A Couple of Spills a Year, That's Normal? Learning and Greenwashing in the Pipeline Industry

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Abstract

From 2000 to 2020, the standardized spill volume of refined petroleum pipelines has stayed constant at about 15 bbl per billion barrel-miles transported. In contrast, from 1980 to 2000, standardized spill volume had about halved. This dissertation researches why pipeline operators in the US keep causing and getting away with pipeline spills. The dissertation uses two lenses, organizational learning and greenwashing. These lenses reveal why, despite continuous efforts by engineers, the safety record of the industry has stagnated. The learning literature suggests that it is commonplace for organizational learning to converge at a high level of performance, as observed in the pipeline industry. Greenwashing is a strategy for organizations to escape negative consequences for poor environmental performance.

The first chapter reveals the mechanisms behind the convergence in organizational learning. The empirical section uses a dataset of 6,147 pipeline spills, and qualitative data on 10 significant pipeline spill. This research reveals that valid learning only occurs in response to the spills that an operator experiences. For a general theory of learning, the empirical findings suggests that learning converges when the organization or system that learns has developed a high degree of complexity. Because of this complexity, learning in response to triggers such as failures is not sufficient anymore for making aggregate improvements. Learning turns into a perpetual game of whack-a-mole.

The second chapter takes an encompassing look at the learning literature and promotes a more universal, new theory on the validity and reliability of learning. When learning goes beyond incremental improvements and touches on fundamental assumptions, organizations or industries can break out of their trajectory. However, many learning outcomes that have been thought of as "breakthroughs" have not led to the promised revolutions in the market. Validity and reliability fill an important gap in the literature of learning: even when learning produces sensible and internally consistent insights, these insights are meaningless if they do not serve for the organization to better understand, predict, and control existing problems, limitations, or bottlenecks–that is, if the knowledge is not valid. And valid knowledge still fails to make an impact if it is not reliable, meaning not shared across the organizational members who are to implement the insights.

Finally, the third chapter discusses how pipeline operators keep in check the backlash for the environmental pollution that they cause. Pipeline operators shield themselves from criticism using new technology. When an operator causes a spill, the operator can point to the latest development in the constant flow of new technology as a remedy for future spills. The third chapter uses the same data on pipeline spills and pipeline networks as the first chapter, and adds text data from operators and industry level actors. I then track empirically how these patterns of greenwashing are diffused in the pipeline industry. This analysis sheds light on the role of industry level actors (such as the American Petroleum Institute) in greenwashing.

Keywords: organizational learning, greenwashing, industry level, population level, pipeline spills

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Introduction

> "[T]here is perhaps an over-emphasis of technology in [Leak Detection Systems]. A recurring theme is that of false alarms. The implication is that [a Leak Detection System] is expected to perform as an elementary industrial automation alarm, with an on/off state and six-sigma reliability. Any alarm that does not correspond to an actual leak is, with this thinking, an indicator of a failure of the LDS system. Instead, multiple technical studies confirm that far more thought is required in dealing with leak alarms" – Shaw et al. (2012, p. 2-3).

How does an industry get stuck with a never-ending series of pollution events? It is the conventional view of organizational learning that performance measures, after initially exhibiting fast improvements, will settle at at a certain level (Argote 2013b). In other words, learning levels off. The *organizational knowledge* view–the dominant stream of the learning literature–suggests that organizations accumulate knowledge which is held by individuals, in routines, or in transactive memory systems (Argote & Miron-Spektor 2011, Bingham & Eisenhardt 2011). New knowledge is added to an existing "stock", presumably until there is no more new insights to be added. Disclosure of the outcomes of this learning process then is a subsequent, separate step–the organization makes a strategic decision as to which outcomes to share with stakeholders. To withhold negative information on environmental performance in this step would constitute greenwashing (Lyon & Maxwell 2011).

An alternative view suggests that organizations can break out of existing trajectories and escape their constraints in learning–but that to do so requires a considerable rethinking of existing paradigms (March 2010). For instance, an organization can reimagine how it measures performance (Argyris & Schön 1978). This is consistent with the *organizational routines* view, which holds that organizations develop not knowledge but patterns of action in stable environments (Bingham & Eisenhardt 2011). The organizational routines view also postulates that in the absence of significant interventions, intricate but ultimately obsolete systems develop, for instance ones that rely on outdated technologies (March 1991). With sufficient complexity, these systems can generate a never-ending stream of unexpected interactions and externalities, which then become relevant for sustainability research when the organization or industry has a catastrophic potential (Beck 1992, Perrow 1984). One would hope for stakeholders to be able to identify the pattern of unexpected interactions and externalities, but under an inadequate environmental regime the organization or industry can escape scrutiny through greenwashing (Lyon & Montgomery 2015).

