Moving the Energy Business From Smart to Genius by Building Corporate IQ

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Summary

Moving the energy business from smart asset developers to genius organizations by building corporate intelligence quotient (IQ) is advocated in this study. A company's overall effectiveness in creating primary business value from the available knowledge resources (internally and externally) can be expressed as a corporate IQ score in the framework defined here, using a new questionnaire comprising 140 questions. This questionnaire has now been applied to seven energy companies: five oil operators, one service company, and one natural-gas transmission-service operator. The sample groups are still small, but an interesting pattern emerges that confirms the general notion that internationally operating companies are best at developing organizational intelligence. Their higher corporate IQ is essential to enable them to operate effectively in a highly competitive market. The new data reported here may provide useful insight for national oil companies (NOCs) that wish to improve their organizational intelligence if required by an ambition to internationalize their operations. Companies that excel at organizational learning are better prepared to outperform their competitors. International oil companies (IOCs) also can strive to further the enhancement of their corporate IQ by use of the periodic assessments and interventions outlined in this study.

Introduction

Most oil companies realize that the development of unique knowledge can be a powerful competitive instrument, particularly so when such knowledge enables the optimization of value across the energy value chain. A landmark step toward prominent strategic use of unique knowledge in the oil industry was made around 2005 with the introduction of Smart Fields (Shell), I-fields (Chevron), and Field of the Future (BP), all of which are trademarked concepts built around competitive knowledge of workflow processes and new technology tools. Real-time asset management in digital (rather than mechanical/analog) oil fields allows the continual gathering of data and monitoring of the production system (Unneland and Hauser 2005). Failed equipment can be detected and replaced rapidly, which reduces downtime in production. Real-time asset management optimizes workflow efficiency and thereby also improves the net cash flow.

Although perceived as slow by some because of large asset investments with life cycles ranging from a decade (small field), to several decades [liquefied-natural-gas (LNG) liquefaction plant] to half a century or more (major field), the energy business remains extremely competitive. Improved competitive performance can be achieved by accelerating clockspeed (Weijermars 2009a, 2009b). Firm speed in time-based competition, as documented for the oil and gas industry, may vary considerably (Pacheco-de-Almeida et al. 2008). If the execution speed of investment projects is too slow, substantial revenue losses are incurred. Companies that best exploit their project-execution speed (such as ExxonMobil and China Petroleum Corporation) are able to do so because of the quality of their dynamic capabilities (Pacheco-de-Almeida et al. 2008), which is related to organizational intelligence.

The 2008/2009 financial crisis has put oil companies further to the test: Their response to rapid changes in the business environment must be fast and decisive (Weijermars 2010). Investors scrutinize the profitability of an oil company, whereas consumers want their oil delivered economically in a secure supply to meet their increasing energy demand and in an environmentally friendly fashion. The oil industry, therefore, is continually challenged to develop new technology and new concepts that improve their value chain to keep up with society's rising expectations. Optimum performance of companies requires improvement of the corporate IQ by organizational learning, and improving the corporate IQ helps to speed up the performance (McKelvey 2004, 2007).

This paper lays a foundation for further corporate IQ assessments and future in-depth studies. Early results from a newly designed corporate IQ test are reported; the test was completed by 41 professionals of seven major energy companies. The results confirm that NOCs that have moved toward privatization and internationalization were enabled to do so by optimizing their knowledge resources—as can be inferred from their relatively high corporate IQ scores. Privatized NOCs learn rapidly and have become intelligent rivals of IOCs that already excel at organizational learning.

Organizational Intelligence

The concept of organizational learning was first launched by Peter Senge in his book *The Fifth Discipline* (1990) and has matured through work that highlighted the importance of networked intelligence development in organizations (Allee 1997; Argote 1999; Skyrme 1999; Gilley and Maycunich 2000). Companies can capitalize on organizational learning programs by focusing such learning onto the development of corporate IQ. Previous work by Koulopoulos et al. (1998), Mendelson and Ziegler (1999), and Matheson and Matheson (2001) used brief questionnaires to assess organizational intelligence (see Appendix A).

A new framework for organizational learning distinguishes four knowledge performance categories (knowledge focus areas, **Fig. 1**). These focus areas refer to a company's effectiveness in (1) stimulating new knowledge development, (2) applying this knowledge in goal-oriented ways, (3) building new assets with this goal-oriented knowledge, and (4) communicating why the organization has unique knowledge capacities that allow it to lead the industry. If companies begin to make provisions for periodic IQ assessments, then the effect of the associated targeted interventions on the development of their organizational intelligence can be monitored and studied. The initiation and development of such research are important for the future optimization of corporate IQs.

High-corporate-IQ organizations stand out in their IQ rating because they have sharper perceptive antennae, notice new opportunities and new risks more quickly, and spot patterns, trends, and dangers that others do not see—or see only later. Such smart organizations make more-insightful inferences and learn quicker so that they adapt faster to changes in the business environment. "Burning-platform"-type crisis situations (Conner 1992; Rogers 1995) or "melting-iceberg" situations (Kotter and Rathgeber 2006) are instantly recognized by proactive managers at all levels in smart organizations. They will be able to act and remediate the situation without undue delays. The clockspeed (Fine 1996, 1998; Weijermars 2009a, 2009b) is commonly fast for smart organizations, and the need for change is recognized with a sense of urgency and—as advised by Kotter (1978)—is acted upon swiftly when needed. Consequently, organizational learning simply is so fast in smart organizations that major crises are anticipated long before a lethal nonalignment of the company and its environment would occur. Amendments to the company strategy can be made quickly

