Changing the Dialogue

A Series on the New Business Dynamics

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Asset/Equipment Integrity Governance:
Operations–Enterprise Alignment

White Paper

A Case for Board Oversight

Version 1.0

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Integrity is the essence of everything successful.

–R. Buckminster Fuller
1895–1983

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Acknowledgements

This document is not an academic peer review piece. Rather it posits a new approach toward organizational governance (corporate and otherwise). Following the tradition of research, it seeks to build on accepted hypotheses to offer an enhance version of organization governance.

As such, this work is not so much the enlightened position of the author as it is the continuing amalgamation of the sum total of knowledge in this field. The author owes more gratitude that can be repaid to those who came before and hopefully, this argument will further the discussion and others will build upon this model.

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Table of Contents

Table of Figures

Table of Tables

Forward

The twelve months beginning April 2010 may go down in history as one of the most active periods regarding the exposure we all have to critical energy producing infrastructure. In chronological order the following high visible catastrophic incidents changed the way the ***i*** generation views the energy industry.

- BP Deepwater Horizon aka Macondo—commencing April 20, 2010
- San Bruno Pipeline Explosion—commencing September 9, 2010
- Fukushima Daiichi Nuclear Incident—commencing March 11, 2011

It should be noted that recovery from all three events is still underway and will mostly likely take years and many billions of dollars to remediate. Also, all incents have resulted in not just regulatory review and upgrade, but a soul searching assessment of the long term strategies and perceived value to society for each sector. Indeed, a very large price to be paid, post facto.

This is the first draft of a new governance model, extending traditional thinking into field operations. As industry restructures its approach to managing risk at all levels of the enterprise, a new way of thinking about governance is appropriate.

Much has been written about asset management and equipment integrity and it is not our intention herein to review the entire scope of this vast subject. It does appear; however, that in some ways we are putting the cart-before-the-horse. Engineering driven maintenance processes all have their place and there is no argument as to their criticality.

It does appear that from the specific event, BP Macondo in April 2010, a Sarbanes-Oxley like regulatory model is rapidly emerging. This model requires that the Chief Executive Officer "sign off" on field operational processes and that a reliable 3rd party audit these processes. Moreover, this requirement is extended to supply chain partners—very far down the chain.

Given that most CEOs and their Board members are not engineers or were practicing early in their careers, an additional level of exposure is taken on by these individuals. Directors and Officers Liability Insurance (D&O) aside, reputations, careers, shareholder value are not replaceable.

Society is driving these requirements and their rather onerous penalties for non performance on heavy industry demanding it operate in a responsible manner at all levels. Regulatory compliance is a function of the society's wishes for its environment.

Modern governance can be traced back to Agency Theory. When hired management is entrusted with the welfare of organizational owners, it takes the responsibility not just to steward balance sheet assets and knowledge, but to return high, risk adjusted value. In an era when one lower level employee or contractor can put ALL at risk, it is necessary that robust checks and balances drive all the way down an extended enterprise.

The purpose of this paper is to put forth a construct that enables the policies, processes and work procedures required to meet the expectations of not just organizational ownership and regulatory compliance but the rights of the society in which industry operates. Events of this period should never be repeated!

-- Scott M. Shemwell
October 2011

Executive Summary

As a result of the industrial accidents events of 2010 and 2011, there is a heightened sense of awareness of the need for greater scrutiny of operations. The industry is responding in all the usual ways, with a greater focus on safety, work processes, training, etc. What is missing is a new governance model. The Asset/Equipment Integrity Governance (AEIG) model developed herein addresses this gap.

The importance of strong governance with is implication of strong shareholder rights can not be overstated. Management is an agent of the owners. As such it has the fiduciary responsibility to not just be the custodian of shareholder value but to maximize that value.

Sarbanes-Oxley drove a new level of shareholder rights in the aftermath of the debacles at the beginning of the century. As we enter the next decade, operational concerns are now taken to the same level.

AEIG is the new governance model that extends investor concerns of the last decade to the needs of the current owners. Moreover, while comprehensive, it is a model that management can implement quite readily. This document provides interested parties with a detailed roadmap for a sustainable AEIG model that will add significant shareholder value.

The AEIG model is based on four pillars;

- Maturity Level
- Portfolio Management
- Policies & Procedures
- Criticality

Moreover it is built on the Asset Maturity Model (Appendix I) approach to asset portfolio management and the Compliance Management triumvirate (Appendix II).

Owners are demanding hired management to be held to a high standard going forward. Moreover, society is intolerant of future major industrial catastrophes. The AEIG construct with its implementation guidelines described in this work provides the framework of a solution that can be implemented across multiple industry sectors.

AEIG captures all aspects of organizational governance as extended to the supply chain and operations/production processes. It provides management with a quantifiable approach that incorporates the subjective knowledge of the organization and other constituents into a singular model

Transparency, strong management, viable products/services are key performance indicators in the global markets. However, all of these metrics must be demonstrable. Sarbanes-Oxley addressed transparency, customers ascertain product/service viability, and management strength is subjective.

Strong governance demonstrates a strength of purpose. AEIG takes governance to the next level and demonstrates to investors a level of transparency and management capability hitherto unknown by many in corporate America (by extension rest of the world).

Senior executive should challenge their organizations to review, adapt and implement AEIG. Another perspective—before society implements AEIG for them.

Introduction

Contemporary corporate *Governance Models* came back into vogue shortly after the corporate abuses by Enron and others around the turn of the century. The resulting Sarbanes-Oxley Act of 2002 is the most visible resulting regulatory behavioral change.[i]

Perhaps more lasting is the tarnished image of large organizations. Perhaps demands from the society in response to perceived abuses on Wall Street over the last several years have resulted in the greater level of regulatory scrutiny. Perhaps industry has earned this place in the spotlight.

During the pit of despair following the Enron championed debacle of the early part of the last decade, one common re-branded metric, ROI became *Return OF Investment*. This tongue in cheek remark became a watch word in the post Enron world—investor sentiment soured on *irrational exuberance* promises and a flight to quality ensued.

As Yogi Berra famously quipped, *"It's like déjà vu, all over again"*. The 2008 recession exposed lapses in adequate governance for such notable organizations as major money centered banks, Fannie Mae and Freddie Mac, and AIG to name a few.

Moreover, it appears that the Security and Exchange (SEC) failed with its governance charge as the likes of Bernard L. Madoff Investment Securities LLC (1960-2008) and Stanford International Bank (-2009) allegedly defrauded investors of billions of dollars. Years of litigation ahead, investors now seek their ROI from the carcasses of these and other ruins.

Would more effective governance have prevented these man made calamities? Researchers, pundits, the media, and others will ponder these post-mortem autopsies. However, unlike the airplane black box, reconstruction of events, their interconnectivity, will be difficult to impossible. CEO resignations and apologies do little for those whose lives and careers have been destroyed by the actions or inactions of those charged with fiduciary responsibilities.

Like the US nuclear Navy, whose culture changed dramatically and inexorably after the loss of several nuclear powered submarines, dramatic, immediate and systemic change in the way firms manage their physical assets and equipment is not an option any more. This change is mandatory!

> *The US Navy has accumulated over 6,200 reactor-years of accident-free experience involving 526 nuclear reactor cores over the course of 240 million kilometres, without a single radiological incident, over a period of more than 50 years*.[ii]

This publication posits a radically new and different approach to safety, environmental protection and operational excellence—an ***Asset/Equipment Integrity Governance*** (AEIG) construct that provides firms of all sizes and from all industry sectors with an approach to directly *align operations to the enterprise governance* processes.

Enter the Boardroom

Effectively, this moves certain aspects of operations to Board oversight. Some will argue that this is outside Board direct responsibilities. However, in a world where ONE "out of limits" technical event or ONE rogue individual can result in the demise of the firm with the subsequent liquidation of shareholder value this construct should not be seen as radical, inappropriate, too hard to do, or not in the stakeholders best interests.

In the US deepwater oil and gas drilling sector, the operator's Chief Executive Officer is charged directly and specifically with personally assuring the market that the firm is in compliance with Sarbanes-Oxley on a quarterly basis. Now he or she is also personally responsible assuring the US government, states along the Gulf of Mexico, shareholders and others that each and every oil well drilled meets stringent regulatory and engineering standards. With the ramifications for failure either from financial reporting and/or operational failures at new and stratospheric levels, the CEO should rightfully demand his or her organization perform at a level of excellence that parallels the US nuclear Navy.

A Financial Hypothesis

Much has been made recently about CEO compensation packages. Corporate stewardship today is not just growing a business or selling the firm to cash out. Stewardship in the heavy industrial sector has a societal aspect to it. Ravaging the environment at a cost of jobs and careers is now deemed as unacceptable behavior. Paraphrasing on recent former CEO, "don't ever expect to get your life back" if a disastrous societal event happens on your watch.

Even if management's charter was shallow top line growth or bottom line margins, empirical data document that strong shareholder rights result in higher share price (more details later). Given that most CEOs metrics include stock price growth, the model posited herein is *accretive*. In other words, strong AEIG is potentially a greater impact on share price than an acquisition (often dilutive). Finally, many operational executives are measure on EBITDA and strong AEIG can drive that metric as well.

It might surprise many to know that the top line revenue to attain a decent Net Income is substantial. A simple example follows:

Revenue	1,000,000
Cost of Good Sold--CGS (50%)	-500,000
Gross Profit	500,000
Sales, General, Accounting—SG&A (20%)	-200,000
R&D and other	-150,000
EBITDA	150,000
Assume depreciation/Amortization is zero	0
Tax Rate @ 35%	-52,500
Net Income	97,500

Impact of Governance on the Net Income Statement

In other words, approximately 9.75% returns to the owners of the corporation—assuming no one time events or other accounting adjustments for the period. Assume that the corporate tax rate can be decreased to 30%, then the net income is $105,000 or a return of 10.5%.

Let's then assume that the tax rate does not change (remains at 35%), then the top line requirement for this shareholder return is an additional $34,100 or over 4.5 times the absolute dollar tax saving. This assumes that CGS remains at 50 percent of revenue, yet SG&A the same.

To summarize, with this simple model, if the tax can be reduced by $7,500, this is the same as a $34,100 increase in revenue with an absolute dollar cost rise in CGS.

If one asks their sales force, what would it take to generate an increase in sales, one suspects that SG&A would also go up—net income goes down. In other words, while

growing the top line is desirable and important, internal controls, such as good tax management are critical to P/E metrics.

This model suggests that corporate governance is on par with market share, profit margin, etc. in terms for financial performance and value creation. One hypothesis suggests that perhaps strong governance is the most important variable in the corporate equation.

If this hypothesis is supported, there is no more important issue in the Boardroom today than governance at the operational level.

A Brief History of Governance

Modern corporate governance can be traced to the *Agency Theory* of the firm. Once an enterprise engages professional management (providers of management services as agents) as opposed to direct executive decision making by the owner(s), a *transaction cost* is imposed on the organization.

Corporate governance took on additional importance following the demise of Enron and others that precipitated a CRISIS IN CONFIDENCE in the capital markets. A renewed focus by governments and investors strove to assure stakeholders that managerial agents in fact were working for the best interests of the owners.

During that period (2002), McKinsey & Company in conjunction with the Global Corporate Governance Forum conducted a study and found that over 75% of over 200 fund managers would value a stock at a higher price point if the company could demonstrate it had strong governance in place. Moreover, the study also revealed that for western markets, firms with strong shareholder rights averaged 12-14% higher stock prices.[iii]

As noted elsewhere, The Sarbanes-Oxley Act of 2002 (H.R. 3763) became the seminal regulatory work that is still in place and provides the "go by" model for the regulatory response now unfolding. The implementation of SOX became mandatory in 2005, and a later survey suggested that from 2002 to 2005 the delta (△) above closed as firms implemented SOX and by 2005, the rising tide of stronger governance requirements has lifted all stocks.[iv]

Much of the current and emerging regulations for the industrial sector are modeled on SOX. This seems reasonable since it has been the law of the land since 2005 and all firms traded on the United States stock exchanges adhere to these requirements.[v] Therefore, economic actors in industrial sectors should plan their future according.

Risk Management

There is a broad body of work in the field of risk management and mitigation. In this section we will address some of the high level aspects of risk management as it relates to the heavy industrial sector. There are other elements of risk management that individual firms may find more relevant in their firm's operations and stand operating procedures.

The main element of the AEIG framework discussion is the recognition that a robust risk management policy and implementation is a critical component and its importance cannot be overstated. Moreover, the risk elements of AEIG should be aligned with the enterprise risk management policy and solutions in place.

In some cases it may be appropriate to make changes to the Enterprise Risk Management model to accommodate AEIG driven requirements—in other words making the ERM more robust.

Extending the Enterprise Risk Management Model

Over the past decade, the understanding of the overall and detailed components of the organizational risk profile has been the subject of a number of initiatives. In 2004, the Committee of Sponsoring Organizations of the Treadway Commission (COSO) released their Enterprise Risk Management—Integrated Framework.[vi]

This is a substantial body of knowledge and addresses risk from the portfolio perspective across the multiple dimensions of a complex, global organization. The COSO framework establishes four categories of risk; alignment with strategic goals, the effective and efficient use of resources in operations, the reliability of the reporting processes, and finally legal and regulatory compliance.

In the 1990's the perspective of the "extended enterprise" was added to the business lexicon. At its root was the construct that large global firm depended heavily on their key supply chain partners.[vii] This industry sector has continued to expand its dependencies and integration with its suppliers. The concept if further developed in Appendix II—Compliance Management.

Therefore, enterprise risk management is now also function of the risk profile of its key suppliers and their key suppliers. This creates an additional metric for risk mitigation frameworks.

One of the lessons learned from the Japanese Just-in-Time inventory model is the unexpected exposure firms have in the event of failure on the part of supplier. The most recent evidence of this exposure was as the result of the Japanese earthquake. Not only were supply chains interrupted, but the key knowledge of certain Japanese companies could not be duplicated otherwise.[viii]

One can argue that risk management frameworks such as the COSO and the one put forth by the Casualty Actuarial Society's Enterprise Risk Management Committee in 2003, capture most if not all aspects of risk, including risks associated with the supply chain.[ix] Conceding that theoretical point, it is the implementation and ongoing management of ERM that trips firms' up. Hence the need for a robust governance model at the operational level.

Formal Safety Assessment

After the Piper Alpha disaster in 1988, *Public Inquiry into the Piper Alpha Disaster,* often referred to as the Cullen Report provided a detailed analysis of disaster and could be argued initiated the concept of the Safety Case. An excerpt from the report states:

> *Primarily the safety case is a matter of ensuring that every company produces a formal safety assessment to assure itself that its operations are safe.*[x]

In other words, every organization is responsible for the safe operation of its facilities, regardless or exogenous forces such as regulations, and there is a requirement for a Formal Safety Assessment, specific to each facility.[xi]

Process Hazards Risk

Coined, Black Swan events, hard to predict and well outside standard deviations, these failures can and have bankrupted even established firms. Most still view quantitative risk

analysis as a function of Monte Carlo modeling or level of confidence expressed as a function of standard deviation from a mean. Laymen often refer to the later as the Bell Curve, although it can be skewed.

Risks from process industry hazards can be expressed as a function of the consequences of those hazards multiplied by the predicted frequency or likelihood of those hazards. For example, the in the equation below:

$$\text{Risk}_{\text{Hazard}} = (\text{Consequences} \times \text{Predicted Frequency})^{xii}$$

Generally, relative standard deviation model are acceptable for many risk management applications. One caveat; just because the calculation generates a specific number this is not a deterministic outcome of a stochastic processes. Outside expected limit real world results are certainly possible.

Simple Risk Assessment Calculations

Humans like to simplify difficult choices. We all like the PowerPoint presentation with its use of bullet points and graphics, although critical engineering decisions using this level of granularity this proved to be a fatal simplification of risk in the Columbia Space Shuttle disaster.[xiii]

Another common model is *High-Medium-Low* which seeks to have the decision maker focus on a very narrow number of outcomes. As might be expected, these models are often constructed so that a split-the-difference approach ends on the Medium expected outcome.

