**Proceedings of the ASME 2020**

**International Mechanical Engineering Congress and Exposition**

**IMECE2020**

**November 16-19, 2020, Portland, OR, USA**

**IMECE2020-23015**

The Innovation Bank: Blockchain Technology and the Decentralization of the Engineering Professions

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**Abstract**

According to Nobel Laureate Robert Solow, 80% of economic growth can be attributed to technological innovation (i.e., science and engineering).  Our problem is that intellectual and creative capital, essential ingredients to innovation, are difficult to measure in situ and are thus often relegated to the “intangible asset” column of the balance sheet. It is much easier to measure changes in the utility of land, labor, and capital as factors of production per the Adam Smith, David Ricardo school of economics. Our opportunity is that modern advances in social platforms, artificial intelligence, and blockchain technology may now provide engineers with the tools to directly measure their social capital, creative capital, and intellectual capital and our specific impact on economic growth. This paper outlines an economic paradigm where value is expressed in terms of “risk removed from complex physical systems” and how this metric may serve as an equivalent, if not superior, factor of production to augment land, labor, and capital utility. This assertion is both appropriate and necessary because systemic risks in the world today, such as climate change, social inequality and pandemics, perpetrate and devalue land, labor, and capital allocations. As with most novel ideas, the implementation of this new economic paradigm is easier said than done. Our success hinges upon the successful reorganization of the engineering and scientific communities.

**Keywords:** Blockchain, engineer, knowledge, innovation, bank, economics, tangible, value, risk.

**Nomenclature**

*B* sensitivity to market volatility $

*D* databits/block

*E*(*R*i) expected rate of return $

*E*(*R*m) expected market return $

HV hierarchy value $

*i* information bits/block

*I* innovation bits/block

K knowledge bits/block

*n* number of network nodes

NV network value $

*R*f risk-free rate of return $

TIB the innovation bank

V value $

W wisdom bits/block

1. **INTRODUCTION**

The engineering professions are segmented in ways that have little to do with the physical laws upon which they have been built. Engineers are segmented by state laws, national boundaries, insurance pools, academic majors, and corporate veils. An engineer that works for Boeing cannot easily work for Bechtel even though building systems and aircraft systems have more in common than not. Rather, one would encounter two industries with a different set of semantics that divide them. A mechanical engineer and an electrical engineer often work from different silos even though few examples exist of purely electrical or purely mechanical systems. Software engineers are not considered by some to be “real engineers” despite the fact that all engineers depend on software engineers, and vice versa.

The problems of the future will require precise and proximate application of diverse combinations of knowledge assets. Today, engineers are confined by the necessity for so-called “innovation” to be translated onto a business template for some 3rd party intermediary that is often not an engineer. There is no common ontology that articulates the engineer’s direct economic interaction with the real physical world. The engineering profession is like an orchestra without a conductor.

**1.1 The invisibility paradox**

By example, a firefighter has little value until there is a fire, then the firefighter is instantly worth millions of dollars per hour preserving life and property. By contrast, fire protection engineers can design buildings that will not burn. But their value is difficult to measure in the absence of the fire. The value of the engineer becomes commoditized at wages that likely fail to attract sufficient quantities of new and diverse entrants. Dr. Robert Solow goes on to suggest that the value of [engineers] is incorrectly attributed to more visible factors.

In reality, engineers and scientists remove risk from complex physical systems such as buildings and airplanes and computer programs – that is their superpower. In the right form, risk is a relatively simple quantity to measure and manage as a tangible financial instrument.

There is nothing inherently wrong, unethical, or immoral with the above arrangements – only that none of these things have anything to do with natural laws and an enormous amount of operational friction must be overcome with each and every advancement of the profession. The Innovation Bank business method seeks to correct these flaws by aligning the tangible economy with the intangible economy, thereby transforming both.

**1.2 The Innovation Bank**

The Innovation Bank (TIB) integrates and capitalizes knowledge assets. TIB is an application of game theory, a simple proof-of-stake (native) blockchain, and actuarial math. TIB is a decentralized network of individual engineers and scientists incentivized to form data *D*, information *i*, and knowledge, *K* asset networks among themselves from which innovation, *I* and wisdom *W* emerge. This network is expressed upon a decentralized ledger comprised of individual claims made by one individual practitioners, which become immutably paired to corresponding validation of those claims made by other practitioners in the network. Each pairing forms a single node with two branches constituting a knowledge asset - “*K* asset.” The aggregate network of *K* assets forms independently of jurisdictions, corporations, or ontological silos thereby eliminating related brokerage and semantic friction. The intrinsic motivation of the practitioners is to accumulate an individual private transaction record of validated claims and claim validations that convert one’s résumé to form a public key. For the non-practitioner, a *K*-asset network of sufficient density would yield extraordinary monetizable “business intelligence.” As the “game” progresses via an increasing number of validated claims, originators of the original claims are rewarded in a manner similar to how a royalty, dividend, or annuity is paid.