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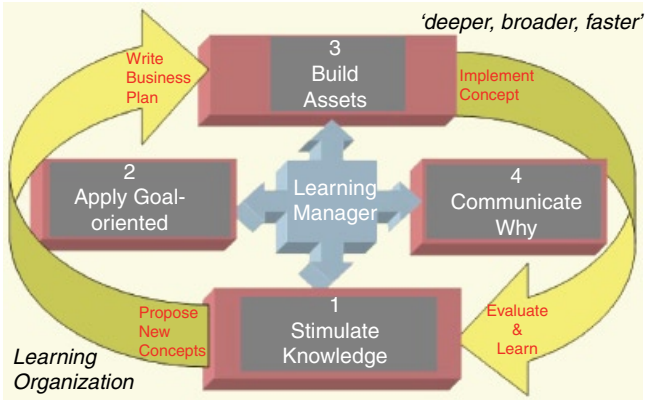

Fig. 1—The organizational learning cycle and business value loop are modeled here into four value-adding focus areas: (1) stimulating knowledge development, aggregation, and exchange; (2) goal-oriented application of acquired knowledge; (3) building of tangible business assets in step with the changing business environment; and (4) communicating the unique values and mission. The role of asset manager in smaller organizations coincides with that of the learning manager. In larger corporations, roles may be split, but this requires seamless feedback between the learning and asset managers.

and are implemented by managerial learning at all levels in the organization to steer the company away from the danger zone of burning platforms or melting icebergs.

The broad development of organizational intelligence also effectively helps a company to ensure that its operational and financial value chains remain closely integrated **(Fig. 2).** The company can either grow or contract over time, in response to changes in the business environment. The development of smart organizations through intensified organizational learning (directed at optimizing the integration of the operational and financial value chains) is not utopia; companies that excel at organizational learning are better prepared to outperform their competitors. Their organizational intelligence will be superior; and to substantiate that, a corporate-IQ scale is needed.

A workbook for *Building Corporate IQ* (Weijermars 2008)—now revised and globally released (Weijermars 2011)—proposes a comprehensive procedure for assessing corporate IQs in the energy industry. The corporate-IQ scale introduced is based on the central-limit-theorem assumption that half the total number of companies score above the average and the other half score below the average. The mean for the corporate-IQ scale is probabilistically set at 100 **(Fig. 3).** The bell curve of corporate IQs (relying upon the central-limit theorem and stochastic calibration of the IQ scale) implies that a quarter of the world's companies are likely to have corporate IQs larger than 110 and another quarter of the world's companies will have IQs below 90. The majority of companies (50% of the total sample) have IQs ranging between 90 and 110.

Applying this approach, the real competitive edge is then held by less than 15% of organizations (normalized in the bell curve) (i.e., those that have IQs higher than 115). These organizations outsmart 85% of their competitors. Still better, if a company's corporate IQ rates 120, it will be in the leading 10% and among the smartest organizations. Once a company is getting smarter, even the smallest incremental increase of its corporate IQ moves it into a progressively more select group of the smartest companies leading the business. A corporate IQ of 130 means a top IQ matched only by 2.5% of all companies; or, alternatively, such companies have a risk of only 1 in 40 of being outsmarted by competitors at any one time.

Corporate-IQ Framework

Organizations must use their integrated resources—their people, technology, and processes—effectively and smartly to create primary business value. This prompts for an organizational learning framework and tools that allow the monitoring of an organization's efficiency in the primary process of value creation. Fig. 1 proposes such a framework, where the business and product life cycles of the company are integrated by knowledge exchanges in four major steps, termed here as activity focus areas.

These four focus areas of corporate-IQ performance correspond to cognitive and social abilities distinguished in personal-IQ tests, as shown in **Fig. 4.** Three of these four IQ focus areas (performance measure categories) directly correspond to those distinguished in personal-IQ tests:

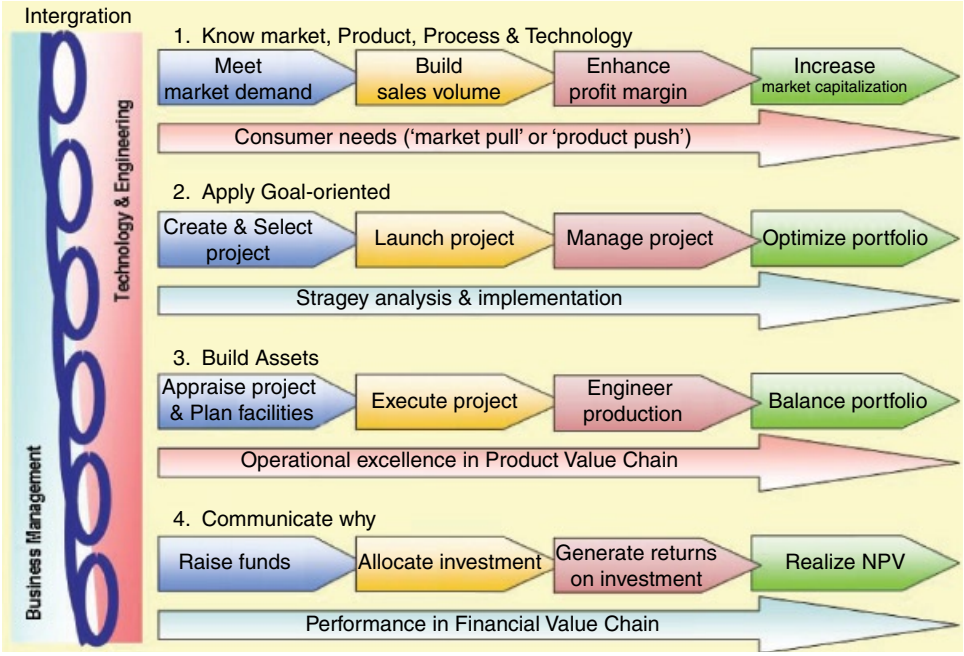

Fig. 2—Product life cycle under constraints of the competitive business environment; constraints must be met by a fitting business strategy that matches the operational product value chain and the financial value chain. All steps must remain integrated optimally at all times. That integration requires knowledge exchange and tools and concepts that optimize organizational learning.