For the topics discussed herein, neither of these risk management approaches is satisfactory. If used, they may even be in breach of management's fiduciary responsibilities as well place the firm outside regulatory compliance.

Simulation Modeling

The level of complexity and importance associated with the issues of this topic is almost astounding. Elements of risk come from all corners and can effectively emerge to take center stage very rapidly. In this environment many traditional risk mitigation models are no longer effective. In such an environment taking a more robust assessment of uncertainty is a better perspective.

> *In an uncertain world, strategy is really about creating options and opening up new choices, not shutting them down.*[xiv]

Moreover, the sheer number of variables involve make it almost impossible to employ traditional tools and understand scenarios that may emerge as likely or even probable.[xv] Moreover, our understanding of the power of modeling versus real time mistake making is not new. In 1994, Morecroft and Sterman but forth the following:

> *Conventional wisdom says that we learn from our errors, but errors in the business world can be prohibitively costly. To truly understand how our complex business organizations function requires different tools than managers typically have been given. One tried and true method is to build models.*[xvi]

Owners of the assets and equipment failures described in this work would certainly agree with this position. Additionally, sometimes it is not clear that all structural aspects of the problem are completely understood and having the ability to perform "non-destructive" testing by simulating scenarios on the computer has merit as well.

> *Unless we can develop an understanding of the underlying structure of a process, whether a physical system such as the universe or a behavioral system such as those found in business processes, our ability to architect the correct processes is limited. Therefore, if we are to avoid re-iterative re-engineering, it is important that we develop a basic understanding of underlying structure. We must also keep in mind that structure is not static.*[xvii]

This is an emerging area with game theory now typically applied to significant business problems.[xviii] Finally, robust training simulations enable complex and in some case situations not readily reproducible in real life, i.e., disaster recovery, military training, etc.

There is a role for the use of such training scenarios in the AEIG model. It is much more cost effective to train personnel in the extended enterprise to deal with issues "off line" so in the event a real incident begins to unfold, it will not be the first time individuals would have addressed the problem.

Most business people travel by air routinely. Airline pilots undergo routine and ongoing training in simulation models. One suspects the last thing passengers would like to hear from the pilot during a midair incident, "I have never seen this before."

We expect pilots to be well trained and able to handle ALL incidents safely. Don't the owners of industrial and energy companies deserve the same from their hired agents (those that pilot their companies)? One also suspects, post BP Macondo that the US government and state of Louisiana would not view the phrase, "I have never seen this before" as an acceptable response. Nor would society!

Concluding Comments

The challenges remain many, complex, and often not well understood. Using advanced techniques and relevant technologies can illuminate scenarios that more simplistic (including statistical) models do not expose. AEIG demands robust and mathematically driven modeling rather than subjective hunches.

That said, stimulation modeling can capture the subjective insight of knowledgeable individuals. Knowledge and intuition can be codified and the resulting scenarios are then available for critic. In other words, much like the airline pilot, simulation is a combination of data and experience.

In 2004, the author defined Knowledge Management as, "A Broad & Informed Approach to Decision-Making and Problem Solving, Integrating Past Experience with New Experimentation."[xix] The model incorporates that which can be put into a database and extracted using Business Intelligence (BI) technology and that which comes from the voice of experience. The synergies of the two lead to true wisdom and the basis for the best decisions.

Risk Breakdown Structure

It is often convenient to devolve an issue like risk into its discrete elements. The Risk Breakdown Structure (RBS) model that follows does just that. This approach breaks risk into several major groupings (in this model Technical, Market, and Business) and their sub components.

Another strength of this approach enables quantitative assessment, sometimes based on qualitative or subjective input. Thus management can view risk from the portfolio of issues and even "weigh" line items according to their experience and supporting data.

Risk Breakdown Structure (RBS)
Project Implementation

		Risk Association	Impact Scale Cost	Time	Scope	Quality	Impact Ave
Technical							
Requirements		2	0.05	0.1	0.2	0.05	0.1
Technology		2	0.1	0.1	0.1	0.1	0.1
Complexity & Interfaces		3	0.2	0.2	0.2	0.2	0.2
Performances and Reliability		2	0.2	0.2	0.2	0.1	0.18
Quality		2	0.1	0.2	0.2	0.1	0.15
	Average	2.2	0.13	0.16	0.18	0.11	0.15
Market							
Sector		3	0.1	0.2	0.2	0.1	0.15
Regulatory		3	0.2	0.2	0.1	0.1	0.15
Customer		3	0.2	0.2	0.2	0.1	0.175
Channels		3	0.4	0.4	0.4	0.4	0.4
	Average	3	0.23	0.25	0.23	0.18	0.22
Business							
Management Team		2	0.2	0.2	0.2	0.2	0.2
Resources		2	0.4	0.2	0.2	0.1	0.225
Funding		3	0.2	0.2	0.2	0.2	0.2
Intellectual Property		1	0.05	0.05	0.05	0.05	0.05
Staffing		3	0.2	0.4	0.4	0.1	0.275
	Average	2.2	0.21	0.21	0.21	0.13	0.19
	Average Risk	2.43	0.19	0.20	0.20	0.14	0.18

Note: Where Risk Association Average is the Mean and Impact Ave (Average) is the Standard Deviation

Example Only - Dummy Numbers Used have NO Relevancy

RA Legend	
Very Low	1
Low	2
Moderate	3
High	4
Very High	5

Impact Legend	
Very Low	0.05
Low	0.1
Moderate	0.2
High	0.4
Very High	0.8

Risk Breakdown Structure

This approach is a vey powerful one and will be part of the AEIG model developed. Once caveat: while number crunching is attractive for some, the numbers in the RBS are relative not absolute. This is a tool to ferret out knowledge, not a crutch to pass the decision-making buck.

Risk Governance Model

The following Risk Governance Model has been developed with an operational focus. It is designed to take those relevant aspects of enterprise risk management and use them in an operational or production environment. As with all governance models described or developed herein, they must be aligned with the enterprise level models.

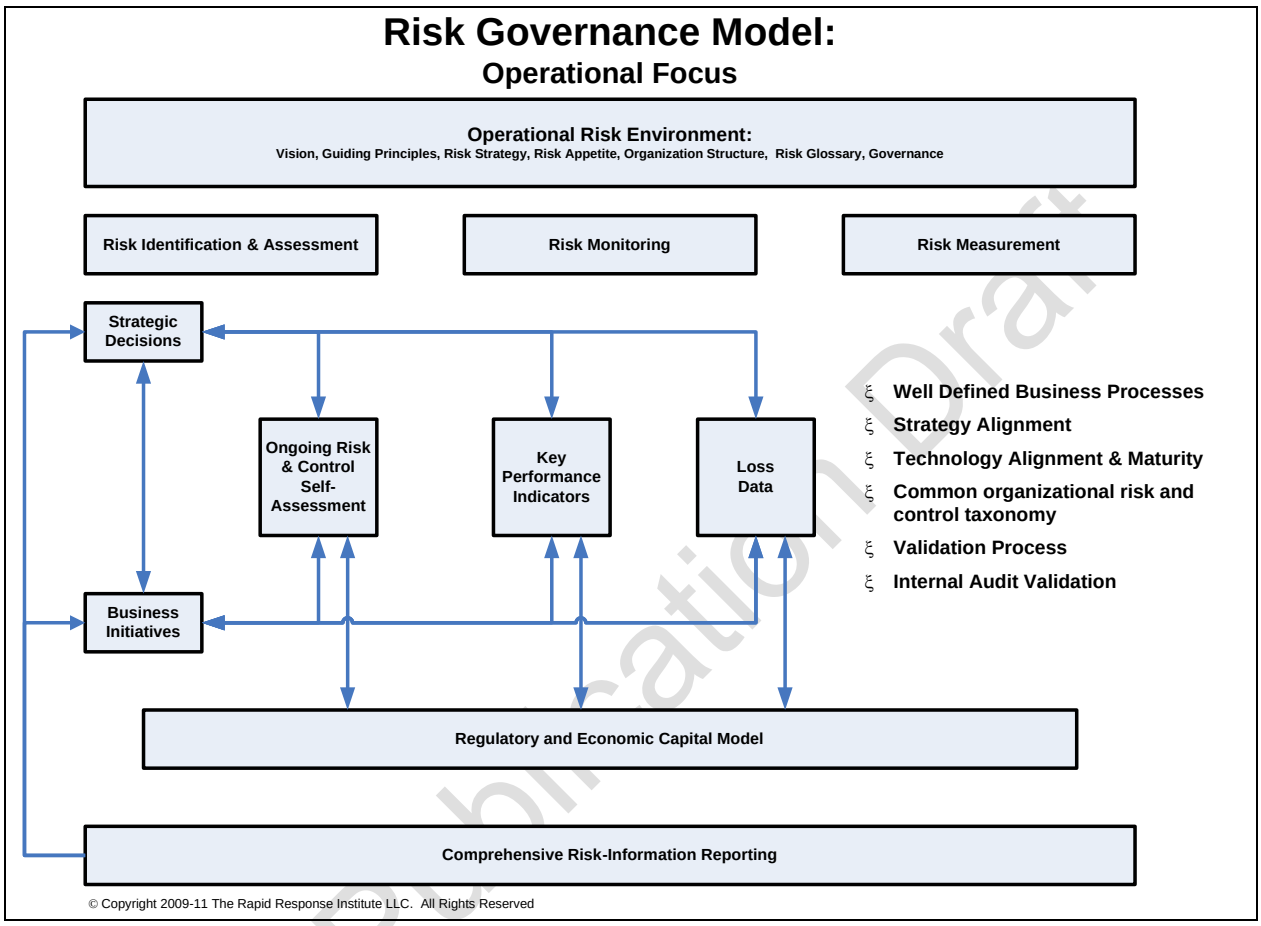
In this case, we identify the operating environment and capture those key elements of the overall risk mitigation process that the organization has codified. For example, the organizational vision and guiding principles are the foundational elements of the model that all follows from. The firm's risk strategy and its appetite for risk along with the organizational structure (and processes) are part of the governance model at the enterprise level as well.

The purpose of the Risk Glossary is to assure that all participants at the operational level use the same nomenclature. This is critical in all aspects of the firm as it decreases chances for miscommunication, especially in times of crisis. One could even say this is part of the organization's very culture.

Three major components to the model are:

- **Risk Identification & Assessment**—Rank order of exposure to a portfolio of possible risks
- **Risk Monitoring**—The process and technology systems necessary to monitor and provide alerts when out-of-limit events occur

- **Risk Measurement**—Incorporating risk monitoring into the Key Performance Indicators and Critical Success Factors used as the basis of decision-making and management.



Risk Governance Model

The other elements of the model are self-explanatory and consist with other governance models that will be discussed next. Alignment with required regulations and capital markets are mandatory as is putting in place those management reporting systems necessary to mitigate risks exposures. At a minimum the following actionable items must be part of the Risk Governance Model used in operations.

- Well Defined Business Processes
- Strategy Alignment
- Technology Alignment & Maturity
- Common organizational risk and control taxonomy
- Validation Process
- Internal Audit Validation

This model is a sustainable approach towards risk management governance and can assure management that field operations are acting in accordance with the risk appetite

the firm is willing to take. It is also a component of the broader based AEIG developed herein.

Too Big to Fail?

There is a common fallacy that organizations (including non-financial) can grow large enough and have deep pockets as well as industry standing that protects them from demise. Some will remember Digital Equipment Corp aka DEC (1957-1998), which at one time had revenues of US$ 14 billion and employed approximately 130,000 employees worldwide.[xx] Compaq Computer Corporation (1982-2002), the acquirer of DEC did not even exist until DEC was a quarter of a century old and itself was later engulfed by HP after only 20 years of life.

Some argue that rapid innovation, calcified cultures, exogenous events, and even poor management result in the premature passing of tech companies. One could argue that the firm's governance model is the umbrella over all organizational processes.

Notable Governance Failures

Organization	Terminal Event
Barings Bank (1762-1995)	"Barings' collapse was due to the unauthorised and ultimately catastrophic activities of, it appears, one individual (Leeson) that went undetected as a consequence of a failure of management and other internal controls of the most basic kind".[xxi]
Bernard L. Madoff Investment Securities LLC (1960-2008)	Elaborate securities fraud Ponzi scheme.[xxii] This led to concerns about the governance model used by the U.S. Securities and Exchange Commission (SEC).[xxiii]
Enron (roots to 1932-2001)	A number of high visibility scandals, often seen as the most notorious in American history.[xxiv] Prior to its bankruptcy on December 2, 2001, the company employed 22,000 with energy related revenue of almost $101 billion in 2000.[xxv]
MCI WorldCom (1997-2004)	Accounting fraud and insider loans led to the Chapter 11 bankruptcy in 2004.[xxvi]
News of the World, UK (1843-2011).	News International announced the shut down o this organization on July 7, 2011 following an extensive phone hacking scandal in the UK.[xxvii]
Royal Dutch Shell (1907-Present)	In 2004 Shell overstated its oil reserves, resulting in loss of confidence in the group, a £17 million fine by the Financial Services Authority and the departure of the chairman Philip Watts. A lawsuit resulted in the payment of $450 million to non-American shareholders in 2007.[xxviii]

Organization	Terminal Event
UBS AG (1912-Present)	The Zurich, Switzerland banking giant, UBS AG disclosed on September 15, 2011 that a trader at UBS Investment Bank in London had lost $2.3 billion through unauthorized trades.[xxix]

Short List of Notable Governance Failures

Eaten by Their Young

Schumpeter's term *Creative Destruction* describes a process whereby the economic structure from within an organization or industry sector that is incessantly or continually revolutionized.[xxx] As organizations grow and reward systems focus on attaining quarterly metrics, it is possible for the firm to begin the calcification process. No longer driven by a "change the world" mantra, settlement begins. This aging process empowers new entrants thus supporting Schumpeter's hypothesis.[xxxi]

Despite the current belief that somehow the current generation is different, able to multi task, and leap tall apples and androids in a single bound, human nature has not changed in thousands of years. As Baby Boomers, those denizens of change in the Age of Aquarius begin to exit the corporate stage, their offspring and their children pick up the gauntlet.

Generational knowledge transfer is always a challenge. As the noted humorist, Mark Twain once quipped, *"When I was a boy of fourteen, my father was so ignorant I could hardly stand to have the old man around. But when I got to be twenty-one, I was astonished by how much he'd learned in seven years."*

So the challenge becomes how is the knowledge and lessons learned over a (organizational) life time codified so that history does not repeat itself as the next generation re-learns hard lessons? Sustainable cultures are built upon governance bedrock.

The list of organizations 50 years old is short. The list of those over 100 years old is exponentially (non-linear) even shorter. One hypothesis: robust governance models establish organizational culture and define organizational sustainability. Even if the goal is to sell the organization in the near term, strong governance (as discussed above) increases value and hence shareholder value points.

Schumpeter's law of refresh is consistent with the physical laws of the universe such as the knowledge that the plate tectonics of the earth constantly change the landscape. So it is true with biological organisms and their business systems.

Progress is made when the learning's of the old are effectively transferred to the new commanders of the universe. Progress is impeded when the new denizens stand still (or reverse) by rehashing the past. Robust governance drives the former and inhibits the later.

Notable Industrial Incidents

It is not the intent to supply a long "laundry" list of industrial incidents with governance failure aspects. The following are provided simply to provide context for this discussion. In a world of complex energy and heavy industrial infrastructure necessary to provide the

goods and services society demands, the multifaceted nature of such infrastructure can be expected to increase not decrease.

Other than legal action taken by various parties, there is one critical result from each of these accidents—***loss of trust by the society***.

