Energy Strategy Reviews 3 (2014) 5–13

Contents lists available at ScienceDirect

Energy Strategy Reviews

journal homepage: www.ees.elsevier.com/esr

ANALYSIS

Dynamic capabilities in the upstream oil and gas sector: Managing next generation competition

Amy Shuen [a], Paul F. Feiler [b], David J. Teece [b,c,*]

[a] University of Hong Kong, Hongkong
[b] Berkeley Research Group, University of California at Berkeley, Berkeley, CA, USA
[c] Haas School, University of California at Berkeley, Berkeley, CA, USA

ARTICLE INFO

Article history:
Received 26 January 2014
Received in revised form
2 May 2014
Accepted 22 May 2014
Available online 7 August 2014

Keywords:
Dynamic capabilities
Upstream oil and gas strategy
Unconventionals
Oil and partnerships
Business ecosystem
Asset orchestration
Multinational corporation
National oil and gas companies
Transformational change

ABSTRACT

The Dynamic Capabilities Framework, originally developed to enhance understanding of strategic agility in high-tech firms operating in high-velocity markets, is shown to be relevant for the Upstream Oil and Gas sector, in the context of five industry game-changers. Here operational and general managers with key strategic decision-making responsibilities significant challenges created by increased demand for energy resources, new technologies that have opened unconventional plays, increased competition, shrinking global geoscience and engineering talent pools, and the reality and perception of environmental risks. The Dynamic Capabilities Framework is distinguished from other "textbook" strategic methodologies and is applied to today's upstream strategic context and inflection point. Dynamic capabilities join with strategy to empower an organization's ability to integrate, build and reconfigure internal and external competencies to address rapidly changing markets. Dynamic capabilities differ from ordinary capabilities in that they orchestrate clusters of ordinary capabilities, best practices and competencies to gain competitive and performance advantages — capturing opportunities and managing strategic risks. Three dynamic capabilities are described that have particular importance for upstream oil and gas companies in the new business environment: (1) ambidexterity across mature and emerging domains; (2) the ability to manage the upstream business ecosystem; and (3) the ability to manage Health, Safety, Security and Environmental (HSSE) considerations in the multinational corporation and throughout the business ecosystem.

1. Introduction

The Dynamic Capabilities Framework was developed to enhance strategic agility in high-tech firms operating in high-velocity markets. A dynamic capability is a meta-process that orchestrates a number of processes, and goes beyond best practices to manage the firm's strategic imperatives. For businesses in high-velocity markets, strategizing cannot be long-term because market and technological uncertainty require constant refocusing for the firm to remain relevant. Leaders create competitive advantage by rapidly transforming their companies with dynamic capabilities that support technological, organizational, operational, and business model innovations.

Today, the Dynamic Capabilities Framework is being used to capture opportunities and mitigate strategic risks in Upstream Oil and Gas Exploration and Production (E&P). Operational and general managers with key strategic decision-making responsibilities employ it to maintain sustainable value, to enhance safety and profitably, to increase reserves and production to meet the company's share of the world's energy needs, and to maintain or advance the company's competitive position. This paper describes how the Dynamic Capabilities Framework can be adapted and employed to capture opportunities and meet the considerable challenges created by recent changes in the industry.[1]

* Corresponding author. Haas School, University of California at Berkeley, Berkeley, CA, USA.
E-mail address: dteece@brg-expert.com (D.J. Teece).

[1] Editor's note: A case study titled "Dynamic Capability and Supermajor EXP," published elsewhere in this issue of Energy Strategy Review, provides details as to how the capabilities approach was used by one E&P firm to enhance its competitive position and financial performance.

http://dx.doi.org/10.1016/j.esr.2014.05.002

To explore the contribution of the Dynamic Capabilities Framework for E&P strategy, we:

a. Describe the weaknesses of textbook strategic methodologies for Upstream Strategy.
b. Explicate the Dynamic Capabilities Framework.
c. Describe how new opportunities and challenges within the upstream industry have created an inflection point that requires a transformative approach to strategy and strategic management. While demand for energy resources continues to increase, new technologies have opened unconventional plays and increased competition. Meanwhile, global geoscience and engineering talent pools have shrunk, and the reality and perception of environmental risk has increased for industry participants.
d. Demonstrate how the Dynamic Capabilities Framework is relevant to today's upstream strategic context.
e. Describe how three specific dynamic capabilities empower upstream strategic imperatives

While we believe that the Dynamic Capabilities Framework is relevant for strategic management in each of the three sectors of the oil and gas industry — upstream, midstream and downstream — and throughout the petroleum industry as a whole, our focus here is on upstream. As this paper demonstrates, the need to create value and increase production, the very considerable economic potential created by new exploration opportunities, and the complexity of the challenges facing upstream strategists and managers require a new and more effective approach to strategic oversight and execution. To survive and prosper in this totally transformed business environment, firms need to develop and employ strong dynamic capabilities.

2. The weaknesses of textbook strategic methodologies for upstream strategy

While E&P companies might benefit from applying traditional strategic management frameworks to navigate the tricky currents of the business environment described below (Section 4), this section explains why several prominent and commonly used analytical tools/frameworks fail to provide both the deep insight into the dilemmas that producers face today and the strategic guidance producers need to address them.

2.1. Porter's five forces

Michael Porter [1] developed his approach partly in reaction to the Strength, Weaknesses, Opportunities, and Threats (SWOT) paradigm, which he considered "unrigorous and ad hoc". According to Porter, strategic managers should focus on five forces: three from horizontal competition (1) the threat of substitute products or services; (2) the threat of established rivals; (3) the threat of new entrants; and two factors from vertical competition: (4) the bargaining power of suppliers and (5) the bargaining power of customers. His emphasis is on assessing the industry and, in particular, on avoiding product markets that are perfectly competitive, where firms can only earn rates of return sufficient to cover the costs of capital. The game (strategy) in Porter's framework is to find a way to shield oneself from the cold winds of competition so as to have a shot at making higher than competitive returns and earning more than the cost of capital.

While the framework is popular, and does provide some overall guidance for assessing developments inside and outside an industry, its usefulness for E&P firms is limited. First, Porter ignores the business ecosystem and "the presence of complementors," which is central to E&P strategy (joint ventures and other strategic and contractual relationships). Second, the role of governments and pressure groups is omitted, which is also important. Third, Porter provides no assistance to strategic managers with respect to how they should compete and how they should manage their asset base to compete better. Fourth, it is difficult to evaluate a particular strategic opportunity without analyzing the resources a particular firm brings to that opportunity.

The five forces framework will give incumbents pause for concern about entry into shale gas and oil ventures, and might suggest an acquisition strategy of both reserves and operators who are already fracking. It will not bring into focus the fact that the large incumbents may lack capabilities or resources to execute high potential investment opportunities.