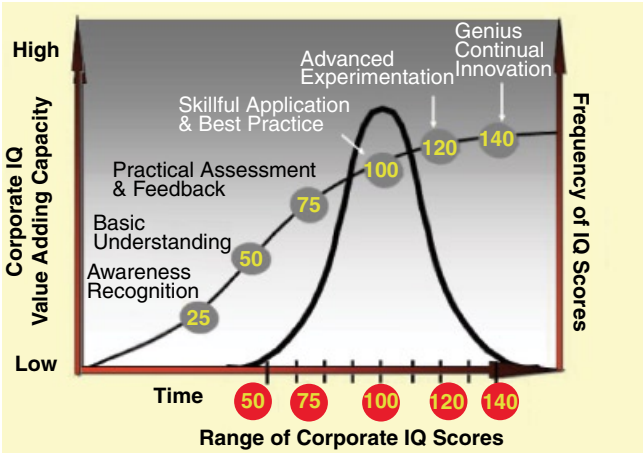

Fig. 3—Corporate-IQ scale and organizational learning curve. The median IQ score for all companies is normalized at 100, in analogy to personal-IQ tests. Acquisition of corporate IQ over time passes through typical stages of enhanced IQ and value-adding capacity.

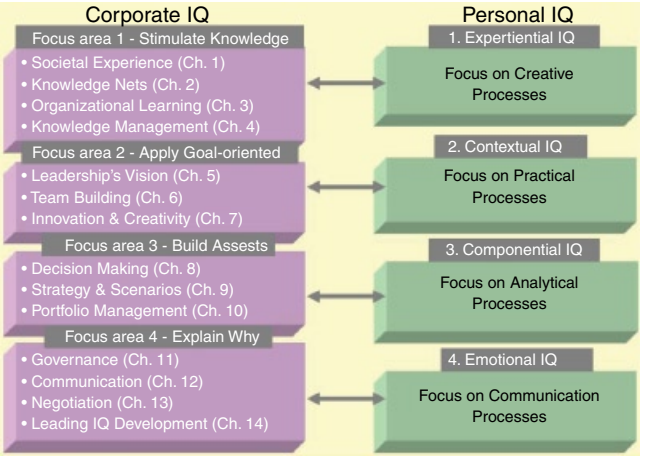

Fig. 4—Four focus areas of corporate-IQ performance correspond to cognitive and social abilities distinguished in personal-IQ tests, as shown here. Each of these focus areas is scored in a cumulative IQ scorecard (see Table A-1 in Appendix A).

1. Stimulating knowledge exchange is the *experiential IQ* aptitude, which focuses on creative processes.

2. Goal-oriented application of this knowledge is the *contextual IQ* aptitude, focusing on practical processes.

3. Building the business assets with this knowledge is the *componential IQ* aptitude, focusing on analytical processes.

4. Communicating in such a way as to make everybody understand why you are unique is not covered in personal IQ tests, but corresponds closely to the *Emotional IQ,* or EQ factor, publicized by Goleman (1997, 2000) and Druskat and Wolff (2001).

Each of the four focus areas must be scored for a particular company, here based on 140 questions in total. The questionnaire requires that the 140 concise statements be answered as true or false. An outline of the corporate-IQ test is given in Appendix A. Questions are designed to test to which degree the organization knows the following:

- How to stimulate creative knowledge exchanges—for example, is the company recruiting new professionals to improve the corporate knowledge base or does every new hire only adopt the company's best practice rather than improving it?
- How to apply this knowledge in a goal-oriented fashion to improve business and decision-making processes—for example, is the vision for the future clear and are all managers aligned?
- How to translate this knowledge into tangible business assets and tap into new opportunities offered by the changing business environment—for example, is the company's strategy clear and is there an auditable decision-making process in place?
- How to communicate the organization's unique knowledge capacities—for example, has the company alienated any shareholders or stakeholders? Is the company's price-to-book value (P/B ratio) undervalued?

Results of Corporate-IQ Tests in Energy Business

The corporate-IQ test has been completed by several groups of petroleum engineers that attended the executive Master of Petroleum Business Engineering program developed by Delft University of Technology (Weijermars 2004; Berkhout et al. 2008; Bos et al. 2008; Currie et al. 2010). Additional IQ scores were sampled while conducting a major change-management program at a Dutch natural-gas-transmission operator, preparing for a strategy shift toward internationalization. All data were collected over the period 2007–09. To protect the identity of the respondee companies, **Table 1** provides a peer-group panel. The results of the IQ-test data for the peer groups are summarized in **Fig. 5.**

The test results confirm the general notion that the building of enhanced corporate IQ by organizational learning has now been taken up successfully by several former NOCs that have moved toward internationalization (e.g., Statoil, Eni, OMV). Such public/private-partnership (PPP) oils were traditionally divided from IOCs (private oils), but privatization of more than a dozen NOCs in the past decade has created an emergent third major group of exploration and production players: PPP oil companies (see Table 1). The PPP oils have rapidly learned to take on more risk and have developed entrepreneurial strategies that in the past kept the business tactics of private oils and state oils distinctly apart. Moving from NOC to IOC status means such companies enter into a much more competitive business climate. IOCs are smart to respond to changes in the business environment and have become agile as they have no protective legislation and monopolistic rights such as those that the NOCs enjoy. Privatization means more risk exposure, and greater organizational intelligence is needed to survive under faster competition.

