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Business Process "De-Engineering": Establishing the Value of the Human Auditor in an Automated Audit System

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ABSTRACT: Automation in auditing is driven by the principles of business process reengineering (BPR), whose default position is to eliminate labor. BPR assumes that assurance arising from human and technological inputs are substitutes and not complements. Until that hypothesis is validated, human auditors should not be perceived as expendable artifacts to be removed as quickly as possible. What is needed is a systematic exploration of what is the *minimum* human involvement for auditing to retain the trust of its stakeholders. In this paper, I propose that business process reengineering in auditing is complemented with what I call *business process "de-engineering" (BPD)*. Whereas BPR asks how to remove workers from a predominantly manual process, BPD asks when *adding* a human would add value to a predominantly automated process. BPD in auditing focuses attention on the human/machine interactions in the audit process and will help determine their relative strengths and weaknesses.

Keywords: business process reengineering; business process de-engineering; audit automation.

I. INTRODUCTION

Business process reengineering (BPR), which calls for the replacement of labor by information technology, is being increasingly applied to auditing (Alles, Brennan, Kogan, and Vasarhelyi 2006; AICPA 2015). Under BPR, human auditors are treated as production inputs to be replaced by technology in the audit process whenever possible. In response, this paper calls for a systematic exploration of what is the *minimum* human involvement for auditing to retain the trust of its stakeholders. I propose that business process reengineering in auditing is complemented with what I call *business process "de-engineering" (BPD)*. Whereas BPR asks how to remove workers from a predominantly manual process, BPD asks when *adding* a human would add value to a predominantly automated process. BPR-led automation in auditing must be combined with a clearer understanding of the value added that the human auditor will continue to provide in generating trust in the audit work product. BPD is designed to serve as a counterweight to the overwhelming pressure under BPR to see human inputs into business processes as a cost to be minimized rather than a resource to be taken advantage of.

II. BUSINESS PROCESS REENGINEERING

Automation is now reaching a critical inflection point at which it is poised to replace not just blue-collar physical work at factories and call centers, but also white-collar judgment-based work like making medical diagnoses, reading X-rays, doing tax returns, and looking up tax law.[1] Frey and Osborne (2017) have predicted that there is a 94 percent probability that automation will replace accountants and auditors. While it is the convergence of new technologies (Anderson 2017) that is making full-blown automation of human judgment increasingly feasible, there has been a long trend toward the replacement of human labor by machines. For example, strip coal mining resulted in a largescale displacement of miners, while demand for dockworkers fell dramatically following the shift toward cargo containerization.

The concept of applying technology to rethink business processes and reduce labor needs was formalized by Hammer (1990), a paper with the famous title "Reengineering Work: Don't Automate, Obliterate". Reengineering breaks down a business process into its component activities and retains only those that add value to customers (Hammer and Champy 1993).

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[1] See, https://www.thelawyermag.com/au/news/general/lawyer-predicts-his-ai-will-replace-tax-agents/201633

Those remaining activities are undertaken using current technology rather than the technology existing at the time the process was originally created. Hammer (1990) concludes his paper with a paragraph that was to launch many rounds of layoffs in companies around the world:

> Information technology offers many options for reorganizing work. But our imaginations must guide our decisions about technology—not the other way around. We must have the boldness to imagine taking 78 days out of an 80-day turnaround time, cutting 75% of overhead, and eliminating 80% of errors. These are not unrealistic goals. If managers have the vision, reengineering will provide a way.

Bain & Company (2018) summarizes the steps involved in BPR:

- Refocus company values on customer needs
- Redesign core processes, often using information technology to enable improvements
- Reorganize a business into cross-functional teams with end-to-end responsibility for a process
- Rethink basic organizational and people issues
- Improve business processes across the organization

Bain & Company (2018; emphasis added) is unusually candid about BPR's consequences: "Business Process Reengineering reduces costs and cycle times by eliminating unproductive activities *and the employees who perform them*."

