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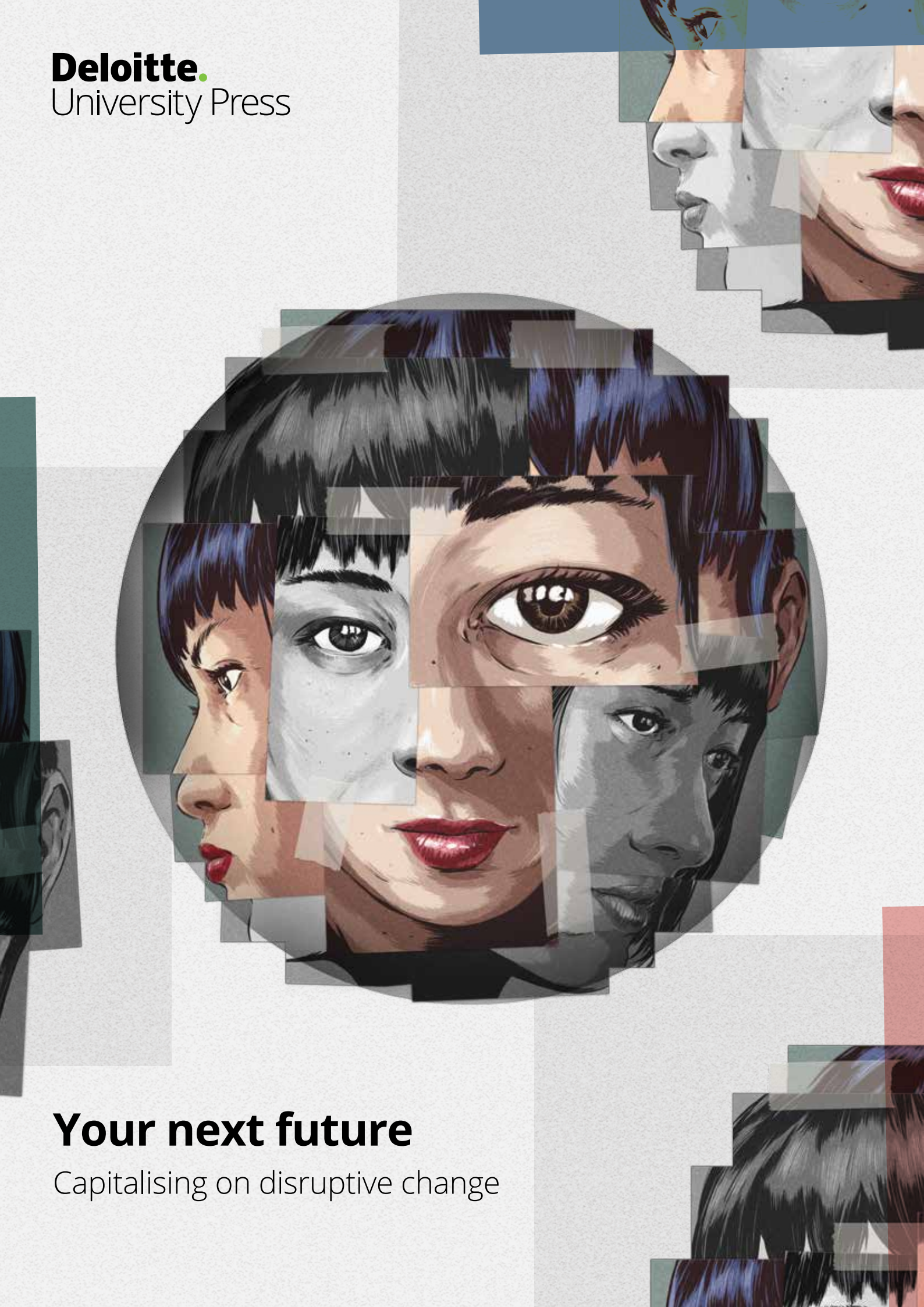

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Foreword

Disruption is not a new phenomenon. It is, more explicitly, the accelerating frequency of disruption that poses a new challenge for organisations.

By its nature, disruption doesn't leave a clear path to follow for our next encounter with it—we can't see it coming. Its unpredictable temperament and the pace at which it arrives often leave organisational leaders devoid of control, let alone equipped to make strategic decisions. This means organisational strategy needs to be at the ready in a new kind of way, so we are all are prepared take advantage when opportunities knock, as disruption plays out in real time.

To understand disruption, it is important to begin by understanding our own bias in seeing it. What we cannot see, we cannot respond to. Finding and understanding disruption is a core approach to defining an organisation's strategic choices and demonstrating how capturing these opportunities enhances shareholder value. And because organisational strategy development is an inherently people-driven process, it is subject to bias and misinterpretation.

Recognising the forces that drive disruptive change, including where, when and how it might happen, combined with what forces drive industry change and organisational transformation, goes hand in hand with this new way of thinking. To make the most of opportunities, organisational leaders and their teams must know how to transform at speed and make the right strategic choices along the journey.

Of particular interest in this paper is how organisations can derive exponential value when an inflection point is reached. An organisation can deliver extraordinary value from finding and exploiting this nonlinear change and evolution in the market—for example, Uber and bitcoin. Technology plays an important role in identifying these unique opportunities. However, the inflection point is often only reached when other factors combine to bring this to fruition—for example, the cost base of the technology, the application of this technology to new markets, regulatory change and consumer behaviour changes.

We hope this paper gives pause to dialogue and debate about the nature and behaviour of disruptive change and how it can play an important role in making better strategic choices—after all, this is at the very heart of delivering increased shareholder value.

Giselle Hodgson
Partner, Monitor Deloitte

Defining disruption

Disruption is a difficult concept to pin down. There are a broad range of phenomena that can all be considered *disruptive* in some sense. This creates tension between our desire for a comprehensive definition, one encompassing this broad scope, and the need for a precise definition, so that we are all clear on what we're talking about. This tension between comprehensive and precise is what has caused problems in previous work defining disruption, such as Clayton Christensen's work on disruptive innovation.[1] The problem is that disruptive innovation uses a narrow definition of disruption—disruption is *this* product adoption process—one aligned with the findings in Professor Christensen's work. While this definition is precise, and provides useful learning, it is not comprehensive, and there are disruptive phenomena that it doesn't cover.

Disruption can be viewed at various levels of abstraction. At the highest level are the long-term shifts—such as the shift from *stocks* to *flows* and the consequent shift from *push* to *pull* highlighted by The Centre for the Edge[3]—which are reshaping the nature of the economy. These disruptions are more endemic as they operate on the whole economy, rather than sectors or industries. The shift from knowledge stocks to flows, which we might pithily describe as "why remember what you can google?" is a prime example, with one consequence that the balance of power has tipped from merchant to consumer. In the past, merchants had the upper hand as they had all the information on product availability and pricing, while customers knew little. Now, with the consumer Internet, modern smartphones and so on, the consumer has the upper hand and often knows more than the merchant. The immediate effect of this disruption is the elimination of the mid-market as customers search the globe for the cheapest or the best (at the best price) rather than compromising based on what they can find from local merchants.