Organization	Date of Initiation	Event
Three Mile Island, USA	March 28, 1979	A relatively minor engineering event resulted in severe damage when operators were not able to diagnose the problem and properly respond.[xxxii]
Union Carbide, Bhopal, India	December 3, 1984	According to the state government of Madhya Pradesh, approximately 3,800 people die and several thousand other individuals experience disabilities after Methyl isocyanate (MIC) gas leaks from a tank at the UCIL Bhopal plant.[xxxiii]
BP Deepwater Horizon, USA	April 20, 2010	An explosion ripped through the Deepwater Horizon drilling rig as the crew completed drilling the exploratory Macondo well deep under the waters of the Gulf of Mexico, began a human, economic, and environmental disaster.[xxxiv]
Pacific Gas and Electric Company (PG&E), San Bruno California, USA	September 9, 2010	A portion of the 30-inch diameter underground natural gas transmission system suddenly ruptured resulting in a major explosion and fire loss of eight lives and the total destruction of 38 homes and significant damage to 88 additional homes and buildings.[xxxv]
Fukushima Daiichi Incident, Japan	March 11, 2011	Following a magnitude 9 earthquake and subsequent Tsunami that breached the retaining wall design height, multiple reactors were damaged and in some cases severely damaged. On April 12, 2011, The Japanese government's nuclear safety agency raises the crisis level of the Fukushima Daiichi power plant accident from 5 to 7. This is the worst on the international scale matching that of the 1986 USSR Chernobyl accident.[xxxvi]

Short List of Notable Industrial Incidents

By some accounts, there have been 36 major oil spills with environmental damage since 1967.[xxxvii] One does have to look hard to find documentation of major industrial accidents allegedly caused by accident of human decision—notably the chemical and energy sectors are the most egregious.[xxxviii]

The point in providing these details—industry has a problem and the society is now demanding that aggressive steps be taken to reduce this level of significant industrial major incidents. Failure to address this problem is not an option!

Overview of Governance Models

A quick review of the literature about corporate governance will yield two basic models; enterprise governance and information technology (IT) governance. A Google search for "corporate governance" will yield almost 31 million results. A similar search for "IT governance" yields approximately 212,000 hits.

Search for "asset governance" yields a little over 9, 100 results and "equipment integrity governance" yield zero hits. Disclaimer: as with everything on the web, these statistics may and will most likely change over time and certainly key words changes will do the same. The point is that the focus on organizational governance has been in other areas.

Typical Organization Governance Model

As discussed, organizational governance evolved to protect the rights of the owners—see Agency Theory. Traditionally, boardroom issues occupied those aspects typically under the governance umbrella with the line of business (LOB) dealt with operational and market concerns.

Orbits Around the CEO & CFO

The author developed this model after the debacle of Enron et al and at the time it was a relevant perspective on the governance of organizational behavior.[xxxix] A further refinement is in order for models of this generation. Governance is extending down deep into the organization and its supply chain.

IT Governance

Developed to assure that Information Technology (IT), now fundamental to achieving organizational value, is aligned with the organization, these models largely focus on providing high value IT solutions at an acceptable risk and cost. Implemented through a

framework and set of internal standards and often based on external IT standards and best practices, IT governance seeks to:

- Make sure that IT is aligned with the corporate strategy and organizational business units
- Assure IT is delivering value to the organization through better and more timely information management
- Mitigate the risk of large IT implementations and reduce "rogue" projects
- Effectively and efficiently manage resources, both internal, contract, and business process outsourcing, i.e., Human Resources information management, etc.
- Sustain a level of performance consistent with organizational goals

Section 404 of Sarbanes-Oxley added new import to IT as it dictated that public companies maintain adequate internal controls over its financial reporting process.[xl] Effectively, the CIO was now charged with putting IT systems in place to assure Sarbanes-Oxley compliance. One could argue that this requirement brought the MIS department into today's knowledge empowered firm. As we will see in the next section, the AEIG governance model will catapult information to a new level of importance.

Centralized vs. Decentralized

One final point to be addressed is whether a centralized or decentralized governance model is used. The concept of decentralized is based on the global and multi-cultural nature of modern firms. For many operational processes this is mostly like appropriate.

However, given the risks associated with errant behavior, centralized governance models are more appropriate. The Barings Bank failure (1995) referred to in this text may have been the result of decentralized governance. UBS on the other hand was able to rapidly take corrective action for a similar event in 2011.

With the advent of instant communications in the *i* world, decentralized governance maybe a format of the past. The risks today are too high for less.

A Model for Operational Governance (AEIG)

The case is made that there is a requirement for a new approach to governance. Building upon and aligned with organizational governance and enterprise risk management, the AEIG model extends these models in a formalized and executable format.

This section develops a brief overview of the Asset/Equipment Integrity Governance model and provides a high level snapshot of it. All of its components are described in detail throughout this document and its End Notes. A more detailed model is provided in Appendix III.

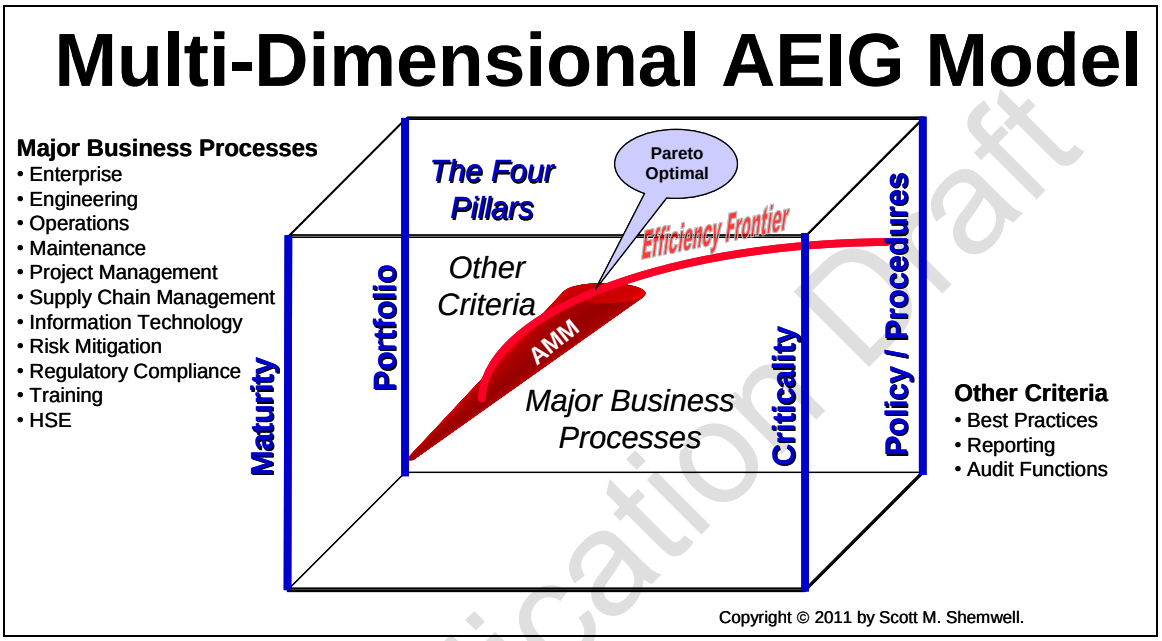
Built upon the four pillars

- **Maturity Level**—The level of maturity the organization has across several metrics
- **Portfolio Management**—View of the organization from a portfolio perspective
- **Policies & Procedures**—External and internal driven requirements such as Standard Operating Procedures (SOP) and regulatory requirements

- **Criticality**—Focus on the most critical aspects and their metrics.

Additional drill down of these four pillars is detailed in Appendix III.

This model makes use of the Asset Maturity Model construct, discussed in detail in Appendix I, this model focuses on the set of organizational assets from a portfolio perspective coupled with Pareto Optimal metrics.



Multi-Dimensional AEIG Model

As depicted in the above graphic and detailed in Appendix III this model is a comprehensive approach to governance at the operational level. If one thinks about it, other than treasury or currency exchange issues, governance IS at the operational level.

The model is multi-dimensional in that it addresses all aspects of governance. This includes all of the major business processes as well as other criteria—as depicted in the graphic above and detailed in Appendix III.

Using the strength of the Asset Maturity Model construct, Appendix I, the AEIG model is a new construct that enables management to truly put a realistic, manageable, and measureable sustainable governance model in place. Given the nature of and requirement for regulatory compliance management (as dictated by society through various government agencies) the AEIG model posited herein is best positioned to enable success with the various constituents.

Unlike many governance models, AEIG is driven by economics and associated econometric models. In this sense, management is provided with a set of tools that can be used (similar to the RBS) to truly calibrate governance performance.

Optimal Performance

Most strive for optimal performance, high efficiency and effectiveness. Most do not know how to achieve this state much less measure it. AEIG and AMM provide a specific set of tools management can employ to realistic measure this level of performance.

Moreover, this approach does not require extensive mathematical experience. Most can assess performance using a spreadsheet. More details are provided in Appendix I.

Definition of Assets and Equipment

The following definitions and discussions are provided for context. As previously stated nomenclature is an important consideration in governance models. It assures a common vocabulary and a basis of culture.

Asset

Discussions around asset management and equipment integrity often yield a vigorous exchange regarding their definition. The nature of an asset can vary widely. For purposes herein, as a general rule of thumb an asset can be defined as a (non-human/Knowledge) revenue producing instrument.

In the energy and heavy industrial sector, marine craft, road vehicles, heavy equipment, pipelines and even manufacturing plants such as refineries and chemical plants will meet this test. However, in the mineral extraction sectors, assets are often defined as proven reserves and hence fall outside of this model.

The model can be extended to include mineral assets and that issue will be addressed in subsequent versions of this work. Finally, while these assets will fall under the accounting definition of an asset and will be part of the organizational balance sheet, that definition of an asset is broader.

Equipment Integrity

Again, as a general rule, (plant production) equipment is a revenue generating piece of hardware (may have software integrated with it) and as such its availability (or uptime) is a Critical Success Factor (CSF). Currently, all sectors are devoting a great deal of energy assuring equipment availability in a safe manner. Predictive maintenance is but one of many tools used to address this issue.

Equipment propensity for wear, tear, and possible failure puts this issue squarely in the Enterprise Risk Management hair sights. Unplanned failures and potentially catastrophic failure with prospective of *Bet-Your-Company* exposure is driving this issue to the CEO's office. Additionally, federal, state and local regulatory bodies continue to take a keen interest into societal exposure resulting from even minor failures of critical equipment.

Industry is now realizing that there is a need for a sound risk management philosophy, with it subsequent Standard Operating Procedures (SOP) and robust engineering processes as part of an overall risk management model.

It is beyond the scope of this document to develop detailed engineering; however, there are four types of equipment maintenance and assessment strategies that encapsulate the overall Equipment Risk Management model.

- **Condition Assessment**—the determination of the structural integrity, performance reliability and function capacity of the item. Typically, this will be conducted during scheduled maintenance. There are significant resources for destructive and non-destructive testing available per industry standards and best practices for any given piece of equipment.
- **Reactive Maintenance**—the immediate response upon a malfunction or failure event.

- **Predictive Maintenance**—the use of data and information taken from real environment operating history to determine possible and potential failure modes in advance.
- **Preventive Maintenance**—the programs put in place to service plant production equipment on a regular basis, designed to prevent failures.[xli]

And finally, most observers would agree that major equipment failures are more systemic in nature than the failure of a single line item in the Bill of Materials. Many catastrophic events are the result of several seemingly unrelated failures of equipment and/or faulting decision making during a moment of crisis and often the overall approach management takes towards field operations.

In other words, Enterprise Risk Management with all of its implications for the overall value of the firm is extended to plant and field operations. It also extends to suppliers of critical components. So while the definition of assets and equipment is wide and varied, the relevant definition should be intuitive in any given organization.

Economic Models

In a real sense, governance models depend on the dynamics of the economic model an industry sector subscribes to. This section describes two, admitted macroeconomic (the larger view of economic behavior) models. However, their relevance at the microeconomic level (supply and demand at the buyer level) is developed below. The AEIG framework capitalizes on the enhanced capabilities of the Information Economy perspective. The deterministic perspective is view as too cumbersome to meet today's challenges/

The Death of Deterministic Economic Models

Depending on your point of view, John Maynard Keynes is either the hero or the goat. In his seminal work, *The General Theory of Employment, Interest, and Money* he wrote,

> " *… we must recognize that only experience can show how far the common will, embodied in the policy of the State, ought to be directed to increasing and supplementing the inducement to invest; and how far it is safe to stimulate the average propensity to consume, without forgoing our aim of depriving capital of its scarcity-value within one or two generations."*[xlii]

From today's perspective, this statement would appear to be static, or at best a sluggish dynamic. Few observers today would view *capital* from a generational perspective. Markets are driven by nanosecond information flow enabled by global communications systems unheard of in Keynes' day.

Conversely, in his book, *The Road to Serfdom*, F. A. Hayek stated,

> *"The choice open to us is not between a system in which everybody will get what he deserves according to some absolute and universal standard of right, and one where the individual shares are determined partly by accident or good or ill chance, but between a system where it is the will of a few persons that decides who is to get what, and one where it depends at least partly on the ability and enterprise of the people concerned and partly on unforeseeable circumstances."*[xliii]

Both of these economists came of age professionally in an era where information flow was slow at best and constrained at worst. Products of a world at war, their views are polar opposites.

At this writing, there appears to be a political tug-of-war as United States elected officials attempt to come to grips with the way forward. Reflecting on the demise of a clear genius and not just champion but leader of individuality, Steve Jobs, one suspects that the parsing of information is a losing strategy. Sorry Professor Keynes. Certainly discussions about generational change rate models are outmoded.

At the end of the last century and the beginning of the current one, pundits often spoke of information flow in terms of Internet Dog Years; a reference to the belief that biologically canines age seven times faster than humans. In an age of ***i*** xxx, one wonders if even dog year metrics provide enough granularity.

The Rise of the Information Economy Model

Prior to Professors Keynes and Hayek, Frederick Taylor, the Father of Scientific Management was the first to undertake the serious study of work processes and functional roles. He remains a controversial individual; however, notable figures such as W. Edwards Deming and others have extended Taylor's construct into today's Six Sigma management model.[xliv]

Rooted in industrial age thinking, firms seek to deliver goods and services based on linear models evolved from Keynes, Hayek, Taylor, Deming and others. Emerging today, are non-linear business models.

Also, evolved from Hayek, Taylor, Deming and others these non-linear models demand massive quantities of timely and accurate data and information to generate shareholder value. In other words, the *productivity of information* is now a better Critical Success Factor (CFS) than productivity of the factory floor and sales distribution network.

This is a model the firm from the perspective of Information Economics rather than simple process flow. A typical set of comparative Metrics covering a wide variety of corporate activities:

- Information Productivity®,
- Transaction Cost,
- Knowledge per Employee,
- Marginal Cost of New Information,
- Expected Value of Marginal Information (EVMI), and
- Other

Clearly, these contrast with traditional benchmarking metrics. However, analysts should readily understand financial and economic models developed herein, as like their predecessors, these metrics are business driven and not a function of raw information technology horsepower.

Finally, from economic utility theory as defined by J.F. Nash, for homogenous markets (such as some segments of the global energy sector), equally efficient firms with constant marginal costs must price their products at their marginal cost. If one firm can lower its marginal costs through the use of information, the resulting reduction in the cost of operations will allow that firm to add greater value to its customers at a lower marginal cost structure.[xlv]

In a previous work, the author developed the construct of Knowledge as an Ecology as it relates to the organization and the sectors it serves.

> *Knowledge Ecology can be described as the interrelationship of intelligent living organisms and their perceptions of fact and understanding.*
>
> *Somewhat different from just business intelligence and information warehouses, knowledge builds on the intuition and experimentation that comes from relevant experience. A knowledge base extends outward, not just capitalizing on the sum total learning of a specific individual organism or the collective experience of a cultural set, but expanding to encompass new ideas and concepts. An ecology of intellectual exchange.*[xlvi]

Readers will note that this section barely touches the substantial body of work available addressing the emergence of information based economic models. It is not the intention herein to fully develop this as a treatise, but only "frame" these trends as they relate to organizational governance issues.