Monga (2015) gives a typical example of BPR:

> Five years ago, 80 clerks and salespeople at Pilot Travel Centers LLC spent a combined 3,200 hours a week tracking and paying for orders for thousands of goods, ranging from candy bars to diesel fuel. They typed the orders into an accounts-payable database, and printed out thousands of checks to pay suppliers. After slipping them into envelopes and adding postage, they put the checks in the mail. "It was just awful," said David Clothier, treasurer of the Knoxville, Tenn., company, which operates more than 500 Pilot Flying J truck stops nationwide. "There were humans everywhere." Today, a computer "robot"—basically software—automates these tasks. Suppliers send their invoices to Pilot Travel electronically. Its software sends out payments and records every transaction. As a result, the company needs just 10 clerks working a weekly total of 400 hours to pay suppliers. Robots are taking over corporate finance departments, performing work that often required whole teams of people.

"It was just awful. There were humans everywhere" captures an attitude in BPR that sees workers as simply a roadblock to automation. CEOs attending the 2019 Davos conference evidently share this mentality (Roose 2019; emphasis added):

> All over the world, executives are spending billions of dollars to transform their businesses into lean, digitized, highly automated operations. They crave the fat profit margins automation can deliver, and they see A.I. as a golden ticket to savings, perhaps by letting them whittle departments with thousands of workers down to just a few dozen. "People are looking to achieve very big numbers," said Mohit Joshi, the president of Infosys, a technology and consulting firm that helps other businesses automate their operations. "Earlier they had incremental, 5 to 10 percent goals in reducing their work force. Now they're saying, "*Why can't we do it with 1 percent of the people we have?*"

III. BPR IN CONTINUOUS AUDITING

Despite the claim of starting with "a blank sheet of paper," business process reengineering is undertaken *relative* to an existing, predominantly manual, process that is analyzed with the aim of eliminating activities done by workers that are no longer considered as value adding. Teeter and Brennan (2008) use BPR to bring about continuous auditing of the IT internal audit:

> Reengineering was essential to shift the focus from subjective controls tests that require auditor interpretation to objective tests that can be automated and produce reports that are useful to management. For example, a manual control may look like this: "Gain an understanding of X process. Verify Y function isn't allowed." The team would build a rule for the second half of the test based on a manual investigation of the first part of the test. Each of the tests classified as "manual" were evaluated for automation potential. In some cases, existing rules provided the validation necessary. In other cases, limitations in the CCM platform would allow a rule to be created but the results would not be correct, so the rule was scrapped. Successful rules would be indicated in the spreadsheet and in the end a complete list of automated and manual rules was compiled for each module.

Teeter and Brennan (2008) describe the familiar approach of automating using reengineering. What I draw attention to, however, is both its genericity—since, for all practical purposes, it is not specific to auditing—and its reliance on technological

determinism. By that, I mean that the number of activities not automated is assumed to keep shrinking over time as the technology to automate them improves. For example, KPMG sees automation iteratively increasing from basic to enhanced and finally cognitive, with the corresponding tools being robotic process automation (RPA), machine learning, and artificial intelligence (AI) respectively.[2] This is analogous to the way in which automobile technology has steadily increased in capability from power steering and braking, to cruise control, and then adaptive cruise control, along with parallel parking and backup assist.[3] The development of auto-technology is following the logic of reengineering, with the eventual aim of eliminating the need for a human driver (Walker 2019).

By contrast to this steady development in the auto industry, the accounting profession was until recently criticized for lagging in the application of technologies already in widespread use by their own clients (AICPA 2012). Now, however, AICPA chair Barry Melancon (2017) notes that the Big 4 accounting firms spend $3–5 billion annually on new technology. Writing on behalf of Continuity Michaud (2015) states: "We believe the time is fast approaching when audits no longer have to consume so many resources and when audits no longer require on-site personnel. In fact, we see a time in the not too distant future when audits can be conducted virtually and almost at the touch of a button." A "push button" audit may be more of a rhetorical device than a practical reality, but it usefully raises the question of the limits of automation in auditing. Should auditing be subject to reengineering as if it were any other business process—with the ultimate end goal of eliminating all human auditors—or is there something unique about auditing that should restrict its full automation?

