years and months. We learned this was very inefficient and our technology department implemented improvements as hardware and software advancements became available. Our business would generally use multiple servers which were purchased and depreciated, each one dedicated to a specific function within the corporation. Likely each networked together and linked to the online/Internet world with a separate IP address. Another advancement introduced an improvement designed to reduce the number of servers, known as the technology of virtualization. In the technology of virtualization, one physical server is "divided up" into more than one area in RAM memory. Each area in RAM acts as if it is a separate computer. A user could access an e-commerce site on the server, and not be aware that there may be different e-commerce sites on the same physical server. Each virtualized site would have its own IP address. This is more efficient than using one physical server for one task; in addition, the business increases its network efficiency. Each virtual server within the physical server could run its own operating system and applications. These virtualized instances are managed by a Hypervisor. [Ferro] Table 1 may help explain:

TABLE 1
DIVISIONS OF THE OPERATING SYSTEM

Hypervisors	Containers
The hardware level is virtualized	The operating system is virtualized
The operating system is abstracted from the hardware	Applications are abstracted from the operating system
Each instance takes up storage space	Only one storage space (plus or minus) is used to allow a layer to execute
Takes a while to boot the operating system	Boots very quickly

*The above table is a summary of information from Ferro [Ferro]

The operating system is virtualized as a container or bucket. [Butler] Containers execute under the host operating system. Hypervisors allow more than one operating system to execute on the physical server (hardware). Both Hypervisors and Containers have appropriate usages in different situations. [Butler]

Comparative Energy Expense Decision Considerations

"It's no secret: data centers (DS) are consuming more energy than ever before. In fact, they are the fastest-growing consumers of electricity in the United States." [VMTurbo] This is why the CC/DS environment must be constantly monitored. Underutilization (with the assumption that virtualization is used in both environments) of data storage is a major problem. [VMTurbo] One aspect of the move to cloud computing is to move parts of (or all of) a company's data storage to the cloud. Thus, organizations need to monitor their data storage(s) and their cloud(s).

"VMTurbo helps you use existing hardware more efficiently—safely packing higher workload densities, reducing overhead and saving energy." [VMTurbo] This brings up again the concept of virtualization and usage of containers. The business can use Hypervisors and/or Containers in its data storage, as can the provider of a cloud computing operation. Comparisons between the two alternatives will occur for a business to determine which meets its needs. The trend is a migration toward the CC/DS environment.

"Data centers are responsible for between 1.1 and 1.5 percent of global energy use (compare that to transportation at 25 percent), and Google's data centers are less than a percent of that." [Hölzle] "According to a recent report from Pike Research, continued adoption of cloud computing will have major implications on both data center "energy consumption and greenhouse gas emissions." [Hickey]

Now let's return to DS security since it is very important for data in the CC/DS. Implementing security may lead to additional energy costs. However, this can be minimized since the cloud provider is providing security for multiple clients. [Lin] Our collective volume purchase of energy and the potential rate increases discussed now enter into our monitoring/analytics of the CC/DS contractual payments from our business.

Consideration of the monitoring/analytics includes our knowledge that energy used by a PC, virtual machines in a server, etc., can be measured or approximated [Microsoft Research][O'Reilly]. This means that the energy used by an application, virtual machine, laptop, desktop and server can be measured. [Microsoft Research] This measurement may be used to determine when one of the above are becoming less useful, i.e., as a consideration that the measurement of depreciation needs to be adjusted. As the energy usage increases, then the efficiency of the technology is decreasing (thus the usefulness is measured using a basis other than years and months.)

Improving Measurement & Reporting

Could we set up a system where a client could use more than one CC/DS and thus migrate between them? Can we view CC/DS services as we do other purchasing decisions and allow our company to select between purchasing capital assets and using assets not shown on the balance sheet – outsourced services including the infrastructure used? Could we establish a method by which we use energy as the useful life based upon consumption of energy rather than an arbitrary year and month method? Do we see emerging from the impact of the CC/DS environment an alternative measurement and improved measurement for depreciation?