TIB addresses five fundamental ideas:

* What is a blockchain and why is it important?
* The formation of the K asset.
* Network value vs. hierarchy value
* The value game
* The WIKiD tools algorithm

**1.3 What is a Blockchain and why is it important?**

Despite the solidity that the name implies, a blockchain is software. Blockchain exists because computers are very good at copying data, and poor at not copying data. Without blockchain, things like contracts are difficult to execute since either party can modify the terms and neither can prove which is the valid contract without a 3rd-party intermediary such as a bank, broker, lawyer, escrow service, etc. In other words, a blockchain replaces intermediaries. The economic implications are obvious.

A second and more interesting vector for blockchain can be described as blue sky / green field applications: a discovery of the things that can only be done with blockchain that could never have been viable without blockchain. This is the focus of The Innovation Bank.

The mathematics governing blockchains can be daunting. For illustrative purposes, a blockchain is to information what a check-valve is to water or what a diode is to electricity. Just as a world without check valves or diodes is nearly unimaginable now, reflect on how primitive our present “blockchainless” world will appear once TIB permeates the engineering and scientific disciplines.

**1.4 Blockchain as a time function**

It is not a trivial task to render a computer unable to copy data. Consider a high-security penitentiary where one must pass a series of steel doors in order to exit. The doors are on timers so that the door behind must be closed before the door in front opens thus creating a one-way prisoner flow. If spy movies, synchronization of watches is critical to mission success. In navigation, all GPS satellites must agree on the time to within nanoseconds. The same is true of stock market transactions. In engineering calculations, gravity, viscosity, elasticity, pendulum length, diffusion constants and heat transfer coefficients dictate time constants. Blockchains serve the role of the conductor to the orchestra providing consensus to the valid time interval within which decentralized events are coordinated.

**1.5 What are tokens and why are they valuable?**

Consider the door actuation in the previous example, every time a cycle is completed, a blockchain produces an electronic token similar to a receipt one gets from the Home Depot to memorialize the transaction. A valid receipt can be used to claim a warranty, return the object, exchange for another object, etc. In a very generalized way, the receipt represents value not unlike paper or electronic dollars. With the addition of mutual reciprocity of a community of economic actors, currency can be created. Herein lies both great promise and great problems.

Modern Blockchain technology arose with the advent of Bitcoin and has since been implicated in dubious transactions, epic thievery, and fringe politics. Blockchain has also been rebranded as “Decentralized Ledger Technology” by mainstream firms such as IBM, Amazon, and Microsoft in their broader portfolio of data productivity services mostly without token generating events.

**1.6 The Formation of The K Asset**

Corporate leadership frequently claims: “Knowledge is our greatest asset.” However, few actually treat knowledge like an asset. An asset is generally described in terms of the quantity and a quality of something. An 8-ounce glass of drinking water is a completely different asset than 8-acre feet of irrigation water, yet each possesses a nearly identical formulation.

For the purposes of TIB, a K asset’s node and two branches form when two practitioners create a validated claim. The claim serves as the quantity (definition) and the validation serves as the quality (characteristics) of the node. The blockchain records the asset in time and produces a receipt (token(s)) issued to each participant. This is the fundamental unit of value formed by TIB.

Various combinations of K assets yield products, services, and solutions for mitigating systemic risk.

**1.7 Network value (NV) vs. hierarchy value (HV)**

Modern warfare demonstrates that a large command and control military (HV) is inefficient against a collection of semi-autonomous terrorist cells (NV). Modern platforms such as Google, Facebook, and AirBnB, take advantage of such network effects enjoying astronomical market valuations despite having few hard assets. Their value is derived from their NV, thus exposing the weakness of conventional HV seen in conventional corporations such as GM, GE, AT&T etc.

**1.7.1 Hierarchy** The value of legacy business structure is expressed in terms of market demand and sensitivity to risk as expressed by the Capital Asset Pricing Model (CAPM).

E(Ri) = Rf + Bi (E(Rm) - Rf) (1)

where *E*(*R*i) is expected rate of return on capital amount, *R*f is risk-free rate of return, *B*i is sensitivity to market volatility, and *E*(*R*m) is expected market return. The CAPM valuation model for an organization is dominated by market risk multiplied by a firm's sensitivity to market risk and is largely a linear function except where monopoly or some duopoly conditions exist.

**1.7.2 Networks**A network is characterized by a collection of nodes and branches connecting nodes. The value of networks is a function of the total number of nodes and the total number of possible connections that can be completed between them multiplied by some coefficient of value for the quality of those connections.