2.2. Distinctive competencies

In order to explain long run superior performance, some scholars have focused on what they call "distinctive competences" [2–4]. A key foundation for distinctive competence is top management itself. Top management sets strategy, shapes culture, and makes the key resource allocation decisions. The framework underscores the importance of quality management, but without specifying the desirable traits of top management and what leaders are supposed to do, other than adhere to a good long-run vision [5], be good leaders [6] and be change agents effectuating transformation [7].

A single-minded emphasis on the role of management as an explanation for superior performance ignores a variety of other factors important for understanding longer run firm performance. The firm may be lacking key assets, may have a poor balance sheet, and may be ossified in its decision making. Its not just the quality of management; it is the assets (tangible and intangible) that managers get to (or choose to) manage, both inside the firm and external to it.

2.3. Resource-based-view (RBV)

The resource-based view (RBV) maintains that a firm's competitive advantage lies in its ability to utilize a cluster of available intangible and tangible resources [8–10]. These resources are difficult to imitate by competitors and thereby create sustainable value. They should be valuable (V), rare (R), inimitable (I) and non-substitutable (N). Protecting and managing these resources engenders good performance [11,12].

The RVB applied properly, will generally suggest that an E&P firm's intangible assets, not its reserve base (be that oil, gas, coal, or key wind turbine locations), are more determinative of its long-term financial performance. A proper focus on intangibles (technical know-how, organizational capabilities, including management itself) is likely to be most helpful. This view supports the old adage that oil (and gas) is found "in the mind; not in the ground."

In 2001, under criticism from Priem and Butler, Barney admitted that the VRIN framework applied only to static environments, not dynamic ones, which are characterized by high velocity and rapid change [13]. The Dynamic Capabilities Framework can then be seen as a further elaboration of the RVB, reengineering it for the complex, rapidly changing markets that most businesses face today.

3. The dynamic capabilities framework

As defined by Teece, Pisano and Shuen [14,15], dynamic capabilities are "the ability to integrate, build and reconfigure internal and external competencies to address rapidly changing markets." The Dynamic Capabilities Framework took shape during the 1990s [14,16]. It has attracted interest as a potentially overarching paradigm for the field of strategic management. It also implicitly propounds a new theory of the firm and of firm-level competitive advantage.

"Dynamic Capabilities" focus not on an organization's intentions, motivations, or strategy, although strategy may be implicated; rather they focus on what the organization can actually accomplish.

Capabilities arise from past activities and are shaped in part by managerial decisions; such decisions create, mold, and deploy capabilities [17].

Strong dynamic capabilities are unlikely, on their own, to result in competitive advantage. As discussed below, strategy must be matched to capabilities in order to predict when and how dynamic capabilities will impact the firm's performance. Strong dynamic capabilities and good strategy have combined to sustain competitive advantage in firms that have endured for decades, even as they shifted the focus of their activities.

In the earlier versions of dynamic capabilities [14], three processes are recognized as core to dynamic capabilities: (1) coordinating/integrating, (2) learning, and (3) reconfiguration. Integration and coordination routines involve combining resources, such as with the new product development process. Learning is an outcome of practice and experimentation and allows tasks to be performed effectively. Reconfiguration refers to transformation, which in turn requires recombination of existing resources. In Teece [15], "asset orchestration" is identified as a meta-process that envelops and engages all three processes.

Only business processes and business models that yield value-enhancing differentiation constitute genuine dynamic capabilities. Such processes are usually quite unique and firm specific and may be thought of as "signature processes" or "signature business models." These arise from the firm's organizational heritage and so are difficult for competitors to imitate. In order to make dynamic capabilities more operational, Teece [15] identifies three types of "orchestration" processes/activities: sensing, seizing and transforming (for a description of these processes, see Feiler and Teece: Case Study, in this issue).

An understanding of dynamic capabilities can be sharpened by comparing them with ordinary capabilities. Ordinary capabilities permit sufficiency (and occasionally excellence) in the performance of a well-delineated task. They generally fall into three categories: administration, operations and governance. Ordinary capabilities are embedded in some combination of: (1) skilled personnel, including, under certain circumstances, independent contractors; (2) facilities and equipment; and (3) processes and routines, including any supporting technical manuals and the administrative coordination needed to get the job done. Strong ordinary capabilities indicate that the firm has achieved "best practices," and owns or has access to skilled people and advanced equipment.

Ordinary capabilities are usually in the public domain; hence, they can be "bought." Best practices are in this sense ordinary. Best practices, however, may be difficult or costly to outsource since they are often the result of learning, economies of scope and absorptive capacity. Additionally, even ordinary capabilities may be difficult for a given firm to achieve on its own without the benefit of the right environment, talent, resources, core and complementary assets. Whether bought or developed internally, best operational practices are those that increase speed, quality and efficiency. Best practices can be thought of as those that "continuously collect and analyze performance information, that set challenging and interlinked short- and long-run targets, and that reward high performers and retrain/fire low performers" [18]. Eisenhardt and Martin [19] have provided details of the routines and processes that undergird such ordinary capabilities.

Strong ordinary capabilities are built on best practices; dynamic capabilities are built on signature practices and employ differentiated business models. Signature practices arise from a company's heritage and business models, including its prior management actions and context-specific learning [20].

The essence of dynamic capabilities is that they cannot generally be bought (apart from acquiring the entire organization); they must be built. They are often highly context specific. The growth and potential transformation of the enterprise envisioned when an enterprise has strong dynamic capabilities go beyond the notion of "strategic fit." Table 1summarizes basic distinction between ordinary and dynamic capabilities.

As already noted, dynamic capabilities, although essential for creating sustainable competitive advantage, must still be used in aid of, and in conjunction with, a good strategy in order to be effective. Strategy, capabilities and the business environment coevolve. Nonetheless, a strategy that is consistent, coherent and accommodating of innovation is needed to help achieve competitive advantage. A firm with strong dynamic capabilities is able to flesh out the details around strategic intent and to implement strategic actions quickly and effectively. Hence, dynamic capabilities and business strategy co-determine firm performance.

The dynamic capabilities framework emphasizes the need to look beyond ensuring that a business runs smoothly. The latter constitutes technical efficiency, which is relatively easy to achieve. The ability to dynamically formulate and execute strategy, achieve alignment with markets and shape them where possible is the essential requirement for durable enterprise growth and profitability. Managers at all levels must look around and ahead to detect and respond to opportunities and threats. Strong dynamic capabilities allow an organization or business unit not only to do things right but also to do the right things (i.e. what is necessary to become and stay competitive).