With the overview of considerations described in the previous section, the accounting model can be improved due to the CC/DS environment and the model then becomes more useful and consistent with the role of providing financial data used by decision makers and external parties including regulatory and tax agencies. One begins by recognizing the need to ask, "it is possible that cloud computing adoption may be limited by the structure of accounting principles." Some say this will occur, because this new rule "…will make it harder to capitalize the cost of cloud set-up and implementation costs…" [Dix] Instead, organizations may continue with the status quo. [Dix] Accounting for depreciation evolved from the Conceptual Framework structure and is thus a rule-focused approach. Areas of reporting and usage in

accounting are shown internally to the company in our simple scenario and work toward the external reporting aspects of a redefinition of 'useful life.'

Energy-Based Analysis

Existing cost measures and methods for internal accounting can be supplemented or replaced by one in which energy cost is the key cost-driver. The role of managerial accounting is to use multiple cost measurement methods for internal decision making. Accountants begin with the traditional cost variance analysis related to direct materials, direct labor, the allocation of overhead and the easy assumption from its inception that these variances were designed primarily for a manufacturing company. Variances are straight-forward and useful in many internal decisions for a company. These concepts have also been adapted to non-manufacturing business situations to allow companies to analyze the costs used in delivering all types of products and services. Constant in this traditional costing effort is that depreciation, capitalization, outsourcing, expenses and many other decisions are based upon the defining of 'useful life' measured in years and months. Yet from business one knows of examples such as a hospital which replaced inefficient equipment, and pushed it to the side of a room until its depreciation was used up for financial and tax purposes.

A more integrated approach such as Activity-Based-Costing (ABC) evolved through efforts to better analyze costs over a broader (improved) view of multiple operations undertaken to produce, sell, and deliver products and services. ABC offered advantages over the traditional job-order and process costing which involved traditional product costing methods which evolved from the concept of full absorption costing used in financial accounting. Datar and Rajan describe activity-based costing as follows:

> "Activity-based costing (ABC) refines a costing system by identifying individual activities as the fundamental cost objects. An activity is an event, task, or unit of work with a specified purpose – for example, designing products, setting up machines, operating machines, and distributing products……. To help make strategic decisions, ABC systems identify activities in all functions of the value chain, calculate costs of individual activities, and assign costs to cost objects such as products and services on the basis of the mix of activities needed to produce each product or service."

The accounting profession accepted (applied) the "new" method as it began to rethink how internal costing should be monitored and analyzed and how this effort could be improved. Perhaps it is time to add another new method as we recognize the impact of the CC/DS environment on business decision making. Let's consider the impact of a redefinition of 'useful life' on the traditional cost analysis presented below:

Direct Materials + Direct Labor + Manufacturing Overhead Allocated
= Total Product Cost (1)

Depreciation of equipment is included in Manufacturing Overhead being allocated to product costs. However, if engineering data exists which can monitor energy consumption by machine and thus equate it to units produced by a machine then depreciation should not be allocated. The analysis should appear as:

Direct Materials + Direct Labor + Direct Energy Usage +
Manufacturing Overhead Allocated = Total Product Cost (2)

Consider where the cost analysis changes and the improved costing which results:

- The depreciation costs in Manufacturing Overhead are divided based upon engineering data to more accurately identify direct costs of production.
- A redefining of direct vs indirect costs occurs.
- An improved measurement of product costing held in inventory results.

- Establishes a more accurate measure of variable costs by adding the new variable energy consumption cost to the typical variable costs identified: direct materials, direct labor, and variable overhead. This reduces the allocation of indirect overhead which often includes depreciation based upon the traditional useful life criteria.
- Potentially changes the conversion cost basis for product costing. Consider that if energy costs are the significant costs for operations using robotics and a reduced labor force, energy could become a better allocation basis than direct labor which has been replaced by robotic and artificial intelligence (energy consuming) tools.

Energy-Based-Analysis becomes a model in which all costs are better matched based upon the underlying usage of energy for technology-driven assets. A new perspective has been introduced into the internal decision making of the business. It does not replace or modify existing methods including ABC; however, it does allow a business to measure costs based upon energy consumption rather than based upon a series of related activities. Energy consumption underlies all decisions made; from the acquisition of capital assets, to migration to the CC/DS environment, from the mix of CC/DS services required to meet our needs to improve the business profitability, to when to consider acquisition verses outsourcing operations. The sophistication of software used for product design and development, retooling of machines or replacing machines with the new electronic equivalent of "tool dies," improved robotic operations and simple replacement because a new machine in any area of a company proves to be one made with the consideration that a new machine reduces energy consumption and is more efficient. The key feature is the use of engineering data to measure energy consumption and a change in equipment efficiency. In other words, to use this data so better decisions can be consistently made on whether it is economical (profitable) to purchase, migrate to the CC/DS environment or switch within the CC/DS world using energy cost as the key cost-driver and defining usage in energy consumption.