There are two primary aspects of these types of models that are relevant to AEIG:

- Macro and micro economic models today are driven by non-linear/stochastic data and information intensive exogenous actors/events—separating the informational "wheat from the chaff" is also a major challenge. Moreover, deterministic operational models are dated and may not response as rapidly as events unfold.
- The extensive use of Knowledge Workers in extended work processes is the norm and as such an *ecologically valid* governance construct is mandatory. Given the critical interdependencies of today's global enterprises, the "butterfly effect" takes on additional criticality.

Summary

AEIG represents the next threshold in organizational governance. The Board of Directors must now look past previous models and deep into the activities at the Line of Business (LOB) level. Fiduciary responsibility and potential destruction of shareholder value demands no less.

AEIG is a construct that assures shareholder value will be protected. ROI can now mean return on investment, not just a concern about return OF investment. 21st century owners demand no less from those entrusted *via-a-vie* their agency agreement.

This is just the beginning of a dialogue that will continue, perhaps for decades, as societies come to grips with their need for heavy industry and energy goods and services and concerns of exposure. Strong governance in this area will result in similar shareholder value increase as from the implementation of Sarbanes-Oxley and the "lifting of all boats" associated with its implementation.

The AEIG construct will drive shareholder value going forward!

Further Case Study Information

Additional information on the above case studies as well as other Process Simulation/Optimization projects is available from the author. His contact information follows.

About the Author

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Glossary of Terms

The following terms are used in this White Paper and the definitions are provided for completeness and reader convenience. The author makes no representation that the definitions are accurate and/or complete. Direct quotations are in italics and so referenced.

Term	Definition
Accounting definition of an asset	*Something that an entity has acquired or purchased, and that has money value (its cost, book value, market value, or residual value).*[xlvii]
Accretive	*In corporate finance, accretive acquisitions of assets or businesses will add more value than the cost of the acquisition, either immediately or over time.*[xlviii]
Agency Theory	*Theory of the firm that explores relationships between property rights and financial structures. Agency costs include of monitoring the agreement and loss if the agent's fails to maximize the principal's welfare.*[xlix]
Array of Compliance	*Developed herein, elements in the Integrated Compliance Management Framework described in mathematical terms thus can be represented by software engines.*
Asset/Equipment Integrity Governance (AEIG)	*A governance construct that provides firms of all sizes and from all industry sectors with an approach to directly align operations to the enterprise governance processes.*
Barrel of oil equivalent (BOE)	*The barrel of oil equivalent (BOE) is a unit of energy based on the approximate energy released by burning one barrel (42 U.S. gallons) of crude oil.*[l]
Bell Curve	*A normal distribution of data.*[li]
Black Swan	*An event or occurrence that deviates beyond what is normally expected of a situation and that would be extremely difficult to predict. This term was popularized by Nassim Nicholas Taleb, a finance professor and former Wall Street trader.*[lii]
Butterfly Effect	*The concept that small events can have large, widespread consequences.*[liii]
Capital structure	*Mix of a company's long-term debt, specific short-term debt, common equity and preferred equity.*[liv]
Crisis Management	*Responding to a business crisis once it has occurred.*[lv]
EBITDA	*Essentially net income with interest, taxes, depreciation, and amortization added back to it,*[lvi]
Economic efficiency	***Economic efficiency** is used to refer to a number of related concepts. A system can be called economically **efficient** if:* • *No one can be made better off without making someone else worse off.* • *More output cannot be obtained without increasing the amount of inputs.* • *Production proceeds at the lowest possible per-unit cost.* *These definitions of efficiency are not exactly equivalent. However, they are all encompassed by the idea that nothing more can be achieved given the resources available.*[lvii]
Expected Value of Marginal Information (EVMI)	*EVMI represents the probabilistic maximum acceptable cost of new information to the decision process.*[lviii]
Information Productivity®	*Information Productivity® has been a United States Trademark #1,959,644 of Strassmann, Inc. since 1996. As Information Productivity™ it dates back to 1987.*[lix]
Key Performance Indicator (KPI)	*Key Performance Indicators are quantifiable measurements agreed to beforehand, that reflect the critical success factors of an organization.*[lx]

Term	Definition
Knowledge per Employee	*Similar to financial metrics such as revenue per employee, this ratio provides insight into the relative, relevant knowledge an organization holds per employees as a function of it industry peer group.*
License to Operate	*Grant of permission to undertake a trade or carry out a business activity, subject to regulation or supervision by the licensing authority.*[lxi]
Marginal Cost of New Information	*In economics and finance, marginal cost is the change in total cost that arises when the quantity produced changes by one unit.*[lxii] *The difficulty, of course, is defining what one unit of information is. This construct is further developed with the EVMI metric as further defined in the Asset Maturity Model Appendix in this document.*
Monte Carlo simulation	*Also known as the Monte Carlo Method lets you see all the possible outcomes of your decisions and assess the impact of risk, allowing for better decision making under uncertainty.*[lxiii]
Rapid Response Management (RRM)	*An organizational construct or mental model that enables the organization and its key partners to rapidly sense changes and respond accordingly.*[lxiv]
Safety and Environmental Management System (SEMS)	*Bureau of Ocean Energy Management, Regulation and Enforcement (BOEMRE) SEMS regulations Rule (30 CFR 250). SEMS Toolkit is available from the IADC.*[lxv]
Safety Case	*Primarily the safety case is a matter of ensuring that every company produces a formal safety assessment to assure itself that its operations are safe.*
Scientific Management	*The administration of a business or industry based on experimental studies of efficiency; the application of the principles of the scientific method to managing a business or industry.*[lxvi]
Six Sigma	*A fact-based, data-driven philosophy of quality improvement that values defect prevention over defect detection.*[lxvii]
SOX	*Abbreviation for The Sarbanes-Oxley Act of 2002.*[lxviii]
Statistical Process Control (SPC)	*A standardizing technique used for steering a process in a desired direction, reducing variation, increasing knowledge about the process, assessing process capability and providing performance benchmarks*[lxix]
Stochastic	*Statistically random variation.*[lxx]
SWOT Analysis	*Strength, Weakness, Opportunity, Threat assessment often used in marketing positioning processes. It is also useful to assess other aspects of organizational behavior and structure.*
Transaction Cost	*The cost associated with exchange of goods or services and incurred in overcoming market imperfections. Transaction costs cover a wide range: communication charges, legal fees, informational cost of finding the price, quality, and durability, etc., and may also include transportation costs.*[lxxi]
Velocity of Information	*Similar to the economic theory, Velocity of Money, it is the frequency at which information is exchanged.*[lxxii]

Appendix I—The Asset Maturity Model

The following discussion on the Asset Maturity Model is taken from; Shemwell, Scott M. & Murphy, D. Paul. (2004, September). Roadmap to Enterprise Optimization: A Guide to the Impact of Information Driven Field Operations on the Petroleum Corporation and is quoted herein with permission.

Background

Overview of Maturity Models

The Asset Maturity Model (AMM) Version 1.1 is a five-step staged maturity model[lxxiii] similar in its approach to others that have been used to describe the *maturity* of business and technical processes, most notably the Capability Maturity Model® for Software developed by the Carnegie Mellon Software Engineering Institute.[lxxiv]

Types of Maturity Models

Maturity models are typically of two types, staged or continuous. The continuous representation uses capability levels to measure process improvement, while the staged representation uses maturity levels. The main difference between maturity levels and capability levels is the representation they belong to and how they are applied:

- **Capability** levels, which belong to the continuous representation, apply to an organization's process-improvement achievement for each process area. There are generally six capability levels, numbered 0 through 5. Each capability level corresponds to a generic goal and a set of generic and specific practices.

Capability Level	Continuous Representation Capability Levels
0	Incomplete
1	Basic
2	Structured
3	Standardized
4	Integrated
5	Optimized

- **Maturity** levels, which belong to the staged representation, apply to an organization's overall maturity. There are five maturity levels, numbered 1 through 5. Each maturity level comprises a predefined set of process areas.

Maturity Level	Staged Representation Maturity Levels
1	Basic
2	Structured
3	Standardized
4	Integrated
5	Optimized

The continuous representation has more specific practices than the staged representation because the continuous representation has two types of specific practices, *base and advanced*, whereas the staged representation has only one type of specific practice.

In the continuous representation, generic practices exist for capability levels 1-5, whereas, in the staged representation, only the generic practices from capability levels 2 and 3 appear; there are no generic practices from capability levels 1, 4, and 5. Equivalent staging enables the results of appraisals using the continuous representation to be translated into maturity levels.

Advancing Through Maturity Levels

Organizations can achieve progressive improvements in their organizational maturity by first achieving stability at their current level and continuing to the most advanced level, organization-wide continuous process improvement, using both quantitative and qualitative data to make decisions.

Since organizational maturity describes the range of expected results that can be achieved by an organization, it is one means of predicting the most likely outcomes from the next project the organization undertakes. For instance, at maturity level 2, the organization has been elevated from ad hoc to disciplined by establishing sound project management. As organizations achieve the generic and specific goals for the set of process areas in a maturity level, they are increasing the organizational maturity and reaping the benefits of process improvement.

Skipping Maturity Levels

The staged representation identifies the maturity levels through which an organization should evolve to establish a culture of excellence. Because each maturity level forms a necessary foundation on which to build the next level, trying to skip maturity levels is usually counterproductive.

At the same time, we must recognize that process improvement efforts should focus on the needs of the organization in the context of its business environment and that process areas at higher maturity levels may address the current needs of an organization or project. For example, organizations seeking to move from maturity level 1 to maturity level 2 are frequently told to establish a process group, which is addressed by the Organizational Process Focus process area that resides at maturity level 3. While a process group is not a necessary characteristic of a maturity level 2 organization, it can be a useful part of the organization's approach to achieving maturity level 2.

This situation is sometimes characterized as “establishing a maturity level 3 engineering process group to bootstrap the maturity level 1 organization to maturity level 2.” Maturity level 1 process-improvement activities may depend primarily on the insight and competence of the engineering process group staff until an infrastructure to support more disciplined and widespread improvement is in place. Organizations can institute specific process improvements at any time they choose, even before they are prepared to advance to the maturity level at which the specific practice is recommended. However, organizations should understand that the stability of these improvements is at greater risk, since the foundation for their successful institutionalization has not been completed. Processes without the proper foundation may fail at the very point they are needed most – under stress.

A defined process that is characteristic of a maturity level 3 organization can be placed at great risk if maturity level 2 management practices are deficient. For example, management may make a poorly planned schedule commitment or fail to control changes to baseline requirements. Similarly, many organizations collect the detailed data characteristic of maturity level 4, only to find the data unusable because of inconsistency in processes and measurement definitions.

Another example of using processes associated with higher maturity level process areas is in the process of building products. Certainly, we would expect maturity level 1 organizations to perform requirements analysis, design, integration, and verification. However, these activities are not described until maturity level 3, where they are described as the coherent, well-integrated engineering processes of a project management capability, put in place so that the engineering improvements are not lost by having an ad-hoc management process.

Component Categories

The components of a maturity model are grouped into three categories that reflect how they are to be interpreted:

- **Required:** Specific goals and generic goals are required model components. These components must be achieved by an organization’s planned and implemented processes. Required components are essential to rating the achievement of a process area. Goal achievement (or satisfaction) is used in appraisals as the basis upon which process area satisfaction and organizational maturity are determined. Only the statement of the specific or generic goal is a required model component. The title of a specific or generic goal and any notes associated with the goal are considered informative model components.
- **Expected:** Specific practices and generic practices are expected model components. Expected components describe what an organization will typically implement to achieve a required component. Expected components guide those implementing improvements or performing appraisals. Either the practices as described or acceptable alternatives to them are expected to be present in the planned and implemented processes of the organization before goals can be considered satisfied. Only the statement of the practice is an expected model component. The title of a practice and any notes associated with the practice are considered informative model components.
- **Informative:** Sub-practices, typical work products, discipline amplifications, generic practice elaborations, goal and practice titles, goal and practice notes, and references are informative model components that help model users understand the goals and practices and how they can be achieved. Informative

components provide details that help model users get started in thinking about how to approach goals and practices.

The glossary of terms is not a required, expected, or informative element of maturity models. The terms in the glossary should be interpreted within the context of the component where they appear.

When a maturity model is used as a guide, processes are planned and implemented that conform to the required and expected components of process areas. Conformance with a process area means that, in the planned and implemented processes, there is an associated process (or processes) that address either the specific and generic practices of the process area or alternatives that clearly and unequivocally accomplish a result that meets the goal associated with that specific or generic practice.

Model Components

Process Areas

A process area is a cluster of related practices in an area that, when performed collectively, satisfy a set of goals considered important for making significant improvement in that area. All maturity model process areas are common to both continuous and staged representations. In the staged representation, process areas are organized by maturity levels.

Specific Goals

Specific goals apply to a process area and address the unique characteristics that describe what must be implemented to satisfy the process area. Specific goals are required model components and are used in appraisals to help determine whether a process area is satisfied.

Specific Practices

A specific practice is an activity that is considered important in achieving the associated specific goal. The specific practices describe the activities expected to result in achievement of the specific goals of a process area. Specific practices are expected model components.

Common Features

Four common features organize the generic practices of each process area. Common features are model components that are not rated in any way. They are only groupings that provide a way to present the generic practices. Each common feature is designated by an abbreviation as shown:

- Commitment to Perform (CO)
- Ability to Perform (AB)
- Directing Implementation (DI)
- Verifying Implementation (VE)

Typical Work Products

Typical work products are an informative model component that provides example outputs from a specific or generic practice. These examples are called “typical work products” because there are often other work products that are just as effective, but are not listed.

Sub-practices

Sub-practices are detailed descriptions that provide guidance for interpreting specific or generic practices. Sub-practices may be worded as if prescriptive, but are actually an informative component in maturity models meant only to provide ideas that may be useful for process improvement.

Discipline Amplifications

Discipline amplifications are informative model components that contain information relevant to a particular discipline and are associated with specific practices. For example, if in the AMM model, you want to find a disciplined amplification for software engineering, you would look in the model for items labeled “For Software Engineering.” The same is true for other disciplines.

Generic Goals

Generic goals are called “generic” because the same goal statement appears in multiple process areas. In the staged representation, each process area has only one generic goal. Achievement of a generic goal in a process area signifies improved control in planning and implementing the processes associated with that process area, thus indicating whether these processes are likely to be effective, repeatable, and lasting. Generic goals are required model components and are used in appraisals to determine whether a process area is satisfied. (Only the generic goal title and statement appear in the process areas).

Generic Practices

Generic practices provide institutionalization to ensure that the processes associated with the process area will be effective, repeatable, and lasting. Generic practices are categorized by generic goals and common features and are expected components in maturity models. (Only the generic practice title, statement, and elaborations appear in the process areas.)

Generic Practice Elaborations

Generic practice elaborations are informative model components that appear in each process area to provide guidance on how the generic practices should uniquely be applied to the process area. For example, when the generic practice “Train the people performing or supporting the planned process as needed” is incorporated into the Configuration Management process area, the specific kinds of training for doing configuration management are described.

References

References are informative model components that direct the user to additional or more detailed information in related process areas. Typical phrases expressing these pointers are “Refer to the Organizational Training process area for more information about identifying training needs and providing the necessary training” or “Refer to the Decision Analysis and Resolution process area for more information about evaluating and selecting among alternatives.”

Development of the Asset Maturity Model

A review of a company’s portfolio of assets will most likely reveal a collection of resources that span a variety of exposures or risks, differing performance, and dissimilar stages of life, or levels of maturity. The life-cycle curve is well understood and, by default, organizations make assessments of the investment they expect to undertake in each asset.

The AMM is not focused on the asset life-cycle model, but on the robust nature of a revenue-producing asset. In other words, what is this resource producing and if x investment is made, what additional performance can be expected?