More recently, the Centre for the Edge has been investigating the space between the economy-wide disruptions of the Big Shift and that narrower definition of disruptive innovation with its *patterns of disruption* series.[4] This work develops a definition of disruption based on markets—parts of an economy, as opposed to the whole-of-economy impacts described by the Big Shift—where disruption is considered to occur when most of the leading incumbents are displaced by a new approach that is challenging to replicate. This disruption can act in multiple ways, captured as a set of nine patterns. Each pattern represents an approach—a strategy if you will—that, given the right conditions, can disrupt a market. While not universal forces, these patterns are likely to occur in more than one market, but not all markets. Patterns of disruption provide us with a model of disruption that reaches from the big shifts reshaping economies down through the patterns of disruption reshaping markets, to disruptive innovation. This model is expansive, but it is not yet comprehensive. A key challenge for a market-based approach to defining disruption is in how they define "market." One of the consequences of the Big Shift is that the boundaries between markets are blurring and moving around, making it difficult to identify well-formed and stable markets. While there are a few drivers behind this trend, a key one is a shift from markets, where value is defined by merchants in terms of product feature-function, to communities, where value is defined by consumers and is multidimensional, stemming from a shared narrative. Value used to be objective, based on the merchant and their offering. Value is now subjective, defined relative to the merchant's relationship to the customer and the community they are part of, and based on the customer's and community's relative preferences, built around a shared narrative.

What is disruption?

First, we should be clear on what disruption is, and what it isn't. We might say that disruption is a disturbance that we did not anticipate. Current strategy methodologies are very good at scanning the environment for anticipated opportunities and problems, but can't account for the unknown unknowns.

These unknown unknowns fall into two groups:

- Black swans: Low-probability, high-impact events that can dramatically alter the course of history
- The tyranny of incrementalism: Gradual shifts slowly transforming business in ways not yet fully understood.

Indeed, the purpose of the Shift Index[2], published by the Centre for the Edge, is to quantify and make visible these long-term incremental shifts.

It is not possible to develop a single definition for disruption that is both comprehensive and precise.

It was this observation—that value is now more subjective—that prompted the authors to look at the problem with a wider lens. Disruption has typically been considered to act on a market (or "the market," the whole economy), with incumbents getting displaced when a new entrant finds a way to create superior value, where value is defined in terms of feature-function. It is value in the market that is disrupted while it's a firm's relationship to the market that makes the firm subject to the disruption. Today it might be more productive to say that disruption acts on firms, as value is defined by the customer and it is a firm's relationship to the customer, and the community that they are part of, that makes it subject to disruption. We should also remember that behind both of these modes of disruption sits the Big Shift.

It is not possible to develop a single definition for disruption that is both comprehensive and precise. Instead, we need to develop a set of related definitions, where the definitions focus on understanding disruption at different levels of detail or levels of granularity (as outlined in figure 1). The Big Shift represents disruption at the largest scale, where a disruption affects the whole economy, or at least large swaths of it. Big-shift disruption stems from long-term, incremental trends, interacting in interesting ways, reshaping the economy. This represents forces that we are all struggling with. Patterns of disruption focused on a medium level of scale, where a disruption will affect some parts of the economy—markets—but not others. Patterns of disruption *occur* when most of the leading incumbents are displaced by a new approach that is challenging to replicate. And, finally, sources of disruption, which this report looks into, points to disruption at the finest scale, where disruption acts on a firm. The *source* of disruption is an unanticipated and dramatic change in the value that an organisation provides. This is an inherently subjective definition, as we observe changes in value from a particular organisation's point of view.

Figure 1. How does disruption manifest?
Our definition of disruption depends on how narrowly or broadly disruption's impact will be felt.

Narrow → **Broad**

Sources of disruption	Patterns of disruption	The Big Shift
Will a disruption affect us, our firm in particular?	Is disruption changing the landscape around us?	How does disruption shape the economy as a whole?
Disruption is an unanticipated and dramatic change in the value that an (our) organisation provides.	**Disruption occurs when most of the leading incumbents are displaced by a new approach that is challenging to replicate.**	**Disruption stems from long-term, incremental trends, interacting in interesting ways and reshaping the economy.**
Disruption is specific and concrete: Can we predict it?	Disruption is a pattern of change in the composition of a market or sector: Can we leverage it?	Disruption is a shift in the nature of the economy: How must we evolve?
Examples • Blockchain: enables the creation of a ledger that doesn't require a central authority, resulting in the elimination of some intermediaries. • Uber: arbitrages the gap between the art of the possible and what regulation allows to create superior value for customers.	*Examples* • Price-performance improvement in communication technology shifted the advantage from firms to markets. • AirBnb: created a short-term accomodation market to leverage adjacent assets—spare rooms—to reshape the market.	*Examples* • The shift from knowledge stocks to knowledge flows has moved the balance of power from merchant to consumer. • Value is now defined by consumption—multidimensional and relative—not producer-objective feature-function.

Anticipating a disrupted world

The business environment feels more threatening today than it did in the past. Business leaders increasingly find themselves at the mercy of disruptors that cast doubt on the stability of all firms, industries and economies. Disruption has become a cliché, and the industry built around it is over-reliant on Kodak and Blockbuster case studies. However, it does capture our uncertainty about *disrupting* or *being disrupted*. We point the finger at the speed of technological change, the rapid adoption of new products and compressed product life cycles. Traditional barriers to entry are low and dropping; upfront investments are being replaced by purchases *as a service* and capital for other purchases is easier to find, while social media and cheap shipping are slashing the cost of operating globally. There's also the risk that a firm from outside the industry might turn it upside down, as Apple did for smartphones. When we encounter disruption, our efforts to mitigate damage and maximise opportunity are hampered as we are unable to obtain key skills in time. The natural reaction is to rein in investment and enact policies to reduce risk, batten down the hatches to weather the storm. But is this the right approach?

> "We spend less time than we should on strategy and more time than we should on regulation in our business today versus our business tomorrow."
> — *Directors' Cut: Board effectiveness,* Deloitte[5]

An acronym—VUCA—was coined to describe this business environment as *volatile*, *uncertain*, *complex* and *ambiguous*. Our response is to invest. Invest in slack, stockpile inventory and overbuy talent, to ride out volatility. Invest in restructuring to counter complexity. Invest in analytics to reduce uncertainty. Invest in experiments to separate cause from effect, eliminating ambiguity. The problem is that the threats keeping us awake at night are vague and nonspecific, not well formed and precise. We want to avoid our Kodak moment, but where should we invest?

