Data Science in Finance and Economics

Review

Autonomous human-machine teams: Reality constrains logic, but hides the complexity of data dependency

William F. Lawless*

Department of Mathematics and Psychology, Paine College, 1235 15th Street, Augusta, GA 30901, USA

* **Correspondence:** Email: w.lawless@icloud.com; Tel: 706-445-1648.

Abstract: In this review, scientists have struggled to apply logic to rational beliefs of collectives, concluding that belief logics fail in the face of conflict and uncertainty where reality governs. We have generalized this finding by concluding that traditional social science based on independent concepts about individuals and interpretations of reality requires too many fixes to address its replication crisis, yet ignores the generalization of individuals to teams, for which social science has become largely irrelevant. Unable to process the data dependencies of autonomous human-machine teammates in orthogonal roles for successful teams, producing zero correlations, this problem extends to traditional social science predicated on the belief that perceptions in closed systems (laboratories) are eality. But, as the National Academy of Sciences has noted, this assumption fails in open spaces. Thus, the study of group processes has de-evolved to become overly focused on individuals (e.g., biases), which do not generalize to teams. For a theory of autonomous human-machine teams and systems, generalization is critical. By using an open-systems approach, we have been able to explain the failures of social science, and its ack of success in the field, and we have generalized to autonomous human-machine teams and human-human teams. We extend our theory to conclude that traditional belief logics uses assumptions that, if not tested in reality (e.g., with debates), can be lethal (e.g, DoD's drone tragedy in Afghanistan in 2021). We conclude that an AI machine operating interdependently with a human teammate, jointly challenging each other's beliefs about reality while sharing and shaping their experiences, is the path to autonomy in the open, justifying our research program.

Keywords: interdependence; autonomy; human-machine teams; systems; uncertainty

Abbreviations: SEP: Structural; entropy production; MEP: Maximum entropy production.

1. Introduction

Logic, social science concepts, machine learning (ML), and the science of teams have had virtually no generalization to autonomous human-machine teams and systems. For an application to autonomous teams, scientists, including the National Academy of Sciences (Endsley et al., 2021), are in the dark about how to proceed, a problem we addressed earlier (Lawless, 2017) and in this article (Lawless, 2022c).

Mann (2018) struggled to extend the rational logic of beliefs to collectives, concluding that belief logic fails in the face of conflict and uncertainty in open systems where reality governs. We have generalized his finding by concluding that basing the traditional social sciences on independent concepts and simple interpretations of reality requires too many fixes to address the replication crisis in social science (Nosek, 2015); overlooked, however, is the much greater problem of the inability to generalize in social science from individuals to teams (Lawless, 2022a), meaning that the discipline has largely failed as a science that builds from one new finding to the next (e.g., in economics, see the first sentence in Rudd, 2021: "Mainstream economics is replete with ideas that "everyone knows" to be true, but that are actually arrant nonsense."). The problem with traditional social science is that it is constructed of a perceived reality inside of closed systems, that is considered to be accurate in the field; e.g., Jussim's (1993) reflection-construction model. But the National Academy of Sciences has said (Endsley et al., 2021) that this assumption fails in open systems. Instead, traditional group theory studies the effect that the collective "other" has cognitively on a target individual but not on a team (e.g., a married couple, a work team, allies, merger partners, etc.). Thus, the study of group processes has focused on biases (Leach, 2021), but biases cannot be generalized beyond their limited conceptualizations of reality set as they are within closed system models. Worse, many of these biases have been found to be not valid (e.g., implicit racism was found to be invalid by Blanton et al., 2009).

We recognize that while biases, *per se*, cannot be generalized, their diffusion in social society and among scientists, too, is an effect of the interdependence which pervades all of the human interaction (Jones, 1998); e.g., regarding the award to Einstein for his comparatively minor discovery of the photoelectric effect rather than the extraordinary accomplishment of his general theory of relativity, "we can see the toxic effect of contemporary politics and bigotry on the science of the day. Whether or not a scientific advancement is worthy of recognition by the scientific establishment should have nothing to do with the race, gender, religion, social background, or the politics of the scientists involved" (Friedman, 2022). The suspicion was that members of the Nobel nominating committee impugned Einstein's greater accomplishment of general relativity because he was a Jew.

But, for the construction, operation and performance of human-machine teams and systems, generalization is critical. Like quantum physics where one finding leads to another, a discovery in a field of science should generalize to the next discovery; for example, why has self-esteem not led to another discovery? Self-esteem was hailed as a great discovery by the American Psychological

Association in 1995 (Bednar and Peterson, 1995), but then found to be an invalid concept ten years later (Baumeister et al., 2005)

In contrast, by using an open-systems approach, we have been able to not only explain the failures of social science and its lack of application to human-machine teams, but, more importantly, we can generalize from our theory to autonomous human-machine teams (e.g., Lawless, 2022c). Specifically, by definition, the use of independent and identically distributed (i.i.d.) data has meant that an observed social event cannot be reconstructed (Schölkopf et al., 2021). Surprisingly, what we find with autonomous human-machine teams generalizes to improve human-human teams, systems scientists and, indirectly, even individuals (e.g., if an individual does not fit in a chosen team, try another). In this study, we extend our theory to conclude that traditional models of logic make assumptions that if not tested in reality (e.g., with debates) can be dangerous and even lethal as our theory has predicted (Sofge et al., 2019; see DoD's drone tragedy in Section 3.3.2). We would expect the same to occur for the Turing test, that computer logic able to fool an individual human in a closed laboratory would likely fail when attempting to navigate in an open environment (e.g., Google's LaMDA system, or Open AI's GPT-3; in Gopnik, 2022); but that an AI machine system interdependent with a human teammate, both operating in the world and exploring it together while jointly sharing and shaping their experiences, would have a better chance to succeed in the open autonomously, encouraging us to proceed with our research program (Lawless, 2022a,b,c).

Overview of the review article: In this review, in addition to the introduction above, we provide in the following major sections a review of our thesis; our model; method; discussion; and conclusions and challenges. In addition, in each of these sections, we provide a roadmap of that section's subsections.

2. Thesis

2.1. Thesis

In this section, we review monism and its problem with a lack of generalization that it addresses; and we provide a brief history of how interdependence has been viewed over the years. The challenge is to connect an aspect of a team's reality with a concept.

2.1.1. Monism

To address the problem of generalization applied to autonomy, we begin with a realist perspective of logic, context and beliefs. The primary source of the problem with generalization is the reigning belief in monism by social scientists that human beliefs and behavior share a 1:1 correspondence (e.g., McLeod, 2008). Also, see David Hume's (1975) copy principle: "All our simple ideas in their first appearance are deriv'd from simple impressions, which are correspondent to them, and which they exactly represent." Instead, we argue, the introduction of interdependence changes social science from a 1:1 science of the individual, to a science of the interaction with complementary tradeoffs, changing it into an open science, exactly what the National Academy of Sciences has challenged the science community to promote (Endsley et al., 2021). That change addresses the inability of logic based on beliefs to generalize to autonomy.

2.1.2. History of interdependence

Interdependence has long been a topic for social scientists. From Bastiat (1850), "In the sphere of economics an action, a habit, an institution or a law engenders not just one effect but a series of effects. … [thus] industries are interdependent. They form a huge entity in which every part communicates with every other part through hidden channels. What is saved in one benefits all".

Lewin (1951) introduced interdependence to generations of psychology and organizational theorists. Jones (1998) summarized the value of interdependence: "most of our lives are conducted in groups and most of our life-important decisions occur in contexts of social interdependence"; however, he concluded, a study of interdependence in the laboratory usually leads to "bewildering complexities."

The conclusion by Jones was accompanied in the same volume with a recommendation by Kenny and his colleagues (1998) to delete interdependence from experimental data. Kenny's recommendation was akin to considering that quantum effects are "pesky" (Lawless, 2020). As a result, social scientists tend to ignore interdependence because it is difficult for them to understand and manage in the laboratory.

Our approach has been the opposite: Theorize about perfect and imperfect teams, hypothesize how their effects can be observed in the field, seek the evidence; iterate these steps, all the while improving theory, hypotheses, and observations; and finally, generalize to autonomous human-machine teams.

2.2. Model

In this section, we review our model; and the mathematics of uncertainty in our model. We focus on data dependency; i.e., the data collected is dependent on state dependency (Davies, 2021).

2.2.1. Model Support

In this subsection, we review our past findings for teams on interference; redundancy; innovation; vulnerability; and deception.

2.2.2. Interference

Interdependence creates interference. It can be constructive and help to amplify the effects of interaction. Or, it can be destructive and dampen an interaction's effects. We focus on teams because they are more tractable mathematically than individuals or groups; as previously mentioned, data collected from individuals (i.i.d. data) cannot reconstruct an observed social event (Schölkopf et al., 2021); and, unlike teams, groups are too amorphous to generalize from their results. In this review, we concentrate on teams but we leave systems as a future challenge. For now, we assume that systems must be more attractive to a team than when a team is isolated by itself as a team.

In an open science, reality consists of contexts that are clearly understood, and contexts infused with uncertainty such as those situations that include conflict (Lawless et al., 2019). In clear and certain contexts, especially when governed by clearly understood and widely accepted social norms, human communication among team members performing together likely occurs at a minimum (e.g., a cook; waiter; and cashier working together in a well-operated restaurant). When members of a collective

communicate among themselves, they often first call out to each other to obtain awareness that couples their minds, allowing a recipient to be tuned for possible action before a signal is sent, not only increasing the power of their collective (see the review by Sliwa, 2021), but also suggesting that a minimal signal works best to coordinate or adjust a team's activities. Sliwa suggests that when a context is certain, the communication channel can be minimized. But, deception, an application of interdependence, makes even certain contexts uncertain, requiring debate and wide-open channels. We consider deception with case studies later.

Among the many examples available of interdependence, when market prices interdependently affect demand, the demand-price relationship is described by a term called elasticity. From Karaian and Majerol (2022), "The price elasticity of demand, to use its full name, measures how sensitive buyers are to price changes. Typically, when the price of, say, a can of Coke goes up, people buy fewer cans or switch to a cheaper brand. If a small rise in price leads to a big fall in demand, the item is said to be more elastic." These switches may be disabled by authoritarian governments.

2.2.3. Redundancy

The very best teams of scientists have been found to be highly interdependent (Cummings, 2015; see also Cooke and Hilton, 2015), contradicting Conant's (1976) application of Shannon's (1948) information theory to teams and organizations, whereby Conant recommended minimizing interdependence (Cummings also contradicted Kenny's team's conclusions mentioned above). Thus, based on the theory that we have developed, we hypothesized and found that redundant individuals decrease the interdependence in a team (Lawless, 2017a,b), which we concluded helps to establish it as a resource for a team when constructive.

2.2.4. Innovation

We have also found that innovation is associated with a nation's education of its citizens; i.e., the more education, the more patent productivity experienced by a nation (Lawless, 2022c). We return to this study later with a new analysis. Years earlier, however, we found that education had no effect on improving the combat performance of USAF fighter pilots (reviewed in Lawless, 2022b). We concluded that these two skills—one necessarily cognitive to be able to innovate and apply successfully for patents, the other necessarily physical for success in air-to-air combat—were orthogonal, an important finding that alone invalidates the assumption of a 1:1 correspondence in social science between cognition and behavior; accounts for the failure of traditional concepts in social science; and accounts for the inability of social science to generalize from individuals to teams, machines and autonomy.

2.2.5. Vulnerability

We extended our findings to include vulnerability in a team, that non-interdependent systems were especially vulnerable to highly interdependent systems; e.g., less educated nations were vulnerable to more educated ones (Lawless, 2022b). We used as one example the Uber car fatality in 2018, where we attributed the cause of the accident to an independent Uber car and its independent

human operator. The car was struggling to categorize the human pedestrian crossing in front of it outside of the pedestrian crosswalk, while the human operator was otherwise engaged with her tablet, neither working interdependently as a team to prevent the fatal accident. We treat vulnerability in more detail later.

2.2.6. Deception

We began earlier to apply interdependence to cyber systems, to discover that deception often defeated cybersecurity systems (reviewed in Lawless, 2022c). We explore deception further in this review.

2.3. The mathematics of uncertainty in our model

In this subsection, we review the duality captured by Equation 1; uncertainty; tradeoffs; teams; tragedy; the randomness associated with teams; and provide a summary in the Discussion section.