The impact of privatization on firm performance has been reviewed in detail previously (Wolf 2009; Wolf and Pollitt 2008). Econometric analysis by Wolf (2009) of the performance and efficiency of state oils (23 NOCs, 100% state-owned) vs. private oils (21 IOCs, fully private firms) over a 20-year period (1987–2006) showed that the NOCs studied employ up to 71% more personnel for a comparable asset base and generate up to 18% less output from these assets than their private counterparts. The difference in performance between the Organization of Petroleum Exporting Countries (OPEC) NOCs and non-OPEC NOCs is particularly striking: Across the 20-year sample, non-OPEC firms on average have a 2.3 times higher labor-intensity ratio (employees/assets) than OPEC firms, and their output per employee is 66% lower than that of the OPEC benchmark. **Table 2** highlights the major differences in workflow effectiveness for IOCs and NOCs.

TABLE 1—SELECTED OPERATORS IN THE UPSTREAM OIL AND GAS BUSINESS

NOCs State Oils and Natural Gas Operators	PPS Transitional Oils	IOCs Private Oils and Service Companies
Aramco	Statoil	Exxon
Petronas	Eni	Chevron
Pertamina	OMV	Shell
Staatsolie	Petrobras	BP
PDVSA	ONGC	Baker Hughes
Gasunie	Gazprom	Schlumberger

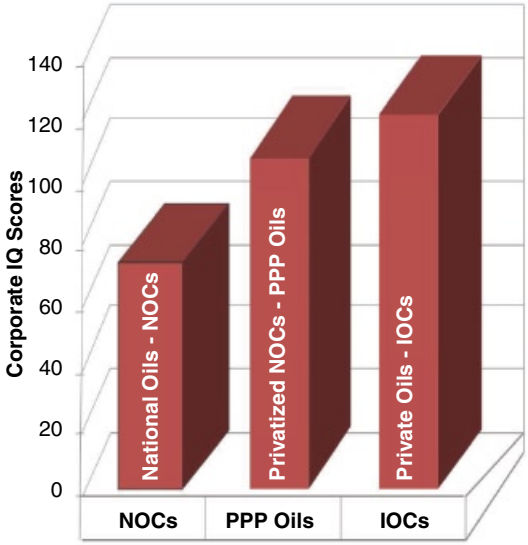

Fig. 5—Corporate-IQ scores for peer-group panel. Number of respondents are: NOCs (30), PPP oils (7), and IOCs (4).

The physical output performance of the top five NOCs vs. top five IOCs (see Table 2) is mostly assumed to be an effect of "easy oil" vs. "complex oil" (Wolf 2009). The hydrocarbon reserves of the top five state oils are trapped in huge geological reservoirs from which they can be produced at low cost: with no or little flow stimulation, using facilities that remain operational for decades. In other words, the reservoirs of the top five NOCs can be produced with favorable capital and labor requirements. In spite of their high physical output, revenue and net income of the top five NOCs are depressed by subsidized sale of oil products in domestic markets and heavy reliance on external service companies and consultancies (which pushes operational expenditure up and pushes earnings down). Additionally, the NOC majors suffer huge working capital tie ups (receivables, capital advances to the State), and operational expenditures and capital expenditures are often burdened with noncore business responsibilities such as public health services and other community services, including regional infrastructure development.

Most PPP oils did not voluntarily privatize and internationalize but were forced to take on more risk when easy oil reserves started to dwindle in their home countries (e.g., Statoil, OMV, and Eni). This required such former NOCs to develop entrepreneurial strategies, previously only championed by IOCs. By mastering the technology and the strategy viewpoints of both sides (i.e., of NOCs and IOCs), PPP oils (e.g., Statoil, Eni, OMV) have steadily gained in competitive power. This applies to emergent PPP oils that completed their transition from NOCs over the past decade, but they have been preceded by many former NOCs (such as Total, Repsol, YPF, PetroCanada, and BP) that followed the evolutionary path by means of PPP oil status and subsequently transformed into fully privatized IOCs **(Table 3).** The proactive development of in-house knowledge is featured at the core of all of these emergent PPP oils; knowledge development by organizational learning brought them the skills and competencies required for their new competitive business roles. An industry survey of NOC capacity development for building LNG liquefaction plants by Ledesma (2009) confirms that in-house knowledge development develops hand in hand with the international outlook of NOCs.

The findings reported here highlight how some NOCs that move toward PPP oils (and eventually toward IOCs) have learned to optimize their knowledge resources during their move toward privatization and internationalization. Methods for improving the probability of success in international corporations have been modeled in earlier research by Weijermars et al. (2008).

Bringing About Change in Corporate IQ

It is extremely important that the upper management of an energy company recognize the importance of organizational learning—they must support a drive to improve the corporate IQ. Successful company leaders have been discovered to outperform their competitors by their ability to establish a climate for faster organizational learning. With a dedicated organizational learning program, the corporate IQ can rise rather than decline **(Fig. 6).** Dedicated organizational learning refers to a corporate learning program aimed not at the development of individual skills and competencies but at a communal understanding of the organizational learning framework that determines the effectiveness and competitiveness of the organization.