Each revenue-producing asset in every industry has its own unique life cycle. Power generating plants, grid infrastructure, and oilfield production infrastructure all require differing assessments of the investment to be made to insure maximum performance over a given period. Firms decide when to upgrade, and when to dispose of assets against specific criteria determined by the portfolio management model the firm uses to manage its business.

The AMM ties IT and business process investments to the firm’s portfolio of assets. In this sense, it is a more realistic approach than traditional net present value (NPV) models. Every asset has an individual characteristic. The investment criterion for each asset differs and IT expenditures are no different from any other investment in that asset. However, a complication is that many IT solutions are focused at the enterprise level and therefore are not specific to individual assets.

The AMM is not focused on the asset life-cycle model, but on the robust nature of a revenue-producing asset.

One size does not fit all, and each asset requires a specific management process.

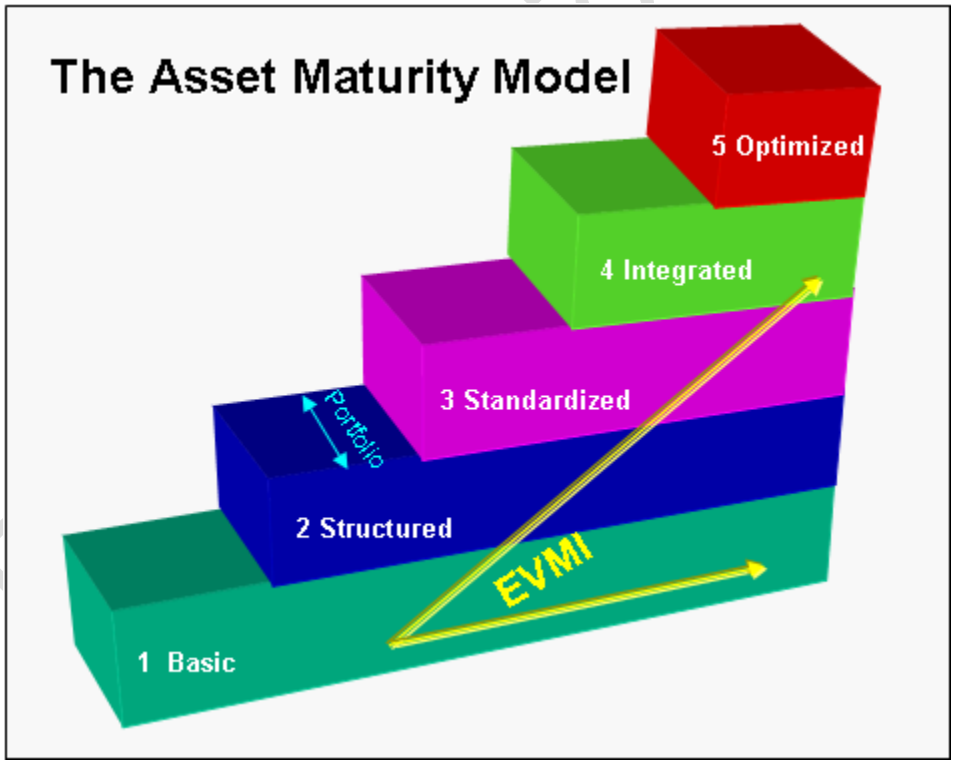
For example, an aging, low revenue-producing asset most likely cannot be enhanced by significant IT investment. Investment in other high-revenue producers may have a greater impact on the bottom line. Each investment decision must be assessed independently, and then rolled up into the total company portfolio.

Description of the Asset Maturity Model

Stages of the AMM

The AMM provides the principles and practices underlying the investment of IT in each asset class and is intended to provide organizations with a logical methodology for making IT decisions. It comprises the following five stages:

1. **Basic** – Assets in this class are managed with minimum IT infrastructure. Processes are ad hoc and robust systems are not required to deliver the maximum value.
2. **Structured** – These types of assets capitalize on IT solutions composed of a COTS (commercial off-the-shelf) solution with a minimum of customization – strictly limited to minor configuration with no code change.
3. **Standardized** – IT solutions are configured to support well-defined and documented management and engineering processes. Information systems may be customized to the specific the needs of an asset.
4. **Integrated** – Assets in this category are networked together and back to an operation center(s). Operators manage performance, capitalizing on sophisticated systems that integrate field assets to Enterprise Resource Planning (ERP) systems. A diverse set of software applications from a number of vendors may be deployed.
5. **Optimized** – Asset management is enabled by a continuous improvement (Six-Sigma) intelligent solution (comprised of smart devices with human oversight systems) that fully integrates field performance with the back office. Feedback and feed forward loops capitalize on all aspects of this approach, driving asset performance to its Pareto optimal equilibrium.



The Asset Maturity Model

It is important to realize that each organization's asset portfolio may include all levels of asset maturity; however, a more optimal enterprise-level approach may be to focus on

fewer asset classes – in much the same manner that firms emphasize specific core competencies.

AMM Value Proposition

Putting a common, expensive, large-scale enterprise-wide IT solution in place for all assets may not be either necessary or cost effective. Optimal enterprise performance is defined as obtaining maximum value from the portfolio of assets using appropriate business processes and investment levels in information technology. Suitable expenditures in technology should always increase the yield of a particular asset.

Moreover, there is a cost associated with putting into place the processes and systems needed to operate at each step in the model. Management must assess whether the cost of taking a step or two will result in a return that meets organizational goals. Adhering to the model will help assess whether the time and cost required is the best use of capital.

The AMM is designed to be an instrument for both the end user community as well as IT suppliers, and holds the promise of better alignment between these two parties. Vendors can focus on those firm's that are the most likely consumers of their products and solutions, and customers can more effectively ascertain the value proposition of a technology offering as it relates to their specific portfolio of assets.

AMM Level Definitions

Maturity levels consist of a predefined set of process areas. The maturity levels are measured by the achievement of the specific and generic goals that apply to each predefined set of process areas. The following sections describe the characteristics of each maturity level in detail.

Maturity Level 1: Basic

At maturity level 1, processes are usually ad hoc and chaotic. The organization usually does not provide a stable environment. Success in these organizations depends on the competence and heroics of the people in the organization and not on the use of proven processes. In spite of this ad hoc, chaotic environment, maturity level 1 organizations often produce products and services that work; however, they frequently exceed the budget and schedule of their projects.

Maturity level 1 organizations are characterized by a tendency to over commit, abandon processes in the time of crisis, and not always be able to repeat their past successes.

For the E&P industry this stage indicates those assets that are managed essentially manually, with information being collected in the field, summarized and periodically forwarded, in many different formats, timescales (sometimes daily, sometimes weekly, sometimes monthly) and degrees of accuracy to centralized information processes. In addition, while each field office probably accomplishes many of the same things, each uses somewhat different tools and processes than other field offices. In these areas we typically see inaccurate or missing information, unplanned (and maybe unrecognized) production outages, inadequately trained personnel, AFE overruns, etc. However, in many of these assets the investment needed to improve the situation may not be justified.

Maturity Level 2: Structured

At maturity level 2, an organization has achieved all the specific and generic goals of the maturity level 2 process areas. In other words, the projects of the organization have ensured that requirements are managed and that processes are planned, performed, measured, and controlled.

The process discipline reflected by maturity level 2 helps to ensure that existing practices are retained during times of stress. When these practices are in place, projects are performed and managed according to their documented plans.

At maturity level 2, requirements, processes, work products, and services are managed. The status of the work products and the delivery of services are visible to management at defined points (for example, at major milestones and at the completion of major tasks).

Commitments are established among relevant stakeholders and are revised as needed. Work products are reviewed with stakeholders and are controlled. The work products and services satisfy their specified requirements, standards, and objectives.

For the E&P industry, this indicates those assets where there are at least common requirements for field information, in terms of data elements, accuracy, and timeliness. Information will generally be collected by systems such as SCADA and a degree of review and editing will be accomplished prior to the information being periodically forwarded to centralized processing. Processes to be accomplished are commonly understood, and each project or field office has its own structured and approved processes for major work components, even though these processes may not be standardized enterprise-wide.

Maturity Level 3: Standardized

At maturity level 3, an organization has achieved all the specific and generic goals of the process areas assigned to maturity levels 2 and 3. At maturity level 3, processes are well characterized and understood, and are described in standards, procedures, tools, and methods.

The organization's set of standard processes, which is the basis for maturity level 3, is established and improved over time. These standard processes are used to establish consistency across the organization. Projects establish their defined processes by tailoring the organization's set of standard processes according to tailoring guidelines.

The organization's management establishes process objectives based on the organization's set of standard processes and ensures that these objectives are appropriately addressed.

A critical distinction between maturity level 2 and maturity level 3 is the scope of standards, process descriptions, and procedures. At maturity level 2, the standards, process descriptions, and procedures may be quite different in each specific instance of the process (for example, on a particular project). At maturity level 3, the standards, process descriptions, and procedures for a project are tailored from the organization's set of standard processes to suit a particular project or organizational unit. The organization's set of standard processes includes the processes addressed at maturity level 2 and maturity level 3. As a result, the processes that are performed across the organization are consistent except for the differences allowed by the tailoring guidelines.

Another critical distinction is that at maturity level 3, processes are typically described in more detail and more rigorously than at maturity level 2. At maturity level 3, processes

are managed more proactively using an understanding of the interrelationships of the process activities and detailed measures of the process, its work products, and its services.

In addition to standardized business and project methodology processes, for the E&P industry this likely would indicate those assets where each asset is individually measured, standardized information is automatically collected in a process-relevant time and forwarded for processing, again in process relevant time. Production and production accounting systems would be tightly linked and would feed information, generally summarized, into the back office systems. However, because the enterprise's systems are not all integrated (Stage 4) there could still be differences in production numbers between the sales, production and revenue systems.

Maturity Level 4: Integrated

At maturity level 4, an organization has achieved all the specific goals of the process areas assigned to maturity levels 2, 3, and 4 and the generic goals assigned to maturity levels 2 and 3. Sub-processes are selected that significantly contribute to overall process performance. These selected sub-processes are controlled using statistical and other quantitative techniques.

Quantitative objectives for quality and process performance are established and used as criteria in managing processes. Quantitative objectives are based on the needs of the customer, end users, organization, and process implementers. Quality and process performance is understood in statistical terms and is managed throughout the life of the processes.[lxxv]

For these processes, detailed measures of process performance are collected and statistically analyzed. Special causes of process variation are identified and, where appropriate, the sources of special causes are corrected to prevent future occurrences.

Quality and process performance measures are incorporated into the organization's measurement repository to support fact-based decision making in the future.

A critical distinction between maturity level 3 and maturity level 4 is the integration and predictability of process performance. At maturity level 4, the performance of processes is controlled using statistical and other quantitative techniques, and is quantitatively predictable. At maturity level 3, processes are only qualitatively predictable.

For the E&P industry, Stage 4 requires tightly linked systems with, for example, only one set of accurate, nearly real-time production numbers which are used by operations, accounting, sales, etc. Note that since the AMM assumes that different assets in a single company may be managed differently, this capability would likely apply only to certain asset groups, fields, etc., rather than to the entire enterprise. [lxxvi]

Maturity Level 5: Optimized

At maturity level 5, an organization has achieved all the specific goals of the process areas assigned to maturity levels 2, 3, 4, and 5 and the generic goals assigned to maturity levels 2 and 3. Processes are continually improved based on a quantitative understanding of the common causes of variation inherent in processes.

Maturity level 5 focuses on continually improving process performance through both incremental and innovative technological improvements. Quantitative process-improvement objectives for the organization are established, continually revised to reflect

changing business objectives, and used as criteria in managing process improvement.[lxxvii] The effects of deployed process improvements are measured and evaluated against the quantitative process-improvement objectives. Both the defined processes and the organization's set of standard processes are targets of measurable improvement activities.

Process improvements to address common causes of process variation and measurably improve the organization's processes are identified, evaluated, and deployed. Improvements are selected based on a quantitative understanding of their expected contribution to achieving the organization's process-improvement objectives versus the cost and impact to the organization. The performance of the organization's processes is continually improved.

Optimizing processes that are agile and innovative depends on the participation of an empowered workforce aligned with the business values and objectives of the organization. The organization's ability to rapidly respond to changes and opportunities is enhanced by finding ways to accelerate and share learning.[lxxviii] Improvement of the processes is inherently part of everybody's role, resulting in a cycle of continual improvement.

For the E&P industry, this stage would assume capabilities such as real-time well control and optimization and field and reservoir-level optimization, based on both models and actual production information. It also implies lean manufacturing techniques for the design and construction of major production facilities.[lxxix] While no company will manage all assets at this stage, each company's "crown jewel" assets are strong candidates for this stage of maturity.

Using the AMM

Economic Concepts Underlying the AMM

Introduction

For more than half a century the value proposition for investments in information technology (IT) has been elusive.[lxxx] Moreover, the asset intensive industry sector has often lagged other sectors in developing the business case for IT spending.

Recently, *Asset Management* process and workflow models have a built in expectation that data and information will flow between the revenue producing field assets such as an oil field, refinery, power grid, etc.[lxxxi] and the back office Enterprise Resource Planning (ERP) solution.[lxxxii] While this approach to asset management makes a great deal of sense, it remains unclear how this approach will be implemented in E&P companies, especially with the large number of legacy systems (both in the field and back office).

Key Economic Concepts

Economic Value

Any responsible investment must have a positive return (at least as calculated pro forma at inception). In the asset intensive sector, top management is typically measured based on Return on Capital Employed (ROCE), sometimes adjusted for Risk. Individual projects are measured as a function of their Net Present Value (NPV) and sometimes by an Internal Rate of Return (IRR). The E&P industry continues to struggle with generating

realistic cost estimates and achieving sustainable returns and in many cases the revenue-producing asset does not actually return the Cost of Capital.

However, Wall Street demands that firms competing for capital generate returns commensurate with the risks associated with the venture. Moreover, demographics are working against the sector as the workforce ages in the US and Europe and the petroleum business shifts overseas. This change entails dealing with the subsequent cultural differences and need to develop a technologically astute workforce, as well as mitigating the continuing high cost of labor.

Economic Value Analysis

Economic Value Analysis (EVA) is expressed in monetary terms and is defined as the difference between operating income after taxes and the opportunity cost of the equity of the business.[lxxxiii] While recently employed to manage our business, as with a number of *new* business models[lxxxiv], the economic value proposition dates back at least to 1890 and the work of economist, Alfred Marshall who wrote:

> *"What remains of this [owner or manager's] profit after deducting interest on his capital at the current rate may be called his earnings of undertaking or management."*[lxxxv]

Economic Profit

According to Copeland,[lxxxvi] as a measure of *dollars of economic value*, economic profit is a function of return on capital (monetary measurement) over a single period (fiscal year).

EP = IC x (ROIC - WACC)

Where, **EP** = Economic Profit	**IC** = Invested Capital (operating working capital + net fixed assets + other assets)
ROIC = Return on Invested Capital (Net Operating Profit Less Adjusted Taxes divided by Invested Capital or, NOPLAT / IC)	**WACC** = Weighted Average Cost of Capital (equity and debt)

Economic Profit

ROIC is a better analytical tool for understanding performance than the traditional industry metric, Return on Assets (ROA), because it focuses on the true operating performance of the firm. The other variables in the EP equation are robust as well and take into consideration a number of micro and macro-economic factors that are both under control of management and outside the control of management. However, both macro and micro sets of variables depend on and can be influenced by the timeliness, quality, and quantity of information available to the firm.

Economic Value Add (EVA) is a metric that helps managers and shareholders understand whether the worth of the firm or a business unit is growing or declining. This metric is used extensively in corporate America and is often the determining factor in individual incentive programs. Many executives have incentive plans tied to their ability, the ability of diverse teams, and the ability of the firm itself to add economic value. Certainly top management's compensation and the price of the corporation's stock are directly linked to the organization's ability to create economic value. Oil and gas firms are

also judged against the universe of firms, not just those corporations in the oil & gas industry. All public and most private firms are competing for funds in the capital markets against the likes of Coca-Cola, Microsoft, etc. At this level, it is not satisfactory to just be better at our jobs than our competitor; we must be competitive with everyone else as well.