Metcalfe’s law for networks suggests that the theoretical value of a network will be proportional to the square of the number of nodes according to the following relationship. Theoretical value V(t) is proportional to:

V(t) : n(n - 1) / 2. (2)

This value asymptotically approaches exponential growth as the square of the number of participants in the system.

The actual value would be related to the quality of the nodes, the actual number of existing branches, and the net quality for the transactions that transpire over the network.

For Example, the value of a network platform such as Facebook, Airbnb or even BitCoin is often estimated with Metcalfe’s Law of Networks[[1](#_ENREF_1)]. Simply stated, the theoretical value will be proportional to the square of the number of nodes in the network by the following relationship.

*V*(*t*) : (C) × *n*2 , (3)

where C is a constant of proportionality. For example, the market capitalization value of Facebook (2015) may be calculated as follows:

*V*(Facebook) = (5.70 × 10-9) x *n*2, (4)

where *n* is the total number of users, and 5.70 x 10-9 is the average value assigned to each of their 1.5 billion users (2015) This is an incredibly small number that represents the raw value of an incredibly large number of users, squared - the product of which established the stock price.

Engineering network would have a similar relationship when arranged in a network, except an engineer may yield very high value information. When this number is multiplied by the square of the number of colleagues in the network, the valuation of an engineering network may also become very large. The value for the engineer’s constant would be proportional to the amount of risk removed from a system.

Social Media platforms derive value from creating “digital roads and bridges” that connect large populations of people. We now have the means and methods to assess real roads, bridges, and infrastructure by NV and thus prioritize and capitalize our infrastructure needs as such.

1. **THE VALUE GAME**

Game mechanics are essential to incentivizing efficient and worthwhile interaction of practitioners. Claimants and validators each receive a cryptographic token in return for forming a valid node and two-branch knowledge asset. On applications such as LinkedIn, the dominant strategy is to accumulate the maximum allowed, albeit, unvalidated “connections”. By contrast, promiscuity on The Innovation Bank could reflect negatively since the connections are immutable – if your validator turns out to be a criminal, this could reflect negatively on one’s transaction record. Likewise, making a claim in which nobody else is willing to validate could constitute an act of mis-information which would likewise reflect poorly on the transaction record. Since a transaction record is cast in time the consequence for abandoning a poor transaction record becomes greater as time advances since the practitioner would essentially need to start over and validate every claim anew.

Transaction records are also critical to the Value Game. A transaction record replaces the Resumé / CV system with a validated set of professional claims. The transaction record may become a public key to open select datasets or opportunities. For example, if someone seeks to access a nuclear power plant, their transaction record must include a specific sequence of claims validated by a community of validators who also possesses a specific sequence of validated claims, and so forth. The likelihood of unauthorized access approaches zero with each layer of specificity.

A value game is a condition in which it is in everyone’s best interest to preserve an asset than to consume an asset. Examples include community associations, condominium associations, and most professional organizations and affinity groups. In this case, the security of TIB is assured by the individual actors in a fault-tolerant network with the ability to isolate aberrations from the central body of data.

**2.1 The WIKiD Tools Algorithm**

The WIKiD Tool algorithm provides a mathematical framework for discerning and measuring intangible assets

**WIKiD stands for**

**W**isdom, **I**nnovation, **K**nowledge, **i**nformation **D**ata

To date, the current definition for innovation is as follows:

*The process of translating an idea or invention into a good or service that creates value or for which customers will pay. To be called an****innovation****, an idea must be replicable at an economical cost and must satisfy a specific need.*

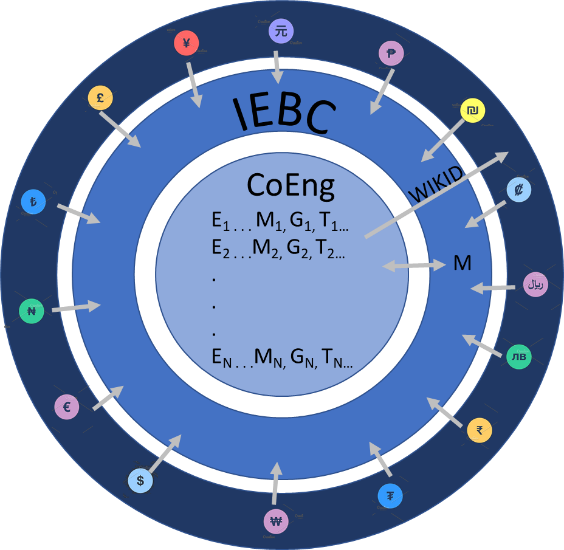
The problem is that this definition presents a single equation with four unknowns, i.e., ideation, utility, value, - and the necessity for mass market adoption. Such a definition cannot be resolved in advance of the supposed outcome. Further, this definition does not provide units in which an innovation may be measured. Each of the other WIKiD elements are defined in a similar imperfect manner. The inability to measure these elements precisely and discretely contribute to their classification as intangible, rather than tangible assets.