Learning faster than the competitors is an intelligent process, whereby transformational change in the business environment is recognized early and accommodated by the company's strategic readjustments. Every time a company stumbles, one may ask: Could this have been prevented by early foresight? Were there developments inside the company or imminent changes in its business environment that predictably led to the failure of the company? Has the company failed to adapt to its changing business environment? Companies that fail to keep up with the speed of transformational change in their industry will disconnect and run the risk of failure. Corporate failures (e.g., ENRON and those of recent financials) are a result of catastrophic IQ declines, in connection with events that compromised organizational learning **(Fig. 7).**

Also, NOCs that want to internationalize can do so successfully only by truly opening up and following dedicated organizational learning programs. Organizations can climb along the organizational learning curve (see also Fig. 3) to improve their corporate IQ systematically over time. In essence, the IQ component scores can be used to support and direct the organizational learning process. Interventions required to remedy weaknesses in corporate IQ can be identified by periodic IQ assessments, as outlined in the schedule of **Fig. 8.** The key lesson is that top management should not focus on operational efficiency alone but must safeguard the development of corporate IQ by organizational learning to shift the company into new business opportunities and ensure growth or caution to prevent contraction well ahead of such disruptions.

TABLE 2—RELATIVE WORKFLOW EFFICIENCY OF IOCs VS. NOCs[*]

Companies	Output Per Employee (kilo-bbl)	Revenue Per Employee (million USD)	Net Income Per Employee (USD)
Top 5 IOCs[**]	51.5	1.36	80,300
Top 5 NOCs[†]	68.8	0.77	67,900
All Private Oils	37.9	0.80	64,400
All State Oils	31.7	0.44	40,000

[*]All numbers 20-year averages (1987–2006), data analyzed by Wolf (2008)
[**]Top 5 IOCs: Exxon, Shell, BP, Chevron, and ConocoPhillips
[†]Top 5 NOCs: Saudi Aramco, NIOC, KPC, Sonatrach, and PDVSA

TABLE 3—PROGRESSION OF SELECTED OPERATORS FROM NOC TO PPP AND IOC STATUS (% SHOWS STATE PARTICIPATION)

NOCs State Oils Before Privatization	Transition to PPP Oil	Transition to Fully Privatized IOC
BP—68%	1977—51%	1995—0%
Total—100%	1992—30%	1996-0%
Repsol—100%	1989—67%	1997—0%
YPF—100%	1993—41%	2000—0%
PetroCanada—100%	1991—81%	2004—0%
Eni—100%	1995—85%	Not yet
	1996—30%	
OMV—100%	1987—85%	Not yet
	1996—35%	
Petrobras—62%	2000—45%	Not yet
	2001—40%	
Statoil—100%	2001—81%	Not yet
	2007—71%	

If a company scores a relatively low corporate IQ, what remedies are possible? Corporate weaknesses can be identified from the detailed test scores. **Fig. 9a** shows an example of lagging scores for each of the focus areas tested in the corporate-IQ assessment. Fig. 9b compiles these results into subscores for (1) experiential IQ, (2) contextual IQ, (3) componential IQ, and (4) emotional IQ. These IQ components refer to the company's respective effectiveness in (1) stimulating new knowledge development, (2) applying this knowledge in a goal-oriented fashion, (3) building new assets with this goal-oriented knowledge, and (4) communicating why the organization has unique knowledge capacities that allow it to excel. Such data can be used to improve the company's IQ scores over time by dedicated organizational learning.

An important point to address is that a large proportion of high-personal-IQ individuals in a company does not necessarily translate to a high corporate-IQ score. Their effective interaction hinges on the quality of the team focus, communication skills, and collective bargaining power in the larger business environment. Also, high-IQ individuals commonly find ways to work rapidly around problems in low-IQ organizations, and this tends to lead to islands of tacit knowledge or only partially uncovered explicit knowledge. Smart individuals surely prefer to work in high-IQ organizations **(Fig. 10)** and will join the smarter competitors if their own company's IQ shows no aptitude to learn and improve. Periodic review of the corporate IQ and enhancement programs is therefore considered

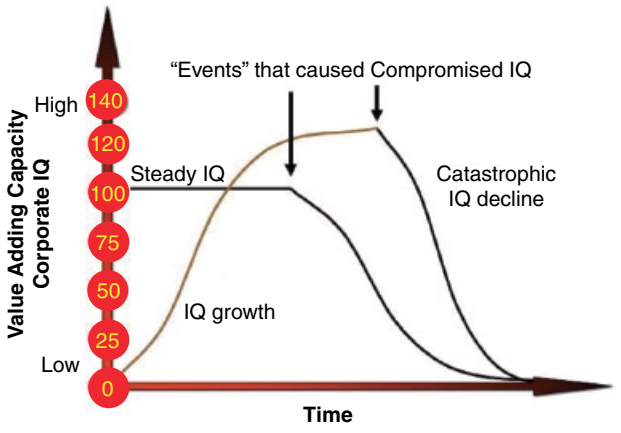

Fig. 7—Catastrophic IQ decline may occur when corporate knowledge is falsified or frauded. Immediate restoration of integrity in the organizational learning process and knowledge management system must occur to prevent total collapse of such compromised organizations.

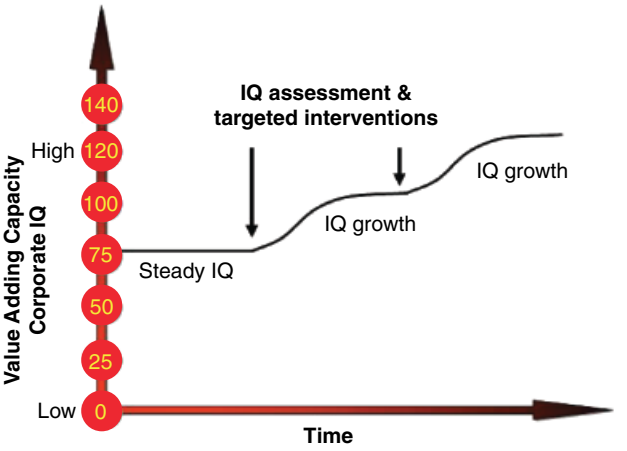

Fig. 6—The purpose of a corporate-IQ assessment program is to maximize growth of the IQ through targeted interventions that translate to higher value-adding capacity.

essential to retain motivated, smart professionals and to attract new intelligent workers.