Former SEC chair Arthur Levitt (2004; emphasis added) saw something distinctive about the audit profession, stating:

> The bankruptcy of Enron and the implosion of Arthur Andersen opened the public's eyes to a widespread erosion of ethical values and a dereliction of duty by accountants on both sides of the table—a lack of moral and ethical judgment on the part of management, compounded by the failure of the auditors to blow the whistle. As a result, investor confidence was undermined. Deep skepticism and fear have replaced trust. All the players in our market system—analysts, executives, brokers, mutual fund directors and managers, institutional investors, board of directors, and regulators—have an obligation to win back the people's trust. But all of these efforts will be for naught if the public does not trust auditors. The accounting profession is a profession like no other, and, in my mind, one of the most noble in our marketplace. You are private-sector actors with a public role to play. With that precious franchise come [sic] some unique pressures and challenges. *In most businesses, the watchword is "The customer is always right." Accountants, however, are charged with telling the customer when he's wrong*. What other profession has that responsibility? What other profession is enshrined in our nation's securities laws to serve no interest but the public's? What other profession so directly holds the keys to public confidence—the lifeblood of our markets?

IV. THE ROLE OF TECHNOLOGY IN AUDITING

The audit failures identified by Levitt (2004) make the case for the replacement of fallible humans with incorruptible machines. However, will automation undermine the "precious franchise" of auditing? There is a higher risk of that occurring when auditing is treated as just another process to be reengineered, since that ignores the role of *trust* that Levitt (2004) identifies as the key necessity for auditing. Can stakeholders of audited financial statements derive trust from an audit process that is predominantly technology based? Alles and Gray (2020) model assurance as arising from both the human and technology inputs into the audit process. They hypothesize that as the capability of the technology in the audit process increases, technology-*driven* assurance will convert into technology-*based* assurance, meaning that technology goes from being an *input* into the audit process to becoming the *source* of assurance.

Technology-based assurance might seem implausible were it not for the fact that the driverless car that is so eagerly anticipated requires exactly the same level of trust in technology—and does so in a setting where, unlike in auditing, lives are at stake. Driverless cars bring with them a whole host of difficult issues and unexpected consequences, ranging from changes in legal liability to reductions in car ownership and a fall in the number of organs available for transplant.[4] What is the equivalent set of implications for automated auditing? Will technology-based assurance arise organically as Alles and Gray (2020) assume, or will it have to be fostered by the profession and by regulators, and if so, how?

The problem with reengineering is that since its default position is to reduce labor, it tends to place little value on it. Thus, Roose (2019) quotes the CEO of JD.com as saying, "I hope my company would be 100 percent automation [sic] someday." In the case of auditing, such a mentality threatens to throw the baby out with the bathwater, since it assumes that human-based and technology-driven/-based assurance are substitutes and not complements. Until that hypothesis is validated, automating audits

[2] See, https://home.kpmg/in/en/home/services/advisory/management-consulting/robotic-process-automation.html
[3] See, https://www.motortrend.com/news/2019-bmw-330i-four-tech-features-we-love/
[4] See, https://medium.com/@DonotInnovate/73-mind-blowing-implications-of-a-driverless-future-58d23d1f338d

FIGURE 1
The Game of Jenga

using reengineering incurs a system risk that is currently not considered in the literature. By that, I mean that we are doing the equivalent of playing a game of Jenga with auditing (see Figure 1), pulling out labor from the audit work process and hoping that trust in the whole system will not collapse as a result.

Unintended Consequence of Technology

Technology also has unintended consequences, especially when it interacts with humans. As Thakkar (2019) points out, "Backup cameras, mandatory on all new cars as of last year, are intended to prevent accidents. Between 2008 and 2011, the percentage of new cars sold with backup cameras doubled, but the backup fatality rate declined by less than a third while backup injuries dropped only 8 percent." The National Highway Traffic Safety Administration (NHTSA 2007) points out the reason for this discrepancy: "drivers tended to become overly dependent on their backing aid systems and rear-view cameras" and "many respondents were not aware of system limitations and believed that their systems would help them to avoid collisions when in fact they would have been unlikely to have helped." The two crashes of the The Boeing Company's 737 Max brought about by the aircraft's Maneuvering Characteristics Augmentation System (MCAS) are a deadly example of how AI designed to solve a narrow problem can give rise to new and unexpected ones. In short, even given the imperatives of "automating through obliteration" of existing manual processes, there are reasons for keeping a clearly defined role for humans in business processes, especially where trust and highly complex technology with ill-understood interactive effects are involved.