With hindsight it's easy to see that Kodak should have invested in the digital camera. The firm did, after all, invent the technology. While hindsight is a wonderful thing, foresight is harder to come by. Disruption is problematic; like innovation, it's challenging to anticipate but seems clear in hindsight.

Few potential disruptions become actual disruptions. Futurists can paint possible futures, but we need to understand the probabilities and investment profiles of these scenarios. We need a thesis to guide us, a structured approach to discovering and quantifying these disrupted futures, so that we can create real options[6] to bring possible futures into the present, integrating them into our strategy formation process.

Three insights

Solving this problem hinges on three insights.

First, disruption is *degenerate*.[7] A single outcome, a disruption, might be triggered by a large number of *different* processes.[8] To draw on just one of many possible analogies with biology, the nervous system in a lobster's digestive tract can have 100–200 *thousand* different neural states that all produce the same behaviour. Behaviour is encoded in the relationships between the neurons, rather than within neurons. This makes it impossible to deduce the digestive tract's operation by isolating individual neurons and inspecting them. Similarly, it will be impossible to understand disruption by identifying and analysing individual contributors without considering the complex relationships between them.

Second, disruption is *constructive*. We frame disruption too narrowly, focusing largely on technology when technology alone is insufficient to trigger a disruption. We must acknowledge that while technology changes society, society also changes technology. We should also consider the social forces that shape technology's adoption by society as another contributor. Commercial factors also provide an important lens: Not all that is technically possible is commercially feasible.

Third, disruption is *subjective*. A new technology might disrupt our sector or industry, but it may not disrupt us. The reverse is also true. The application

Business leaders increasingly find themselves at the mercy of disruptors that cast doubt on the stability of all firms, industries and economies.

of blockchain technology to trade finance is a good example, as it will streamline processes and improve risk management for many stakeholders through improved transparency and reduced reliance on centrally managed data. Correspondent banks, though, may be disintermediated. Our concern in this report is disruption to *our* business, not markets (via patterns of disruption), the economy (via the Big Shift) or disruption in general.

We need to be clear about what we mean by disruption if we are to anticipate it. Common definitions are insufficient. Many are circular, simply telling us that disruption is disruptive. Defining disruption in terms of *disruptive technologies*[9] doesn't pass the degeneracy test. We might even define disruption as "offer[ing] a fundamentally better alternative (to the present approach) for solving a customer problem, in a cheaper, quicker and more convenient manner with technology playing a key enabling role"[10] but this doesn't pass the subjectivity test. Disruption is only disruptive if it acts on *our* business in some way. Consequentially, we provide the following definition: *Disruption is an unanticipated and dramatic change in the value that an organisation provides.*[11]

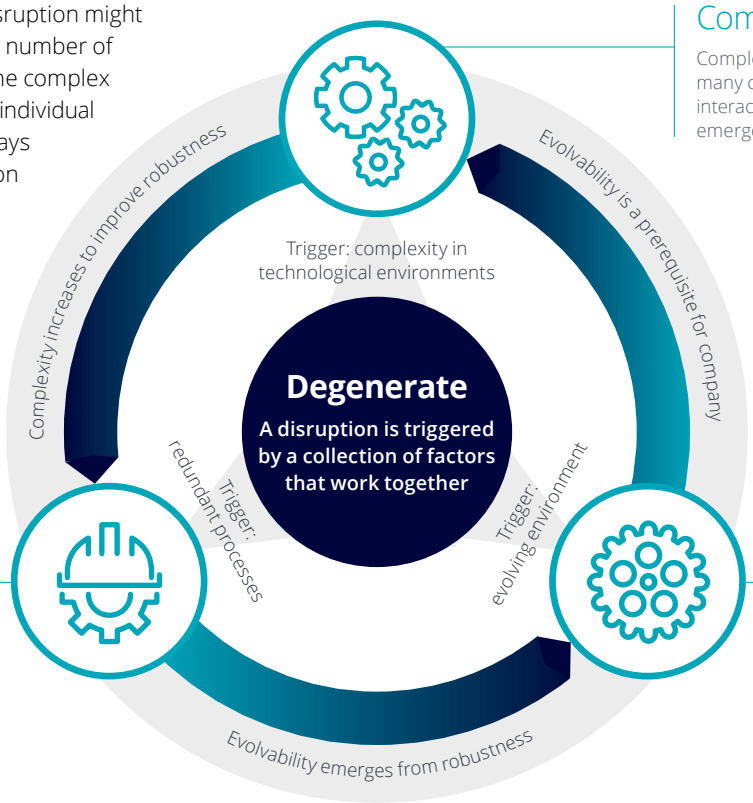
With this we can build a model of disruption that enables us to discover potential threats to our firm by identifying *where* and *how* on our firm a disruption might act, and by providing us with a framework for estimating *when* the threat is realised and disruption occurs.

Disruption is problematic; like innovation, it's challenging to anticipate but seems clear in hindsight.

Figure 2. Three insights into disruption

Disruption is degenerate

A single outcome, a disruption might be triggered by a large number of different processes. The complex relationships between individual contributors must always come into consideration when identifying and analysing contributors for disruptors.



Complex

Complex systems involve many components that interact dynamically to create emergent behaviours.

Robust

Robust systems are redundant, containing duplicate, independent sub-systems that provide identical capabilities.

Evolvable

The incremental accumulation of changes in a competitive environment results in periods of stability, interrupted by brief periods of rapid change.

Derived from: James Whitacre and Axel Bender, "Degeneracy: A design principle for achieving robustness and evolvability," figure 10, *Journal of Theoretical Biology* 263, no. 1 (March 7, 2010).
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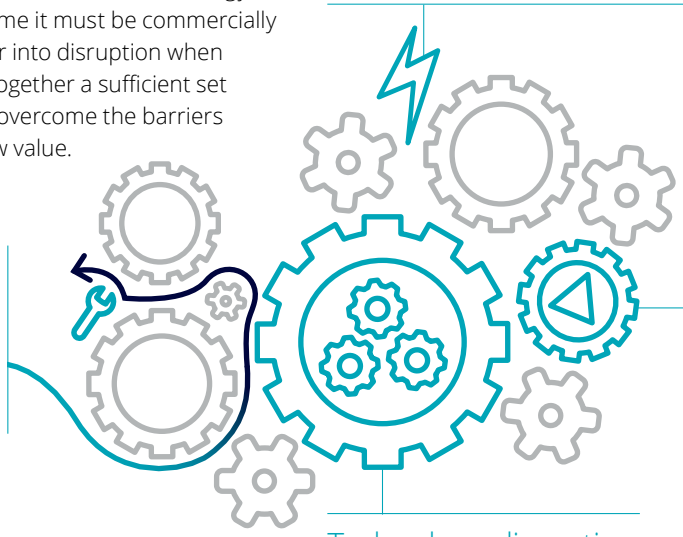
Disruption is constructive

Technology alone is not sufficient in creating a disruption. Social forces will contribute to technology adoption, and at the same time it must be commercially feasible. A disruptor tips over into disruption when an agent for change brings together a sufficient set of enablers, and the drivers overcome the barriers to enable the creation of new value.