Recommendations and Conclusions

Fast deployment of new knowledge, tools, and skills provides key drivers for enhanced business performance. Episodic paradigm shifts are avoided by high-corporate-IQ organizations. They mostly stay abreast of the changing business landscape, as paradigm shifts are sometimes necessary but can also be disruptive. Intelligent organizations steer toward new best practices and solutions—well ahead of the disruptive phase. People, technology, and work processes remain the principal agents for value creation in the oil and gas industry. The production control room and reservoir simulation and visualization centers are linked up or combined for greater operating efficiency by integrating the work processes between production and reservoir engineers (Unneland and Hauser 2005). The effective integration of new and existing technologies requires simultaneous optimization with other resources across the value chain in an effective workflow.

Changing the corporate IQ takes time; managers at low-corporate-IQ companies tend to suffer from "groupthink" (Jannis 1982), and this provides a formidable challenge when the need for change arises for NOCs. Such companies are perceived by their managers as powerful, and they commonly assume that this power exists because their company is (already) best in business. However, there is no competition for such national operators because there are no

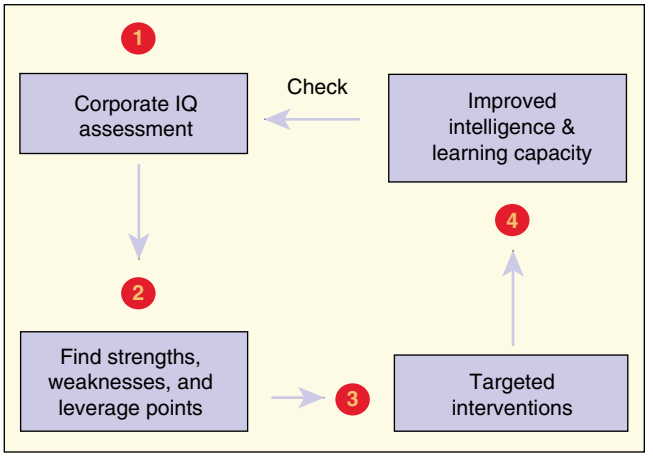

Fig. 8—The outcome of the corporate IQ assessment (1) provides diagnostics (2) for improvement in targeted interventions (3) that enhance the organizational learning capacity (4). The periodic IQ assessment will reveal whether the targeted interventions were effective and thus lead to positive growth of the corporate IQ.

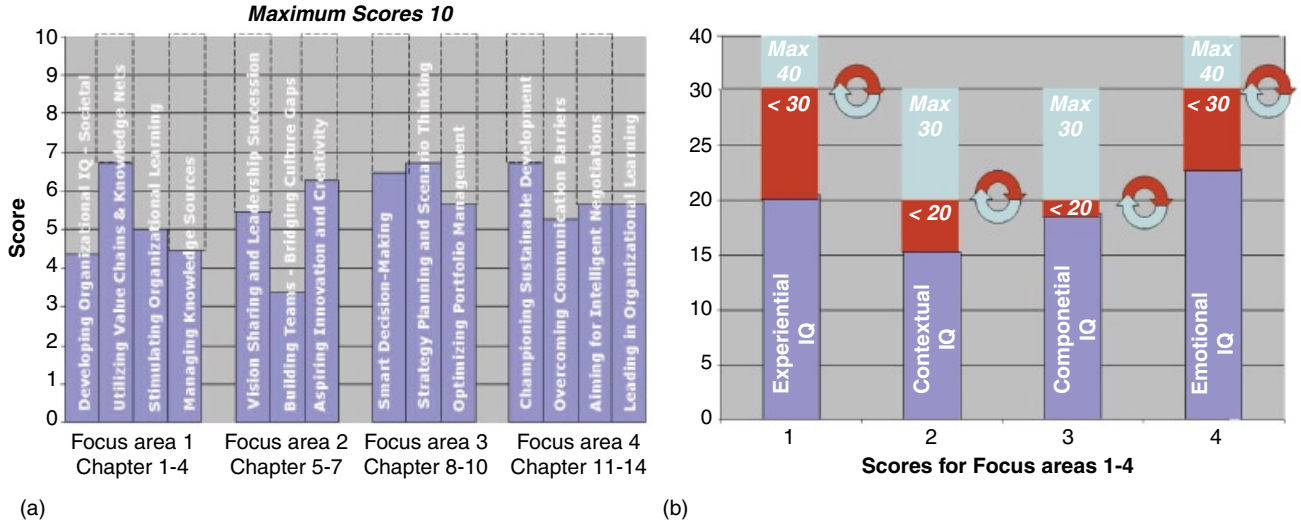

Fig. 9—(a) The outcome of the IQ assessment per chapter identifies the relative strengths and weaknesses of the company in each of the four focus areas and detailed performance categories. (b) Scores for these four IQ components provide further insight into strengths and weakness in the corporate IQ. This information directs targeted interventions to improve the corporate IQ.

peer competitors with whom to compare or compete. Because of their perceived excellence and the monopoly position that ensures reasonable income from their operations, the need for change is seldom felt within NOCs.