V. BUSINESS PROCESS DE-ENGINEERING (BPD)

Thus, to prevent a MCAS-type failure arising in auditing, human auditors cannot be perceived as simply expendable artifacts to be removed from the audit process as quickly as possible. What is needed is a systematic exploration of what is the essential *minimum* of human involvement for auditing to retain the trust of its stakeholders. That level may decrease as technology improves, but it cannot be assumed to be zero right now, or perhaps ever. Since that is the default logic of business process reengineering, this paper proposes that BPR in auditing is supplemented with what I call *business process "de-*

engineering" (BPD). BPR aims to remove labor from a *predominantly manual* process. BPD methodically examines when *adding* a role for humans in a *largely automated process* will create value.

Applying de-engineering to the 737 Max might have resulted in Boeing anticipating situations where pilots cannot rely on the MCAS system to act autonomously, such as conflicting air speed sensors, or when MCAS lowers the plane's nose even as its altitude keeps falling. That is when human intervention should be facilitated, even encouraged, rather than leaving it to the pilot of a crashing plane to desperately read the instruction manual.[5] In order to lower training costs, what Boeing actually did was to design MCAS so that pilots were not required to be even aware of its existence.[6] It also made sensors that might have alerted pilots to faults with the MCAS an extra-cost option because it did not see that as a risk that warranted human oversight.[7]

In an audit setting, BPD forces an assessment of where, when, and why having a human auditor adds value. That is a question that the profession has not had to ask itself thus far, since the starting point of reengineering auditing is a manual process—which makes it all too easy to take the removal of labor by automation too far, too fast. As automation reduces headcount, the assumption is that auditors will shift from data analysis to skills better suited for humans, such as judging tone at the top. Vasarhelyi, Warren, Teeter, and Titera (2014) predict, "As more work is performed automatically, auditors will have the opportunity to focus more on honing their judgment to the client's environment." That sounds seductive, but will auditors use their spare time to reduce costs, increase audit quality, or seek to enhance revenue through new client development and selling advisory services instead? With compliance seen as "tedious," the strong implication is that audit firms will prefer that remaining costly human labor is used for activities that drive profits, while continually seeking to eliminate it otherwise. For example, a recent U.K. study shows that many audits there are priced as loss-leaders for more lucrative work from clients, which is a strong incentive to reduce the largest source of audit costs today, which is personnel.[8]

Vasarhelyi et al. (2014) presume that the audit of the actual numbers of the firm can be safely left to analytics and AI, but there is no evidence as yet as to the extent to which an audit can be automated while maintaining the trust of stakeholders. Boeing did test flights of the 737 Max without coming across the black swan events that can cause MCAS to crash a plane, but auditors do not have the equivalent of test pilots putting a new plane through its paces in a simulator and in the air. Moreover, MCAS is controlling a mechanical system, but an *auditor interacts with a motivated, knowledgeable manager who can learn through experience*. Would managers who wish to cook the books find automated auditing easier to game than to risk attempting to corrupt a human auditor? Keep in mind that while the audit process may be automated, and so may the client's accounting system, reporting will remain under the control of a human CEO. The implications of that inescapable human/machine interaction have not been studied sufficiently in the literature. By contrast, a BPD perspective will focus more attention on the essential human/human interactions in the audit process.

VI. STRESS AND FRACTURE POINTS IN BPD

Automated processes have what I call *stress* points and *fracture* points. Stress points arise when an inflexible automated system interacts in unexpected ways with humans, thus leading the system to spiral out of control. For example, the MCAS system in the 737 Max was designed to reengage ten seconds after being manually disengaged (unless it was shut down altogether in a procedure that many pilots were not trained to do) resulting in a "tug of war" between the automated system and the pilot.[9] De-engineering requires stress points to be identified and remediated, as Boeing plans to do with a software update that will limit the number of times the MCAS resets. Thakkar's (2019) example of the overreliance by drivers on backup cameras shows the danger to auditors of "outsourcing" their work to a black box AI system without fully understanding its limitations—for example, the sensitivity of audit analytics, such as cluster analysis and neural networks, to initial parameter choice.