Dynamic capabilities reside, in part, with individual managers and the top management team and, in part, with superordinate values and routines that enable an enterprise to perform beyond best practice. At certain key junctures, the ability of a CEO and the top management team to recognize a key development or trend, then delineate a response and guide the firm in co-creation and co-development activities, may be the most important element of the firm's dynamic capabilities. But the organization's values, culture, and its collective ability to quickly implement a new business model or other changes are also integral to the strength or weakness of the firm's dynamic capabilities.

4. A perfect storm of industry game changers

We believe that the Dynamic Capabilities Framework provides the leaders of upstream firms a method to effectively and efficiently capture opportunities, create value, and mitigate risks amid the

Table 1
Dynamic versus ordinary capabilities.

	Ordinary capabilities	Dynamic capabilities
Purpose	Technical efficiency in business functions	Achieving congruence with and with technological and business opportunities and customer needs
Tripartite schema	Operations, administration, and governance	Sensing, seizing, and transforming
Capability-level goal	Best practice	Signature process
Priority	Doing things right	Doing the right things
Imitability	Relatively imitable	Inimitable
Mechanisms of attainability	Buy or build	Innovate and build
Result	Technical fitness	Evolutionary fitness

challenges created by a "perfect storm" of industry game-changers that together constitute a "strategic inflection point" [21]. At least five factors have triggered a climacteric for upstream entities; some have been building for decades, others are very recent. Only the confluence of several factors could bring about such a "perfect storm" of upheaval that has strategic implications for all producers — the national oil and gas companies, the supermajors, and the independents.

4.1. Increasing demand for oil and gas requires significantly increased production

Economists and strategists in most oil and gas companies regularly develop energy consumption scenarios. These provide projections on energy demand, over a 25–50 year period, broken down by resource (oil, gas, coal, nuclear, renewables, etc.). Most show a consistent pattern:

- Between 2000–2050, total worldwide energy consumption doubles
- Oil and gas production increases to meet demand through 2040, when production levels off and demand is increasingly met by biomass and other renewables.
- A significant portion of the increased demand originates from developing countries.
- A rampant worldwide urbanization is occurring, which will move the world's urban population well above the current 50%; this is likely to shape and increase future energy needs.

One measure investors use to judge the operating performance of an E&P company is the Reserve Replacement Ratio (RRR).[2] The RRR measures the amount of proved reserves added to a company's reserve base during a given year relative to the amount of oil and gas produced. To sustain 2% production growth requires a 118% RRR. Most majors target year-over-year production growth over 3%. They envision continuing at that level or more each year for the next two decades to meet their share of the energy demand allocated to oil and gas. However, in 2012, the two largest American oil companies, Exxon and Chevron, reported RRRs of 115% and 112% respectively, while European competitors reported somewhat concerning RRRs: BP (77%); Shell (85%) and Total (93%).

Generally, two options are open to oil and gas companies to increase their reserves: (1) increase reserves through acquisition strategies; purchasing proven reserves; (2) increase reserves through organic strategies, including partnerships (joint ventures), which support the continued discovery of new resources.[3]

- *Acquisition strategies*. 2012 saw a wave of Oil and Gas acquisition activity in the U.S., Russia and Canada: $254B was spent on 679 deals, with approximately 33% of these driven by Unconventionals [22,23]. Purchasing proven reserves, however, does nothing to increase global production to meet increased demand; it simply shifts production to the acquirer.[4]
- *Partnering and organic growth strategies*. Most companies produce new organic discoveries with risk sharing partners (partial asset swaps). In 2012, joint ventures were omnipresent: Chevron with Argentina's state-run company; BP with Russia; Shell with national oil companies that own interests in the Arctic; Total in Africa; and Exxon everywhere. Most majors have embarked on opening new frontiers in challenging locations (e.g., the Arctic). They compete with the independents in the niche basins, where securing the best positions in those basins makes the venture economically feasible. They are also deploying new technologies to rejuvenate heartlands that were previously deemed depleted; while also pursing unconventional plays.

To expand reserves, either through acquisitions or organically, managers must focus attention on certain clusters of activity, what we call, Dynamic Capabilities. When well developed, these address a range of exigencies: the rapid integration of acquisitions; the ongoing management of joint ventures, not only to realize production targets, but also achieve efficiencies, quality and safety; the ability to more effectively predict volumes and the subsurface reality (risk); the rapid deployment of technology and people into potentially hostile environments; and the requirement of ubiquitous change, and associated learning, throughout the organization.

4.2. Unconventionals: new technologies, new geographies, new processes, new opportunity and the need for ubiquitous learning

Given the increasing scarcity of relatively cheap conventional hydrocarbons, upstream companies are investing in Unconventional oil and gas to grow reserves and production (RRR). Unconventional operations focus on shale plays which yield natural gas, NGLs, gas condensates, and crude oil. Tight gas, coal bed methane, oil sands, and heavy oil are non-shale Unconventional resources. The move toward Unconventionals requires the development and application of new technologies and new processes in new geographies. With Unconventional plays, managers confront both great opportunity and considerable challenge. This requires organizational change, learning and a different set of managerial priorities.

The development and application of cost effective fracking technologies, beginning first in the U.S., is a monumental game changer. In the last 15 years, horizontal drilling and hydraulic fracking have made large quantities of tight shale gas and oil reserves viable. Today over 60% of all new oil and gas wells are hydraulically fractured [25], employing over 2.5 million people worldwide, approximately 1 million in the US [26]. US domestic gas reserves have tripled; China's by an order of magnitude. The International Energy Agency [26] has projected that due to the recent tight oil boom, the US will surpass Saudi Arabia and Russia to become the world's largest oil producer by 2017–2020.

About 30% of US oil production is extracted today from tight oil formations. Production of gas and associated natural gas liquids has already begun to surge, reducing net imports of oil and gas. This development is likely to transform the US to a net exporter of oil and gas within the decade. It is also leading to greater dispersion in the distribution of viable energy reserves, to include nations as disparate as China and Poland.

Increased North American LNG exports create complexity and disruptive change for the LNG industry, resulting in either epic opportunities or strategic risks to revenue and profit that could threaten all industry participants. Goncalves [27] raises the critical questions:

- How much demand growth and LNG exports can North American shale production sustain at reasonably low prices — and how much will regional natural gas prices increase due to the LNG exports?
- If North American LNG exports grow rapidly, how will competing foreign LNG producers fare and will global demand grow rapidly enough to absorb the extra supply?
- Ultimately, to what extent and how fast will these trends reduce global LNG prices and impact "shale spreads" — and will this occur

[2] RRR is a common proxy for value creation in the IOCs. Another proxy is market value. Adding to the changing landscape is the emergence of new IOC business models that do not necessarily boost RRR but do generate profits. Service contracts between some IOCs and Iraq are examples [24].

[3] Diversification into biomass and other renewables is becoming an important part of value creation for the majors and NOCs, but is normally managed strategically and organizationally apart from upstream E&P operations.