Act of God

Disruption is due to an extrinsic and unpredictable force, events unrelated to the creation of new value. Acts of God represent the limit of what is knowable and foreseeable.



Barrier disruption

Disruption is due to inflated barriers, where external forces conspire to hold back the art of the possible until the pent-up value is so great that a non-linear change of value is released.

Driver disruption

Disruption might be triggered by inflated drivers, where another actor takes existing technologies and dramatically increases the perceived value without advancing of the art of the possible.

Technology disruption

Disruption triggered by the accumulation of new technologies enables the advancement of the art of the possible.

Disruption is subjective

A new technology might disrupt the market, but it may not disrupt us. The reverse is also true. Our concern is disruption to our business, not disruptors in general. Consequently we need to consider *how* and *where* the disruptions acts on our organisation if we're to understand how disruption will affect us.

Where disruption affects an organisation

	Artifice	Product	Organisation	Relationship
	The creation of unprecedented products, or new ways of creating existing products	The creation of new products that makes existing products redundant	The creation of new means of production that makes existing means redundant	The reconfiguring of value chains and value networks, redefining or eliminating roles in the process

***How* disruption affects an organisation**

Discontinuous The creation of new capability that did not previously exist, where the change in value is the difference between a world with, and one without, the change.

Capability	Displacement	System	Inversion
The artifice produces a distinctly new capability that can be used to create new products and services. The telegraph divorced the transit of information from the transit of goods, enabling its users to get information relevant to the stock market well before their competitors.	A new product is developed that creates a new type of value, displacing simpler products that are more narrowly defined. The iPhone, which is more a small mobile computer than smartphone, replaced established smartphones.	A new system—a new value network—is developed as a consequence of recognising that a confluence of factors enables us to rethink the foundations of the value chain or network. The modern multimodal container network, for example, was the result of combining containers and digital computers, and developing new special-purpose ships and trucks, eliminating much of the manual handling required and slashing cost on the process.	A confluence of factors results in an inversion, the sense of the relationship between two actors flipping. The emergence of the public Internet and express logistics meant that, for the first time, customers had more information about the products they were considering than the merchant, and could source the product globally.

Inflection Where an established trend unexpectedly changes direction, typically when underlying long-term trends cross each other or pass a threshold, enabling a different approach that creates significantly more value.

Amplification	Substitution	Process	Replacement
The artifice significantly amplifies an existing capability, typically automation of a previously manual task, enabling a dramatic change in the value proposition for existing products. The printing press replaced monks copying books with a wine press and metal type, placing us on the path to modern high-volume printing, and enabling the mass distribution of printed books.	A new product is developed from a few factors, replacing earlier, related products by providing superior value. A good example is that of digital cameras replacing film (chemical) cameras.	A new production process is developed as a consequence of recognising that a confluence of factors enables us to rethink the principles underpinning how we construct and optimise our process. The modern production line, for example, combined specialisation and electric power.	A confluence of factors results in one relationship replacing another. Social media and modern smartphones, for example, enable customers to rely on peer recommendations rather than brands, with the power of brands declining as a consequence.

Disruptions at the left end of the scale have tended to become easier to respond to over time (less disruptive) as the environment has become increasingly entailed, making it harder for technologies to be, in themselves, disruptive.

Disruptions at the right end of the scale were uncommon in the lightly entailed environment of the past, but have become more common in today's rich technological environment, increasingly allowing industries and sectors to be reinvented.

Bringing the future into the present

Consider the building industry—specifically, the construction of mid- to high-rise buildings. Construction has not changed significantly over the last few hundred years and is fundamentally a craft-driven process. A location is identified, the building is designed, funds are raised and then materials are delivered to a team onsite who rivet steel, hammer nails, pour concrete and, more recently, attach flap A to slot A. Modern construction sites might feature nail guns and electric cranes rather than the hammers and hoists of the pharaohs, but the paradigm of incrementally adding value to the site remains. Where might disruption arise in such a stable industry?

Finding problems

A typical approach is to scan the environment to identify "disruptive" technologies, scoring each technology on dimensions such as the *likelihood* that the technology will reach maturity soon and the commercial *impact* when it does. Technologies given a high score attract scarce resources. Low-scoring ones are largely ignored. This approach implicitly assumes that disruption is due to an identifiable *disruptor*, whose impact and significance may be analysed in isolation from other factors.

3D printing, often used as an example of a disruptor in the building industry, enables us to mechanically create curved walls. The wall is designed digitally, a frame erected (the "printer") and workers stand by while the wall is deposited layer by layer. 3D printing promises a number of commercial benefits: reduced materials usage, shorter construction time and lower labour costs, in addition to the ability to easily create curved walls. That certainly seems disruptive.

In this case, we are considering a future where builders are threatened by a new capability, a cheaper and faster way to create walls and a technique that also enables the creation of curved walls. However, 3D printing is merely one way of doing this. If we are to anticipate, hedge against or trigger this threat, then we must consider other technologies that provide a similar capability. Disruption is degenerate. New materials might enable flexible walls that can be shaped onsite. An extrusion process could allow walls to be manufactured off-site, then trucked to the site and lifted into place, avoiding assembly and disassembly of a 3D printer. It's the effect that concerns us, and which we must focus on, not the cause.

Walls are also complex structures. It's not enough for a 3D printer to deposit material layer by layer until the wall is complete. The wall requires services to be run through it: power, water and gas. A surface will likely need to be applied, paint at a minimum, and any doors and windows installed. One technology on its own is rarely enough. Disruption is constructive. Other technology and non-technology factors, such as process change, must be developed and integrated into the solution if it is to disrupt the market.

And finally, we also need to consider that disruption must threaten our business. Disruption is subjective. The capability must be challenging or transformative for *us* to adopt or replicate. Building is a craft-driven process that has been with us as long as civilisation. The pyramids, to choose one example, relied on basic surveying, chisels, boats, wooden hoists, ramps and hordes of indentured citizens, but still adhered to the same process as a modern construction site. Creation of a cheaper and faster technique for building walls is unlikely to disrupt builders as it simply represents yet another technology to be integrated into the construction process.

Finding opportunities

Mapping potential disruptions to determine if they are or could be actual disruptions helps us to decide which of the weak signals that we are bombarded with deserve our attention. Unfortunately, it doesn't enable us to predict how disruption might threaten us. To resolve this we must consider disruption from a subjective point of view, asking: *who*, *what*, *why* and *where*.