2.3.1. Duality

A single human has a well-hidden dual nature. Regarding teams, a single human is either an individual or the member of a team, but not both simultaneously (Lawless, 2020). This dualism is expressed more fully by the uncertainty in a team's structure (ΔSEP), where we assume that a better structured team produces less entropy than a poorly arranged team, an effect that should be observable to humans and machines alike. This assumption establishes an observable tradeoff between structure and performance. If the performance of a team is the uncertainty in its maximum entropy production (ΔMEP), together with its structure, the tradeoff results in Equation 1:

$$\Delta SEP * \Delta MEP \sim C \qquad (1)$$

2.3.2. Uncertainty

In Equation 1, the uncertainty or entropy in a team's structural arrangement times the uncertainty in the maximum entropy productivity of the team is approximately equal to an unknown constant (for mathematical details, see Lawless, 2022c). To reiterate, our first discovery with Equation 1 was the tradeoff between the dualism in a team's structural entropy and its performance among the top oil firms (Lawless, 2017a), which we replicated with the world's top militaries (Lawless, 2017b); in these two studies, we found that the more redundancy in a team (i.e., a greater ΔSEP), the less productive it was (i.e., a lower ΔMEP).

2.3.3. Tradeoffs

In support of Equation 1, tradeoffs are common to decision-making, whether in business, military matters, or personal relationships. For example, strategists must balance the dual nature of competing goals and requirements. Tradeoffs require strategic decision-makers to resolve the structural tensions within the strategic decision-making landscape, whereas dualism considers the "alignment of

potentially unlimited aspirations with necessarily limited capabilities" (Gaddis, 2018). Also from Gaddis, "Competing priorities, limited resources and the presence of uncertainty combine to create difficult strategic problems … As Lady Justice balances the evidence in front of her to render judgment and make decisions, she wears a blindfold. This lack of sight represents her impartiality and ability to consider evidence without regard to the status or power of either side. Strategic decision-makers must similarly be able to impartially approach their strategic challenges and put aside personal biases."

2.3.4. Building Teams and Breaking Teams Apart

The duality inherent in Equation 1 has much more to say about teams. We concluded that the greater a team's structural entropy (more ΔSEP), the more likely the team was vulnerable to splitting apart if it were freely able to break apart, which may not be possible under the authoritarian regimes that use suppression or compliance to control their citizens, their teams and their systems. Oppositely, as a team's structural fittedness improves (i.e., how well a team's members fit together; in Lawless, 2022c), the more energy it can expend on being productive, characterized by its maximum entropy production (ΔMEP).

2.3.5. Tragedy and Conflict

Faced with uncertainty, teams make decisions that can lead to tragedy when their decisions are not checked. We used Equation 1 to explain the U.S. Department of Defense's (DoD, 2021) use of a drone in late August of 2021 that killed an innocent adult and several children based on DoD's faulty risk perceptions.

2.3.6. Randomness associated with teams

In its report, the National Academy of Sciences (NAS) drew two conclusions, the first was about open science, which we have already discussed. The second, from Endsley et al. (2021): The "performance of a team is not decomposable to, or an aggregation of, individual performances." This second conclusion is a claim that was not cited, which tells us that while the Academy liked it, they could not understand or justify it. However, it follows directly from Equation 1: we can understand what a team is doing as a whole, but we cannot decompose its parts into separate agents for study because its parts are interacting and dependent on each other, exactly how Schrödinger (1935) first described entanglement. More importantly, when these agents are playing in orthogonal roles (e.g., cook, cashier, etc.), data dependency means that the information derived from them is often orthogonal, producing zero correlations, casting further doubt on 1:1 relationships and i.i.d. data, as predicted by Schölkopf and colleagues (2021). We have generalized Schrödinger by concluding that, since social science has been unable to predict fittedness, this irreducible uncertainty in a team's arrangement is how nature introduces randomness into human life; i.e., if it is not possible to predict what teammate fits with which teammate, fittedness is only achieved by testing and retesting until it is found, a pursuit likely not possible in unfree countries.

2.3.7.   Other: Generalizing to quantum systems

There are misperceptions about entanglement that interdependence helps to clarify. First, from Cole (2015), the misperception: "If two quantum particles are entangled, they become, in effect, two parts of a single unit. What happens to one entangled particle happens to the other, no matter how far apart they are." This view of entanglement is not correct; instead, entangled particles are dependent on each other, so that a measurement of one part disturbs the other part (we have known for decades that the effect of measurement on a team disturbs it; e.g., Roethlisberger and Dickson, 1939).

Table 1 is provided to help readers sort through the predictions and results.

Table 1. Predictions from Section 2 and Results from Section 3.

Section	Topic	Section	Topic
2.2.2	Interference	3.1.4	Authoritarianism
2.2.3 & 2.2.4	Redundancy and Innovation	3.1.1	Games
2.25	Vulnerability	3.3	Vulnerability
2.2.6	Deception	3.1.3	Deception and Beliefs
2.3.1	Duality	3.4	Leadership
2.3.2	Uncertainty	3.3.1	Uncertainties
2.3.3	Tradeoffs	3.3.3	Government
2.3.4	Teams	3.2	Firm Divorces
2.3.5	Tragedy and Conflict	3.3.2	Conflict
2.3.6	Randomness	3.2	Mergers

3. Methods and results

In this section, we review prior results and provide new case studies and analyses. We review belief logics, mergers, vulnerabilities and leadership.

3.1. Belief logics

In this subsection of our review, we provide new case studies plus an example of how belief logics or intuition mislead; we cover an example of game theory; beliefs and deception; and authoritarianism.

3.1.1.   An example of faulty logic

Numerous examples contradict logic's simple view of social reality. But we focus on a single example: in a news article in Science magazine, Cohen (2013) reported that the female partners of HIV infected males participated in a study of a new drug to prevent infection from the disease. At the end of the study, the women reported using the drug (PrEP) 90% of the time, and their unused returns seemed to validate their report. But when the researchers later analyzed blood levels of drugs in the women, they found that no more than 30% had evidence of anti-HIV drugs in their bodies at any visit.

"There was a profound discordance between what they told us, what they brought back, and what we measured," infectious disease specialist Jeanne Marrazzo said about the female participants in her study.

3.1.2. Game theory

One of the best examples of belief logic gone amiss is with the use of game theory. Game theory is easy to understand, easy to apply in the laboratory, and its results are convincing. One reason may be the easy control of variables in the laboratory for game theory. However, games fail in the field possibly due to the lack of control of variables in the field, meaning that a different specialized game is required for different contexts. For example, based on repeated games, Axelrod (1984) concluded that competition reduced social welfare: "the pursuit of self-interest by each [participant] leads to a poor outcome for all." This outcome can be avoided, he argued, when sufficient punishment exists to discourage competition. Instead, we have concluded that punishment is the tool of authoritarian regimes. With a reanalysis of data from Lawless (2022c), we construct Fig. 1 below for a multiple regression. In it, we found just the opposite of Axelrod's finding, that is, the more freedom and education (higher Human Development Index, or HDI), the more innovative was a society:
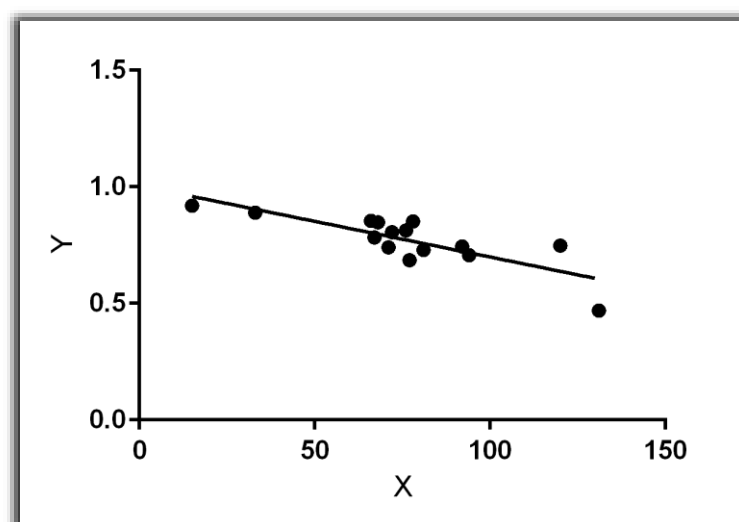

Figure 1. With data from the U.N. for Middle Eastern North African (MENA) countries, the *Y* axis represents data from the U.N. Human Development Index (HDI), with higher HDI scores reflecting more education and social well-being (https://hdr.undp.org/data-center/country-insights#/ranks) and with Patent Productivity Rankings displayed inversely on the *X* axis; i.e., higher productivity is ranked lower (please note that five MENA countries were omitted due to their lack of a patent productivity ranking: Iraq; Libya; Palestine; Sudan; Syria; from https://www.globalinnovationindex.org/Home). The regression is significant ($p < .001$), with $R^2 = 0.6508$ (for more details, see Lawless, 2022c).

Games with preordained proofs

Games were originally designed for interdependent situations to be manipulated by scientists in a closed laboratory (Von Neumann and Morgenstern, 1953). But the lack of physical reality and observational uncertainty from the observer-actor interactions during games was criticized by Bohr, the quantum physicist. Von Neumann and Morgenstern feared that Bohr's criticism, if correct, would make a rational model of the interaction "inconceivable". Played in closed systems, retired U.S. General Zinni (Augier and Barrett, 2021) complained that the use of war games results in "preordained proofs." This question is serious not only for games, but training in general; e.g., can we train police to take action during a mass shooting: "A $50 million facility in upstate New York is trying to teach officers the thing they'll need most during the next mass shooting: bravery" (Ashford, 2022). Not only is the training suspect, but so are the predictions that result. An example of a war game recently played in a Washington think tank found that the U.S. and Taiwan would successfully defend Taiwan, but at a high cost (Strobel, 2022): "Taiwan's economy would be shattered, and the U.S. military so battered that it would take years to rebuild, with repercussions for America's global power." A disturbing prediction, however, it is the same sort of prediction that was made before Russia invaded Ukraine, that Russia would overwhelm the smaller country in short order, but this prediction failed completely. "Virtually nobody—and certainly not Putin himself—thought Ukraine could hold the mighty Russian military at bay" (Arkin, 2022).

3.1.3. Beliefs and deception

Beliefs are thought to be intuitive and to be mostly accurate (Kahneman, 1962). However, deceivers rely on this supposed accuracy. We consider case studies of deception implemented with interdependence.

Examples of deception

Disney and other retailers filed an antitrust lawsuit against credit card companies, Visa and Mastercard for activities filed in a lawsuit begun in 2005 over interchange fees, where merchants were charged for every transaction by the bank that issued the card (Dash, 2005). Many companies that rely heavily on credit card purchases, like retailers, argue that the card companies' hold on the market effectively allows them to price-fix their fees, increasing prices for consumers. The new lawsuit, led by Disney, charges that the continuation of their old practices was designed from the beginning to be hidden from its and the public's view (Sorkin et al., 2022).

In accordance with Equation 1, for deception to work, it must keep its true reality hidden by minimizing *SEP*. For example, shares were given by a company profiting from a new North Carolina tribal casino to the family members of politicians and other political figures during the time when the company's backers were seeking federal approval for the casino project, according to interviews and documents reviewed by *The Wall Street Journal* (Maremont, 2022). "The stakes held by the politically connected people were masked from public view through several layers of corporations and limited-liability companies."

Deceivers rely on promises that are difficult to confirm. As an example, from Finley (2022b), "Last week kicked off the fraud trial of Trevor Milton, founder and former CEO of electric-vehicle

startup Nikola. The government alleges that he deceived retail investors about Nikola's technology … Nikola merged with the special-purpose acquisition company VectoIQ Acquisition Corp., launched by Cowen Investments, BlackRock and former General Motors executives. These inside investors received millions of shares in VectoIQ and also floated some to the public at $10 apiece to raise money to acquire another company … GM announced on Sept. 8, 2020, that it was taking an 11% stake in Nikola, which CEO Mary Barra heralded as an "industry leading disrupter." Two days later, short-selling firm Hindenburg Research published a report exposing Mr. Milton's deceptions. Nikola's stock price plunged, and a couple of weeks later Mr. Milton stepped aside from the company".

The application of interdependence as deception is important to business and the military. Our insight is that deceivers maximize their lack of discovery by minimizing structural entropy production with their presence by acting as fully motivated members of a team until it is time for them to attack their duped opponents; e.g., saboteurs used surprise to attack the Russian air base and ammunition dumps in Russian-held Crimea (Coles, 2022).

Military deception

Deception has always been central to military operations; e.g., at sea, phantom ships are rapidly becoming the "latest weapons in the global information war" (Harris, 2021). From Murphy (2022), "When you want to see if you can generate fake data that will trick your discriminator into thinking an F-35 is present where it is not, you will employ a generator. The generator, when trained against a discriminator, will be able to detect patterns your discriminator is using in order to understand how to trick it. And just as one can trick the algorithm into seeing something that is not there, an adversary can camouflage itself. Since the amount of information these algorithms receive is mind-blowingly large, some hideously simple patterns may emerge to break the discriminator."