[4] Analysts value RRR resulting from organic growth higher than RRR that is purchased.

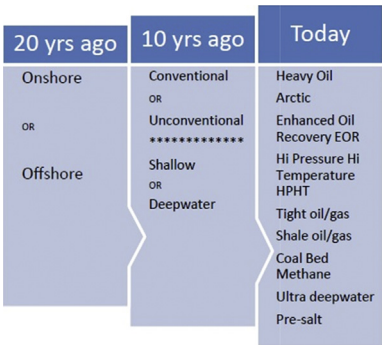

Fig. 1. The increasing diversity of oil and gas "plays".

through softened oil-indexation or perhaps the partial or full elimination of oil indexation in favor of greater use of natural gas or LNG hub pricing.

The answers to these questions drive the profitability, or losses, of major LNG suppliers and traders as well as major LNG importers, buyers, and national gas suppliers (Fig. 1).[5]

The economic vagaries of Unconventional resources challenge conventional methodologies for investment decision-making. While extraction of hydrocarbons from shale is technically viable, economic viability remains problematic [28–30]. Several industry cases have shown economic and financial viability (e.g., EOG Resources), however, successes occur predominantly with agile, first-moving independents, compared to IOCs [31,32].

The challenges of managing unconventional production deepen with the following list of considerations:

- Oil and gas companies must manage both the technical difficulties of drilling in new geological formations, and the non-technical risks related to adverse media attention, public criticism and increasing governmental regulation concerning the environmental effects of fracking. These include the migration of gases and fracturing chemicals to the surface, contamination from spills, depletion of fresh water, earthquakes, water contamination, noise, and air pollution. Some governments have barred fracking operations, after oil and gas companies have made significant investments. In response, new treaties involving Canada, the EU and the US have come into force, which allow private investors to sue governments when operations are curtailed [33–35]; however, these agreements are not in place in many high-potential locations around the world.
- The amount of oil and gas capable of being extracted given current technologies is significantly less than the amount of oil and gas present in the shale, increasing the uncertainty of predictions related to the volumes that could potentially be added to reserves, potentially impacting the profitability of such projects, and leading to uncertainty about future pricing.
- Unconventional wells are depleted more rapidly than conventional wells, challenging traditional calculations related to the long-term ROI of leases, transportation and logistical support.
- In many locations shortages of drilling rigs create significant delays. In some locations, this has recently been abated by the implementation of new mobile rigs ("pad" technology), which essentially double the number of wells a particular rig can drill per year [36,37]. The new rigs are expensive and tend to create a competitive advantage for the larger players, who can afford them.
- Large oil and gas companies with capabilities sharpened to capture value from mega-projects need to reconfigure their resources and processes for fracking operations, which involve numerous wells in a single field and other logistical challenges.
- Those working on Unconventional Ventures need to traverse a steep learning curve before achieving process efficiencies.

The cluster of activities that must be managed is extensive and often overwhelming, particularly given: the number of wells that must be drilled as compared to conventional operations; the fact that many Unconventional projects are understaffed; the technical complexity of fracking and horizontal drilling; delays related to the supply of rigs and parts; environmental considerations; team and managerial inexperience; the need to coordinate and assure the quality of the work of contractors and vendors; the distance or inaccessibility of operations from refineries or processing centers; and the provision of living accommodations, food and amenities for the vast number of people who often suddenly deploy to isolated locations.

4.3. The rise of national oil and gas companies, large independents and service companies alongside the supermajors provides both competitive challenges and collaborative opportunities, increasing the complexity of strategic decisions

The rise of national oil and gas companies, large independents and service companies alongside the supermajors provides both competitive challenges, as well as collaborative possibilities. The characteristics and differences among these entities with regard to access to strategic focus, resources, technical and non-technical capabilities, experience with conventional megaprojects vs. unconventional resource plays, learning, agility, and responsiveness are well-documented in the literature and are generally acknowledged throughout the industry [38–40].

One example of such comparisons, consistent with the "dynamic capabilities" framework, concerns recent research on "clockspeed" [41–43]. A large-scale study of "time-to-build" of oil and gas facilities worldwide (1996–2005) suggests that firms with faster "clockspeed" or intrinsic execution speed capabilities have a performance and valuation advantage [44]. Firms in faster clockspeed industries are encouraged to design and assemble assets as well as their supply, distribution and alliance networks to gain a series of temporary competitive advantages [45]. Exxon, Shell and Chevron are identified as firm-level "clockspeed" leaders in their set of 6 IOC supermajors; ENI, ONGC and StatOil in their set of 6 public-private partnerships (NOCs) using the proxies of workflow speed, improvement of risk and portfolio value accrual [41].

Increasing strategic complexity for managers, however, is the fact that within their own bucket, the NOCs, IOCs and Independents are not homogeneous. The diversity of size, geology, accessibility, strategic focus, and operational competence within and among these upstream entities creates a great deal of complexity in managing both competitive and collaborative interactions. For example, among NOCs, some are essentially politically entities that lack technical expertise and exhibit low labor and capital efficiency; while others are very sophisticated direct competitors of the supermajors, who compete for positions, and explore and produce oil and gas outside their own borders. Most NOC's cannot exist without creating partnerships; others are

[5] Fig. 1 is a diagrammatic modification of data presented in Fig. 17, New Technologies, attributed source: Energy Intelligence North Sea Market Review 2012, p. 63, in V. Marcel, Chapter 6, "Finding the Right Partners for National Oil Companies," in V. Marcel and B. Mitchell. Chatham House Report. What's Next for the Oil & Gas Industry (Oct. 2012), The Royal Institute of International Affairs, London, UK.

blocking entry or expelling competitors to further their economic or political interests.[6]

A given Supermajor, therefore, cannot have a strategy for dealing with the National Oil Companies or with the large Independents, per se, but must simultaneously develop a number of strategic approaches related to the nature and character of interactions with particular NOCs around the world, with specific Independents, with Service Providers and with other Supermajors, depending on what they need and where they want to operate.

Given the strategic impact of the rise of the NOCs, large Independents and Service Providers, all entities now need to be more aware and nimble in relation to the interests and abilities of particular competitors. In some cases, this may mean that responsibility for strategy development and execution should be decentralized, and given to managers with strong knowledge of a particular region or country. One way or the other, "local" knowledge needs to be brought to the attention of those responsible for strategic decisions.

In all cases, active management of a cluster of activities is needed to gather intelligence and manage partnerships (build and manage or dissolve) with an increasing number of powerful competitors. The rise of the NOCs and large Independents alongside the majors makes these capabilities both important and complex.