If 3D printing—or other production technologies for that matter—is unlikely to threaten the building industry, then what will? Our taxonomy identified four places where technology disruption could act: *artifice*, the creation of unprecedented capabilities that are challenging to replicate; *product*, new solutions that make existing products redundant by providing a different, rather than incrementally better, value proposition to the customer; *organisation*, finding new means of production that make existing means redundant; and *relationships*, the reconfiguration of value chains and value networks, redefining or eliminating a firm's role in the market. We also identified two factors that support or inhibit actions. The first is due to *drivers*, where a competitor creates a gap between the value provided by incumbents and what customers' demand, commonly known as the "innovator's dilemma."[12] The second is due to *barriers*, where a competitor exploits a gap between what external forces, such as regulatory frameworks, allow and what is technically possible.

Returning to our building example, starting at the bottom of our taxonomy: Can we see a gap due to drivers, where the value demanded by (or promised to) the market has pulled away from what incumbents provide; or due to barriers, where regulation is holding back the art of the possible? We might argue that building regulations and demand are somewhat out of kilter with current practice, but it's clear, unlike ridesharing, that the gap has not grown to the point where disruption looms large enough to threaten the industry.

We might also disregard artifice, the discovery of a unique capability. Technologies that enable, for example, 3D printing of walls are interesting, but they don't change the fundamental value proposition of the building industry, delivering the dramatic change in value that disruption demands. Construction is a highly entailed environment—a complex environment dependent on a large number of interdependent technologies and practices—and is unlikely to be shaken by a single new technology. Product can also be set aside, as can relationships. The building product is multifunctional, so the industry should be immune to any rapid change in how consumers (and firms) choose to use them. It doesn't matter to the builder if the buildings they create are used by traditional firms and housing, some funky new blended living-working environment, or a "smart building" full of sensors. Similarly, the role between builder, clients, financers and suppliers is unlikely to change as buildings are constructed to client specifications.

The organisation, though—how builders organise themselves—appears ripe for disruption. What is fundamentally a craft-based industry, unchanged in many lifetimes, could be radically reorganised to deliver much shorter build times at lower cost, while holding quality constant. This isn't as simple as creating a new building *process*, rethinking the principles used to organise existing activities, as Henry Ford did with the production line. It is a question of developing a new building *system*, a new collection of technologies and value networks that radically changes the way we view construction.

We can already see examples of this. Northern European countries have, for some time, used modular approaches to constructing residential housing to fit the time onsite into the short Northern summer. These approaches can be scaled up and industrialised via modern, flexible manufacturing technology. Broad Sustainable Building, a Chinese firm, erected a modular 57-storey skyscraper in 19 days.[13] Unitised Building, based in Melbourne, has a slick LEGO-like system capable of building a modern, high-quality eight-storey residential apartment complex in four weeks.[14] Both of these approaches are digitised, automated and unlike conventional building. Most of the technology platform is there and it is possible for these processes to deliver a comparable end product, so the question must be why *hasn't* this disrupted the market?

Mid- and high-rise buildings use a funding model that isn't compatible with a modular, off-site approach. Trusts are created for proposed buildings, and loans are secured using the future building as collateral. The banks release funds incrementally, first enabling the builders to purchase land, then providing regular payments after progress has been validated via quantity surveying. A modular off-site system requires a different risk model, with some funds released before going onsite, but once onsite construction starts the building progresses so rapidly that the bank's risk management processes struggle to keep up.

Creating options

Now that we're equipped to identify *where* a particular business might be disrupted, we can investigate *what* might cause this disruption, what the change in value might look like and the size of the threat. Only then can we try and answer *when*, by identifying potential barriers, drivers and enablers, using some measure of the completeness of this set to determine how far away the disruption is.

Quantifying the size of the threat (or opportunity) enables us to price the disruption. What would we be willing to invest today to bring the disruption forward, triggering it early, to prepare ourselves so that we can pounce when that threat crystallises, or to attempt to delay the event? The shift from a craft-driven to a flexible manufacturing paradigm in our building example is predicated on the ability to digitally model a building. Digital tools are required to manipulate the model, cut it up and feed it to numerically controlled machines and achieve the manufacturing tolerances required, a technique called *design for manufacture*. Consequently, investment in a *building information model* is a precondition if you are to capitalise on the shift in paradigms, elevating them from a tool to help manage the complexity of the modern building process (similar to how ship builders use models to ensure that pipes don't pass through bulk heads, or across the table in the officers' mess) into a tool for transforming the current craft-based system. Similar investments can be made in experimenting with new commercial and risk models, or developing potential technologies. The building information model also provides a foundation for exploring new approaches to integrate customers into the design process, with technologies such as virtual or augmented reality creating further opportunities for dramatic time and cost reductions.

The value of expectation

Disruption theories often seem lacking since they highlight a significant concern but are not predictive. At a macro level we can gauge the risk and potential impact of disruptions on industries and sectors, as we showed in *Short fuse, big bang*.[15] We can even describe the different ways it progresses through and improves the operation of markets, such as patterns of disruption[16] with which we can identify disruption progressing through a market, or as a playbook for creating our own disruption. Once a disruption dissipates, the industry is more efficient, with larger consumer or producer surpluses.

However, disruption is more problematic for individual firms. The C-suite and the board are concerned with avoiding disruption or understanding how to be a successful disruptor. While disruption creates value in aggregate, the challenge for an individual firm is to ensure that it is one of the creators of that value.

The limits of reductionism

A large part of the problem in trying to integrate unknown unknowns into our methodologies is our reductionist approach. We want every problem to have a cause, so every *disruption* must be explained by a *disrupter*. The narrative fallacy describes "our limited ability to look at sequences of facts without weaving an explanation into them."[17] We break disruption into pieces and seek cause-and-effect relationships between them, which we re-assemble into stories explaining *why* disruption occurred.

Reductionism has served us well. Consider the success of our reductive approach to drug discovery, identifying compounds capable of curing many ills. This approach is reaching its limits though. Massive scientific and technological gains over the last few decades should have increased the quality of biological science and raised industrial R&D efficiency. However, headwinds have pushed inflation-adjusted industrial R&D cost per novel drug up by a factor of 100 from 1950 through 2010, with drugs more likely to fail in clinical development today than in the 1970s.[18] Our quest to find further compounds to treat ailments is now trapped in a spiral of diminishing returns.

Similarly, early disruptions—consider the long bow or telegraph—are due to the combination of a few technologies. More recent disruptions—the Internet and global multimodal container network are good examples—are more complex, more highly entailed.