When the corporate-IQ test indicates that the company's organizational learning is lagging, a dedicated program of organizational learning must be accompanied by an intensive change-management program (and vice versa). Resistance to change will be fierce (Quirke 1995), and the corporate culture will be resilient to change (Cameron and Quinn 1999; Ford 2008). Resistance to change needs to be overcome by a stepwise approach, as advocated by Kotter (1978). Recent work outlined the importance of adjusting organizational structures to remove barriers to organizational learning (Sakalas and Venskus 2007). The corporate-IQ test outlined here can monitor the progress in such organizations while organizational learning takes place, and while the company is subjected to the changes that expose it to a more competitive business environment.

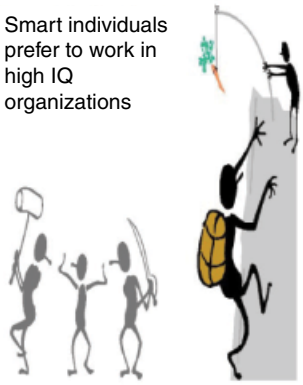

Fig. 10—Most high-IQ individuals thrive in high-IQ organizations and shun low-IQ environments. However, concluding that having high-IQ individuals in your organization automatically leads to high corporate-IQ scores is wrong. In fact, the ability to successfully cooperate in teams is key in achieving deeper, broader, and faster knowledge exchange. Star teams face their own interpersonal challenges. Experienced team workers know that teams composed of professionals of highly diverse focus (i.e., practical, creative, investigative, controlling) are the most successful.

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Appendix A: Background of Corporate-IQ Tests

Comparison With Previous Work. The questions for assessing corporate IQ in this study have been modeled on those used in proven certification methods and management methodologies. Such certifications and methodologies include Sarbanes-Oxley Governance rules, US Securities and Exchange Commission guidelines, generally accepted accounting-principles accountancy rules, International Organization for Standardization 14001, and 9001, European Foundation for Quality Management, the Office of Gas and Electricity Markets' asset risk management, Publicly Available Specification 55, Six Sigma, lean, total quality management, balanced score cards, earned value management, professional engineering operations, Project Management Institute, SUMMIT, and Prince.

The questionnaire also carefully builds onto the trends, concepts, and needs set forth in previous work. For example, Koulopoulos et al. (1998) distinguished between higher- and lower-IQ companies. The results showed that high-IQ organizations focus on innovation, external responsiveness, adapt to changes, and encourage learning and process innovation by employees. There has been no follow-up to track temporal changes in corporate IQ.

Mendelson and Ziegler (1999) includes an assessment tool of an organization's future health, which they call organizational IQ. The assessment has been applied to 164 organizations worldwide in a McKinsey and Company sponsored study. But there has been no attempt to continue this work into an extended effort to track changes in organizational IQ.

Cisco's Internet Business Solutions for some time used an online IQ self-assessment tool comprising a 20-question IQ expertise test. This tool provided a qualitative measure for determining your company's business potential in the Internet Economy based on Hartman et al. (2000). Obviously, this tool is of very limited scope.

Matheson and Matheson (2001) used an "Organizational IQ Indicator Scoresheet" and accumulated approximately 1,000 responses from individuals in several hundred organizations. That work was an extension of their 1998 study described in *The Smart Organization* (Matheson and Matheson 1998). Their results are interesting, but the mixing of several hundred organizations with a total of 1,000 respondees means it became impossible to determine the precise reflection of the score sheets on individual organizations.

Underwood (2004) presents the results of a study of 15 global competitors and determined that high-corporate-IQ companies consistently ranked among the top performers of their industries. Likewise, low-IQ companies ranked at the bottom of their industries. Underwood describes corporate IQ as the interrelationship between a firm's strategy, organization, character, and competitors.

Test Scope. The scope of competitive corporate-IQ testing advocated here envisions national and international comparisons to eventually join an aggregated corporate-IQ database. Clear instructions for the assessment procedure (Weijermars 2008, 2011) make this assessment tool for corporate IQ more practical and more comprehensive than previous tools. The targeted interventions based on a fundamental understanding of the concept of corporate IQ make this assessment tool also more efficient. The cumulative IQ scorecard aims at periodic IQ reviews.

Any IQ questionnaire must stand up to

- Reliability*:* The ability of a test to yield nearly the same score when the same organizations are tested or when repeated on the same test or an alternative form of the test.
- Validity*:* The ability of a test to measure what it is intended to measure. Test items that are valid in one cultural context may lose their validity in a different context.
- Standardization*:* Establishing norms for comparing the scores of organizations that will take a test in the future.

The preliminary results reported in this study suggest that the corporate-IQ test is reliable, provides valid outcomes, and sets a clear standard.

Bell-Curve Mathematics. The distribution of the questionnaire results represents a set of specific variables. The central-limit theorem states that any set of variables has a distribution with a finite mean and variance that tends to the normal distribution. While statisticians and mathematicians uniformly use the term normal distribution for this distribution, physicists sometimes call

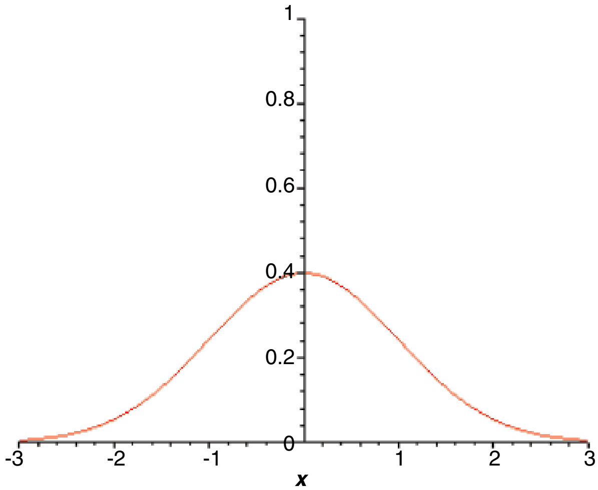

Fig. A-1—Standard normal bell-curve plot (μ = 0 and σ = 1).