Fracture points are more fundamental failings where the domain of an automated system does not encompass all possible event spaces. For example, the first 737 Max crash in Indonesia was precipitated by the failure of maintenance personnel of a cheaply run airline to repair a flight sensor. Boeing did not plan for such an eventuality (for the good reason that they did not want to encourage such negligence), although triple redundancy could have reduced the risk. Probably the best argument for having a pilot, and not a machine, fly an aircraft was provided by Chesley Sullenberger, the pilot who saved the US Airways plane that lost both engines to bird strikes.[10] People are not as efficient as machines and prone to panic and fatigue, but they can

[5] See, https://www.businessinsider.com/lion-air-cockpit-recording-captains-searched-manual-try-stop-crash-2019-3
[6] See, https://www.nytimes.com/2019/02/03/world/asia/lion-air-plane-crash-pilots.html
[7] See, https://www.nytimes.com/2019/03/21/business/boeing-safety-features-charge.html?searchResultPosition=8
[8] See, https://www.theguardian.com/business/2019/apr/01/big-four-accountancy-firms-cost-overruns-audits
[9] See, https://www.nytimes.com/interactive/2018/12/26/world/asia/lion-air-crash-12-minutes.html and https://www.nytimes.com/2019/03/15/business/boeing-ethiopian-crash.html
[10] See, https://www.nytimes.com/2009/01/17/nyregion/17pilot.html

also respond more innovatively to unexpected events, as Sullenberger did on the Hudson. This is another argument for retaining a carefully calibrated minimum level of human input into a process as an insurance policy, even if doing so adds value only in low probability/high impact states. Sullenberger also told a congressional panel on the Boeing 737 Max that "an automated flight control system on the 737 Max 'was fatally flawed and should never have been approved . . . we shouldn't have to expect pilots to compensate for flawed designs.'"[11]

An example of a fracture point in auditing is when the training set of the AI system does not include types of audit failure that have not arisen before. This is more likely when new technologies such as blockchain disrupt existing businesses, or black swan events occur, like the correlated housing price fall in the Great Recession of 2008. The fact that the audit environment is more dynamic (thanks to the human managers of the client) than a mechanical system suggests that it is also more liable to fracture.

Both stress and fracture points have a larger macro impact in fully automated settings. An argument in favor of aircraft automation is the prevalence of pilot error in crashes, sometimes deliberately, as in the case of suicide by pilot. By definition, however, these are idiosyncratic events, meaning that the risk can be reduced by diversification (i.e., many different pilots). In contrast, a failing of an automated system is liable to be replicable across all its implementations. This creates a systematic risk that has to be remediated through a methodical examination of faults and the propagation of standardized solutions, a task the National Transportation Safety Board (NTSB) undertakes for airplane crashes.

There is a case for the equivalent of the NTSB to be established in the audit domain to autopsy failures in widely used audit software. Moreover, since there is much less variation across similar technologies than across even similarly trained people, there are economies of scale from stress testing technology before deployment. Such precertification was once done for aircraft by the Federal Aviation Authority and, again, the equivalent could be done with audit technology. This can take place inside the audit firm (especially if the technology is proprietary), or across the industry by a regulator. Doing both precertification *ex ante* and failure investigation *ex post* would go a long way toward making technology-based assurance a reality.

VII. A RESEARCH AGENDA INTO BPD

A systematic research program into business process de-engineering in auditing will focus attention on identifying and remediating the human/machine interactions in the audit process, finding and strengthening essential human/human interactions and rigorously determining the strengths and weaknesses of both the human and technology inputs as sources of assurance. The psychology of workers interacting with technology—especially AI, the study of cognitive limitations, the extent to which the mentality of reengineering devalues human inputs, and the systematic studying of human attributes used in audits and a timeline of their possible replacement/supplementation by technology are all topics that warrant further study. Some of these issues are obviously already the subject of intense research, but placing them within the BPD perspective gives a particular focus on the relative value added of human and technological inputs into the audit work process.

Complementing reengineering with de-engineering will enable the technological and human inputs into assurance to converge into a system in which both add the greatest value to the audit process while not biasing the implementation process toward one or against the other.

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[11] See, https://www.npr.org/2019/06/19/734248714/pilots-criticize-boeing-saying-737-max-should-never-have-been-approved

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