The surprise blitzkrieg by Ukraian forces over a weekend in early September 2022 seems to have been predicated partly on panic among some of the Russian military aggressors caused by the use of deception: "The advance was enabled by a misinformation campaign by the Ukrainian military, which signaled throughout August that it was readying a counterattack on another side of the country, near the southern region of Kherson. This led to Russia pulling troops from other occupied regions to reinforce defense lines in the south, with analysts estimating that about 15,000 to 25,000 soldiers had been deployed there by mid-August. The decision by Ukraine to tout its counteroffensive in the south before striking in the northeast is a standard technique for misdirection …" (Dlugy, 2022).

Over the centuries, deception has always gone hand in hand with innovation: "the remit of Chinese intelligence services does cover industrial secrets as well as military and government ones, and their leadership takes that responsibility seriously. It's what rising economic powers have always done: In the late 18th century, the newly independent US offered bounties for textile workers to smuggle loom designs from the great British cotton mills. Those mills had been built in part to specifications once pilfered from Italian silk spinners. And that industry, in turn, wouldn't have existed without silkworm eggs spirited out centuries before from China…. [Ongoing in China today, its] intelligence-gathering apparatus … relies not only on trained spies and officers of China's Ministry of State Security but also on ordinary engineers and scientists" (Robertson and Bennett, 2022).

Cancer cells

Humans and animals freely use deception. But in a new discovery, "researchers found that cells from some types of cancers escaped destruction by the immune system by hiding inside other cancer cells," (Kolata, 2022).

3.1.4. Authoritarianism

Interdependence, when constructive, amplifies the social performance of teams and systems; but when destructive, it amplifies the negative effects of the adverse forces it unleashes (Lawless, 2022b), reflecting minority control (Lawless et al., 2014). Despite its sluggish economy from strict lockdowns in China's approach to Covid-19 and a slumping property market, the present Chinese leader is fighting to maintain his authority (Wong, 2022). One advantage of authoritarians is gained by an industrial policy, say for advancing computer chip technology, which China has exploited for advantage by marshaling its resources (e.g., Wang, 2022). However, there are several flaws with governing by minority control of authoritarians, kings, gang leaders, consensus-seekers, and mobs, especially if they can suppress interdependence, inadvertently dampening innovation.

Politics

The interdependence of a nation's politics, especially its inequality, affects its national security. Lyall (2020) concludes that a military is more effective when it is inclusive of its diverse social groups, and that it is not possible to reform a military without resolving the underlying inequalities of a nation the military serves: "successful armies are inclusive; unsuccessful ones largely die by their own hands, wracked by the poison of inequality that kills them, sometimes slowly, sometimes quickly, from the inside out." This result may account in part for Russia's failure in Ukraine. A fuller account includes interdependence.

Authoritarians short-circuit interdependence by using corruption to manage people. From Wong (2022): "Chinese leader Xi Jinping is elevating trusted subordinates into party and government posts that command key levers of political power, galvanizing his authority as he prepares to extend his rule for another five years. Poised to claim a third term as Communist Party chief at a twice-a-decade party congress this fall, Mr. Xi has assigned associates to senior roles overseeing law enforcement and propaganda in recent weeks, clearing their paths toward higher office. Some vocal Xi supporters won promotions, while one prominent ally retained his position in the face of public anger over his recent performance. Others out of favor with Mr. Xi have been eased into less-important roles. The Chinese leader also stepped up a broad propaganda drive in recent months to celebrate his decade in power. Top lieutenants have sung Mr. Xi's praises with rising fervor, calling on party members to swear loyalty to their … leader." Those favored allies have been able to collect fees from fellow citizens for their loyalty, a path to riches (Lawless, 2017b).

Turmoil

Turmoil versus a pacific citizenry. First, turmoil. There is the belief that too much turmoil is bad for the U.S.; e.g., from Haass (2022), "Ultimately, however, the biggest risk to U.S. security in the decade to come is to be found in the United States itself. A country divided against itself cannot stand;

nor can it be effective in the world, as a fractious United States will not be viewed as a reliable or predictable partner or leader. Nor will it be able to tackle its domestic challenges. Bridging the country's divisions will take sustained effort on the part of politicians, educators, religious leaders, and parents." But turmoil, if managed, can transform, too.

Peace and quiet

In contrast to turmoil, China's social data experiment in two places suggests that the same data technology run with sensors, drones and robot dogs used to terrorize and remold those who resist its party's rule can also coddle and reassure those who accept its rule. "As it amasses ever more data on the movements and habits of its people … China's Communist Party dangles the promise of a perfectly engineered society: one in which artificial intelligence companies work hand in glove with police to track down fugitives, find abducted children and publicly shame jaywalkers; in which public services, rewards for good deeds and punishments for misbehavior are all delivered with mathematical precision and efficiency. … Mr. Xi is now trying to write a new social contract. Rather than entice citizens with the possibility of riches, he instead offers them security and convenience—a predictable world in which thousands of algorithms neutralize threats and sand away the frictions of daily life. … Hangzhou is rife with … sensors … to improve residents' lives … [by feeding] data into algorithms that alleviate traffic congestion, monitor food safety and help escort first responders to a scene more quickly. … [But in] Xinjiang, where authorities have carried out a multiyear campaign of forcible assimilation targeting Uyghurs and other Turkic Muslim groups … [those] deemed likely to cause trouble are sent to prison or to one of the … "transformation through education centers" … the largest incarceration of a religious minority since World War II" (Chin and Lin (2022).

George Kennan, author of the Long Telegram, concluded that "... at the bottom of the Kremlin's view of world affairs is a traditional and instinctive Russian sense of insecurity." (Leffler, 2007; Gaddis, 2011). We disagree, partially. By suppressing interdependence and with it the free interchange of ideas, innovation is itself suppressed or at least dampened except for those projects favored by command economists (Lawless, 2022c). In short, the primary driver of innovation cannot be sustained, the internal contradictions expressed by Kennan about the Soviet Union. Suppression is happening in China in 2022 claimed a report by a United Nations agency which investigated and determined that human rights violations have been committed as part of the Chinese government's efforts to combat terrorism and extremism, including the possible use of forced labor and internment camps (Wong and Areddy, 2022). The report's assessment that China's crackdown in Xinjiang could amount to "crimes against humanity," described in the *New York Times* (Ramzy, 2022), illustrates the power of state-sponsored suppression: "When overseas Uyghurs spoke out about the authorities' abuses in Xinjiang, China targeted their families back home, sentencing their relatives to long prison terms and using the full weight of state media and prominent Chinese diplomats to denounce the activists as liars and frauds."

The U.N. report about China's abuses followed another which charged China with the practice of a form of genocide in the Xinjiang region (Hua, 2021). China rejects these two clams, but there have also been reports of organ removals from live prisoners (Robertson and Lavee, 2022). China rejects these new clams, too, but in this case, "Instructions to state-managed medical journals to cease publishing such details could have been issued" (Robertson and Lavee, 2022).

Consensus-seeking

Consensus-seeking was thought to be a replacement for democratic decision-making in Europe and with the U.S. Department of Energy (DOE). However, Europe has struggled with consensus seeking: "The requirement for consensus in the European Council often holds policy-making hostage to national interests in areas which Council could and should decide by a qualified majority" (WP, 2001). The consensus-seeking Europeans are now vulnerable to authoritarian Russia: "Factories, businesses, and families across Europe are battling for survival as Russia's chokehold on the continent's natural gas supply sends prices to astronomical heights, unleashing a brutal economic storm that has tested European solidarity about Russia's war in Ukraine and fueled fears of an impending recession" (Lu, 2022).

Regarding DOE, comparing the nuclear waste cleanup at the DOE Hanford site in the State of Washington with the cleanup at the DOE Savannah River Site (SRS) in South Carolina, based on findings from the field, we have found that Hanford has been impeded in its cleanup by the recommendations of its consensus-seeking Citizens Advisory Board (CAB), placing Hanford 25 or more years behind an accelerated cleanup of SRS encouraged by its majority-ruled CAB. Comparing the lack of progress at Hanford with SRS, we have concluded that consensus-seeking allows minorities to block concrete actions, leading us to conflate the minority control of consensus-seeking systems with authoritarianism (Lawless et al., 2014).

3.2. Mergers

In this subsection, we review mergers with new case studies to illustrate the difficulty of transforming a firm in the hope that restructuring it will lead to its improved performance.

Merger case studies provide a view of the reality of team behavior in a free market as a team seeks to transform its structure to obtain minimum *SEP* in Equation 1 to become more competitive by selecting better-fitted teammates. We consider mergers that have succeeded, and spinoffs for those that have failed. In a free market, mergers and spin-offs in businesses often occur to open new markets, adopt new technology, repair a vulnerability, discard a poorly performing element of a business, increase a firm's competitiveness, or to gain a larger share of a market. Vulnerable firms in a growing market represent targets to be acquired. The end result is a deepening of a firm's market model, its revision, failure and spin-offs, in a new model entirely. Competition is the primary means of determining strengths and weaknesses of the structure of teams and systems, such as the following snapshots of these businesses; e.g., after having grown frustrated to attract more government agencies to its cloud business, Microsoft is now attempting to rally allies to help in its fight against Amazon's dominance of cloud-computing for government agencies (Tilley, 2022). When a firm suffers significant losses, it becomes vulnerable to a merger target or, at least, tries to reset itself with a major transformation; e.g., Terlep (2022a), writes that the severe losses reported by Peloton Interactive, Inc., have forced the firm in its struggle to save itself by "eschewing some fundamental aspects of its decade-old business model." In this part of our review, with case studies about mergers, we consider survival; consolidation; growth; market loss; spin-offs; and summed in the Discussion.

3.2.1. Survival

From Belkin (2022), many colleges in financial trouble are seeking mergers as their means to survive. Similarly, Roomba, a seller of robotic vacuum cleaners, was struggling and got bought by Amazon, "giving the online retailer another connected-home product that deepens its ties to consumers' homes" (Hart, 2022). Amazon has been losing ground fast to Walmart (Finley, 2022a). Amazon's bid for iRobot is a naked play for the company's artificial-intelligence and robotics expertise. Amazon's home-monitoring Astro robot, however, has been panned by several tech reviewers.

3.2.2. Consolidation

Consolidation is also occurring in the newspaper business, reflected by Cox's offer to buy Axios, which has been unable to compete at its smaller scale (Lukpat et al., 2022).

3.2.3. Growth

Some companies grow rapidly after a merger; e.g., beginning as a rechargeable-battery maker in 1995, after acquiring a small state-owned automaker in China in 2003 and supported by Warren Buffett in 2008, the car firm, BYD has grown into a major car company strong enough to challenge Tesla across the globe (Cheng, 2022a; however, as possibly part of a cautionary tale, Buffett has subsequently slightly reduced his holdings in BYD; in Cheng, 2022b). On the other hand, with its renewed intent to disrupt healthcare in a highly competitive market, focused on medical practices that operate across a network of over 189 offices, Amazon is acquiring One Medical Network, its first major acquisition under its new Chief Executive (Evans and Herrera, 2022). Amazon beat CVS to the acquisition of One Medical, but CVS is still seeking to fulfill its "efforts to add primary-care practices and doctors to its payroll … [and] to expand its in-home health presence … by seeking to buy Signify Health" (Lombardo et al., 2022). And, in the past, "Pfizer had tried to develop its own sickle-cell drug, but it failed," leading it to try to buy "Global Blood Therapeutics, which has one of the few approved treatments for sickle-cell disease" (Rockoff, 2022). As another example of an attempt to rearrange itself to grow (Lombardo et al., 2022), "Adobe agreed to buy collaboration-software company Figma for around $20 billion, using the biggest deal in its history to acquire a small-but-fast-growing rival that the tech giant hopes can give it access to a broader group of customers. … Figma is relatively little known to the wider public but its cloud-based collaboration tools have gained a loyal following among software developers and product managers who build apps and other technology products. Adobe executives said they think the acquisition will enable them to tap into demand from such users in a way that is complementary to the base of designers who use its existing software tools."

However, countering its own plans in health care, "Amazon told employees in an email on Wednesday that it is shutting down Amazon Care, its in-house foray into providing primary and urgent health care. The move comes a month after Amazon announced plans to buy a much larger competitor, One Medical" (Weise, 2022).