Energy-Based Reporting

When reporting to external users and tax agencies, at year end for purposes of improving the bottom-line income figure or to take advantage of the latest change in the tax code, a business reconsiders acquisition and tax strategies. This can be easily described with our simple scenario used before with a generic business. The business takes off-line equipment no longer efficient and replaces it with new equipment. However, depreciation has not yet expired for tax (and accounting purposes) so the equipment is set off to the side or in a storage area until its depreciable life has expired. In theory it is no longer in productive use. In reality it is useful in lowering reported income for financial and tax purposes. Improving the accuracy of the year-end strategy should be the goal of all businesses by having decisions made based upon an energy useful life as its basis. Depreciation expires, the asset is removed from productive use, income remains consistently determined and taxable income is based upon financial depreciation (energy usage).

Financial Reporting

A review of the FASB Standards Codification (FASB) provides the underlying accounting assumptions regarding depreciable assets. Section 360 (10) (35) defines the measurement expectations under Generally Accepted Accounting Principles (GAAP) as:

> "This procedure is known as *depreciation* accounting, a system of accounting which aims to distribute the cost or other basic value of tangible capital assets, less salvage (if any), over the estimated useful life of the unit (which may be a group of assets) in a systematic and rational manner. It is a process of allocation, not of valuation." (FASB 2016)

The measurement and recording of depreciation cost is related to the issues of product and period costing. Depreciation is based upon an asset's useful life and is reported either as an allocated cost to inventoried assets through the allocation of manufacturing overhead or traditional depreciation expense for non-manufacturing related capitalized assets and thus is reported by selecting a useful life measured in years and months. In fact, all allocation through depreciation as defined as based upon the assumed measurement of a useful life in years and months. By doing so the allocation method allows for a

selection from multiple depreciation methods ranging from straight-line to double-declining balance to match expense to revenue in a manner which is advantageous to the business.

However, using energy consumption (usage) based upon engineering data related to machine usage and energy consumption the matching of depreciation and revenues becomes a more accurate result. An improved result would be one in which actual usage in operations (manufacturing and non-manufacturing) is based upon a consistency between actual criteria in decisions made to acquire, use, replace, upgrade, and/or outsource (CC/DS or traditional outsource activities) and the measurement of the results of those criteria used in financial reporting. Inventory costs under full absorption costing are measured more accurately. Capital asset depreciation is determined under a more viable usage basis.

Tax Depreciation

Depreciation for income tax purposes is no longer based upon the original useful life assumption established under the conceptual framework and described in Generally Accepted Accounting Principles. Congress created its own arbitrary useful life model labeled the Modified Accelerated Cost Recovery System (MACRS) in 1986.[Wolters Kluwer] Congress has also demonstrated through various changes to the tax code that the concept of a useful life is arbitrary and subject to change. Some examples are:

- Energy Policy Act of 2005 (EPACT) offered businesses tax deductions for the costs of improving the energy efficiency of commercial buildings. [Public Law]
- Emergency Economic Stabilization Act of 2008 extended provisions in EPACT to provide the following tax incentives:
- Deduction of the Cost of Energy-Efficient Property Installed in Commercial Buildings
- Extension of Energy Investment Tax Credits, and
- Accelerated Depreciation for Smart Meters and Smart Grid Systems [Tax Advisor]
- Tax Cuts & Jobs Act of 2017 provides for replacing current depreciation 'bonus' provisions with a 100% depreciation decreasing by 20% each year beginning in 2023. The same Act provides for increasing Section 179 depreciation deduction for small businesses to up to $1,000,000. [Tax Policy Center]

The tax code defined useful life perspective could be eliminated by linking usage to reduced energy savings/consumption levels and thus the energy tax credits above and other enacted energy provisions in the tax code could cease to be an issue to consider when deciding changes in the code. Energy usage is a more effective basis for determining tax liability in that it mirrors the reality of business decisions made related to the profitability of the business. By using engineering advances to monitor and analyze efficient usage and thus energy consumption taxable income becomes consistently defined under political and economic policies in the financial reporting effort. Removed is the arbitrary establishment of a useful life for a capitalized asset, replaced with an energy usage method.