A modern disruption involves a large number of *contributors*. While these contributors might be *necessary*, few are *sufficient* on their own. In many cases these contributors may even be *optional*, as they are simply one of a number of acceptable options.[19]

Our continued focus on identifying disruptors leads us to focus on the wrong things. Efforts to identify disruptive technologies via environmental scans are fraught with danger. Any such scan will surface many potential disruptors without acknowledging that disruptors tend to act in groups. Nor does it acknowledge that most will be optional, few necessary, and hardly any sufficient. We will also be considering them outside the context of the social (and possibly the commercial) factors that will shape adoption. Without this context all potential disruptors appear equal. Like the team that faced Three Mile Island's partial nuclear meltdown, we'll be confronted by a wall of alarms with no way of telling which ones to focus on, unable to act intelligently.

We need to consider a broad range of *contributors* rather than just *technologies*. It is also clear that contributors come in groups that can, somehow, work together to trigger a disruption. We also need to consider disruption to be a degenerate process in that one outcome, the disruption, might be triggered by a large a number of *different* groups of contributors.

This raises two challenges. The first is to understand how a group of contributors combine and interact to trigger a disruption. The second is to understand how our new model can be used to predict disruption. Creating a taxonomy of disruptive triggers will provide us with a tool with which we can hunt disruption, converting some of the unknown unknowns in known unknowns, thereby integrating them into our strategies.

While disruption creates value in aggregate, the challenge for an individual firm is to ensure that it is one of the creators of that value.

Finding triggers

Disruption is an emergent property—it does not spring forth from a *single* disruptor. It's the result of a group of (potential) contributors, and interactions within the group and with their environment. It's a complex, nonlinear process on which our reductive predilection, our desire to break a problem into its component parts and analyse them in isolation, doesn't work. As Karl Polanyi pointed out, information exists on the interfaces between entities, in how they interact and their shared history, and not just in the entities themselves.[20] Therefore, dissecting a problem into its components to isolate a cause results in the deletion of vital information contained in those interactions. Like economic, psychological, biological, social or other systems that display unexpected or new behaviour not observed in individual components, "more is different."[21]

Table 1. Identifying the triggers of disruption

System	Actor	Emergent property
Economic	Semi-rational agents	Markets that behave in unexpected and sometimes erratic ways, which often can't be inferred from an understanding of the behaviour of their agents
Psychological	Neurons transmitting nerve impulses without awareness, responding to signals in a predictable and mechanical way	A mind making sense of its environment in a qualitatively different way to its unconscious neurons, producing the emergent property of consciousness
Biological	Termites, lacking any conscious understanding of architecture	Societies of termites, which exhibit the emergent property of collective "intelligence," building complex mounds without the need for a central planner of the construction

A shift to synthesis

Disruption's triggers are more intractable and untraceable than we are led to believe by these narratives about a single new "disruptive technology." Complex business processes and highly entailed technology ecosystems create emergent effects that can't be easily traced to a root cause.

Consider the global multimodal container network, possibly one of the most disruptive developments in living memory. The network's development slashed the cost of shipping by around 60 percent.[22] Established docks were eradicated, along with the neighbourhoods and workforces that supported them, as shipping moved to new facilities. The modern concept of globalisation—dominated by off-shoring—is a direct result. Clearly the global multimodal container network was disruptive.

However, the container network is not the result of a single well-defined technology. Nor should it be considered a technology in and of itself. The network relies on a range of technologies, many of which are optional, some which are necessary, and none that are sufficient.

Malcom McLean, a trucking magnate, conceived the container network when he created a new shipping *system*, rather than attempting to optimise the existing process. Containers were already an established technology. McLean standardised the container's dimensions and developed technology to clip them together.[23] New ships, train carriages and truck trailers were designed so that containers could be lifted directly into, and out of, them, rather than requiring teams of stevedores (the elimination of many stevedores is where the majority of the savings came from). The logistics workflow was redesigned, and new docks developed to support this workflow. And, finally, putting all the goods into identical boxes required the development of computer systems to track goods.

The global multimodal container network is a modern wonder, one where the whole is greater than the parts. The network itself was developed over 10 years or so, and did not spring forward, fully formed. None of the technologies used or developed to create the network were *sufficient*. Few, if any, were *necessary*. The majority were merely *optional*.

Using this example, we can consider how we might shape our model for disruption.

First we should acknowledge that technology plays an enabling role. However, the solution requires a complete set of technologies, as none of the individual technologies were themselves sufficient, and few were necessary. We should be quite expansive in what we consider a technology in our model of disruption. For the purpose of this report we will define technology as *"tools and practices deliberately employed as natural (rather than supernatural) means for attaining clearly identifiable ends."*[24]

Second, for a disruption to be adopted it needs to provide some new capability, new value, an economic impetus. This capability might have not previously been available, such as the telegraph, which enabled information to travel significantly faster than goods for the first time. Or the capability may be due to an inflection point where some change in the environment means that something that wasn't commercially viable, now is. The global multimodal container network is an example of new capabilities *driving* disruption.

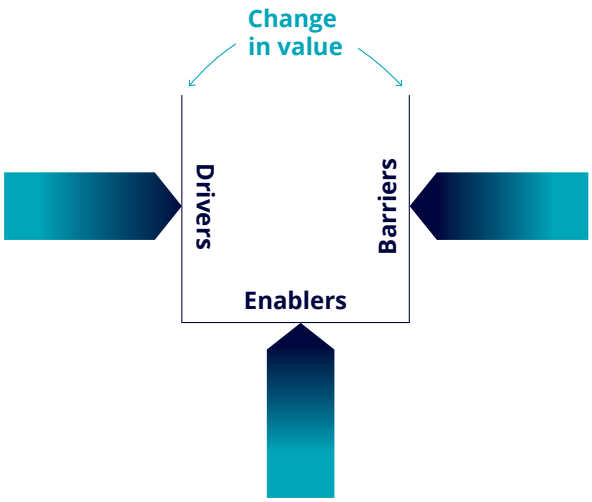
Third, we need to acknowledge that there are often barriers preventing a disruptor from tipping over into disruption. The most obvious examples are regulation and cost, though society's preferences and social mores will also contribute. We should also enumerate the disruptor's barriers, the specific regulations, social factors and costs holding it back.

With that we can consider our model complete. It consists of:

- *enablers*, a set of enabling technologies that are collectively capable of delivering the disruption
- *drivers*, the new capability that the disruption provides
- *barriers*, the set of regulations, social presences and cost that holds the disruption back

A disruptor tips over into disruption when an agent for change brings together a sufficient set of enablers, and the drivers overcome the barriers (that is, the drivers create enough value to overcome the inertia provided by the barriers) to enable the creation of new value.

Figure 3. A model for disruption



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This raises an important question: What types of value can we expect a successful disruptor to create? What is the nature of disruption?