Cost of Capital

The firm's average cost of capital is the weighted average of the organization's cost of long-term debt (risk free rate + company premium) and cost of equity (average return on similar risk investment, see β). Cost of capital can be seen as the minimum return required in order for investors to remain with the firm.

In many cases, organizations do not earn their cost of capital. Many managers are measured as a function of some return on investment criteria and most projects (of all types, not just IT) seek a Net Present Value (NPV) that is positive. However, neither positive metric necessarily indicates that the organization is not liquidating itself. If the firm cannot earn its cost of capital, then in economic terms, it is liquidating itself.

Capital Asset Pricing Model (CAPM)

Some observers suggest that the objective of the firm is to maximize profit. The contemporary concept of the firm, however, is to create value for its shareholders. The accepted metric for accomplishing this objective is the price of the publicly traded firm's stock. Moreover, this principle provides a rational approach for managing the firm and provides for the efficient allocation of resources by investors across industries, as they seek the highest return.

As shareholders look for superior returns from a plethora of market opportunities, they are faced with risk management decisions. Investor risk has two components, systematic and unsystematic.

- **Systematic** is that risk that is due to overall market conditions; investors cannot avoid this risk. Securities, partly the result of their industry segment, are relatively positioned against the market in general by the β (beta) coefficient. This coefficient provides investors a statistical measure to weigh stock risk against overall market risk.

- **Unsystematic** risk is directly related to an individual security. Investors can diversify or avoid this risk altogether. It follows that management can influence unsystematic risk issues, e.g., technology, labor, etc. Unsystematic risk accounts for approximately 70 percent of the total risk or variance of a stock. Other factors include the risk free rate of return (typically based on US Treasury bills) and the overall expected value of return for the market portfolio.

The Capital Asset Pricing Model (CAPM), the expected rate of return for stock *j*, during a single period, can be defined as follows:

$$\bar{R}_j = i + (\bar{R}_m - i)ß_j$$

Where,

i	is the risk-free rate
$\bar{R}_m$	is the expected value of return for the market portfolio
$ß_j$	is the beta coefficient for security *j*

Capital Asset Pricing Model

This model is in general use and provides a convenient tool for comparing securities' risks as well as asset portfolio mix. As with the economic value model, the value of the firm is largely determined by its capital structure. Working capital structure is a fundamental component of the valuation process.

Some empirical evidence suggests that the Arbitrage Pricing Model (APM) is a better indicator of value of the firm since it is a multi-factor approach. For purposes of the impact of Integrated Operations on the value of the firm, it is not important which model the firm uses, as all models will yield insight into the interaction of variables affecting the value of the firm.

What is important is the recognition that information management is just as critical to firm valuation as any other variable that contributes to the valuation models. CAPM derives the theoretical required return given the risk of the market as a whole as well as the baseline risk free rate.

The expected return on an asset **E(r)** is calculated using CAPM to discount future cash flows to their present value. Riskier assets will require higher "hurdle rates." Since all assets generate information that can be used to assess today's asset value or price, it follows that the firm's information strategy is a fundamental component of CAPM development.

Working Capital

Working capital is usually defined as *current assets less current liabilities*, and although generally an accounting concept, it describes a phylum of management judgments that influences the set of current assets and current liabilities. For purposes of these discussions, it is useful to view the structure of the firm's working capital as three components:

1. Liquidity,
2. Receivables and inventories, and
3. Current liabilities.

According to the CAPM, receivables and inventories should be viewed from the same perspective as fixed assets. This approach addresses the inherent risk associated with non-liquid assets as opposed to the flexibility allowed by readily disposable holdings. By definition, liquid assets are cash or securities that can be converted to cash readily, with minimum transaction costs and at no capital loss.

As an organization changes the structure of its working capital, as indicated by the percentage mix of the three components, its risk profile changes. Industries that require firms to have a large fixed asset base and inventories (in the form of raw materials, work-in-progress, and finished goods) may present barriers to entry, but such firms may also pose a higher unsystematic risk than firms in industries that do not require this long-term commitment.

Firms are competing for capital in the general market as well as within their own industry segment. Therefore, management must make decisions that increase the overall attractiveness of the firm to the investor community. Recently, firms have largely achieved a just-in-time approach to inventory management, as well as an aggressive pursuit of receivables collection in the form of decreasing Days Sales Outstanding (DSO). These processes are largely under management's control, and the often spectacular results from implementing aggressive programs have been widely reported.

However, this increasing dependence on the firm's supply chain (vendors and customers) has threatened the firm when events, such as the United Parcel Service (UPS) strike or a plant shutdown, literally leave many organizations without the means of meeting customer commitments, as a result of a key supplier's failure to deliver.

The value of the firm has thus been both positively and negatively impacted by these changes. How the firm manages its processes in the future vis-à-vis its competitors will be increasingly important. Failure to be equally efficient will negatively affect the firm's stock price, while superior performance will enhance the firm's value.

Integrated Operations has a direct effect on working capital. It enables better management of product as it moves from the raw material phase into the manufacturing process. It allows firms to mitigate risk, thus enhancing portfolio valuation, and it can have a direct impact on both CAPEX and OPEX costs. One or all of these factors directly affect working capital and cost of capital calculations.

Impact of Capital Structure on the 'Bottom Line'

Changes in working capital structure such as one might find when inventories are adjusted downward to reflect real-time information WILL affect shareholder value and stock prices. From a *just-in-time* perspective, any decrease in inventory will increase the stock price, as decreased inventory enhances economic profit.

> *Interested readers are invited to verify variances in the economic profit profile of their own organizations as part of a 'What If' scenario contingency planning process. For example, build a baseline model of the firm's current situation and then make changes. A simple spreadsheet is all that is necessary to make these calculations.*

Firms that do not intelligently address their working capital components and succumb to cavalier reactions to the uncertainty associated with this phenomenon are destined to pay a steep price. The financial markets have shown themselves to be very unforgiving of managerial misjudgments. The full implementation of the Sarbanes-Oxley reporting and assurance requirements is another significant factor. Moreover, as firms prepare for this event, less than four quarters away, their very actions will have a direct impact on today's stock valuation.[lxxxvii]

Enterprises that do not understand these dynamics will suffer a direct, negative financial impact. Corporations that correctly recognize these dynamics and their potential impact

may actually be well positioned to maximize production, thus increasing shareholder value. These organizations may even be able to take market share from (or in the E&P sector today, simply acquire) poorly prepared competitors.

Impact on Working Capital

> *Firms can, in fact, destroy shareholder value in the very process of trying to protect against uncertainties*.[lxxxviii]

Of great concern before the millennium rollover was that IT systems would fail, thus exposing the firm to disruption. The short or easy view suggested that this was IT system vulnerability with limited impact on the business.

This statement may no longer be true. Online or real-time system failures of 21st Century firms are directly tied to operations and therefore, system outages can destroy significant shareholder value. For example, in the large-scale systemic information network, failures can result in

- Loss of Revenue,
- Destruction of property,
- Litigation,
- HSE Issues, and
- Focus from Regulatory Agencies,

As happened during the August 2003 Northeast United States electric power *Blackout*.

If this is the case, then financial and economic models such as the Capital Asset Pricing Model are relevant as IT realigns from technically driven to business-driven models.

Reliability of Real-Time Decision Support Systems will Drive 21st Century Business Models

Economic Concepts Construct

The foundation of the Value Construct is the Asset Maturity Model. This construct provides a robust decision support solution set that enables Operational Excellence. From its econometric structure, the construct capitalizes on a full range of economic and financial modeling, integrating a superior depth of process change management understanding.

Incorporated in this paradigm is a set of related metrics, such as EVA and ROCE that are founded upon economic and financial models such as CAPM and Real Options. The depth provides management with assurances that the logic of the construct is grounded in strong, tested, economic and financial theory.

The Integrated Operations Mind Map, discussed later, provides a high-level understanding of the interactions of this large set of dynamic subsystems. To achieve the Pareto Optimal population along the efficiency frontier, a logic system must be constructed that provides for the synergies that can be captured when strong theory is operationalized.[lxxxix] This construct is such a vehicle developed specifically for asset intensive industries.

Expected Value of Marginal Information

Against the background and criteria of EVA, firms are making decisions every day. Most E&P organizations are augmenting the decision making process with new information,

e.g., additional well logs, 4D seismic, new market data, etc. This introduces a new concept, the *expected value of marginal information*, EVMI. Readers should note that we are using the economic definition of *marginal utility; the amount of satisfaction obtained from consumption of the last unit of a good or service* (Rutherford, 1995).

Thus, from Ragsdale (1995) additional information, when added to the firm's estimate of the probabilities associated with the uncertain outcome of a decision can be expressed as follows:

EVMI = (Expected value of the best decision *with* new information (obtained at no cost)) minus (Expected value of the best decision *without* new information)

EVMI Model

EVMI represents the probabilistic maximum acceptable *cost* of new information to the decision process. As long as the real cost of new information does not exceed EVMI, then the information is adding economic value to the firm. In other words, it is the threshold value proposition or NPV (net present value) = 0 for new information.

An NPV in excess of the marginal utility of information represents economic value to the firm.

For example, if the expected cost of new seismic information (acquisition, processing, interpretation, etc.) is $1,000,000 then the economic profit to the firm must exceed this cost. It is beyond the scope of this paper to develop this mathematics, but interested readers can *plug* their own variables into the above equations and see if a project is adding *dollars of economic value* to their firm. Be forewarned, there is an element of subjective analysis involved in this process; it is not a strictly mechanical expertise.

Efficiency Frontier

Utility theory is concerned with the choices and decisions that individuals make as well as their judgments of preference, worth, or value. Economists are interested in both the **Predictive,** or ability of a theory to predict actual choice behavior as well as **Prescriptive,** or how an individual should make a decision.[xc]

Utility theory has become a cornerstone of economic assessment processes with the Pareto Optimal, or measure of efficiency (in game theory) where there is no other outcome without diminishing at least one position. This concept is often thought of as the Efficiency Frontier, where the portfolio of positions is maximized.[xci]

Portfolio Management

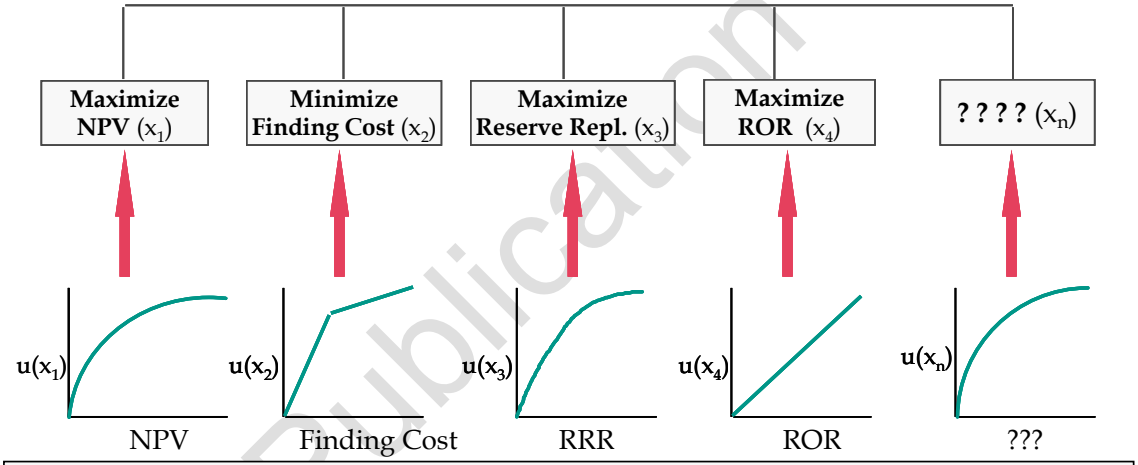
Modern portfolio theory (MPT) techniques seek to maximize the portfolio's return as part of a risk mitigation process. Financial investors, asset intensive firms, and others all use this basic technique as a core management process.

Metric Alignment

Generally, asset intensive firms focus on managing their portfolio of revenue producing properties. However, one aspect of MPT that is often overlooked is the system of business metrics that guide behaviors of individuals, divisions, and even supply chain partners as each works to maximize performance.

Specifically, as it relates to the management of assets in the AMM model, managing the system of metrics is an important consideration when making EVMI decisions. Companies generally get the behavior that they measure and reward. Members of the team must have their reward systems aligned if the value to the firm is to be maximized. In other words, individual metrics or multi-criteria must also be Pareto Optimal and fit along the Efficiency Frontier.[xcii] If metric alignment is skewed, the opportunity for confusion and even inaction is higher. This friction often results in diminished returns as a result of lower organizational performance.

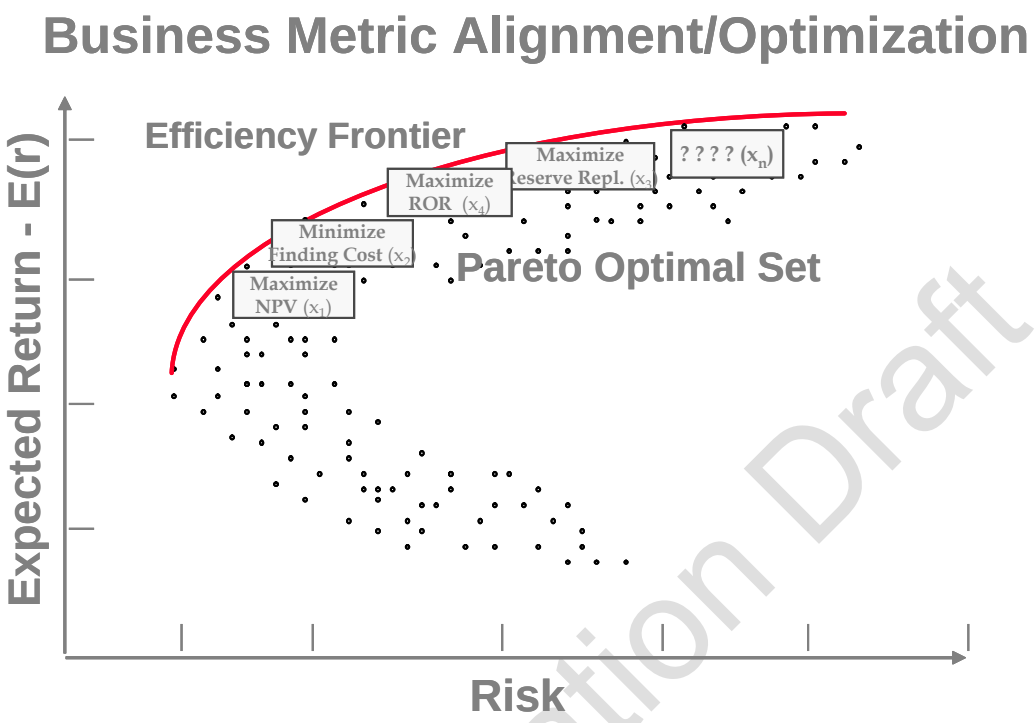
A Multi-Criteria Approach Allows Consideration of the Relative Importance of Each Portfolio Evaluation Criteria



The challenge is to develop a methodology to optimize numerous potentially competing metrics in order to optimize at the enterprise level..

Multi-Criteria Approach Model

Aligning metrics is not an easy process. It takes some work and thought to develop a schema that rewards all participants both for individual effort that allows them to achieve highest economic performance, as well as the team play necessary to achieve the Pareto Optimal scenario.



Business Metric Alignment/Optimization

When the organization has achieved a scenario where all vested interests are rewarded at the maximum level for all, then it can expect that it's Return on Assets (ROA) as a function of risk is maximized, in accordance with both Utility and Modern Portfolio Management Theories.

Taxonomy

Each firm has a set of assets, often classified by a variety of portfolio metrics. Firms classify assets as a function of current and potential future performance.