The inconsistent predictions of the two views, and their implications for persistent environmental pollution raises two questions. (1) *How does the convergence of performance measures take place?* When the convergence has taken place in an organization or industry, do we see evidence for either the organizational knowledge or the organizational routines view? The organizational knowledge view suggests that once performance has converged, either no new knowledge is gained, or knowledge disappears at the same rate as it is produced (Argote 2013a). The organizational routines view makes no such prediction, instead, if that view was accurate we would see increasingly intricate routines with ultimately have little impact on performance.

An obvious extension to the first question is a look at possibilities for organizations to break out of a state of convergence. The *organizational routines* literature holds that organizations can break out of a state of convergence through what the *organizational routines* literature calls either double-loop learning (Argyris & Schön 1978) or high-intellect learning (March 2010). Two overlooked attributes of knowledge, *validity* and *reliability* could mend the split between the two streams of the organizational learning literature. *Validity* describes whether knowledge does allow an organization to better understand, predict, and control problems, such as technological limitations or bottlenecks. *Reliability* describes the degree to which member of the organization have command of the knowledge (Rerup & Zbaracki forthcoming). Validity and reliability allow for a critical view on the first question, and whether that state of convergence is inevitable.

(2) The state of convergence should be fairly obvious to stakeholders when environmental pollution is involved. The second research question addresses the difficulties that continuous environmental pollution would be expected to entail. *How does an organization manage–or greenwash–its convergence to a state of constant pollution?* If the state of convergence is obvious for observers, one would expect calls for substantive change to be quite loud. But the pipeline industry has maintained the status quo for twenty years, which presumably requires an effort to maintain the status quo rather than just an absence of efforts to break out of the state of convergence.

To answer the research questions, this dissertation employs data on the US pipeline industry. The pipeline industry offers an advantage over other industries with regard to studying environmental impacts, learning, and greenwashing, in that the industry's environmental pollution very much takes place in the public. Unlike other industries, pipeline spills do not occur inside private plants, locked away from the public eye. Pipeline spills usually occur on public land that the pipeline operator has only acquired the right-of-way of. Pipeline spills also receive a lot of attention from the press, government agencies, and environmental grassroot organizations. These actors pay particular attention to large pipeline spills, which make up for a majority of annual spill volume. Finally, the scrutiny of oil spills also ensures that the reported data is more accurate. Government-employed emergency responders are on site alongside the company employees and can ensure a more accurate reporting of pollution data than is the case for routine environmental emissions.

Quantitative data from 2004-2019 allows us to observe learning and greenwashing in the pipeline industry. For this period of time, data is available from the Pipeline and Hazardous Materials Safety Administration (PHMSA) on how much oil each American operator transported over what distance every year. PHMSA also provides a dataset that contains data on each individual pipeline spill that occurred over that period of time.[1]. Data on the spills includes a narrative, how much oil was spilled and recovered, and what other impacts (e.g., injuries or deaths) occurred. Over the 16 years of the observation period, 6,147 pipeline spills were recorded, including 2,246 that the PHMSA classified as significant based on either a spill volume of over 50 barrels, more than $50k in damages, or a casualty, injury, fire or explosion. Whereas crude oil pipelines period showed a significant improvement in pipeline safety over the observation period, the standardized spill volume of refined petroleum pipelines stayed as an almost constant rate of about 15bbl per billion barrel-miles transported (see Figure 1).

Qualitative data provides an understanding of the mechanisms of learning in the pipeline industry. That constant spill rate for refined petroleum pipelines is surprising, given the significant technological advancements in the areas of inline inspection tools, leak detection, and SCADA systems which allow for the remote supervision and control of pipelines. A repository on the largest or otherwise significant pipeline spills by the National Transportation Safety Board (NTSB) provides an in-depth understanding of accident causes. Since 1969, NTSB has authored 142 accident reports and briefs.[2]. For this dissertation I select the 10 most recent full accident reports. As a robustness check, I also select the 15 most significant accidents according to spill volume, net loss, number of injuries and fatalities, and property damage (top 3 per category), and collect independent archival data on these spills. As of 2020, little empirical research exists on the pipeline industry. Park and Rogan (2019) uses the PHMSA dataset to study how reputation affects relationships with exchange partners. Zakikhani, Nasiri, and Zayed (2020) review the research into pipeline failures in the area of engineering, which has largely ignored organizational factors.