4.4. Managing the human resource strategy in its parts and interactions

A fundamental challenge for all Oil and Gas companies involves managing a cluster of human resource activities that provide enough people (capacity; recruitment; resourcing), who are doing the right things (technical competence; safety; learning and development), in the right role, with the right people (teams), in the right seat and place, at the right time (deployment), with the right supervision (management), all headed in the right direction (strategy and leadership). Deficiencies in the ways people are managed, alone and in their interactions, can undermine value creation, production, create disasters, and demolish a strategy.

- For the foreseeable future, capacity in E&P is challenged by a decreasing and aging geoscience talent pool. Given current trends, for the next 20 years, the supply of geoscientists will not meet the demand for geoscientists [46].
- Traditional organizational support structures (HR; Learning and Development; Recruitment; Deployment) may not be aligned with the strategic requirements of the Ventures/Projects. In some companies, "The tail is wagging the dog!"
- There are often acute deficiencies related to learning and cross-generational mentoring, particularly related to capabilities for highly complex and high value ventures (e.g., Unconventionals).[7]
- A large portion of a company's talent resources may be contractors who are (understandably) not properly aligned with the company's culture, processes and strategy.
- Deployment within the organization is not aligned with strategic priorities. Other priorities take precedence over getting the Ventures, with highest or potentially highest economic value, the human resources they need.
- Strategic investment decisions about what to drill need to be connected to an analysis of current organizational capability. A particular project or venture may have high-potential economic value, but may not be doable given the level of technical competencies or available human assets. Many firms do not ask the "doability" question when making strategic decisions about investments.

A focus inside the organization alone as the context for resolving human resource challenges ignores systemic solutions available in the company's business ecosystem: partnerships with service companies, joint ventures, the use of contractors, etc. As we will explain, dynamic capabilities that empower people strategy lead to a better management of a cluster of activities inside and outside the organization that recruit, train, and retain the talent required to create value (see Feiler and Teece, Case Study in this issue).

4.5. Managing health, safety, security and environmental risks throughout the business ecosystem

On April 20, 2010, an explosion and subsequent fire on the Deepwater Horizon semi-submersible Mobile Offshore Drilling Unit (MODU), killed 11 workers and injured 16 others. The unit was owned and operated by Transocean, which was drilling for BP in the Macondo Prospect oil field about 40 miles (60 km) southeast of the Louisiana coast. The explosion caused the Deepwater Horizon to burn and sink, triggering a massive offshore oil spill in the Gulf of Mexico. This environmental disaster is now considered the second largest in U.S. history, behind the Dust Bowl [47]. Not only was the explosion disastrous for Transocean, BP and Cameron International, it also led to severe criticism of the oil and gas industry as a whole and curtailment of drilling operations in the Gulf of Mexico.

Many factors contributed to the disaster [48]. Together they indicate that the management of health, safety, security and environmental (HSSE) risks requires attention and asset orchestration activities not only throughout the organization but also in the wider business ecosystem. This kind of management task differs from other kinds of risk management, such as regulatory or compliance risk, where point-of-risk solutions may be adequate. Since the origins of these risks are complex, since the impacts of these risks cross boundaries of the organization, involving partners to whom key operational activities are outsourced, and since the impacts of these risks simultaneously affect several drivers of economic value, not just for one company but for all E&P companies, a comprehensive, systemic, cultural and strategic capability around HSSE must be developed and applied by firms seeking longer term survival, growth, and prosperity.

5. The relevance of the dynamic capabilities framework for upstream strategy

The Dynamic Capabilities Framework was developed to enhance strategic agility in high-tech firms operating in high-velocity markets. While there are clear differences between the strategic foci of high-tech firms and E&P Oil and Gas companies, and in their business environments, in both, leaders are confronting global industry shifts. They must generate and implement organizational and managerial innovations, both internally and within their ecosystems, to capture opportunities, overcome challenges, mitigate risks and achieve and sustain competitiveness. Both involve increasing supply in the face of increasing demand; managing and responding to competition from new entrants; deploying new technologies; managing challenges related to

[6] One of the key factors driving change and uncertainty in this industry is the unstable and often hostile political environment in many oil and gas producing host countries. In this article, where the focus is on competitive and collaborative advantage derived by dynamic capabilities, we unfortunately give short shrift to the literature on non-market strategies, the difficulties of managing government-business relationships in the oil and gas industry and the issues of rent extraction connected to political power and entities such as NOCs that have non-market mandates or non-financial/economic incentives. We do address this briefly in the Feiler and Teece case study, also in this volume, in the discussion of a dynamic capability that effectively manages the centralized-decentralized polarity in multinational oil and gas companies.

[7] In the Feiler and Teece case study, which is the companion piece to this article in this volume, we identify learning and cross-generational mentoring as a dynamic capability implemented by Supermajor EXP.

human resource deficiencies; management of the business ecosystems, and of the centralized-decentralized polarity in multinational contexts [49]. These challenges are not entirely unique to oil and gas; accordingly, we see insights gained from the application and testing of this model in other industries to be relevant for upstream oil and gas entities.In this section we illustrate the applicability of the Dynamic Capabilities Framework to Upstream E&P by describing three dynamic capabilities that we consider to be particularly important for the industry today.

5.1. Dynamic capability: ambidexterity across mature and emerging domains

In shifting business environments, inertia kills companies. The ability to learn, adapt and reconfigure assets and foundational capabilities creates sustainable value and competitive advantage. One challenge faced by the supermajors and large NOCs, however, is that, in the current business environment, both mature ventures (e.g., heartlands and deep water) and new opportunities (e.g., Unconventionals) are strategically important. How do leaders reconfigure assets to compete simultaneously in both mature and emerging businesses? O'Reilly and Tushman [50,51] use the term "ambidexterity" to describe the particular dynamic capability that involves a leader's cognitive and behavioral ability to establish, align and sustain the competencies, structures and cultures that, on the one hand, forward the interests of the mature business, while, on the other hand, drive innovation.

The competencies, structures and cultures that lead to success in mature vs. emerging businesses are different and sometimes contradictory [51,52]. Success in mature businesses requires control, efficiency, replicable processes, increased productivity and reduced variance. Success in emerging businesses requires autonomy, innovation, search and discovery and embracing variation. Ambidextrous leaders simultaneously promote both, establishing separate organizational entities, business models, processes, systems, and cultures for each, while holding them together through unified strategic intent, common values and linking mechanisms to leverage assets.

In the brief history of the exploration and production of Unconventional resources, the major oil and gas companies have had to catch up with the independents that discovered and developed fracking technology (e.g., Mitchell Energy, now Devon). Many of the supermajors had fine-tuned their capabilities and organizational structures for megaprojects — huge reserves in deep-water locations or other international locations. Such capabilities, however, are not optimal for the development of Unconventional resources. By 2011, however, several of the major oil and gas companies had caught up and surpassed most of the independents. Of the 14,000+ US oil and gas companies, 10 account for 33% of natural gas production. At the head of the list is ExxonMobil with BP, Chevron, and ConocoPhillips also in the top 10 [53].