Consider the game token called Quant associated with a specific block in time and distributed to practitioners by an immutable ledger upon creation of a complete knowledge asset. As the blockchain constantly creates blocks, say on one-hour intervals, a unit of measurement can now describe participant activity. For example, suppose one practitioner produces one claim or validation every hour. Their productivity can be specified as one Quant per hour. We can now describe the other WIKiD elements as derivatives (and antiderivatives) of the rate of change of knowledge assets.

**2.2 WIKiD definitions**

* *Data are digital strings placed on a ledger related to observations, in a specific unidirectional time sequence.*
* *information is comprised of and is a function a data set or data sets that have been interpreted as a potential asset, i.e. blueprint, algorithm, mechanism, formulation, circuit, structure, etc.*
* *Knowledge is comprised of and is a function derived from an information set or information sets that holds value as defined by risk mitigation*
* *Innovation is the physical manifestation or cybernetic deployment derived from a K asset or a set of K assets*
* *Wisdom is the adoption or rejection of an innovation or set of innovations*

The time function provides the ability to form derivatives. For example, one cannot normally identify innovation before it happens, but one could identify high rates of change in knowledge and use that as a proxy for identifying innovation.  If one needs to identify knowledge in a community, one could similarly audit the network for high rates of change of information among persons as a proxy for the presence of knowledge.  In that manner, the derivatives of the WIKiD tools sequence are useful if given a verified database of information immutably cast in time on a blockchain.  A concept of how WIKiD facilitates the flow of each of the five components from the practitioners to the real world is given in Figure 1.



**FIGURE 1:** PROPOSED STRUCTURE FOR MONETIZING A NETWORK OF “CoEngineers” VIA AN INTEGRATED ENGINEERING BLOCKCHAIN WHREREBY “WIKiD” FLOWS DIRECTLY FROM CoEngineers TO THE OUTSIDE WORLD WITH INSTITUTIONAL CONSORTIUM GOVERNANCE.

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**3. THEORY**

Clearly each of the data levels relies upon the lower levels. Conversely new data is also created from higher levels, so a circular WIKiD economy emerges, each being derived from another:

For example it would be reasonable to assume that if in fact wisdom can be measured, then it likely has a sort of bell curve that rides with the individual (small at birth, large in mid-life, null at death), and we can thus assign a time function to it that is proportional to the product of the amount of extant wisdom innovation the technology or organism has and the amount of innovation the technology or organism has been exposed to:

, (5)

where *t* is the time over which the technology or organism has had to acquire wisdom.

This is clearly a simplification, as we have not considered other resources such as technological energy that the organism has access to [[2](#_ENREF_2), [3](#_ENREF_3)].

By analogy and extension, innovation rate for a given node is a function of prior innovation experience and extant knowledge

. (6)

Moving down the hierarchy, knowledge is a function of information and prior knowledge,

, (7)

information acquisition is a function of both the information content extant within the technology or organism (memory) and the data to which the particular technological or biological node is exposed,

, (8)

Lastly, new data is created at a rate that is proportional to the amount of matter and energy available to informed, knowledgeable, innovative, and likely wise technologies and organisms

. (9)

**4. CONCLUSION**

The process described above, while novel within mainstream engineering culture, is typical and indeed fundamental to network platforms such as Google, Facebook, AirBnB, etc., These platforms simply provide electronic bridges that connect large populations of people. TIB enables engineers to measure their productivity by the same calculus, except with real bridges, highways, and physical infrastructure. These ideas are consistent with the way that money is “created” in a conventional capitalist system. Money is simply a measure of productivity, either *r* or *p*. It is difficult to make money if you cannot measure your productivity. A simple idea that engineers have had difficulty in manifesting for themselves because we are segmented to a point where we are unable to organize under a single ontology.

Blockchains are immutable - information only flows in one direction. The source of media hype surrounding blockchain is reflected by the banking, legal, and business domains where immutability is rare - any transaction can be overturned by a law or a regulation, or a bankruptcy. But engineers are very familiar with immutability; you can’t unpour concrete or return the lumber to the forest. Engineers may prove to be quite adept in this environment.

In a complicated world with complex systemic problems appearing with increasing frequency and interdependence, treating symptoms alone will not mitigate the peril. Engineers must treat the causes of risk that impact these complex systems. This is a battle we can win with modern means, methods, and networked organization.

**ACKNOWLEDGEMENTS**

The authors gratefully acknowledge the support the NSPE in its charter of the Financial Technologies Taskforce and the founders and contributors to the many iterations of this work.

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