As an example of a small firm growing rapidly in its relatively new market (Garcia, 2022), "Apollo Global Management Inc. agreed to sell wireless tower company Parallel Infrastructure to a buyer backed by Palistar Capital, which plans to invest more than $1 billion to expand the business.

The deal would create one of the largest cellphone infrastructure companies in the U.S., with more than 2,000 sites either operating or under construction across 41 states, once Parallel is combined with developer Harmoni Towers LLC, New York-based Palistar said. Palistar acquired Harmoni in June 2020."

Growing to increase competitiveness. In its fight with Frontier airlines to increase its market share, JetBlue is buying Spirit Airlines to become the fifth largest U.S. air-carrier, giving the "national low-cost carrier" combination the capability of competing against the four "larger airlines that control some 80% of domestic seat capacity" (Sider, 2022).

3.2.4. Reducing costs

Mergers can reduce the cost of operations. From Kang (2022), a merger is under consideration by Kroger Grocery to buy its smaller rival Albertsons to better compete against Walmart, which would remain larger than the combination after a merger. But the merged firm would allow it to negotiate better with vendors to cut costs in purchasing products and to pass on the savings for the benefit of its customers.

3.2.5. Market losses

Consolidation mergers offer a way to rearrange two firms to reduce the competition in a market that is providing insufficient revenue for two of the leading firms; e.g., Orange and Masmovil Spanish telecoms agreed to merge (Batchelor and Nussbaum, 2022).

3.2.6. Firm divorces

The need for a spin-off of the weaker parts of a firm is the insufficiency of energy brought into the full firm needed to survive. Spinoffs provide a parent company struggling to survive with a new opportunity to increase profits by being able to become more focused on specific products or services, that is, the parent company seeks to turn its past with a losing strategy into a strategy that is a winning strategy. For example, General Electric is breaking into three units (Vranica and Gryta, 2022): Vernova, for its power business; GE Aerospace; and GE Healthcare. Similarly, Roland (2022) reported that GSK, formerly GlaxoSmithKline, spun off its consumer-healthcare business into a new standalone company called Haleon PLC; the bet by GSK, a pharmaceuticals giant, is that its greater focus on more innovative drugs and vaccines will accelerate GSK's growth.

An example of a major split is provided by the giant accounting firm, Ernst and Young (Eaglesham, 2022): "The far-reaching proposal would separate EY's accountants who audit companies such as Amazon.com Inc. from its faster-growing consulting business, which advises on tax issues, deals and more. EY projects a surge in growth and greater profitability for the consulting business once it is freed from conflict-of-interest rules that limit the services it can sell to audit clients. The firm audits Silicon Valley giants including Amazon, Salesforce Inc., Workday Inc. and Google parent Alphabet Inc. That limits its ability to compete in the fast-growing area of consultants teaming up with tech giants to sell outsourced services to companies. ... "This is something that will change the industry," Carmine Di Sibio, EY's global chairman and chief executive, said in an interview. Rivals beg to differ. Deloitte, KPMG and PricewaterhouseCoopers have all said they plan to keep consulting and auditing

under one roof. These other Big Four firms hope to exploit EY's focus on its restructuring to poach clients and employees, according to people familiar with the matter."

3.3. Vulnerabilities

In this subsection, we review vulnerabilities from the perspective afforded by Equation 1.

These results apply to vulnerable firms in a consolidating market; e.g., from Berger (2022), building on its past success with acquisitions, "DSV A/S is pursuing more business in the U.S. as the acquisition-focused freight forwarder consolidates its power among the world's largest supply-chain companies. The Danish forwarder has been among the most aggressive firms in the shipping sector at buying and integrating underperforming peers in the highly-fragmented market for managing the freight transportation and logistics behind global trade."

3.3.1.   Uncertainties

Vulnerabilities are widespread where uncertainty operates. For example, from an FBI alert (FBI, 2022), by initiating a "flash" loan that triggers an exploit in a DeFi's smart contracts; by exploiting a signature verification vulnerability in a DeFi's token bridge; and by, among others, exploiting a series of vulnerabilities from manipulating cryptocurrency price pairs with a DeFi's use of a single price oracle, "Cyber criminals are increasingly exploiting vulnerabilities in the smart contracts governing DeFi platforms to steal cryptocurrency ... A smart contract is a self-executing contract with the terms of the agreement between the buyer and seller written directly into lines of code that exist across a distributed, decentralized blockchain network. Cyber criminals seek to take advantage of investors' increased interest in cryptocurrencies, as well as the complexity of cross-chain functionality and the open source nature of DeFi platforms. Between January and March 2022, cyber criminals stole $1.3 billion in cryptocurrencies, almost 97 percent of which was stolen from DeFi platforms, according to the US blockchain analysis firm Chainalysis … an increase from 72 percent in 2021 and 30 percent in 2020, respectively."

Trying to remove a vulnerability not only may not work with corporate mergers, but also may not work in governance; e.g., in Mexico, "Many officials and analysts say that the endless bloodshed — a signal of a government losing control over the country — has been exacerbated by the transformative security strategy put in place by the current president, Andrés Manuel López Obrador, shortly after taking office, which gutted intelligence operations and so far has failed to quell the carnage" (Abi-Habib and Lopez, 2022).

3.3.2.   Tragedy and conflict

The U.S. Department of Defense's decision to fire a missile from a drone at a car in Afghanistan in 2021 killed 10 innocent civilians, a tragedy that might have been prevented had it been challenged. According to DoD (2021), this tragedy that might have been averted had one of its "red teams" been in a position to challenge the DoD team's poor risk perceptions as they were being created, and untested in a highly emotional state during DoD's withdrawal from Afghanistan (Lawless, 2022a).

Vulnerabilities occur in open conflict and in wars, too, where attacks against the vulnerabilities of superior forces can neutralize the larger force; e.g., attacks behind front lines in Crimea by Ukraine against Russian occupiers (Marson et al., 2022): "Explosions rocked an ammunition depot in Crimea, damaging rail tracks and power lines and marking a fresh blow to Moscow's war effort. … The explosions underscore Russia's vulnerabilities as Ukraine seeks to retake territory in its south that Russia occupied in the early stages of the war. Ukraine, which lacks the forces for a head-on assault, has sought to erode Russia's ability to wage war by targeting ammunition dumps, command posts and bridges, usually with long-range rocket launchers provided by the U.S. Russia has reinforced its military in the south with thousands of troops that were transferred from eastern Ukraine."

According to Gorbachev, who recently died, when asked in 2014 by a Siberian news outlet about the possibility of open conflict between Ukraine and Russia, Gorbachev said, "A war between Russia and Ukraine — this is absurd" (Troianovski, 2022). Yet today in 2022, "In Ukraine, Mr. Putin is fighting in the shadows of the empire whose end Mr. Gorbachev presided over, having started a war that has killed thousands in the name of restoring Moscow's dominance over what it claims to be Russian lands. But Mr. Putin's battle to reverse Mr. Gorbachev's legacy extends beyond territorial control to the personal and political freedoms that the last Soviet president ushered in — and that the Kremlin is now fast unraveling" (Troianovski, 2022).

3.3.3. Government

Vulnerabilities can also be imposed when governments block teams and firms from making tradeoffs. Also, forced merger reversals in non-free markets can occur, especially if they reflect the actions of leaders in a command economy. Under the guise of a regulatory crackdown, to reverse a successful merger, Huang (2022) reported that, "Tencent Holdings Ltd. … is looking to sell most or all of its stake in food-delivery company Meituan … people familiar with the matter said, as Beijing seeks to curb the power and influence of the country's internet giants. … Meituan, which went public in Hong Kong in 2018, is one of China's most valuable tech companies. … The company operates an app that hundreds of millions of Chinese citizens use to order meals and groceries, and make travel and restaurant bookings. Tencent has been a large shareholder of Meituan since the latter's early days, and Meituan has leveraged Tencent's WeChat ecosystem to expand its user base."

China is building vulnerabilities by rejecting meritocracy: "The Chinese elite is a group of people called Princelings. They are children, grandchildren, and in-laws and relatives of high-ranking senior CCP leaders. They are the ones who wield absolute political power over the people, which makes them the proprietors of the means of production of the country. The princelings are behind every sector of the Chinese economy: energy, finance, real estate, technology, healthcare, stock exchange, and manufacturing" (Zhang, 2022).

Finally, vulnerabilities leading to bankruptcy are common. However, consider the case of Peabody Energy, the largest U.S. coal miner confronting climate change and the shutdown of large industries due to the Covid pandemic. Before the Russian war started in Ukraine it was nearing bankruptcy, but after the war started, the situation has changed. Peabody is in (Hoyle, 2022): "talks to combine with an Australian rival that could result in a new global giant worth some $6 billion, illustrating how the coal-price surge that followed Russia's invasion of Ukraine is transforming the sector's fortunes. … As recently as two years ago, Peabody was warning that it might enter bankruptcy

protection for a second time, given weakness in coal markets after the Covid-19 pandemic led to a sharp drop in power demand as factories closed or reduced output."

3.4. Leadership

In this subsection, we explore with case studies the value of a leader to the arrangement of a team's structure and its performance.

3.4.1.   Predictions

Predictions from Equation 1: A leader is best when helping a team's structural entropy production to reach a minimum, and the team's productivity to reach a maximum in a direction favorable to accomplishing a team's mission or purpose. We provide several reasons for changes in leadership: Changes at the top due to a CEO's inability to end internal strife; to revive a business; to end a firm's struggles in its market; or, among other reasons, for decisions that led to a loss of reputation in a market; good leadership; and a summary in Discussion.

3.4.2.   Strife

After internal strife renewed over the slow progress with software for Volkswagen's new generation of electric vehicles (Boston and Kantchev, 2022), delays that pushed back the launch of several new models, raising doubts among the company's leading stockholders about the Chief Executive Officer's performance, key shareholders of VW allied with its labor leaders to oust the CEO in the midst of VW's turn to electric vehicles by the German auto company.

3.4.3.   Revival

From Kapner (2022), the new CEO at Bed Bath and Beyond took over in 2019 to revive the home-goods retailer by making it more competitive against the large chains and sellers (Amazon, Target, etc.) created by switching too quickly to private-label brands, an approach that had worked elsewhere (Macy's sold its own private label whiskey in the 19th century; Sears' own private-label tools by Craftsman date to 1927). But the customers of Bed Bath and Beyond liked its 20% off coupon and massive brand-name product selection; the new approach alienated them and sent sales into free fall. The new CEO quit in June, leaving the company struggling to stay afloat.

Struggles. Example A

From Lombardo, Terlep and Kapner (2022), "Some board members, including interim CEO Sue Gove, thought Mr. Arnal was overwhelmed—but didn't want to replace him while the embattled retailer was in the midst of raising money, according to people familiar with the matter. Mr. Arnal told people that he was stressed, working 18-hour days. He was also inundated with emails from individual investors and plaintiffs' lawyers questioning an August sale of some of his Bed Bath and Beyond holdings, the people familiar with the matter said. Mr. Arnal was discussing with the company the possibility of taking a break. On Aug. 31, he, Ms. Gove and other executives announced fresh financing

and briefed investors on a major restructuring. Two days later, Mr. Arnal died from a fall at the New York City skyscraper where he lived."

Struggles. Example B

Along with the recognition that Adidas shares have lost significant value this year, leading the firm to be ranked among the worst performers on the 50-member Euro Stoxx 50 Index, the CEO for Adidas is stepping down (Hipwell and Henning, 2022): "Adidas AG announced the surprise departure of Chief Executive Officer Kasper Rorsted next year, forcing the search for a new leader as the German sporting goods company reels from years of lockdowns and consumer boycotts in China."

Struggles. Example C

Peloton lost one of its co-founders due to the losses it suffered. Terlep (2022b) writes that "co-founder John Foley and other senior leaders are leaving the company in a management shake-up as the maker of connected exercise equipment races to turn itself around. Peloton has struggled with deepening losses this year after a pandemic-fueled spike in demand for its at-home workouts left the company with a glut of unsold bicycles when consumers returned to gyms and outdoor activities. The company's shares have plunged more than 90% over the past year."

Struggles Overcome

From Sorkin and de la Merced (2022), "Narasimhan was tasked with cleaning up Reckitt, which had struggled with slowing sales and an ill-fated $16.6 billion takeover of the infant products maker Mead Johnson. He quickly moved to cut costs while investing in Reckitt's supply chains and product research. He also sold underperforming divisions, and scrapped a potential breakup of the company. Investors and analysts praised his turnaround work. "The business is now on a fundamentally firmer footing," Jeremy Fialko, an analyst at HSBC, wrote in a research note yesterday. Reckitt has delivered four consecutive quarters of above-expectations organic sales growth, and in July, it raised its revenue outlook for this year. (In a sign of his perceived worth, Reckitt's shares fell over 5 percent yesterday after the company disclosed he was leaving.)"