The dynamic capability that engenders competitiveness for the majors in this new business environment involves being dexterous across several domains: mature and emerging ventures, rejuvenation of the heartlands, deep water, capturing the best positions in the boutique basins (where the independents play), new frontiers (e.g., Arctic) and Unconventionals. Separate organizational units, with dedicated financial, human and technological resources can be created to capture each of these opportunities, while ensuring that processes are established to link these sub-units in value-creating ways. To accomplish this, resources are allocated away from mature ventures into emerging ones, which requires rapid learning throughout the organization and its subunits and the outsourcing of jobs to service companies or contractors. Joint ventures with experienced unconventional producers both accelerate learning and expand operations. Finally, leaders need to promote a culture that balances the centralized and decentralized parts of the organization. This facilitates competitive intelligence-gathering, helps track technological change, effectively identifies new opportunities, and promotes operational flexibility and shared values across the organization.

5.2. Dynamic capability: the ability to manage the upstream business ecosystem

Ecosystem management is a dynamic capability essential for ongoing success. The need to increase production, the fact that approximately 90% of the reserves are owned by the NOCs, the decreasing pool of technical experts, the broad range of technical expertise needed for operations, the need to rapidly deploy new technologies, the need to work in locations that are remote or political unstable, all challenge the tradition vertically-integrated E&P firm. A deep understanding and management of the E&P business ecosystem and adeptness with partnering strategies are critical for the management of upstream entities. Nowhere are the strategic management and orchestration skills of leaders tested more than they are managing ecosystem relationships.

This dynamic capability involves the work of developing and communicating strategy and achieving strategic alignment, managing expansion through tradition M&A activity, expanding the use of contractors, vendors and joint ventures with companies and governments (both rivals and complementors), building relationships with service companies, suppliers, universities, research centers, financial institutions, regulatory and standards bodies, governments and the judiciary, and doing all this constantly and simultaneously in many regions around the world. Moreover, closer attention to upstream and downstream linkages is increasingly important. E&P companies pay attention to the marketability of potential supplies when making investment decisions; this requires close attention to pipelines and other forms of transportation. This is positively critical in gas, where the absence of a pipeline (or other means of transportation) may deny the producer commercial opportunities.

Ecosystem management touches on several important drivers of economic value:

(1) *Strategy formation*. When developing strategy at all levels of the organization, mastery of the knowledge-gathering activities that keep leaders abreast of developments in the various parts of the business ecosystem is essential [15]. Knowledge of market conditions, regulations and standards in the geographies where the firm works or wants to work, supplier and vendor innovations and other information created by tapping the business ecosystem increases the ability of leaders to shape opportunities and mitigate risks.
(2) *Management of joint ventures*. Opportunities to join resources, assets, capital, and technical expertise are catalysts for collaborative approaches to large projects or ventures. In parallel with continued high oil prices, advances in technology and the rise of unconventional exploration and development, the number of joint ventures is increasing. Joint ventures are the preferred strategy for NOCs wanting access to US shale plays. In 2013, Sinochem (China) entered into a $1.7B JV with Pioneer Natural Resources for a shale play in West Texas. According to the Energy Information Administration [54], since 2008 foreign companies have established 21 JVs with US operators related to tight oil and shale gas plays. Independents are also partnering more vigorously with the majors. Not only are the numbers of JVs increasing, but today there are many more options for collaborations than in the past: partnerships between private equity funds and upstream companies; small and large independents with the majors; IOCs and NOCs worldwide are creating JVs to enter the US market. Many studies show a high failure rate [55]. Strong management is needed to realize value [56,57].

(3) *Management of NOVs (non-operated ventures)*. NOVs are a key part of the investment portfolio of upstream entities: 22-59% of Supermajor production is operated by others [58]. Worldwide, 23% of equity production is delivered through non-operated ventures, with the figure rising above 50% in some regions. Often non-operating partners do not manage NOVs with the same diligence as their operated ventures, resulting in significant exposure to risk and a failure to realize the potential value in the venture. BP's non-operating partners at Macondo (2010) were exposed to huge liabilities and in turn exposed BP to liabilities. According to Whittaker and Young [58], E&P companies that are effective at realizing value from their NOVs treat them as they would the ventures they operate. Management structures should provide oversight; strategic managers should focus on four "building blocks": (a) clear strategic intent about what each NOV asset contributes to broader company goals; (b) sharp risk and opportunity assessment; (c) consistent NOV organization and governance; and (d) rigorous execution strategies for each NOV asset.

(4) *Acquiring technical capabilities*. The growth of oilfield service companies has brought an increase in outsourcing, including many activities that might once have been considered "core", such as production operations [59]. Mining the business ecosystem for technical capabilities is at the critical for venture success. Essential to adequate staffing of high potential ventures is organizational agility in identifying, onboarding and managing contractors, delegating through contractual relationships projects or parts of projects to services companies and entering into joint ventures. Also, as M&A activity ramps up, in part, to increase organizational capability, strategic managers are increasing dependent on the ecosystem, particularly where it exists apart from the center of the organization, to aid in the identification of potential targets and the provision of organizational and strategic due diligence.

(5) *Development and deployment of new technologies*. Where does an E&P company find new technologies? In house R&D is one component of a relevant search. In fast-paced environments, however, often new product introductions benefit from access to external sources of know-how [52]. Enterprises must search the core as well as the periphery of their business ecosystem for relevant new technology. The search must scan both rivals and potential collaborators — customers, suppliers, complementors, and new entrants — that are active in innovative activity [15].[8]

5.3. Dynamic capability: management of health, safety, security and environmental (HSSE) considerations in the multinational corporation and throughout the business ecosystem

In Section 4.4 above, we established that the management of health, safety, security and environmental (HSSE) risks requires managerial attention spanning the organization and its affiliations. Since the origins of these risks are complex, since the impacts of these risks cross boundaries of the organization, involving partners to whom key operational activities are outsourced, and since the impacts of these risks can be catastrophic, simultaneously affecting several drivers of economic value, not just for one company but for all E&P companies, a comprehensive, systemic, cultural and strategic capability around HSSE must be developed and used.

Today, top E&P firms pay serious attention to managing HSSE, not only for their own workers but also for all those in their ecosystem who touch their operations. One large oilfield service company executive recently credited his ecosystem relationships (e.g., tribal leaders, the CIA, former Navy Seals), with the efficient and safe extraction over 200 company workers, who had been trapped in Libya in 2010 when NATO bombing commenced.

Most upstream companies have large HSSE departments staffed by top leaders, responsible for managing the cluster of activities that protect people and the environment. CEOs make HSSE a part of every speech and every report. In some large E&P companies, discussions about HSSE begin every meeting. Certainly sustaining HSSE has a clear business purpose. Leaders understand that accidents increase regulation, hurt business performance and decrease the value of the company's and the industry's goodwill. There is an increasing personal commitment to the importance of this issue throughout the industry that contradicts stereotypes.