The nature of disruption

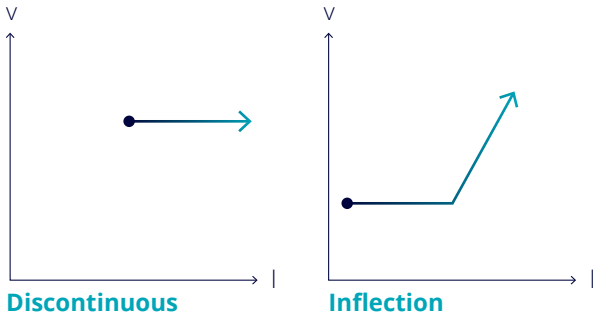
Technologies have become more interdependent, more highly entailed, over time. New technologies build on the capabilities of older ones, leading to the steady accretion of dependencies between technologies as time advances.

Compare the telegraph with the multimodal container network. The telegraph is the simpler of the two: some wire, a switch and battery, and a means of visualising the difference between an open and closed switch. The multimodal container network, on the other hand, is comparatively complex, requiring a broad range of technologies along with effort to standardise and integrate them, and deployment requiring the coordination of many stakeholders.

The telegraph and multimodal container network were both disruptive, but their disruption acted in different ways, creating different types of value. Indeed, we might characterise our model from the previous section as representing a *nonlinear* change in value. Heuristics such as Moore's Law are good examples of regular change, which are easier to anticipate as they are simply the expectation that every year will see the same percentage improvement. Nonlinear change, on the other hand, is harder to predict as we cannot easily extrapolate from past improvements to predict future trends.

Nonlinear change can be broken into two distinct types.

Figure 4. Nonlinear changes in value



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The first is discontinuous change, the creation of a capability that did not previously exist. The change represents the difference between a world with, and one without, the capability. The telegraph, separating the transit of information from the transit of goods, is one such example.

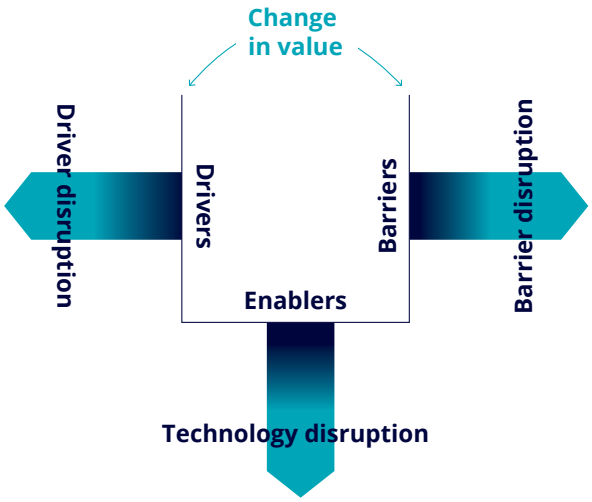
The second is an inflection point, where an established trend unexpectedly changes direction. Inflection points are the result of interactions between long-term trends for two or more contributors, crossing each other or reaching a threshold, such as when incremental improvements in underlying technologies make something that was previously unviable, suddenly viable. This might be the dynamic behind the emergence of bitcoin and distributed ledgers. Bitcoin contains no new math, no new technology, so it is likely that it was cost-performance improvements in the established network technologies that bitcoin relies on that shifted the advantage from traditional centralised solutions to a distributed one.

We must also remember that disruption is an inherently subjective concept. Disruption is only disruptive to the disrupted, not the disrupter or any bystanders. This raises the question: How is the disrupted experiencing this nonlinear change of value?

Using our model we can identify four sources of disruption.

- **Technology disruption:** Disruption is due to the accumulation of new proprietary technology by another actor, where the technology enables the actor to dramatically advance the *art of the possible*. Many disruptions come from this source, from the long bow and telegraph to the global multimodal container network and the iPhone.[25]
- **Driver disruption:** Disruption is due to inflated drivers, where another actor takes an existing technology and dramatically increases the perceived value without advancing the art of the possible, thereby producing a nonlinear change in value. Fewer disruptions come from this source, though one example might be Theranos.[26]
- **Barrier disruption:** Disruption is due to inflated barriers, where external forces conspire to hold back the *art of the possible* until the pent-up value is so great that a nonlinear change of value is released. Uber and the ridesharing industry are good examples of this, where regulators have stifled innovation until the disconnect between what is technically possible and what regulation allows reaches a breaking point.
- **Acts of God:** Disruption is due to an extrinsic and unpredictable force, events unrelated to the creation of new value. We must admit that it will not be possible to uncover all unknown unknowns and predict every possible disruption. Acts of God represent the limit of what is knowable.

Figure 5. The actions of disruption



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Within technology-enabled disruption, as we mentioned above, there are four different places in the firm on which the disruption might act.

- **Artifice:** A competitor develops a new technology, a tool or practice, that in and of itself creates new value. Artifice is disruptive as it enables its owner to deliver a superior version of an existing product or service. Examples include the telegraph, the automated loom, and printing press. Artifice is disruptive as it's challenging to replicate the technology underpinning it.
- **Product:** Existing capabilities are combined in novel ways to create new value for the mass market, supplanting established products and services. The iPhone is the most recent example. Products are disruptive as it can be challenging to discover all the technologies at play and how they are integrated.
- **Organisation:** It indicates the development of a new process or system, a new approach to organising operations, one based on different principles: how the product is organised. Organisation is disruptive as it implies reorganisation, the development of new skills and grandfathering of the old. Henry Ford's moving production line is the obvious example.
- **Relationships:** A combination of trends conspire to change the roles of and relationships between actors in the value chain. A recent example is how a combination of the consumer Internet, express freight and smartphones have flipped the sense of relationship, causing the value of marketed products to be defined by the consumer, rather than by the merchant, in terms of features and functions.

Conclusion

Karl Marx was the first to elaborate on the idea that changes in technology are a significant, if not the primary, force acting on the shape and nature of society. The collection of technologies that spawned the first industrial revolution, to pick one particularly significant example, transformed agricultural societies into industrial ones. The steady march of technological progress since then is largely responsible for the shape of society today, a society where technology has penetrated every nook and cranny. The common view, that rapidly changing technologies are shaping our lives, stems from Marx's observation.

Technological development might be a significant force over the long term, but we're concerned with the short term, and with particular technologies rather than with technology as a whole. If technology as a whole shapes society, then it seems to logically follow that individual technologies are what cause disruption, the short-term but dramatic shifts in the shape of society. This assumption leads us to look for these disruptive technologies, as it implies that we must control the disruptive technology if we are to successfully navigate the disruption.