Reputation. Example A

From Steinberg and colleagues (2022), the Swiss bank, Credit Suisse Group, is planning to release its Chief Executive Officer in an effort to turn around its struggling fortunes. The exiting CEO was at the head of the bank since the pandemic started; as such, he presided over a series of costly mishaps, including the implosion of two major clients in 2021, Greensill Capital and Archegos Capital Management. He led the bank's cleanups of these mishaps, but apparently, he did not convince investors and board members that the bank was succeeding.

Reputation. Example B

From Lieber (2022), the Israeli cyber firm, NSO, "The Israeli cybersecurity company NSO Group is replacing its chief executive and will lay off 100 employees, the firm said Sunday, in a reorganization that comes after criticism that clients have abused its powerful spyware. The move follows a U.S. decision last year to blacklist NSO over allegations that its surveillance software, called Pegasus, has

been used inappropriately. Those pressures have put the company at risk of defaulting on debt that Moody's Corp. estimated was around $500 million in November."

Good leadership

Based on Equation 1, we conclude that when successful, leaders must acknowledge their team's weaknesses, including their own, and fix them, replacing weak teammates and leaders where possible, but also leaning on leaders at lower levels (Talty, 2022). An example, from pro-tennis, comes from Top Tennis Player, Danielle Collins: "Your technique and the things that you learn tactically in your first couple of tournaments, and the ways that you figure out to win matches and how to use your strengths and how to work around your weaknesses—those are the things that end up making you into a good player … It doesn't just happen overnight, it takes years and years of hard work. And all of that hard work started with my dad" (Bachman, 2022).

4. Discussion

We discuss the sections and then we provide an overview. First, to sum up our model (Section 2.3), our past research has found that there is value in the randomness for the construction of a successful team; that survival is important to a team; that intelligence occurs from the interactions of a team, not in summing the intelligence nor the education of each team member (Cooke and Lawless, 2021); and that losing matters to a team and may cause it to divorce or replace elements of its team. We also reviewed vulnerabilities, competition, and that logic disconnected from physical reality produces misleading results. We have not reviewed our findings regarding boundaries (Lawless, 2017a,b); however, teams and systems need boundaries to reduce outside interference; deception; and to establish a baseline for knowing when an attack on a vulnerability has occurred.

Second, beliefs (Section 3.1) based on principles, especially for what are thought to be clear contexts can be used to deceive believers into making mistakes, including the generation of social conflict. Moreover, deception, it seems, is central to life. Directly contradicting the beliefs of Axelrod (1984), it is not surprising, then, to see that, by being a leader in Middle Eastern North African (MENA) nations in educating its children, Israel is also a leader in innovation across the MENA countries (based on U.N. and other sources for data, re-analyzed herein (reviewed in Lawless, 2022c).

Third, regarding authoritarians (Section 3.1.4), guided by Equation 1, authoritarians reduce interdependence by employing censorship, suppression and other tactics that thwart the free exchange of ideas and markets under liberalism. Great universities depend on free inquiry and academic excellence. However, censorship across U.S. academic campuses has begun to hurt the supremacy of higher education presently enjoyed in the U.S. university system in 2022, casting doubt on whether U.S. universities will lead the world a century from now, foreshadowed by the extraordinary losses of world-class scientists and research facilities suffered by German Universities in the early part of the 20th Century, and presently being experienced in China today: "The greatest challenge confronting Chinese universities today is not the competition they face abroad but the obstruction they encounter at home" (Kirby, 2022).

Fourth, considering mergers with Equation 1 (Section 3.2), mergers reflect the tradeoffs between the opportunities to restructure a team to increase its performance, with what is available for a merger that might work. Noteworthy is the random nature of the process and the outcomes that are observed.

The goal of a merger or spin-off is to strengthen a structure by minimizing its vulnerabilities. Mergers illustrate the dynamics of random choices in teams. Seldom do mergers lead to success (Christensen et al., 2011), underscoring that randomness is key to appreciating Equation 1. Mergers imply that innovation is often difficult to be transferred across the boundary of a team or system, like a nation. We also know from evolution experiments manipulating reptiles facing predators or not conducted between islands that the adaptation of either risk-taking or suppression behaviors can become instilled in a species (Lapiedra et al., 2018).

Fifth, regarding vulnerabilities (Section 3.3), a team's structure can be observed by humans and machines. Attacking a vulnerability disrupts the performance of a team, and the path to defeating the attacked team in an open competition.

Sixth, randomness supports Equation 1 (Section 3.4). Randomness occurs in the choices made by leaders and their teams, illustrated by the mergers and acquisitions that fail to work (Lawless, 2019); e.g., "Once the market leader in online restaurant food ordering in the U.S., Grubhub now lags behind DoorDash Inc. and Uber Technologies Inc.'s Eats division. … Grubhub's parent company [Just Eat Takeway, Inc.] has written down the value of the online food-ordering service by 3 billion euros, equivalent to a little over \$3 billion, just a year after buying the pandemic-era darling for \$7.3 billion" (Stiff, 2022).

In this review, overall, we extended our theory to conclude that traditional models of belief logics make assumptions that if not tested in reality (e.g., with debates; in Lawless, 2022a) can be dangerous and even lethal as our theory has predicted (Lawless, 2020a). For example, the DoD's tragic decision to fire a missile from a drone at a car in Afghanistan in 2021 killed 10 innocent civilians, but DoD's tragic decision might have been prevented had it been challenged by a "red team" when making decisions for high-risk situations (DoD, 2021). Debate is the only path to a truth, however, limited, when faced with uncertainty. There are several examples in addition to DoD's recommendation to challenge its own logic in its decisions with "red teams." Another is the "informed assessment of competing interests" that occurs during an appeals process, noted by Justice Ginsburg (2011). And, in a trial, requiring a "witness to submit to cross-examination [is] the 'greatest legal engine ever invented for the discovery of truth'" (U.S. Supreme Court, 1970).

Leadership is best exemplified by a quiet implementation of a leader's choices and decisions. When the context is certain, and operations are efficient and successful, leadership is easy; a leader's successful execution should produce low entropy by a team's structure relative to its performance. When the context is uncertain or hobbled by conflict, however, leadership is fraught with hard choices, characterized by a team's structure producing higher entropy relative to its lower-entropy performance, the opposite of a team's goal.

Creating an information theory of value (valence) is a challenge that extends to data that mixes reality and belief logics, although the effective and efficient operations of autonomous human-machine teams demand the orthogonal dualisms in the information that produce zero correlations. With Shannon (1948), the probability of communicating the letter z is about 0, its information content (surprise) is 10.4 bits, much greater than the letter e at 0.09 and 3.5, respectively. Thus, a tradeoff exists between increased likelihood and unlikely surprise. The data for Shannon's information is assumed to be i.i.d., meaning that dependency is excluded in the data; however, dependency is implicit in determining the probabilities for Shannon information; i.e., certain letters are more likely to co-occur. That said, Shannon information implies that a for-sure, certain, no-surprise occurrence

has an information content of 0 (e.g., predicting sunrise tomorrow); but no dependency in the data prevents us from extending to a conjugate factor. In contrast, we can use Heisenberg's uncertainty principle to predict that a conjugate variable when fully known has a conjugate co-variable that is fully unknown. This indicates a disconnect. A conjugate variable implies that $[A, B] = ab - ba \neq 0$. Thus, the data collected for a successful team is dependent and non-commutative. In a team with members in orthogonal roles, if the data collected is independent (i.i.d.), by definition, it will likely disagree (a cook and a waitress see their same world differently). Thus, not surprisingly, the theory of complementarity in social relations has failed as a social theory (Berscheid and Reis, 1998). From the theory of Shannon information, not surprisingly, there is likely greater agreement among waitresses and among cooks than can be found in waitress-cook pairs; however, the pair's information value is explicitly interdependent. For structure-performance complementarity, the better they work together, the less information they generate *even if they disagree about why*. Then the tradeoff is located in a team, not in its information or its data, so that as the structural entropy from a well-functioning team goes to zero, its conjugate performance entropy goes to infinity. To reiterate, if a team's structure is conjugate to its performance, that establishes complementarity in a team: as structural entropy goes to zero in the limit for the perfect team, its performance entropy becomes a maximum. More importantly, if the team is perfect, no one will know why, preventing copies (viz., no cloning; in Lawless, 2022c).

5. Conclusions and challenges

Social science is mostly closed and cannot be generalized to autonomous human-machine teams. A recent study conducted in a partially opened environment tested a long-standing influential theory in social science by Granovetter (1973), considered a cornerstone, where the authors confirmed that relatively weak social ties on LinkedIn proved twice as effective in securing employment as stronger social ties (Rajkumar et al., 2022). Further, the authors concluded that weak-ties were more useful for job seekers in high-tech fields like artificial intelligence, while strong ties were more useful for employment in low-tech fields that relied less on software. Even if correct, however, Granovetter's theory is not applicable to skills required for a specific job, to autonomy, nor can it be generalized to autonomous human-machine teams or to teamwork.

As a future challenge that crosses from Shannon information to an information theory of value, maximizing the information transferred between memoryless receivers and transmitters is important. Memoryless channels require a code book (i.e., an external memory). Humans, however, have memories and operate in contexts where transmitting information between teammates is a function, broadly speaking, of different contexts. In well-known contexts among dependent teammates (e.g., a restaurant's cook, waiter and cashier), the signals sent to coordinate each other in this well-established but data-dependent context are minimum (Sliwa, 2021). In unclear contexts, containing uncertainty or conflict, rules exist to maximize the information between debaters (prosecutor, defense attorney, politicians, scientists, etc.). This maximum information allows a participant to find and exploit the vulnerabilities in their opponent's argument, requiring memory. Then, a future challenge, after each brick of context is determined, a memoryless channel is needed to transmit maximum surprise.

We reviewed our past research, including randomness in the construction of a successful team, survival of a team, intelligence in a team, losses to a team and divorce between elements of a team; vulnerabilities and competition; and the inability of logic disconnected from physical reality to play a

part when confronted by uncertainty. According to the one-to-one logic of Hume (1975; Morris and Brown, 2022), the merits of political decisions are to be judged by observation. But our theory of the dual nature of humans and team members reaches the opposite conclusion, that the tradeoffs uncovered during debate are essential to the random construction of a team, to its performance, and to the systems within which a team is located. That helps to explain why teams situated in noisy republics with strong checks and balances are on average more productive than those under the control of gangs, autocracies, kingdoms, and consent-seeking minorities (Lawless, 2022c). And that explains the central failure of authoritarians: to stay in power, they must suppress interdependence, the critical ingredient that free countries exploit to innovate to defeat authoritarians; e.g., "What has happened in Ukraine is a systemic breakdown of leadership that lead the country into a poorly understood war, insisting that victory is just around the corner if it simply holds the line" (Friedman, 2022).

Another challenge. Were the mathematics of teams more precise than with the constant in Equation 1, such as with the use of Planck's constant in quantum mechanics, conjugate variables would be an important consideration. Presently, our theory applies to tradeoffs between the structure and performance of teams. A future challenge is the search for the existence of other conjugate pairs.

AI works in well-defined contexts (Davenport and Miller, 2022), but it cannot understand context, which requires debate when context contains uncertainty, conflict or fluctuations, none of which belief logic can resolve. Resolution requires debate and the persuasion of neutral observers (Lawless, 2019).

Patrick Collison, the co-founder and chief executive of the multibillion-dollar payments company Stripe, has been developing a new discipline that calls for "a new science of progress" (see Collison and Cowen, 2019). Interviewed, Collison said that "For hundreds of thousands of years, human history played out without any rapid, marked advance in material living standards. And then, suddenly, in just the past few hundred years, everything changed: "Humanity achieved a truly mind-boggling amount of progress in the evolutionary blink of an eye. In the early 21st century, we are all living in a world where progress is bequeathed. And yet we understand shockingly little about what drives that progress in the first place" (Klein, 2022). In contrast, we concluded that progress occurs when the freedom to build teams that confront problems of interest; the fullest possible education of all of a nation's citizens free of constraints; the freedom for the random exploration of all solution spaces; and the freedom to challenge received wisdom (Lawless, 2022c).

The ideas about freedom have been around for a long time. Applied to commerce, Montesquieu believed that free markets ameliorated social conflict and war (Cohler et al., 1989). Adam Smith (1977) felt that free trade promoted wealth. Hayek (1944) believed that the heavy hand of government, like socialism, ended prosperity. von Mises (in Klein, 2021) added that in open markets, too much uncertainty existed than any government could manage without a heavy-handed approach that increased corruption and the theft of innovation. We have taken their ideas further.