Most oil executives realize that there is no room for complacency. They understand that with increased production, increased M&A activity, certain levels of inexperience with Unconventionals, combined with geo-political uncertainties, the risks are omnipresent. Managerial orchestration of resources that create effective Health, Safety, Security and Environmental (HSSE) performance is increasingly complex and a strategic imperative for upstream companies.

6. Conclusion

A dynamic capability is a meta-process that involves orchestration and leadership across a cluster of activities — resources, processes, and best practices — to manage comprehensively and systemically, something that is strategically critical. Dynamic capabilities empower and make precise decisions about direction, they align stakeholders, engender readiness for change, and theyincrease agility for capturing value and for risk mitigation.

We began by describing how new opportunities and challenges within the upstream industry have created an inflection point that requires a transformative approach to strategy and strategic management. Capturing and producing new oil and gas resources is complicated by increased competition, new technologies that open up unconventional plays, the rise of NOCs, large Independents and service companies. Meanwhile, a decrease in global geoscience and engineering talent pools, the need to manage post-Macondo risks, pressure toward alternative sources of energy, complicate short term as well as long term decisions.

We have outlined the Dynamic Capabilities Framework to show how it has evolved from a strategic model employed by high-tech companies to undergird agility in high-velocity markets, to a comprehensive strategic framework relevant for upstream oil and gas entities as they capture opportunities and manage risks in the changing business environment. Strong Dynamic capabilities can sharpen strategic agility and are the key to seizing and profiting from opportunities in the new business environment. Dynamic capabilities empower upstream strategy.

Acknowledgements

Barclay Gibbs, Gardner Walkup, Chris Goncalves, Chris Gulick, Greg Linden and the editor, Don Lessard provided many helpful comments.

References

[1] M. Porter, Competitive Strategy, The Free Press, New York, 1980.

[8] In fact, it has long been the case that across industries and time, new entrants have been responsible for a substantial share of revolutionary products and processes: the jet engine (Whittle in England; Henkel and Junkers in Germany), catalytic cracking in petroleum refining (Houdry), the electric typewriter (IBM), electronic computing (IBM), electrostatic copying (Haloid), PTFE vascular grafts (WL Gore), the microwave oven (Raytheon), and diet cola (RC Cola). This is also the case in oil and gas. In 1997, Mitchell Energy's engineers discovered how to effectively fracture shale. Their innovation is today changing the world.