The world is not so simple, unfortunately. We can trace our way back from disruption to technology, but it is not possible to reverse direction and find our way from technology to subsequent disruption. Our intuition has misled us, as the relationship between technology and disruption is not one of cause and effect. The relationship is degenerate—to use the formal biological term—one where multiple independent causes can result in the same effect. Our desire for a coherent narrative, one where effect is due to cause, and the responsible parties can be found and tried, has led us astray. Disruption is both more complex and more interesting than our intuitions led us to believe. Not only is disruption degenerate, it is also constructive. Technology might be better thought of as a catalyst that enables a confluence of social forces to come together, when the desire to create new value overcomes barriers to change, and rapidly reconfigures society. Disruption is also subjective, as the changes that concern us are the changes that affect us.

So what should we do about disruption? It's not possible to scan the environment for disruptive technologies, as we'll soon find ourselves overwhelmed with candidates that are potentially disruptive, but which may never have crystallised into actual disruption. If we cannot anticipate disruption, then why bother having a strategy at all? Why not just focus on execution and tactics, relying on momentum to carry us through? This is asking the wrong question though, as it's not possible to anticipate an "unanticipated and dramatic change" (as we defined disruption in the section "Three insights").

Our focus needs to be on the constructive nature of disruption, on how technology can act as a catalyst in the creation of new value, as this is the engine room of disruption. Three approaches are open to us. The first is to review a technology to determine what potential disruptions it might contribute to, and what other factors—the drivers and barriers—need to be combined with the catalyst that is the technology. Blockchain is a good example, as the technology will be disruptive in those situations where its high costs are offset by its ability to eliminate intermediaries. The second is to identify potential disruptions, along with their drivers and barriers, and then attempt to develop a technology platform that catalyses the disruption. The example used in the report was developing new building systems, enabled by a building information model. The third is to identify gaps between what state-of-the-art technology allows—the drivers and technology enablers—and the barriers put in place by regulations or social mores. Uber might be the best example of this approach in the current market.

The value of this approach depends on our ability to imagine how society (or, at least, our business) might appear once the disruption has passed. The qualities of disruption (presented in figure 2) might guide us to the realisation that the development of a new building system might be the key to disrupting the building industry, but it doesn't help us imagine what this building system might look like. This is where we can take advantage of the three horizons of disruptive change—the short-term view of sources of disruption is complemented by (and complements) the longer-term view of patterns of disruption, and even longer view of the Big Shift.

We have also been somewhat arbitrary in calibrating disruption. How high (or low) should we set the bar? Disruption's action is subjective—it's only disruptive if it's disrupting us—what one firm sees as an annoyance another might find a calamity. We need to calibrate our efforts to balance the necessity of filtering noise against the risk of missing disruptions. The key to both of these challenges is to use the three observations outlined in this report—that disruption is degenerate, constructive and subjective—as a basis for a systematic methodology that integrates them into a best-practice strategy formation process.

ENDNOTES

1. A disruptive innovation is an innovation that creates a new market or value network, disrupting established markets or value networks in the process.
2. Peter Evans-Greenwood and Peter Williams, *Australian Shift Index key findings: Setting aside the burdens of the past,* Deloitte Australia, 2014.
3. John Hagel, John Seely Brown, Maggie Wooll, and Andrew de Maar, *The paradox of flows: Can hope flow from fear?,* Deloitte University Press, 2016, https://dupress.deloitte.com/dup-us-en/topics/strategy/shift-index.html.
4. John Hagel, John Seely Brown, Maggie Wooll, and Andrew de Maar, *Patterns of disruption: Anticipating disruptive strategies in a world of unicorns, black swans, and exponentials,* Deloitte University Press, November 12, 2015, http://dupress.com/articles/anticipating-disruptive-strategy-of-market-entrants/.
5. Deloitte, *Directors' Cut: Board effectiveness,* 2015.
6. A real option is the right—but not the obligation—to undertake certain business initiatives, such as deferring, abandoning, expanding, staging or contracting a capital investment project.
7. We are using a particular definition of "degenerate" from physics and biology where a particular outcome is a single *degenerate* case of a more general effect, such as in physics where a single energy level may correspond to more than one quantum state. Degeneracy is observed in any system where there are components that are structurally different but functionally similar. In the case of disruption this means that a single disruption could be the result by a number of different, and otherwise separate and unrelated, causes.
8. Note that this means that disruption is a very *robust* process.
9. Joseph L. Bower and Clayton M. Christensen, "Disruptive technologies: Catching the wave," *Harvard Business Review,* January–February 1995.
10. Sarv Grin, *Digital disruption—opportunities for innovation and growth,* speech to the Committee for Economic Development of Australia (CEDA) Adjusting Australia Series, Sydney, June 11, 2014, http://www.rba.gov.au/speeches/2014/sp-so-110614.html.
11. Note it is the "value we provide" not the "value we create." It's how others perceive our value that matters, not our own opinion.
12. Clayton Christensen, *The Innovator's Dilemma: When New Technologies Cause Great Firms to Fail* (Harvard Business Review Press, May 1, 1997).
13. Associated Press in Changsha, "Chinese construction firm erects 57-storey skyscraper in 19 days," *Guardian,* April 30, 2015, https://www.theguardian.com/world/2015/apr/30/chinese-construction-firm-erects-57-storey-skyscraper-in-19-days.
14. UB1 Little Hero (by Nonda Katsalidis), http://www.unitisedbuilding.com/myportfolio/ub1-little-hero-melbourne/.
15. Deloitte Australia, *Short fuse, big bang,* 2012, http://www2.deloitte.com/au/en/pages/building-lucky-country/articles/digital-disruption-harnessing-the-bang.html.
16. Hagel et al., *Patterns of disruption.*
17. Nassim Nicholas Taleb, *The Black Swan: The Impact of the Highly Improbable,* 2nd ed., (London: Penguin, 2010).
18. Jack W. Scannell and Jim Bosley, *When quality beats quantity: Decision theory, drug discovery, and the reproducibility crisis,* PLOS ONE, February 10, 2016, http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0147215.
19. We use the terms *optional, necessary* and *sufficient* in a formal sense.
20. Michael Polanyi, *Personal Knowledge: Towards a Post-Critical Philosophy* (University of Chicago Press, 1974).
21. Ludwig von Bertalanffy, *General System Theory: Foundations Development Applications* (Allen Lane, 1971).
22. Marc Levinson, *The Box: How the Shipping Container Made the World Smaller and the World Economy Bigger* (Princeton University Press, 2006).
23. We are really talking about "intermodal containers" rather than just "containers."
24. Maurice N. Richter, *Technology and Social Complexity* (State University of New York Press, 1983).
25. This report is an independent publication and has not been authorized, sponsored or otherwise approved by Apple Inc. iPhone is a trademark of Apple Inc., registered in the United States and other countries.
26. Ben Popken, "How $9 billion startup Theranos blew up and laid off 41%," *NBC News,* January 6, 2017, http://www.nbcnews.com/business/consumer/how-9-billion-blood-testing-startup-theranos-blew-n671751.

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