When volatility increases in a market, as with the U.S. bond market, many investors leave it, decreasing liquidity and exacerbating volatility (e.g., the U.S. Treasury market in September 2022; see Duguid et al., 2022). Mergers are pursued for that very purpose, to reduce uncertainty from a gamble to a stable, clearly delineated context (market). Generalizing from the need for stable, highly certain contexts for markets, which restrict uncertainty to competition between individuals, organizations and militaries, the uncertainty in competition can be reduced when a superior force limits the zones of uncertainty. The information derived by these maneuvers is interdependent, far superior to the more copious Shannon i.i.d. data available; inverting Shannon (1948), knowledge means the absence of

uncertainty (Conant, 1976), but it also means that no new information improves or changes that knowledge (Lawless, 2022c), precisely the definition of interdependence as its effects are found in the limit, especially for perfect teams with teammates occupying orthogonal roles (Lawless, 2022b).

A functional republic depends on innovation, with innovation dependent on freedom, human development (education), and robust checks and balances (Lawless, 2022c). Replacing freedom with authoritarianism explains why Russia needs to steal American technology (Miller, 2022): "Stealing U.S. technology for Russian weapons may once have seemed clever and efficient, but it has left Russia with a military industrial base whose production capacity is fatally reliant on access to Western innovation." Russian authoritarianism is also displayed in the different methods of command and control reflecting the suppression of interdependence by Russia but its exploitation by Ukraine (Fidler et al., 2022): "Ukraine's command structure encourages junior officers to make in-the-moment battlefield decisions, an authority that they have used to seize opportunities and quickly take advantage of enemy weaknesses. Russians, by contrast, have been slowed by a Soviet-era decision-making structure, in which orders trickle down the chain of command from Moscow, and troops at the front lines take little initiative".

Democracy unleashes innovation, but also mob rule, checked by strong constitutional limits to power, and the rise of leaders in opposition to mobs. The U.S. Constitution channels uncertainty to the marketplace, to the practice of religion, and, among others, to the education necessary for innovation. We anticipate that similar restrictions will work for systems of autonomous human-machine teams.

Lastly, a closing comment about fittedness. To reiterate from the NAS report, the "performance of a team is not decomposable to, or an aggregation of, individual performances" (Endsley et al., 2021). Our research offers an explanation: just like we cannot predict beforehand that Na and Cl fit together, fittedness acquires an aspect of trial and error, or randomness. Generalizing, perfect fittedness (e.g., NaCl or salt) is characterized by a drop in entropy compared to a team's constituents; and there is a loss of information from the data dependency, a loss offset by the increase in a team's performance. Adding complexity, that loss precludes copying successful autonomous human-machines teams, and a teleology of their success.

Overall, constructive interdependence is a resource that reflects the dependencies of team members, partners, leaders, and the power of ever-larger teams (Cumming, 2015). Interdependence places authoritarian regimes (gangs, command decision systems, consensus seekers, communists) at a disadvantage when using rational belief logic Why, we should ask, do minority-controlled systems persist with their forcible suppression of interdependence when it places their control at a competitive disadvantage?

Acknowledgments

Conflict of interest

The author decleares that no conflicts of interest exist with this manuscript.

References

Abi-Habib M, Lopez O (2022) 'Absolute Warfare': Cartels Terrorize Mexico as Security Forces Fall Short. The president disbanded the Federal Police and created the National Guard to tackle soaring violence, but three years later, criminal cartels have expanded their reach, New York Times. Available from: https://www.nytimes.com/2022/08/31/world/americas/mexico-cartels-violence.html

Arkin A (2022) How Putin Botched the Ukraine War and Put Russia's Military Might at Risk, Newsweek. Available from: https://www.newsweek.com/2022/08/26/how-putin-botched-ukraine-war-put-russias-military-might-risk-1736311.html

Ashford G (2022) The School Shooting Is Fake. Can It Prepare an Officer for a Real One? A $50 million facility in upstate New York is trying to teach officers the thing they'll need most during the next mass shooting: bravery, New York Times. Available from: https://www.nytimes.com/2022/09/24/nyregion/gunman-shooter-training-schools.html

Augier M, Barrett SFX (2021) GENERAL ANTHONY ZINNI (RET.) ON WARGAMING IRAQ, MILLENNIUM CHALLENGE, AND COMPETITION, Center for International Maritime Security. Available from: https://cimsec.org/general-anthony-zinni-ret-on-wargaming-iraq-millennium-challenge-and-competition

Axelrod R (1984) The evolution of cooperation. New York, Basic.

Bachman R (2022) The Landscaper's Daughter Who Grew Into One of America's Top Tennis Players. Danielle Collins, aiming to reach her second Grand Slam final this year, built her game on city courts with her father as coach, Wall Street Journal. Available from https://www.wsj.com/articles/danielle-collins-us-open-naomi-osaka-11661727088

Bastiat MF (1850) CE OU'ON VOIT. CE QU'ON NE VOIT PAS. 'ÉCONOMIE POLITIQUB EN UNE LECON "What is Seen and What is Not Seen, or Political Economy in One Lesson". Paris: Librairie de Guillaumin.

Batchelor V, Nussbaum A (2022) Orange, Masmovil Sign Deal to Forge $19 Billion Telecom Unit. Agreement includes trigger for possible initial share sale. Deal to test EU regulators' willingness to allow consolidation, Bloomberg. Available from https://www.bloomberg.com/news/articles/2022-07-23/orange-masmovil-sign-binding-deal-to-combine-spain-operations

Baumeister RF, Vohs KD (2007) Self-Regulation, Ego Depletion, and Motivation. *Soc Pers Psychol Compass* 1: 115-128. https://doi.org/10.1111/j.1751-9004.2007.00001.x

Bednar RL, Peterson SR (1995) *Self-esteem Paradoxes and innovations in clinical practice, 2nd edition*. Washington, DC: American Psychological Association (APA).

Belkin D (2022) Broke Colleges Resort to Mergers for Survival. Takeovers increase as a shakeup in higher education leaves schools in trouble. Northeastern does a deal for struggling Mills, Wall Street Journal. Available from: https://www.wsj.com/amp/articles/broke-colleges-resort-to-mergers-for-survival-11658239445

Berger P (2022) Logistics Giant DSV Targets U.S. in Renewed Acquisition Drive. CEO Jens Bjørn Andersen has built the freight forwarder into a global heavyweight, but says more consolidation is likely in the highly fragmented market, Wall Street Journal. Available from: https://www.wsj.com/articles/denmarks-dsv-is-turning-its-logistics-acquisition-ambitions-toward-the-u-s-11660317038

Berscheid E, Reis HT (1998) Attraction and close relationships. In DT. Gilbert, G. Lindzey & S.T. Fiske (Eds.), *The handbook of social psychology* 2 (4th Edition), London, UK: Lawrence Erlbaum, 193-281.

Blanton H, Jaccard J, Klick J, et al. (2009) Strong Claims and Weak Evidence: Reassessing the Predictive Validity of the IAT. *J Appl Psychol* 94: 567–582. https://doi.org/10.1037/a0014665

Boston W, Kantchev G (2022) VW Board Ousts CEO Herbert Diess After Pivot to Electric Vehicles. Chief executive is stepping down effective Sept. 1 and will be succeeded by Porsche CEO Oliver Blume, Wall Street Journal. Available from: https://www.wsj.com/articles/volkswagen-ceo-herbert-diess-is-stepping-down-11658507894

Cheng S (2022a) Warren Buffett-Backed Chinese Car Maker BYD Zooms Past Rivals. The company saw sales of electric vehicles and hybrids skyrocket as rivals such as Tesla suffered plant shutdowns elsewhere, Wall Street Journal. Available from: https://www.wsj.com/articles/warren-buffett-backed-chinese-car-maker-byd-zooms-past-rivals-11658754000

Cheng S (2022b) Warren Buffett's Berkshire Hathaway Trims Stake in Chinese Auto Maker BYD. Investment firm sells 1.33 million shares for about $46 million, Wall Street Journal. Available from: https://www.wsj.com/articles/warren-buffetts-berkshire-hathaway-trims-stake-in-chinese-auto-maker-byd-11661880958

Chin J, Lin L (2022) The Two Faces of China's Surveillance State. The government's new social contract promises the security and convenience of a perfectly engineered society—to those who don't resist, Wall Street Journal. Available from: https://www.wsj.com/articles/the-two-faces-of-chinas-surveillance-state-11662130940

Christensen CM, Alton R, Rising C, et al. (2011) The big idea: The new M&A Playbook. Harvard Business Review, Available from: https://hbr.org/2011/03/the-big-idea-the-new-ma-playbook

Cohen J (2013) Human Nature Sinks HIV Prevention Trial. *Science* 351: 1160. http://www.sciencemag.org/news/2013/03/human-nature-sinks-hiv-prevention-trial

Cohler AM, Miller BC, Stone HS (Tr.) (1989/1748) *Montesquieu: The Spirit of the Laws*. Cambridge Texts in the History of Political Thought. Cambridge: Cambridge UP. ISBN 0-521-36974-6 ISBN 978-0-521-36974-9

Cole KC (2015) Wormholes Untangle a Black Hole Paradox. A bold new idea aims to link two famously discordant descriptions of nature. In doing so, it may also reveal how space-time owes its existence to the spooky connections of quantum information, Quanta. Available from https://www.quantamagazine.org/wormhole-entanglement-and-the-firewall-paradox-20150424/

Coles I (2022) Russia Hunts Saboteurs in Crimea After Blasts. Ukrainian officials say missile attacks hit Odessa and Mykolaiv, in the south of the country, Wall Street Journal. Available from: https://www.wsj.com/articles/russia-strikes-ukrainian-ports-after-crimea-blasts-11660734371

Collison P, Cowen T (2019) We Need a New Science of Progress. Humanity needs to get better at knowing how to get better. Available from: https://www.theatlantic.com/science/archive/2019/07/we-need-new-science-progress/594946/

Conant RC (1976) Laws of information which govern systems. *IEEE Trans Syst Man Cyb* 6: 240-255. https://doi.org/10.1109/TSMC.1976.5408775

Cooke NJ, Hilton ML (Eds.) (2015) Enhancing the Effectiveness of Team Science. Authors: Committee on the Science of Team Science; Board on Behavioral, Cognitive, and Sensory Sciences; Division of Behavioral and Social Sciences and Education; National Research Council. Washington (DC): National Academies Press.

Cooke NJ, Lawless WF (2021) *Effective Human-Artificial Intelligence Teaming*, In Lawless, WF, Mittu, R, Sofge DA, Shortell T, McDermott, TA, Engineering Science and Artificial Intelligence, Springer.

Cummings J (2015) Team Science Successes and Challenges. National Science Foundation Sponsored Workshop on Fundamentals of Team Science and the Science of Team Science (June 2), Bethesda MD. Available from: https://www.ohsu.edu/xd/education/schools/school-of-medicine/departments/clinical-departments/radiation-medicine/upload/12-_cummings_talk.pdf

Dash E (2022) Big Retail Chains Sue Visa, Saying Its Fees Are a Form of Price Fixing, New York Times. Available from: https://www.nytimes.com/2005/07/16/business/7-big-retail-chains-sue-visa-saying-its-fees-are-a-form-of-price.html

Davenport TH, Miller SM (2022) Working with AI: Real Stories of Human-Machine Collaboration (Management on the Cutting Edge). The MIT Press.

Davies P (2021) Does new physics lurk inside living matter? Physics Today 73: 34-41. https://doi.org/10.1063/PT.3.4546

Dlugy Y (2022) Reversal of Fortune. A Ukrainian blitz routs Russian troops from northeast and reshapes the war, New York Times. Available from: https://www.nytimes.com/2022/09/12/briefing/russia-ukraine-war-kharkiv-counteroffensive.html

DoD (2021) Pentagon Press Secretary John F. Kirby and Air Force Lt. Gen. Sami D. Said Hold a Press Briefing. Available from: https://www.defense.gov/News/Transcripts/Transcript/Article/2832634/pentagon-press-secretary-john-f-kirby-and-air-force-lt-gen-sami-d-said-hold-a-p/

Duguid K, Samson A, Smith C (2022) 'Volatility vortex' slams into $24tn US government bond market. Key measure of turbulence in Treasuries reaches highest level since 2020 coronavirus crisis, Financial Times. Available from: https://www.ft.com/content/ea41ce6d-e8b2-465e-8dff-8b7fa71dc7b4.