Conclusions

Technological advances emerging from the CC/DS environment provide business with an opportunity to use energy usage rather than an arbitrary useful life concept in the allocation of cost for internal product and pricing decisions and reporting to external financial and tax users. In a rapidly expanding CC/DS environment for all businesses there exists a need for a more relevant measure of the equipment cost allocation. Historical financial and income tax depreciation methods provide engineering - based monitoring/analytical approach based upon a common factor – energy usage or consumption. CC/DS development and acceptance generated a new perspective by opening up the use of energy consumption as the "useful life" measurement basis whether for migration to the CC/DS environment, investment in new replacement internal network infrastructure, or year-end financial and tax strategies. By doing so CC/DS removes the need to continue with a year and month useful life assumption begun when technology did not exist. Improving the consistency between internal managerial accounting, financial accounting, and tax accounting could also streamline the accounting activities resulting in additional efficiencies.

REFERENCES

Butler, B. (2014, September 3). FAQ: Containers. NetworkWorld, Cloud Chronicles. http://www.networld.com/article/2601434/cloud-computing/faq-containers.html Downloaded 1/29/2016.

Datar, S. M., & Rajan, M. V. (2014). Managerial Accounting: Making Decisions and Motivating Performance; Pearson, Bost, MA. p.213.

Dix, J., & NetworkWorld. (2014, September). Will new accounting rule slow adoption of cloud computing? http://www.networkworld.com/article/3026123/cloud-computing/will-new-accounting-rule-slow-adoption-of-cloud-computing.html, January 25, 2016, Downloaded 1/28/2016.

Energy.gov, https://energy.gov/eere/amo/manufacturing-energy-and-carbon-footprints-2010-mecs

Ferro, G. (2014, September). Basic – Docker, Containers, Hypervisors, CoreOS, 2nd. http://etherealmind.com/basics-docker-containers-hypervisors-coreos/ Downloaded 1/29/2016.

Hickey, A. R. (2011, September 20). Cloud Services Axe Data Storage Energy Consumption, Power Costs, CRN. http://www.crn/print/news/cloud/231601736/cloud-services-axe-data-storage-energy-consumption-power-costs.htm". Downloaded 12/21/2015.

Hölzle, U. (2012, September 23). NYTimes.com. Cloud Computing Can Use Energy Efficiently. Downloaded 12/21/2015. http://www.nytimes.com/roomfordebate/ 2012/09/23/informations-environmental-cost/cloud-computing-can-use-energy-efficiently

Lin, Z. (2012). Cloud Computing Saves Energy Cost for Security", Updated September 23, 2012, NYTimes.com, http://www.nytimes.com/roomfordebate/2012/09/23/information-http://www.nytimes. com/roomfordebate/2012/09/23/informations-environmental-cost/cloud-computing-saves-energy-cost-for-security." Downloaded 12/21/2015.

Microsoft. What is cloud computing? Remove limits on your business. http://www.microsoft.com/em-us/server-cloud/solutions/cloud-computing.aspx?WT.srch=1 Downloaded 1/29/2016.

Microsoft Research. Joulemeter: Computation Energy Measurement and Optimization, http://reasearch.microsoft.com/en-us/projects/joulemeter, Copyright 2016 Microsoft. Downloaded 2/2/2016.

O'Reilly, D. (2014, April 15). Calculate4 your PC's energy use. http://www.cnet.com,how-to/calculate-your-pcs-energy-use/?_escaped_fragment_=#1. Downloaded 2/15/2016.

PUBLIC LAW 109–58—AUG. 8, 2005, https://www.ferc.gov/enforcement/enforce-res/EPAct2005.pdf

Tax Advisor. https://www.thetaxadviser.com/issues/2009/ jan/ effectsofemergencyeconomic stabilizationactprovisionsonindividuals.html

Tax Policy Center. http://www.taxpolicycenter.org/feature/analysis-tax-cuts-and-jobs-act, 2017

Teevity. Cloud usage analytics made simple." Http://www.teevity.com/ downloaded 12/21/2015.

Teevity. Cloud costs efficiency", Http://www.teevity.com/cloud-cost-optimization.html, downloaded 12/21/2015.

VMTurbo, email received April 22, 2015 from <emma@vmturbo>

Wolters Kluwer, 2017 U.S. Master Tax Guide, sub-section 1238