[2] E. Learned, C. Christensen, K. Andrews, W. Guth, Business Policy: Text and Cases, Irwin, Homewood, IL, 1969.
[3] L.G. Hrebiniak, C.G. Snow, Top management agreement and organizational performance, Human Relations 35 (12) (1982).
[4] M.A. Hitt, R.D. Ireland, Corporate distinctive competences, strategy, industry and performance, Strat. Manage. J. 6 (3) (1985).
[5] P. Selznick, Leadership in Administration: a Sociological Interpretation, Row, Peterson, Evanston, IL, 1957.
[6] S. Finkelstein, D. Hambrick, Strategic Leadership: Top Executives and Their Effects on Organizations, West Publishing, Minneapolis/St. Paul, MN, 1996.
[7] N.M. Tichy, M.A. Devanna, The transformational leader, Train. Dev. J. 40 (7) (1986) 27–32.
[8] B. Wernerfelt, A resource-based view of the firm, Strat. Manage. J. (2) (1984) 171–180.
[9] R.P. Rumelt, Towards a strategic theory of the firm, in: R.B. Lamb (Ed.), Competitive Strategic Management, Prentice-Hall, Englewood Cliffs, NJ, 1984.
[10] E. Penrose, The Theory of the Growth of the Firm, Basil Blackwell, London, 1959.
[11] J.B. Barney, Firm resources and sustained competitive advantage, J. Manage. South. Manage. Assoc. 17 (1) (1991) 99–120.
[12] J.B. Barney, W. Hesterly, Organizational economics: understanding the relationship between organizations and economic analysis, in: S.R. Clegg, C. Hardy, W.R. Nord (Eds.), Handbook of Organization Studies, Sage Publications, London, 1996.
[13] J.B. Barney, Is the resource-based theory a useful perspective for strategic management research? Yes, Acad. Manage. Rev. 26 (1) (2001) 41–56.
[14] D.J. Teece, G. Pisano, A. Shuen, Dynamic capabilities and strategic management, Strat. Manage. J. 18 (7) (1997) 509–533.
[15] D.J. Teece, Explicating dynamic capabilities: the nature and microfoundations of (sustainable) enterprise performance, Strat. Manage. J. 28 (13) (2007) 1319–1350.
[16] D.J. Teece, G. Pisano, A. Shuen, Firm Capabilities, Resources, and the Concept of Strategy, Center for Research in Management. University of California, Berkeley, 1990, pp. 90–98. CCC Working Paper.
[17] G. Dosi, A. Gambardella, M. Grazzi, L. Orsenigo, The new techno-economic paradigm and its impact on industrial structure, in: J.M. Wolfgang, E. Drechsler, R.K. Reinert (Eds.), Techno-Economic Paradigms, Essays in Honor of Carlota Perez,Anthem Press, London, 2012.
[18] N. Bloom, C. Genakos, R. Sadun, J. Van Reenen, Management Practices Across Firms and Countries, Academy of Management Perspectives, February, 2012, p. 13.
[19] K.M. Eisenhardt, J.A. Martin, Dynamic capabilities: what are they? Strat. Manage. J. 21 (10/11) (2000) 1105–1122.
[20] L. Gratton, S. Ghoshal, Beyond best practice, MIT Sloan Manage. Rev. (Spring, 2005) 49–57.
[21] A. Grove, Only the Paranoid Survive, Doubleday, For a definition of "inflection point, see:, 1996 http://www.investopedia.com/terms/i/inflectionpoint.asp.
[22] B. Lidsky, M. Hirve, A Record $254 Billion in Oil and Gas M&A Deals in 2012, PLS, Inc. and Derrick Petroleum Services, Houston, 2013, p. 1.
[23] M. Donadio, et al., US Oil and Gas Reserves Study 2013, Ernst and Young, 2013. http://www.ey.com/Publication/vwLUAssets/US_oil_and_gas_reserves_study_2013/$FILE/US_oil_and_gas_reserves_study_2013_DW0267.pdf.
[24] Arthur D. Little, New business models for the international oil company, Prism (01/2010).
[25] C.T. Montgomery, M.B. Smith, Hydraulic fracturing: history of an enduring technology, J. Petrol. Technol. (2010) 26–41. Online (Society of Petroleum Engineers).
[26] Golden Rules for a Golden Age of Gas. World Energy Outlook Special Report on Unconventional Gas, IEA, May 29, 2012, pp. 18–27.
[27] C. Goncalves, Epic change and existential risk of North American LNG exports, LNG J. (2013). http://www.brg-expert.com/media/publication/355_Goncalves_LNGJournal_June2013.pdf.
[28] R. Weijermars, US shale gas production outlook based on well roll-out rate scenarios, Appl. Energy vol. 124 (2014) 283–297.
[29] H.-H. Rogner, R. Weijermars, The uncertainty of future commercial shale gas availability, SPE 167710-MS, in: SPE/EAGE European Unconventional Conference and Exhibition held Vienna, Austria, 25–27 February 2014, 2014.
[30] L. Lake, J. Martin, J.D. Ramsey, S. Tilman, A primer on the economics of shale gas production, J. Appl. Corp. Fin. 25 (4) (2013) 87–96.
[31] EOG Resources, Inc., Annual Report, 2013. http://www.eogresources.com/investors/reports/2013/EOGR_2013_Annual_Report.pdf.
[32] R.J. Duman, Economic Viability of Shale Gas Production in the Marcellus Shale; Indicated by Production Rates, Costs and Current Natural Gas Prices, Michigan Technological University, 2012. http://services.lib.mtu.edu/etd/THESIS/2012/Business%26Economics/duman/thesis.pdf.
[33] S. Bakewell, U.K. government lifts ban on shale gas fracking,Bloomberg News. http://www.bloomberg.com/news/2012-12-13/u-k-government-lifts-ban-on-shale-gas-fracking.html, 2012.
[34] A. Nelsen, Draft EU-Canada Trade Treaty Threatens Europe's Fracking Bans, EurActiv.com, 2013. http://www.euractiv.com/trade/draft-eu-canada-trade-treaty-thr-news-519595.
[35] J. Upton, American company sues Canada over fracking moratorium, Grist (October 13, 2013). http://grist.org/news/american-company-sues-canada-over-fracking-moratorium/.
[36] Natural Gas and Technology, NaturalGas.org, 2012. http://www.naturalgas.org/environment/technology.asp.
[37] C. Eaton, New rigs march past the old, Fuelfix, Houston Chronicle (January 19, 2014).
[38] Supermajordammerung, The Economist (August, 2013). http://www.economist.com/node/21582522/print.
[39] D. Ledesma, The Changing Relationship Between NOCs and IOCs in the LNG Chain, Oxford Institute for Energy Studies, 2009, pp. 1–38. http://www.oxfordenergy.org/wpcms/wp-content/uploads/2010/11/NG32-TheChangingRelationshipBetweenNOCsandIOCsintheLNGChain-DavidLedesma-2009.pdf.
[40] C. Stark, The vitality of the independents, PB Oil and Gas (January, 2013). http://pbog.zacpubs.com/the-vitality-of-the-independents/.
[41] R. Weijermars, Competitive advantage from an E&P clockspeed accelerator, First Break 27 (June, 2009) 87–94.
[42] R. Weijermars, Critical drivers of exploration and production clockspeed, Explor. Prod. Oil Gas Rev. (2011) 12–17.
[43] R. Weijermars, Accelerating the three dimensions of E&P clockspeed, Appl. Energy 86 (10) (2009) 2222–2243.
[44] G. Pacheco-de-Almeida, A. Hawk, B. Yeung, The right speed and its value, Strat. Manage. J. (2014). http://bschool.nus.edu/Departments/BussPolicy/BY%20papers/The_Right_Speed_05302012.pdf.
[45] C.H. Fine, Industry Clockspeed and Competency Chain Design: An Introductory Essay, The International Center for Research on the Management of Technology, Sloan, March 1996. WP # 147-96.
[46] I. Gonzales, C. Keane, The Status of the Geoscience Workforce, The American Geological Institute, 2011, p. 97. http://www.agiweb.org/workforce/reports/StatusoftheWorkforce2011overview.pdf.
[47] T. Lager, T. Magnussen, The Deepwater Horizon Accident on Well Macondo #1, Acona Wellpro, Mini Seminar, 2010. http://www.aconawellpro.com/@api/deki/files/251/=MiniSeminar_Macondo_August_2010.pdf.
[48] J.R. Matias, Of mice and men: the ecological disasters — deepwater horizon and the dust bowl, Poseidon Sci. (July 9, 2010). http://poseidonsciences.scienceblog.com/27/of-mice-and-men-the-ecological-disasters-deepwater-horizon-and-the-dust-bowl/.
[49] D.J. Teece, A dynamic capabilities-based entrepreneurial theory of the multinational enterprise, J. Int. Bus. Stud. 45 (2013) 8–37.
[50] C.A. O'Reilly, M.L. Tushman, The ambidextrous organization, Harv. Bus. Rev. (April, 2004) 74–83.
[51] C.A. O'Reilly, M.L. Tushman, Ambidexterity as a dynamic capability: resolving the innovator's dilemma, Res. Org. Behav. 28 (2008) 185–206.
[52] H.W. Chesbrough, D.J. Teece, Organizing for innovation: when is virtual virtuous? Harv. Bus. Rev. 74 (1) (1996) 65–73.
[53] N. Kusnetz, Who are America's top ten drillers? ProPublica (September 11, 2011). http://www.propublica.org/article/who-are-americas-top-10-gas-drillers.
[54] C. Xu, EIA: US investments in shale plays highlight foreign JVs, Oil Gas J. (April 9, 2013). http://www.ogj.com/articles/2013/04/eia-us-investments-in-shale-plays-highlight-foreign-jvs.html.
[55] B. Buchel, Managing partner relations in joint ventures, MIT Sloan Manage. Rev. 44 (4) (2003) 91–95.
[56] D. Nijoka, Navigating Joint Ventures in the Oil and Gas Industry, Ernst and Young White Paper, 2011, http://www.ey.com/Publication/vwLUAssets/Navigating_joint_ventures_in_oil_and_gas_industry/$FILE/Navigating_joint_ventures_in_oil_and_gas_industry.pdf.
[57] D.R. Lessard, The shaping of large engineering projects, in: H. Priemus, B. van dee Wee (Eds.), International Handbook on Mega Projects, Edward Elgar, 2013, pp. 34–56.
[58] P. Whittaker, C. Young, Enhancing the Value of Non-operated Oil and Gas Ventures: How to Focus Resources, Reduce Risk and Improve Performance, Boston Consulting Group White Paper, 2013, https://www.bcgperspectives.com/content/articles/energy_environment_enhancing_value_in_non_operated_oil_gas_ventures/.
[59] R. Kumar, T. Markeset, Development of performance based service strategies for the oil and gas industry: a case study, J. Bus. Ind. Market. 22 (4) (2007).