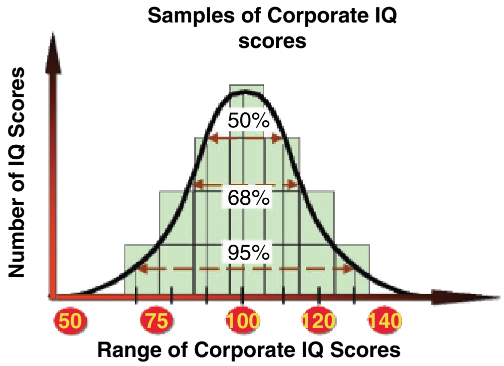

Fig. A-3—Bell-curve plot of hypothetical corporate-IQ spread.

it a Gaussian distribution; and because of its curved flaring shape, social scientists refer to it as the bell curve.

The bell curve **(Fig. A-1)** can be graphed using the following normal probability function *f*(*x*):

$$f(x) = \frac{1}{\sigma\sqrt{2\pi}} e^{\frac{-1}{2}\left(\frac{x-\mu}{\sigma}\right)^2} \quad \text{. . . . .(A-1)}$$

The parameters used in the *x*- and *y*-coordinate system are *e* (the transcendental number 2.71828...), π (the more familiar, but also transcendental number 3.14159....), μ (the mean score on the *x*-axis), and σ (the standard deviation, which becomes the variance σ^2 when squared).

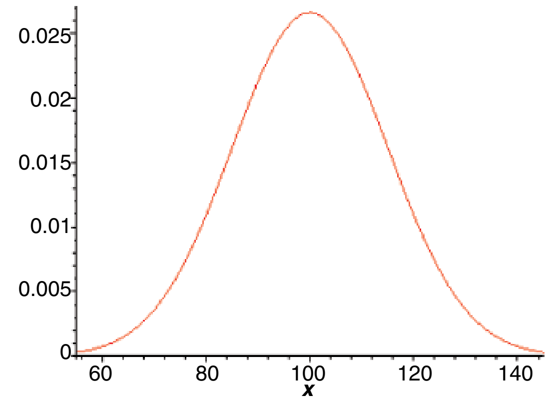

Fig. A-2—Bell-curve plot of IQ spread (μ = 100 and σ = 15).

The bell-curve formula serves to normalize the probability function such that the total area under the curve represents 100% certainty (probability is unity) that the measurements are somewhere under the curve. The height of the curve represents the probability of the measurement density at that given distance away from the mean. Technically, this is the standard normal curve that has μ at the origin ($\mu = 0$ and $\sigma = 1$). Other applications of the normal curve are not symmetric about the *y*-axis but shift the peak of the bell curve away from the origin by choosing μ larger than zero ($\mu > 0$).

For example, IQ plots fix μ at 100 and σ at 15 **(Fig. A-2).** For a normally distributed data set, the empirical rule states that 68% of the data elements are within one standard deviation of the mean, and 95% are within two standard deviations. Graphically, this corresponds to the area under the curve, as shown in **Fig. A-3** for one and two standard deviations. The empirical rule is that 95% of the data must fall within two standard deviations of the mean.

Corporate-IQ Assessment Output. The corporate-IQ assessment tool (Weijermars 2011) can be used for monitoring the efficiency of knowledge development through organizational learning. The organization's effectiveness in creating primary business value from this knowledge is subdivided into four focus areas, as follows:

- *Focus Area I:* Effectiveness in stimulating new knowledge development
- *Focus Area II:* Effectiveness in applying this knowledge in a goal-oriented fashion
- *Focus Area III:* Effectiveness in building new assets with this goal-oriented knowledge
- *Focus Area IV:* Effectiveness in communicating why the organization has unique knowledge that allows it to excel

The questionnaire scores are compiled in **Table A-1** for the focus area clusters outlined stepwise in the chapters of Weijermars (2008, 2011). The experiential IQ component is measured in Focus

TABLE A-1—CUMULATIVE SCORECARD FOR CORPORATE-IQ ASSESSMENT

Chapter	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Individual Scores														
Block Scores	**Focus Area 1: Experiential IQ**				**Focus Area 2: Contextual IQ**			**Focus Area 3: Componential IQ**			**Focus Area 4: Emotional IQ**			
	Total Score: Ch. 1 to 4 (max. 40 points)				Total Score Ch. 5 to 7 (max. 30 points)			Total Score Ch. 8 to 10 (max. 30 points)			Total Score Ch. 11 to 14 (max. 40 points)			
Total Score	**Overall Organizational or Corporate IQ**													
	Total Score Chapters 1 to 14 (max. 140 points, see IQ scale)													

Area 1, contextual IQ component in Focus Area 2, componential IQ component in Focus Area 3, and emotional IQ component in Focus Area 4 (see Fig. 4 in main text). The results of Focus Areas 1 through 4 are then summed to arrive at an overall corporate-IQ score (Table A-1). To minimize individual bias, it remains important to collect a representative number of individual assessments so that the responses can be aggregated into statistical or collective IQ scores. Remedial suggestions are given in Weijermars (2008) together with options for targeted interventions that can be applied after the identification of the corporate strengths and weaknesses—or risks and opportunities.

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