Eaglesham J (2022) EY Leaders Green Light Split Plan. Breakup of auditing and consulting businesses will generate windfalls for partners if successful, Wall Street Journal. Available from: https://www.wsj.com/articles/ey-to-announce-breakup-plan-for-audit-and-advisory-businesses-11662639241

Endsley MR, et al. (2021) Human-AI Teaming: State-of-the-Art and Research Needs. The National Academies of Sciences-Engineering-Medicine. Washington, DC: National Academies Press. Available from: https://www.nap.edu/catalog/26355/human-ai-teaming-state-of-the-art-and-research-needs

Evans M, Herrera S (2022) Amazon Faces Fierce Competition in Health Ambitions After One Medical Deal. Tech giant's acquisition of primary-care clinics is unlike previous expansions into groceries, entertainment and advertising, Wall Street Journal. Available from:

https://www.wsj.com/articles/amazon-faces-fierce-competition-in-health-ambitions-after-one-medical-deal-11658482202

FBI (2022) Cyber Criminals Increasingly Exploit Vulnerabilities in Decentralized Finance Platforms to Obtain Cryptocurrency, Causing Investors to Lose Money, Alert Number I-082922-PSA. Available from: https://www.ic3.gov/Media/Y2022/PSA220829?campaign_id=4&emc=edit_dk_20220831&instance_id=70696&nl=dealbook&regi_id=73891308&segment_id=102829&te=1&user_id=40d18 0f362e4da095b59668641b92e3f

Fidler S, Marson J, Grove T (2022) How Ukrainian Strategy Is Running Circles Around Russia's Lumbering Military. Classic military operations and nimble battlefield decision-making are exploiting the incompetence and top-down command of Russian forces, Wall Street Journal. Available from: https://www.wsj.com/articles/how-ukraines-strategy-is-running-circles-around-russias-lumbering-military-11665584517

Finley A (2022a) Amazon Discovers That Even Paranoids Have Competitors. Its bids for iRobot and One Medical aren't an attempt to take over the world but to keep up with Walmart, Wall Street Journal. Available from: https://www.wsj.com/articles/amazon-discovers-that-even-paranoids-have-competitors-irobot-one-medical-acquisition-walmart-competition-ftc-lina-khan-monopoly-profit-11662901970

Finley A (2022b) When Electric Vehicles Sound Too Good to Be True. The Trevor Milton trial offers a lesson about getting into vehicles with socially responsible investors, Wall Street Journal. Available from: https://www.wsj.com/articles/when-electric-vehicles-sound-too-good-to-be-true-nikola-trevor-milton-fraud-trial-indictment-spac-vectoiq-blackrock-theranos-11663534517

Friedman RM (2022) The 100th Anniversary of Einstein's Nobel Prize: Facts and Fiction. *Annalen der Physik* 2200305. https://doi.org/10.1002/andp.202200305

Friedman G (2022) What Is Russia Thinking? Geopolitical Futures. Available from: https://geopoliticalfutures.com/what-is-russia-thinking/

Gaddis JL (2011) *George F. Kennan: An American Life*. New York: Penguin Books.

Garcia L (2022) Apollo Global to Sell Tower Operator Parallel to Palistar-Backed Company. Digital-infrastructure investor Palistar plans to spend more than $1 billion to expand the combined business, Wall Street Journal. Available from: https://www.wsj.com/articles/apollo-global-to-sell-tower-operator-parallel-to-palistar-backed-company-11661855405

Ginsburg RB (2011) American Electric Power Co., Inc., et al. v. Connecticut et al., 10-174. http://www.supremecourt.gov/opinions/10pdf/10-174.pdf

Gopnik A (2022) What AI Still Doesn't Know How to Do. Artificial intelligence programs that learn to write and speak can sound almost human—but they can't think creatively like a small child can, Wall Street Journal. Available from https://www.wsj.com/articles/what-ai-still-doesnt-know-/how-to-do-11657891316

Granovetter MS (1973) The strength of weak ties, *Am J Soc* 78: 1360–1380. https://doi.org/10.1086/225469

Haass R (2022) The Dangerous Decade. A Foreign Policy for a World in Crisis, Foreign Affairs. Available from: https://www.foreignaffairs.com/united-states/dangerous-decade-foreign-policy-world-crisis-richard-haass

Harris M (2021) Phantom Warships Are Courting Chaos in Conflict Zones WIRED. Available from: https://www.wired.com/story/fake-warships-ais-signals-russia-crimea/

Hart C (2022) Amazon Buying Roomba Maker iRobot for $1.7 Billion. Deal for robot vacuum adds to Amazon's connected-home portfolio, Wall Street Journal. Available from: https://www.wsj.com/articles/amazon-buying-roomba-maker-irobot-for-1-7-billion-11659702187

Hayek F (1944) The road to serfdom, Chicago: University of Chicago Press.

Hipwell D, Henning E (2022) Adidas Seeks New CEO Following Rorsted's Surprise Departure. Board agreed with Rorsted to help with transition to new boss. Rorsted engineered Reebok sale, issued recent profit warning, Bloomberg. Available from: https://www.bloomberg.com/news/articles/2022-08-22/adidas-ceo-to-step-down-in-2023-replacement-search-under-way

Hoyle B (2022) Coal Miner Peabody Energy in Deal Talks With Australian Rival Coronado. Coal prices have surged to record highs following Russia's invasion of Ukraine, restoring producers' finances, Wall Street Journal. Available from: https://www.wsj.com/articles/coal-miner-peabody-energy-in-deal-talks-with-australian-rival-coronado-11665561020

Hua S (2021) China's Treatment of Uyghurs Amounts to Genocide, U.K.-Based Panel Finds. Beijing pursues a "deliberate, systematic and concerted policy" to reduce the population of Uyghurs and other ethnic minorities, says panel of lawyers, academics and activists, Wall Street Journal. Available from: https://www.wsj.com/articles/chinas-treatment-of-uyghurs-amounts-to-genocide-u-k-based-panel-finds-11639068852

Huang R (2022) Tencent Weighs Stake Sale in Chinese Delivery Company Meituan. Social-media behemoth considers cutting investments in tech companies as Beijing curbs influence of China's tech giants, Wall Street Journal. Available from: https://www.wsj.com/articles/tencent-weighs-stake-sale-in-chinese-delivery-giant-meituan-11660649913

Hume D (1975) A Treatise of Human Nature, edited by L. A. Selby-Bigge, 2nd ed. revised by PH. Nidditch, Oxford: Clarendon Press.

Jones EE (1998) Major developments in five decades of social psychology, In Gilbert, DT, Fiske, ST, Lindzey, G, The Handbook of Social Psychology 3-57. Boston: McGraw-Hill.

Jussim L (1993) Accuracy in Interpersonal Expectations: A Reflection-Construction Analysis of Current and Classic Research, J Pers 61: 637-668. https://doi.org/10.1111/j.1467-6494.1993.tb00785.x

Kahneman D (2002) Maps of bounded rationality: A perspective on intuitive judgment and choice, Prize Lecture. Available from: http://www.nobelprize.org/nobel_prizes/economic-sciences/laureates/2002/kahnemann-lecture.pdf

Kang J (2022) Kroger to Buy Albertsons in $24.6 Billion Deal That Would Create New Grocery Giant. The combination, which faces likely regulatory scrutiny, would give the grocers greater scale, Wall Street Journal. Available from: https://www.wsj.com/articles/kroger-to-merge-with-albertsons-in-a-24-6-billion-deal-11665745735

Kapner S (2022) Bed Bath & Beyond Followed a Winning Playbook—and Lost. The retailer's emphasis on creating private-label items before modernizing its technology meant it was caught flat-footed when the pandemic struck. 'Where is Mikasa? Wall Street Journal. Available from: https://www.wsj.com/articles/bed-bath-beyond-ceo-private-label-brands-11658547084

Karaian J, Majerol V (2022) Why Are C.E.O.s Suddenly Obsessed With 'Elasticity?' The economic concept, which describes consumers' sensitivity to prices, is a hot topic as inflation soars and executives fret about profits, New York Times. Available from: https://www.nytimes.com/2022/08/19/business/elasticity-prices-inflation.html?

Kennan GF (Note: the author was previously known as "X") (1947), The Sources of Soviet Conduct, *Foreign Affairs*. Available from: https://www.foreignaffairs.com/articles/russian-federation/1947-07-01/sources-soviet-conduct

Kenny DA, Kashy DA, Bolger N (1998) Data analyses in social psychology. *Handbook of Social Psychology*. DT Gilbert, Fiske ST, Lindzey G, Boston MA, McGraw-Hill. 4th Ed., Vol. 1: pp. 233-65.

Kirby WC (2022) Empires of Ideas: Creating the Modern University from Germany to America to China. Belknap Press.

Klein PG (2021) The State of Modern Economics, The Austrian 7, no. 2 (March/April 2021): 4–15. Or, cite: Deist, J. Klein, P. The State of Modern Economics. Interview. Von Mises Institute. Available from: https://mises.org/library/state-modern-economics

Klein E (2022) We know shockingly little about what makes humanity prosper, New York Times. Available from: https://www.nytimes.com/2022/09/27/opinion/ezra-klein-podcast-patrick-collison.html

Kolata G (2022) A Devious Cellular Trick Cancers Can Use to Escape Your Immune System. A researcher discovered that giant cells under a microscope were actually cancer cells hiding inside other cancer cells, New York Times. Available from: https://www.nytimes.com/2022/09/29/health/cancer-hiding-cells.html

Lapiedra O, Schoener TW, Leal M, et al. (2018) Predator-driven natural selection on risk-taking behavior in anole lizards. *Science* 360: 1017-1020. doi: 10.1126/science.aap9289

Lawless WF, Akiyoshi M, Angjellari-Dajcic F, et al. (2014) Public consent for the geologic disposal of highly radioactive wastes and spent nuclear fuel. *Int J Environ Stud* 71: 41-62. https://doi.org/10.1080/00207233.2014.881165

Lawless WF (2017a) The entangled nature of interdependence. Bistability, irreproducibility and uncertainty. *J Math Psychol* 78: 51-64. https://doi.org/10.1016/j.jmp.2016.11.001

Lawless WF (2017b) The physics of teams: Interdependence, measurable entropy and computational emotion. *Front phys* 5:30. https://doi.org/10.3389/fphy.2017.00030

Lawless WF (2019) The Interdependence of Autonomous Human-Machine Teams: The Entropy of Teams, But Not Individuals, Advances Science. *Entropy* 21: 1195. https://doi.org/10.3390/e21121195

Lawless WF (2020) Quantum-Like Interdependence Theory Advances Autonomous Human–Machine Teams (A-HMTs). *Entropy* 22: 1227. https://doi.org/10.3390/e22111227

Lawless WF (2022a) Risk Determination versus Risk Perception: A New Model of Reality for Human–Machine Autonomy. *Informatics* 9: 30. https://doi.org/10.3390/informatics9020030

Lawless WF (2022b) Toward a physics of interdependence for autonomous human-machine systems: The case of the Uber fatal accident. *Front Phys* 2022: 546 https://doi.org/10.3389/fphy.2022.879171

Lawless WF (2022c) Interdependent Autonomous Human-Machine Systems: The Complementarity of Fitness, Vulnerability & Evolution. *Entropy* 24: 1308. https://doi.org/10.3390/e24091308

Lawless WF, Mittu R, Sofge DA, et al. (2019) Editorial, Artificial intelligence (AI), autonomy and human-machine teams: Interdependence, context and explainable AI, *AI Magazine* 40: 5-13. https://doi.org/10.1609/aimag.v40i3.2866.

Leach CW (2021) Editorial, Interpersonal Relations and Group Processes. *J Pers Soc Psychol* http://dx.doi.org/10.1037/pspi0000226

Leffler Melvyn P (2007) For the Soul of Mankind: The United States, the Soviet Union, and the Cold War. New York: Hill and Wang.

Lewin K (1951) Field theory of social science. Selected theoretical papers. Darwin Cartwright (Ed.). New York: Harper & Brothers.