Taxonomy[xciii] models can be developed using the econometric modeling theories described herein. By definition these models "measure" aspects of empirical data and their relationships in the context of economic theory. In other words, it is a combination of mathematical economics, statistics, economic statistics and economic theory. A robust methodology integrates quantitative and qualitative data into a single assessment process.

Moreover, organizational knowledge can be measured from an Ontology perspective, or foundation from which all aspects can be defined. This is a very rigorous approach that requires depth and an understanding of the relationship between a wide range of variables. This is the more effective approach toward developing the basis of the quantification required by the AMM.

Summary

The Asset Maturity Model is fundamentally an econometric approach to assist asset intensive firms in building robust models that meet the test put forth as fundamental to the learning organization.

> *Conventional wisdom says that we learn from our errors, but errors in the business world can be prohibitively costly. To truly understand how our complex business organizations function requires different tools than managers typically have been given. One tried and true method is to build models.*[xciv]

The AMM capitalizes on and integrates current economic and business process thinking into a single methodology designed to provide an instrument for firms to manage information management investments in their revenue producing assets using economic theory as manifested by the Economic Value of Marginal Information algorithm.

The AMM methodology develops detailed implementation processes, an integrated economic and financial model, as well as a risk management technique. This approach is unique not just to the asset intensive sector but to industry in general.

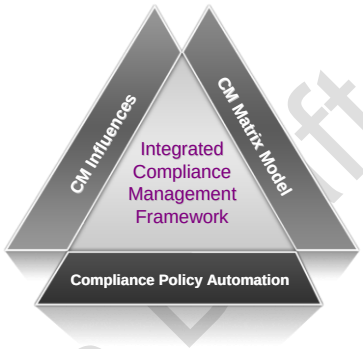
Appendix II—Compliance Management

Asset and Equipment Integrity issues are inexorably linked to regulatory compliance management. Therefore, the focus on this topic includes the development of a compliance management model. In this appendix, we will address three aspects that document a robust compliance solution:

Compliance Management Influencers

Compliance Management Matrix Model

Compliance Policy Automation



Integrated Compliance Management Framework

Compliance Management Influencers

While the specific details of specific regulatory requirements vary by location and industry process, etc., the following diagram provides an overview of the typical regulatory compliance landscape one may find. In this model, there are two major axes.

- Regulatory Authorities
- Interested Constituents

Those Federal, State, and local agencies on the right have a specific, albeit sometimes confusing and inconsistent (across agencies) set of rules to adhere to. However, in some ways these requirements are easier to deal with then the parties shown on the left.

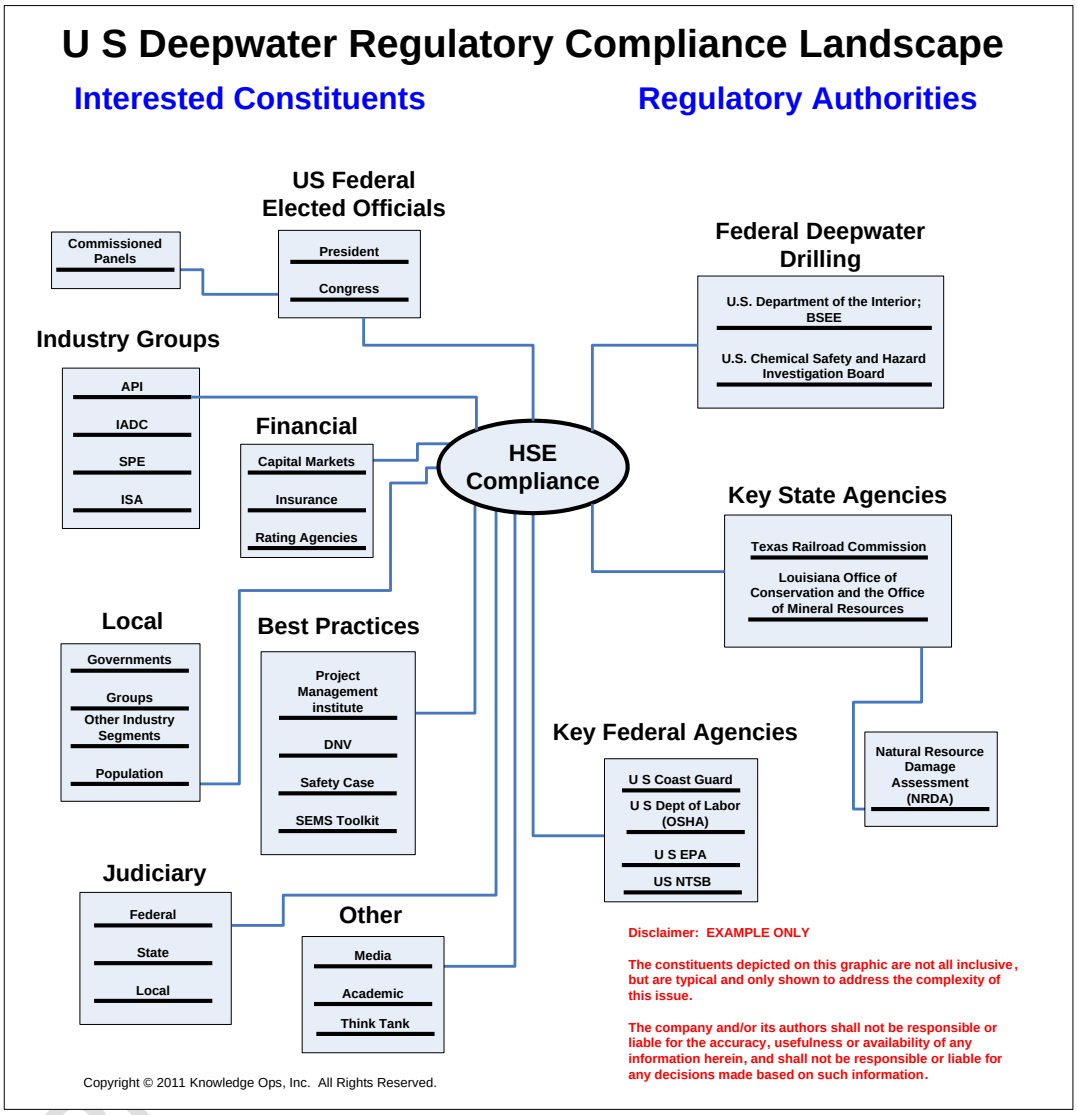
Interested Constituents can include but is not limited to the following:

- Elected officials at all levels
- Industry groups
- Financial markets (including insurance)
- Local groups
- All levels of the Judiciary
- Industry Best Practices, etc
- Other which can include the Media and other public voices.

Depending on circumstances, these groups can be quite vocal, often subjective with a variety of agenda, and are not aligned. This may make them more difficult to deal with in some ways.

Regardless, today's industrial firm must address both sides of this equation proactively. As many organizations and CEOs have learned over the years, if

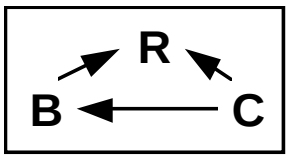
you let events over take you, then real, even perceived *Crisis Management* often ensues.



Example: Regulatory Compliance Landscape

While growing in complexity, achieving Health, Safety, and Environmental (HSE) compliance is a requirement for obtaining and retaining the License to Operate. In the next sections, we will develop the other two sides of the equilateral model, pulling the whole framework into an operable solution.

Compliance Management Matrix Model



THE **R**ELATIONSHIPS, **B**EHAVIORS, and **C**ONDITIONS (**RBC**) model was originally developed to address issues around cross cultural (international) negotiation processes.[xcv] The author first used this model to explore the cross cultural dimensions associated with business negation between East and West cultures.[xcvi]

In a very real sense, the influencers identified above come from a variety of cultures, human interaction processes, and situation awareness perspectives. As such it is appropriate vehicle for the interaction of interested parties and was first documented in January 2011.

> *As shown in the figure, Relationships are the focal point of this perspective, reflecting commonality of interest, balance of power and trust as well as intensity of expressed conflict.*
>
> *Behavior in this model is defined as a broad term including multi-dimensions including intentional as well as unintentional. Finally, Conditions are defined as active and including circumstances, capabilities and skills of the parties, culture, and the environment. Of course, time is a variable in this model as well.*
>
> *One key feature of the R B C Framework is its emphasis on interactive relationships while providing an environment for multiple levels of behavioral analysis. This makes it a useful tool to better understand the new regulatory processes currently unfolding. As we will see later, the number of constituents now engaged belays the use of simplistic linear decision models.*[xcvii]

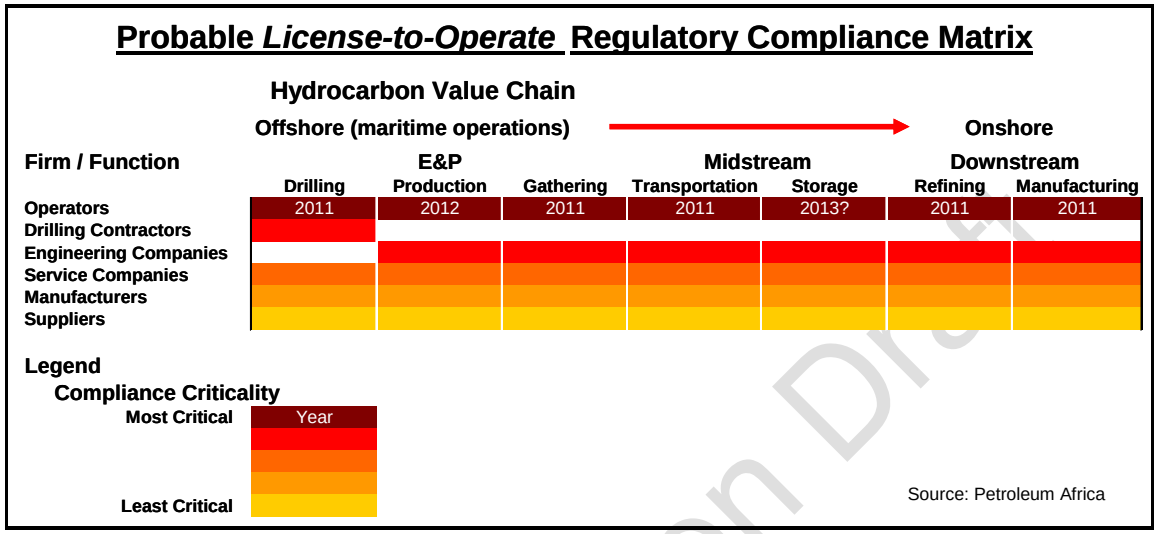
In the simple linear **Influencers** model described above, the number of constituents and agencies can be substantial; however, it can be argued that it is only one dimensional. The organization can simply take in all necessary requirements and implement a simple and just voluminous solution. This still common practice for many firms, but the model is no longer a valid on.

Most major players exist in multiple links of the value chain with a variety of partners and suppliers relevant to the task at hand and the local community. This adds three additional dimensions to compliance management.

1. Supply chain down to and including certain engineering products and components
2. Different segments in an energy or heavy industrial value chain may actually be in different business, e.g., mineral extraction and chemical manufacturing
3. Finally, global firms operate in many countries and locales. The Influencers identified above exist in every geographic area of operations

Additional dimensions to the model include the level of criticality associated with a piece of equipment or a component. For example, an offshore drilling rig is most likely more critical than a pump located on that facility that may either have a back up or operate in a non critical role such as crew quarters air conditioners.

However, even small components such as Space Shuttle solid rocket booster O-rings may have a level of criticality that is mission critical. Function is more important than size or even cost of equipment/components.



Regulatory Compliance Matrix

Finally, at least in the United States, it appears that new regulatory implementation is occurring at differing rates. Clearly, Gulf of Mexico deepwater drilling was a major focal point in 2011. Other sectors do not appear to have the same level of change necessary.

In what will mostly become an often quoted case study, much like the Challenger accident of the 1980's[xcviii] the following excerpt is most telling about this multidimensional aspect of modern heavy industrial processes.

> *The team did not identify any single action or inaction that caused this accident. Rather, a complex and interlined series of mechanical failures, human judgments, engineering design, operational implementation and team interfaces came together to allow the initiation and escalation of the accident Multiple companies, work teams and circumstances were involved over time.*[xcix]

Simplistic models of the past do not address contemporary concerns. Going forward, compliance management using the R B C construct is provides a more robust solution.

Compliance Policy Automation

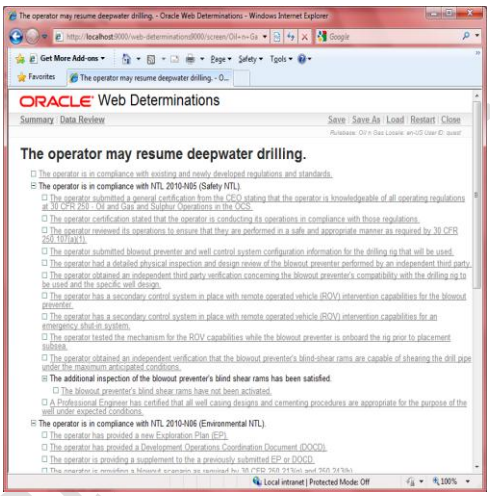
The multidimensional problem stated herein is difficult and perhaps impossible for many organizations to codify into daily operations. Add in corporate SOPs, industry Best Practices and it is possible to create a situation that is unmanageable; at least with current processes.

Generations ago, in the industrial age, society learned how to automate certain processes. In the 1990s' the advent of the Knowledge Worker posited the construct that they were somehow different from their forbearers on the automotive factory line. This hypothesis was challenged.[c]

We know now that while innovation is still an individualist thought process, much can be automated. IT outsourcing is decade old and shows no sign of abating.

So in the case of the elements of the ARRAY OF COMPLIANCE, the scalar data can be managed using readily available technology. For example, a business rules engine that can accept multidimensional data and represent it in a format that employees can manage and assure compliance with regulations, internal SOP and industry Best Practices among other variables.[ci]

- Business & SOP's
- Contractual Obligations
- Company Culture
- Industry Practices
- Mandates, Regulations and Legislation
- Tribal Knowledge
- Embedded in Legacy Systems and Documents



Policy Automation Solution

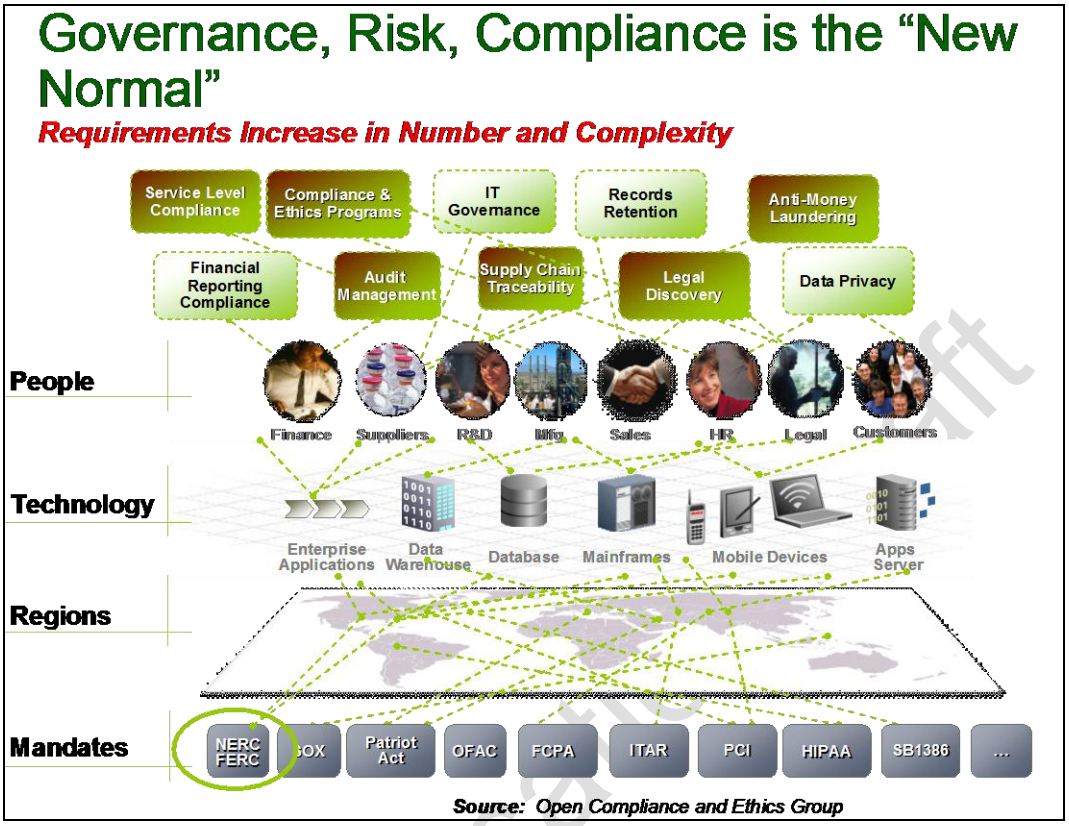
The following figure represents a case study for the electric utility sector. The capability to manage an array of complexity has already been established. The challenge organizations face is the codification of this knowledge into daily operations.