[1] See `https://www.phmsa.dot.gov/data-and-statistics/pipeline/source-data`, accessed 2020-08-30

[2] See `https://www.ntsb.gov/investigations/AccidentReports/Pages/pipeline.aspx`, accessed 2020-08-30

Finally, this dissertation uses text and network data for track greenwashing in the pipeline industry. Headquarter locations and board memberships (BoardEx) uncover connections between pipeline operators. Documents by the American Petroleum Institute (API) and the Association of Oil Pipe Lines (AOPL) reveal developments of the industry level. In addition, this research uses annual reports and safety reports to determine the strategies pursued by individual operators. Natural Language Processing (NLP)–specifically, topic modeling–reveals trends and show their diffusion through the pipeline industry. Finally, we can compare trends with the topics that emerge from the narratives on pipeline spill to distinguish substantive and non-substantive trends.

The context of pipeline spills is suitable for both questions on learning and greenwashing. Pipeline spills, such as other failures, are catalysts for learning (March 1991). In the pipeline industry, learning has high visibility after large pipeline spills take place. We can observe the learning process independent of its outcomes better than in other contexts. Oil spills also bring pipeline operators under high scrutiny. As a result, pipeline safety often enters the public debate. The American Petroleum Institute (API) and the Association of Oil Pipe Lines (AOPL) discuss pipeline safety and their communication strategy in a semi-public fashion. Documents by operators on pipeline safety are also public and widely available. When greenwashing takes place in the pipeline industry, it is a public affair. It is thus easier to obtain data on learning and greenwashing for this industry, compared to most other industries, which operate far less on public lands.

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Insert Figure 1 about here

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Some of the findings of this dissertation might not be fully generalizable. Pipeline systems, with their manifold interactions and catastrophic potential are a great example of the complex systems and externalities discussed by Perrow (1984) and citetBeck1992. The challenges associated with growing complexity may not be present in all other contexts. In particular, uncoupled production methods can allow for much reduced interactive potential. In these contexts, convergence of performance measures and greenwashing might take on a different shape. The complexity of pipeline systems stems from the interaction of mechanics, physics (fluid dynamics are notoriously complicated are of physics), and a complicated command structure. The diverse geography and many jurisdictions of the US also add to the complexity. In addition, there is an economic incentive to run pipeline infrastructure at a very high utilization rate and throughput, e.g., by frequently changing the commodity to be transported according to demand.[3] Altogether, the complexity and interactions are not far off from what Perrow (1984) observed for nuclear power plants. Many other industries constitute complex systems because of their elaborate supply chain structures, a future avenue of research would thus be whether these complex supply chains bring about the same limits to learning.

I make four contributions with this research. (1) This dissertation introduces a context where organizational learning has "bottomed out" and analyzes how learning plays out under these circumstances. The context allows us to study learning despite the absence of aggregate, quantitative improvements in performance measures because (a) we can observe the process of learning independent from the outcome in qualitative data, and (b) rich data, including textual descriptions, is available on the object of learning–individual pipeline spills. This rich data allows us to distinguish a "dynamic" state where performance measures are constant because learning and emerging challenges cancel each other out from a hypothetical "state of equilibrium" where there is no new knowledge to be obtained. Thus, this dissertation brings to the fore a state that large swaths of the learning literature have taken for granted: the "end of learning" period where performance measures make it appear as if the organization has come to a standstill. At least for this case of a complex system with catastrophic

[3] Although pipelines are generally optimized for transporting specific commodities, in principle any pipeline can transport almost any commodity when demand or supply changes.

(2) This dissertation also makes a contribution to the discourse regarding environmental sustainability and technology. The sustainability research community is split as to the role of technology for sustainability. Some work leans more toward a technocentric view with little to no consideration of social systems, for instance in research on low-carbon electricity (e.g., Greenblatt et al. 2017). Other authors emphasize the need for changes to the political and economic system in order reduce damages to the planet, such as the degrowth discourse (Kallis et al. 2018). With regard to that debate, the findings of this research highlight the role that system complexity and unexpected externalities play for continued pollution. The pipeline industry provides a very vivid example of the limits to depolluting existing technology. Further, the greenwashing in the pipeline industry that this research surfaces should act as a cautionary tale on the role and purpose of technology in communication.