Lieber D (2022) Israeli Cyber Firm NSO Replaces CEO, Plans Layoffs. The maker of powerful spyware called Pegasus will focus its business on NATO-member countries, Wall Street Journal. Available from: https://www.wsj.com/articles/israeli-cyber-firm-nso-replaces-ceo-plans-layoffs-11661104478

Lombardo C, Cooper L, Terlep S (2022) CVS Plans to Bid for Signify Health. Deal would help CVS fulfill its ambition to become even bigger provider of medical services, Wall Street Journal. Available from: https://www.wsj.com/articles/cvs-plans-to-bid-for-signify-health-sources-say-11659890029

Lombardo C, Terlep S, Kapner S (2022) Inside Bed Bath & Beyond, Concerns Over Mounting Stress for CFO. The retailer's leaders thought finance chief Gustavo Arnal was overwhelmed; Arnal had discussed taking a break before he died, Wall Street Journal. Available from: https://www.wsj.com/articles/inside-bed-bath-beyond-concerns-over-mounting-stress-for-cfo-11662589539

Lombardo C, Cimilluca D, Tilley A (2022) Adobe to Buy Collaboration-Software Company Figma for About $20 Billion. The technology giant also reported quarterly net income of $1.14 billion, Wall Street Journal. Available from: https://www.wsj.com/articles/adobe-to-buy-figma-for-about-20-billion-sources-say-11663241962

Lu C (2022) Putin's Energy War Is Crushing Europe. The big question is whether it ends up undermining support for Ukraine, Foreign Policy. Available from: https://foreignpolicy.com/2022/09/20/europe-energy-crisis-economy-emergency-russia-war-ukraine/

Lukpat A, Rizzo L, Toonkel J (2022) Axios's $525 Million Sale to Cox Marks Merger of New and Old Media. Deal brings together a digital news site with a legacy media company amid a flurry of publishing mergers, Wall Street Journal. Available from: from https://www.wsj.com/articles/axios-to-be-acquired-by-cox-enterprises-for-525-million-11659969645

Lyall J (2020) Divided Armies: Inequality and Battlefield Performance in Modern War. Princeton University Press.

Mann RP (2018) Collective decision making by rational individuals, PNAS, 115: E10387-E10396; from: https://doi.org/10.1073/pnas.1811964115

Maremont M (2022) Slice of Profits From North Carolina Casino Goes to Relatives of Politicians. Slot-machine firm gave small holdings to politically connected people during effort to develop tribal gambling project, Wall Street Journal. Available from: https://www.wsj.com/articles/slice-of-profits-from-north-carolina-casino-goes-to-relatives-of-politicians-11659268801

Marson J, Simmons AM, Luxmoore M (2022) Explosions Hit Russian Ammunition Depot in Crimea. Blasts prompt evacuations and come a week after explosions at an air base on the peninsula, Wall Street Journal. Available from: https://www.wsj.com/articles/explosions-hit-russian-ammunition-depot-in-crimea-11660635257

McLeod SA, (2008) *Social roles*. Simply Psychology. www.simplypsychology.org/social-roles.html

Miller C (2022) Why Russia Lacks 'Smart' Weapons. Precision-guided munitions require sophisticated microchips, and Russia has long depended on copying or smuggling them from the West rather than developing them on its own, Wall Street Journal. Available from: https://www.wsj.com/articles/why-russia-lacks-smart-weapons-11664461225

Morris WE, Brown CR (2022) "David Hume", *The Stanford Encyclopedia of Philosophy*, Edward N. Zalta (ed.). Available from: https://plato.stanford.edu/archives/sum2022/entries/hume

Murphy D (2022) Sorting Through the Noise: The Evolving Nature of the Fog of War, Strategy Bridge. Available from: https://thestrategybridge.org/the-bridge/2022/9/10/sorting-through-the-noise-the-evolving-nature-of-the-fog-of-war

Nosek B, corresponding author from OCS (2015) Open Collaboration of Science: Estimating the reproducibility of psychological science. *Science* 349: 943; supplementary: 4716-1 to 4716-9. National Academies of Sciences, Engineering, and Medicine. Reproducibility and Replicability in Science. Washington, DC: The National Academies Press. https://doi.org/10.17226/25303

Rajkumar K, Saint-Jacques G, Bojinov I, et al. (2022) A causal test of the strength of weak ties. *Science* 377: 1304-1310. https://doi.org/10.1126/science.abl4476

Ramzy A (2022) For Uyghurs, U.N. Report on China's Abuses Is Long-Awaited Vindication. The report's assessment that China's crackdown in Xinjiang could amount to "crimes against humanity" gives new momentum to a campaign to pressure Beijing, New York Times. Available from: https://www.nytimes.com/2022/09/01/world/asia/china-xinjiang-uyghurs.html

Robertson J, Bennett D (2022) A Chinese Spy Wanted GE's Secrets, But the US Got China's Instead. How the arrest of a burned-out intelligence officer exposed an economic-espionage machine, Bloomberg. Available from: https://www.bloomberg.com/news/features/2022-09-15/china-wanted-ge-s-secrets-but-then-their-spy-got-caught

Robertson MP, Lavee J (2022) Execution by organ procurement: Breaching the dead donor rule in China. *Am J Transplant*. https://doi.org/10.1111/ajt.16969

Rockoff JD (2022) Pfizer Agrees to $5.4 Billion Deal for Global Blood Therapeutics. New York drugmaker to pay $68.50 a share for GBT, which sells a drug for sickle-cell disease and has two more in development, Wall Street Journal. Available from: https://www.wsj.com/articles/pfizer-reaches-5-4-billion-deal-for-global-blood-therapeutics-11659954601

Roland D (2022) GSK Spins Off $36 Billion Consumer-Healthcare Business Haleon. Pharmaceutical giant sheds toothpaste-to-painkillers arm to sharpen focus on drugs and vaccines, Wall Street Journal. Available from: https://www.wsj.com/articles/gsk-spins-off-36-billion-consumer-healthcare-business-haleon-11658135866

Roethlisberger F, Dickson W (1939) Management and the worker. Cambridge: Cambridge University Press.

Rudd JB (2021) Why do we think that inflation expectations matter for inflation?(And should we?). *Rev Keynesian Econ* 10: 25-45. https://doi.org/10.4337/roke.2022.01.02

Schölkopf B, Locatello F, Bauer S, et al. (2021) Towards Causal Representation Learning. Available from: https://arxiv.org/pdf/2102.11107.pdf

Schrödinger E (1935) Discussion of Probability Relations Between Separated Systems, *Proceedings of the Cambridge Philosophical Society* 31: 555–563; 32: 446–451.

Shannon CE (1948) A Mathematical Theory of Communication. *Syst Tech J* 27: 379–423. 10.1002/j.1538-7305.1948.tb01338.x

Sliwa J (2021) Toward collective animal neuroscience. *Science* 374: 397-398. https://doi.org/10.1126/science.abm3060

Sider A (2022) JetBlue Agrees to Buy Spirit Airlines for $3.8 Billion. Deal would create fifth-largest U.S. carrier after JetBlue wrests discount airline from Frontier, Wall Street Journal. Available from: https://www.wsj.com/articles/jetblue-agrees-to-buy-spirit-for-3-8-billion-11659005196

Smith A (1977) An Inquiry into the Nature and Causes of the Wealth of Nations. University of Chicago Press.

Sofge DA, Lawless WF, Mittu R (2019) AI Bookie Bet: Autonomous AI takes responsibility: Threat, savior or both? *AI Magazine* 40: 79-84.

Sorkin AR, Giant V, Gandel S, et al. (2022) The Legal Onslaught Facing Credit Card Companies. Visa faces questions about whether it enabled a porn site to profit from images of child sexual abuse, and both Mastercard and Visa face a new antitrust suit from Disney, New York Times. Available from: https://www.nytimes.com/2022/08/01/business/dealbook/pornhub-visa-mastercard-disney.html

Sorkin AR, de la Merced MJ (2022) Starbucks Names a New Chief Executive. Laxman Narasimhan, who will take over for Howard Schultz in April, will lead the company at a time of a growing unionization movement and rising costs, New York Times. Available from: https://www.nytimes.com/2022/09/01/business/dealbook/starbucks-ceo.html

Steinberg J, Ensign RL, Patrick M (2022) Credit Suisse CEO Thomas Gottstein Set to Depart. Executive has headed the Swiss bank since the start of the pandemic, presided over series of costly mishaps, Wall Street Journal. Available from: https://www.wsj.com/articles/credit-suisse-ceo-thomas-gottstein-set-to-depart-11658858441

Stiff P (2022) Grubhub Parent Takes $3 Billion Write-Down on Food-Ordering Service. Just Eat says it continues to explore the sale of the U.S. business, Wall Street Journal. Available from: https://www.wsj.com/articles/grubhub-parent-takes-3-billion-write-down-on-food-ordering-service-11659532196

Strobel WP (2022) War Game Finds U.S., Taiwan Can Defend Against a Chinese Invasion. All sides would pay a heavy price if ever there were a military conflict over the island, World Street Journal. Available from: https://www.wsj.com/articles/war-game-finds-u-s-taiwan-can-defend-against-a-chinese-invasion-11660047804

Talty J (2022) The Leadership Secrets of Nick Saban. How Alabama's Coach Became the Greatest Ever. New York: Matt Holt, publisher/Penguin Random House.

Terlep S (2022a) Peloton's Quarterly Loss Tops $1.2 Billion as Bike, Treadmill Sales Plunge. Maker of connected fitness equipment says efforts to cut costs and to restructure business around subscriptions are starting to take shape, Wall Street Journal. Available from: https://www.wsj.com/articles/peloton-pton-q4-earnings-report-2022-11661390875

Terlep S (2022b) Peloton Chairman John Foley to Exit in Management Shake-Up. Fitness-equipment maker says legal chief Hisao Kushi and commercial chief Kevin Cornils are also leaving, Wall Street Journal. Available from: https://www.wsj.com/articles/peloton-chairman-john-foley-to-exit-in-management-shake-up-11663014900

Tilley A (2022) Microsoft Asks Google, Oracle to Help Crimp Amazon's U.S. Government Cloud Leadership. Software companies trying to get the U.S. to share its cloud-spending more widely by embracing multicloud approach, Wall Street Journal. Available from: https://www.wsj.com/articles/microsoft-asks-google-oracle-to-help-crimp-amazons-u-s-government-cloud-leadership-11658926801

Troianovski A (2022) With War in Ukraine, Putin Tries to Unravel Gorbachev's Legacy. President Vladimir V. Putin calls the end of the Soviet Union a "genuine tragedy" for Russia, and he blamed Mikhail S. Gorbachev for bending to the demands of a treacherous and duplicitous West, New York Times. Available from: https://www.nytimes.com/2022/08/31/world/europe/gorbachev-putin-russia.html

U.S. Supreme Court (1970) California v. Green, 399 U.S. 149 (1970), California v. Green, No. 387, Argued April 20, 1970, Decided June 23, 1970, 399 U.S. 149.

Van Lange PAM, Ballet D (2015) Interdependence theory, APA Handbook of Personality and Social Psychology: Vol. 3. Interpersonal Relations, M. Mikulincer and P. R. Shaver (Editors-in-Chief).

Von Neumann J, Morgenstern O (1953) Theory of games and economic behavior, Princeton: Princeton University Press.

Vranica S, Gryta T (2022) GE's Latest Invention? 'Vernova,' the New Name for Its Power Business. Conglomerate unveils new brand for power business as it prepares for breakup, Wall Street Journal. Available from: https://www.wsj.com/articles/general-electric-invention-vernova-new-name-power-business-11658097853

Wang CJ (2022) China's Semiconductor Breakthrough. SMIC's 7nm process advancement – despite heavy U.S. sanctions – will have major implications for East Asia, The Diplomat. Available from: https://thediplomat.com/2022/08/chinas-semiconductor-breakthrough/

Weise K (2022) Amazon says it will shut down Amazon Care, its primary and urgent health care business. Last month, the company said it planned to acquire One Medical, a much larger competitor to its own health care business, New York Times. Available from: https://www.nytimes.com/2022/08/24/business/amazon-care.html

Wong CH (2022) China's Xi Promotes Team of Allies to Influential Posts, Fortifying His Power. Chinese leader puts people in position to run law enforcement, propaganda as he gets ready to claim third term, Wall Street Journal. Available from: https://www.wsj.com/articles/chinas-xi-promotes-team-of-allies-to-influential-posts-fortifying-his-power-11659100754

Wong CH, Areddy JT (2022) U.N. Report Says China May Have Committed Crimes Against Humanity in Xinjiang. China lobbied heavily against the report, released in the final minutes of Michelle Bachelet's term as U.N. rights-agency chief, Wall Street Journal. Available from: https://www.wsj.com/articles/u-n-human-rights-agency-issues-report-on-xinjiang-over-chinas-protest-11661986730

WP (2001) White Paper. European governance (COM (2001) 428 final; Brussels, 25.7.2001). Brussels, Commission of the European Community.

Zhang H (2022) China's True Elite. Connection to the Communist Party is more important to success in China than test scores, Law&Liberty. Available from: https://lawliberty.org/book-review/chinas-true-elite

AIMS Press