Some may suggest that such a model is a reach and not within the capabilities of today's technology. Detractors held that "if man was supposed to fly he would have been given wings" and more recently concerns that the new BOEMRE regulations would destroy the Gulf of Mexico deepwater drilling sector. In both cased a work around was found.

The aircraft industry has developed a business model based on safety, equipment reliability, and despite bag and other charges a relatively attractive price point for the general population. This business model with its supply chain components did not come about over night but evolved to the one we are comfortable today.

The drilling industry is not there yet in the public's mind. Hence the new normal for compliance and risk management depicted in the graphic below.

Yet, when one boards an aircraft and spends upwards to twelve or more hours in the hostile environment at 40,000 feet in altitude or more while sipping on cocktails, do we expect any less? Today this is normal. Man does not have wings but he has a brain. So it is with complex compliance management.



GRC—The New Normal

In Summary

The challenges faced today by the heavy industrial sector with regards to regulatory compliance are great. Yet like most significant challenges faced throughout history, they are not insurmountable.

The model posited herein is one approach. It has been vetted in the federal government, electric utility and other sectors. It is available to all today!

Appendix III—AEIG Matrix Framework

As previously noted, an AEIG Matrix Framework is specific to any given organization. While not a one size fits all model, the framework provides management with a roadmap to enable a sophisticated yet easily implemented governance framework for operations.

The following matrix can be customized as required and mathematical metrics can be applied if desired. For example, using a range of 1 – 10, rank order can be assigned to each cell in the spreadsheet version of this model. Similar to Risk Breakdown Structure and other similar models, this approach may assist some readers in their subjective perspective of their AEIG and areas of weaknesses to be address.

The remainder of this appendix describes the aspects of the model.

Overview of the Matrix Model

There are four major aspects of the AEIG Matrix Framework. These aspects frame the governance solution and drive organizational behavior to achieve and acceptable level of AEIG. Each is defined below:

Aspect	Definition
Maturity Level	The Maturity construct has been applied to a number of organizational processes and structure. The Asset Maturity Model developed herein is one. The intent of maturity models is to provide a prospective regarding the ability of the organization to adapt to environmental changes in their sector. In the capacity of the AEIG Framework, the Maturity Level provides insight into the organization's capacity to self actualize governance and the level of command and control that must be exercised. As might be expected, those with lower maturity levels will find AEIG implementation more difficult. • Implicit to the defined Maturity Level is the maturity of the *decision-making processes* within the discipline. • Finally, the Maturity Level of the Enterprise to be discussed later will trump the Maturity Level of other Maturity Level components.
Portfolio Management	Most organizations, especially those in the heavy industrial and energy sectors manage the business using portfolio management techniques. This technique is discussed throughout this document and in this context the strengths and weaknesses of this aspect of governance can dictate how AEIG is implemented.
Policies & Procedures	As the name implies the organization's Standard Operating Procedures (SOP) will play a significant role in AEIG. A SWOT analysis of organizational policies and procedures will dictate areas that may need change to assure AEIG compliance and/or ***alignment*** with the organizational governance model.
Criticality	This is the assessment of how important is a given process in AEIG. Metrics that drive the critical nature of processes and are aligned with management's expectation at the enterprise level.

Four Major Aspects of the AEIG Matrix Framework

Components of Governance

Each of the Major Aspects defined above have several components of governance. These components further refine the granularity of the AEIG Framework.

Maturity Level Governance Components

Component	Definition
Enterprise	The maturity level of the overall enterprise is the fundamental driver for AEIG. Strong enterprise governance will enable strong AEIG. However, a weak governance model at the organizational level cannot be overcome by a strong AEIG. The organizational philosophy driving governance and shareholder rights at the enterprise level will transcend all other components of governance described herein. This is the MOST IMPORTANT component in the model.
Asset Maturity Model (AMM)	This has been well documented in Appendix I. The Asset Maturity Model is fundamentally an econometric approach to assist asset intensive firms in building robust models that meet the test put forth as fundamental to the learning organization.
Technology	In the Roadmap to Enterprise Optimization, the construct of technology maturity was developed. By definition, technology referred to herein the technology used by the firm in the revenue generating or cost management process.[cii] For example, the following four positions describe not just an evolution of technology and associated process change; more importantly, they constitute a statement of the fit-for-purpose of a set of capabilities as a function of the Asset Maturity Model. ● Experimental ● Customized ● Point Solutions ● Commercial Off-the-Shelf (COTS) The use and deployment of technology is another fundamental issue to assure strong AEIG.
Information Technology (IT)	There are a number of IT governance models and it should be aligned with both the enterprise governance as well as AEIG.

Capability Maturity Model Integration (CMMI)	Developed by the Carnegie Mellon Software Engineering Institute (SEI), the following quotation is taken from their web site. *CMMI (Capability Maturity Model Integration) is a process improvement approach that provides organizations with the essential elements of effective processes, which will improve their performance. CMMI-based process improvement includes identifying your organization's process strengths and weaknesses and making process changes to turn weaknesses into strengths.*[ciii]
Management of Change (MOC)	Management of Change is especially important in the post-Macondo world upstream energy finds itself in. Similar concerns exist for other sectors as well.
Project Management	Organizations such as the Project Management Institute (PMI) and others have addressed issues around project management maturity. Given that projects are a major process in asset life cycle management, the level of robustness for this process is a major component of AEIG as well.
Business Process Model (BPM)	This covers and errant business processes not covered by any of the above components.
Risk Management	As discussed in this document, high performance risk management processes are paramount and risk exposure is a function of the maturity of risk management processes.

Nine Maturity Level Components of Governance

Portfolio Management Governance Components

Component	Definition
Linkages	Firms often develop a portfolio of entities that are aligned with their strategic interests. This may create linkages at the operational level that create exposure to other entities. AEIG models must recognize this exposure and compensate for it.
Dependencies	Similar to above, often "bundled service" type solutions create governance issues that must be addresses.
Level of Complexity	Risk is increased as the level of complexity increases. Complex portfolios inherently impact governance models as additional effort to manage them is required.
βετα	The CAPM as discussed in Appendix I is one approach towards testing the systematic risk associated with the portfolio.

Four Portfolio Management Components of Governance

Policies and Procedures Governance Components

Component	Definition
Regulatory	Compliance with appropriate regulatory bodies is paramount to obtaining and keeping the License-to-Operate. AEIG models must address this point and often document to the regulatory bodies that they are in compliance. i.e., SEMS.
Internal SOP	Organizational Standard Operating Procedure can be substantial and must be incorporated into AEIG.
Supplier Contract	Supplier agreements and performance must be aligned with AEIG as well.
Process Improvement	Any process changes must be aligned with AEIG. If not, the company may inadvertently be out of compliance with regulations or negatively impact AEIG.

Four Policies & Procedures Components of Governance

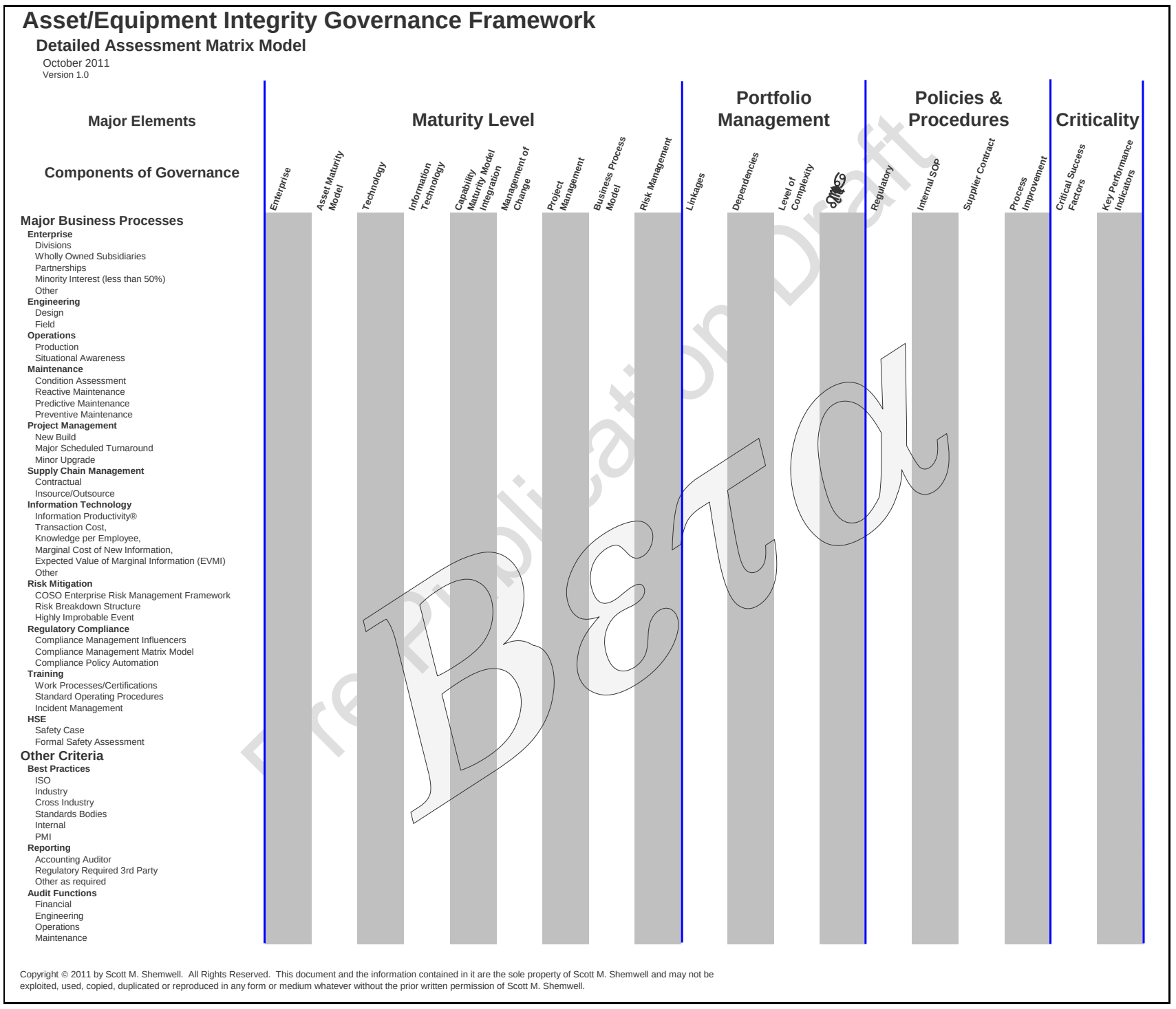
Criticality Governance Components

Component	Definition
Critical Success Factors (CSF)	The importance or *criticality* of a process, task, or action is typically measured, i.e., production uptime. It is important to align executive metrics with AEIG requirements. Failure to do so may weaken AEIG.
Key Performance Indicators (KPI)	Similar to above as these metrics are applied.

Two Criticality Components of Governance

The following chart depicts the AEIG Framework. It is designed to be a worksheet (can be spreadsheet) enabling management to view the overall AEIG model in a single view. As a framework it is designed to have the flexibility necessary to accommodate the nuances of each specific firm.

Some may choose to rank order and even "weight" the variable set and this is a perfectly acceptable way to use this model. Its purpose is to illuminate those areas were governance may be weak and the firm may be at some level of risk or exposure.



Asset/Equipment Integrity Governance Framework

Major Business Processes

In the above AEIG Framework the following Major Business Processes and sub processes/components are listed below along with either there reference in the document where the points are more fully defined or a brief statement to support their inclusion in this model. Users can decide which are relevant for their particular AEIG model.

Major Business Processes	Reference/Discussion
Enterprise	Refers to the organizational structure and enabling processes. The assumption is that firms may have several different business models.
Divisions	
Wholly Owned Subsidiaries	
Partnerships	
Minority Interest (less than 50%)	
Other	
Engineering	Reference to the complete engineering life cycle from initial design through ongoing engineering in the field, upgrades, turnaround, etc.
Design	
Field	
Operations	All aspects of operations and production.
Production	
Situational Awareness	A critical concern that all personnel have a heighten awareness of the surrounding environment, processes, and greater safety awareness.
Maintenance	See Equipment Integrity definition for a more detailed discussion on these four points.
Condition Assessment	
Reactive Maintenance	
Predictive Maintenance	
Preventive Maintenance	
Project Management	The heavy industrial and energy sectors are project intensive. As such, 3rd party contractors are used extensively. This creates weak links in supply chain and engineering processes.
New Build	
Major Scheduled Turnaround	
Minor Upgrade	

Supply Chain Management	As with Project Management, the extensive use of a multitude of supply chain partners creates AEIG exposure. Contract and procurement management must be aligned with AEIG.
Contractual	
Insource/Outsource	
Information Technology	See The Rise of the Information Economy Model for a more detailed discussion
Information Productivity®	
Transaction Cost,	
Knowledge per Employee,	
Marginal Cost of New Information,	
Expected Value of Marginal Information (EVMI)	
Other	
Risk Mitigation	See the section on Simulation Modeling and other
COSO Enterprise Risk Management Framework	
Risk Breakdown Structure	
Highly Improbable Event	
Regulatory Compliance	See Appendix II
Compliance Management Influencers	
Compliance Management Matrix Model	
Compliance Policy Automation	
Training	See the section on Simulation Modeling and other
Work Processes/Certifications	
Standard Operating Procedures	
Incident Management	
Health, Safety, Environment (HSE)	See the section on Risk Management
Safety Case	
Formal Safety Assessment	

Major Business Processes

Other Criteria

In the above AEIG Framework the following Other Criteria and sub processes/components are listed below along with either there reference in the document where the points are more fully defined or a brief statement to support their inclusion in this model. Users can decide which are relevant for their particular AEIG model.

Other Criteria	Reference/Discussion
Best Practices	Best Practices are referred to several times in the document. As with other aspects, any selected must be aligned with AEIG and enterprise governance models. Not all Best Practices are accretive.
ISO	
Industry	
Cross Industry	
Standards Bodies	
Internal	
PMI	
Reporting	See Appendix II as well as other requirements such as SOX etc.
Accounting Auditor	
Regulatory Required 3rd Party	
Other as required	
Audit Functions	Similar to Reporting above, audit trails are more important that before both internally as well as required to be in compliance with various regulations.
Financial	
Engineering	
Operations	
Maintenance	

Other Criteria

Concluding Comments

AEIG is a comprehensive framework that will enable firms to meet the regulatory and shareholder requirements for transparency and oversight in a complex, supply chain enabled heavy industry and energy sector. The model posited herein is straightforward (admittedly detailed) and implementable solution.

AEIG is aligned with corporate governance, available now, and meets the test of reality. This solution can enable firms to assure they obtain and sustain the License to Operate. Revenue at acceptable margins drive stock price—the ultimate value of the corporation.

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