(3) This dissertation moves forward theory on learning by highlighting the considerable effort necessary to leave an existing trajectory. New knowledge needs to be created that is both valid and reliable, which requires for an organization or industry to collectively question preexisting fundamental assumptions. Applied to pipeline spills, this would imply that if society was to collectively decide that oil spills at the current level are not acceptable, then we should not rely on the industry to develop technology and make changes in the current fashion. A more fundamental rethinking of the (physical and political) system of energy delivery would be necessary.

(4) The empirical research on greenwashing highlights the potentially malevolent role that industry level organizations can play, and that technology should be taken with reservation. Actors in the pipeline industry are aware of the possibility to created a better image by creating an association between pipelines and high-tech, even in the absence of better safety performance. These actors may also be aware that is almost impossible for laymen to rebut the validity of technology that is built on decades of engineering research, and that hence the industry can safely entrench itself in this modern realm.

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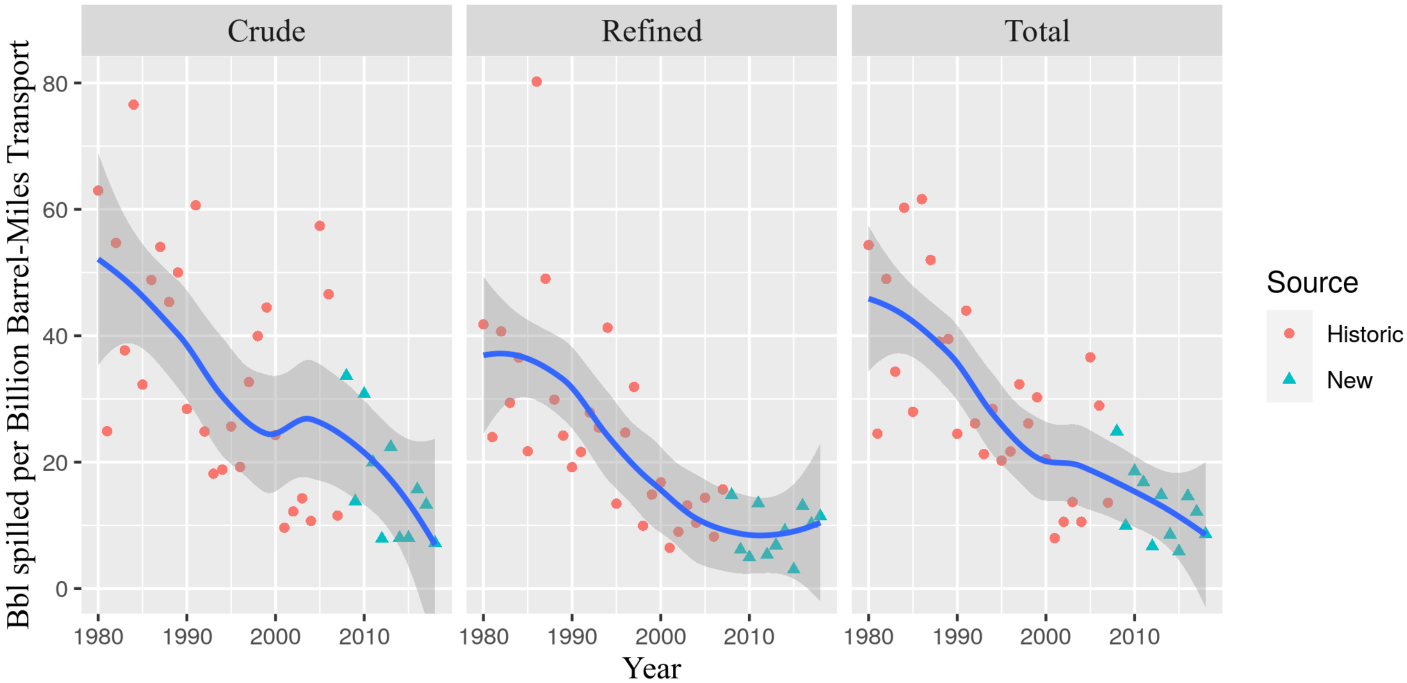
Figure 1. Pipeline safety improvements at the industry level



Blue line:	Local regression (Loess), with confidence interval.
Source (new):	https://github.com/julianbarg/oildata
Source (historic):	http://www.api.org/environment-health-and-safety/clean-water/oil-spill-prevention-and-response/~/media/93371EDFB94C4B4D9C6BBC766F0C4A40.ashx, p. 38