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A report from the
Deloitte Australia Centre for the Edge and prefabAUS

How industries evolve: Interactions, not institutions, drive disruptive change

Industries evolve when their participants find new and better ways to work together. How can organizations surf the wave of these shifting relationships?

About the Deloitte Australia Centre for the Edge

The Deloitte Australia Centre for the Edge, which is part of our global research network, is designed to help businesses profit from emerging technology opportunities. Technology developments strike at the very heart of a business, and finding strategies for corporate growth is essential. Our mission is to identify and explore opportunities that aren't yet on senior management's agenda but should be. While we're focused on long-term trends and opportunities, we also look at the implications for near-term action.

About prefabAUS

prefabAUS is the peak body for Australia's offsite construction industry and acts as the hub for building prefabrication technology and design. prefabAUS is passionate about the impact of prefabrication on transforming our built environment, such as decreasing construction timeframes and construction waste while increasing quality, productivity, and affordability.

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How do industries evolve?

WE'VE ALL SEEN it happen. Our industry is humming along with business as usual, staying more or less stable for perhaps years at a time. Then something erupts onto the scene—a new technology,[1] a public health crisis,[2] a major geopolitical shift, even a dramatic change in fashion preferences[3] —that turns the industry upside down, leaving a swath of failed organizations in its wake. If we're lucky, we avoid being disrupted, and we may even thrive in the new state of affairs. But what about the organizations that didn't survive? Why didn't they see the change coming? And if they did, why weren't they able to adapt?

Disruption—unanticipated step changes in how an industry does business—is one of the main, certainly the most dramatic, forms of industry evolution. What's less evident, though, is the underlying mechanism responsible for much of this evolution. Whether it's Blockbuster falling to Netflix or Oracle's successful transition to cloud,[4] we tend to ascribe an organization's failure or success in dealing with disruption to attributes of the organization itself. They're too slow or too big or, conversely, unusually agile and prepared. But rarely do we dig deeper to ask: What are the Blockbusters of the world too slow *at* and too big *for*? What did Oracle *do* with all that agility?

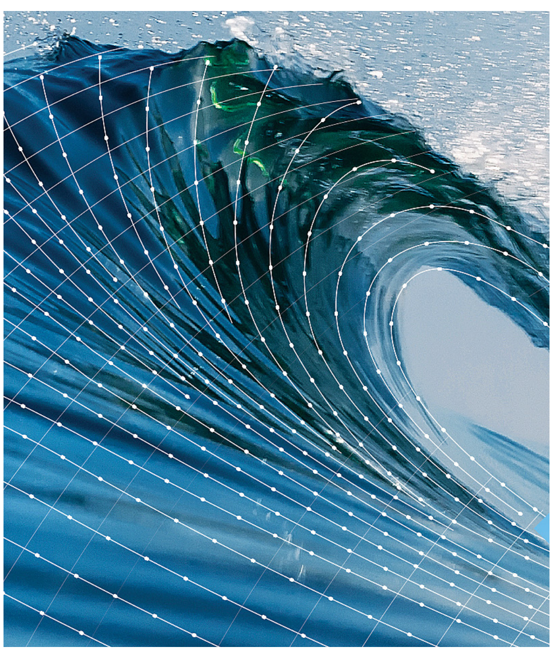
When we examine the way industries evolve, time and time again, we find that it's the *relationships* among organizations—their networks and interactions—that speed disruption along or stand in its way. Streaming video disrupted Blockbuster because distributing physical products requires different institutional relationships from distributing virtual products, and the role Blockbuster played in the physical supply chain simply did not exist in the virtual one. Transitioning to streaming would have required Blockbuster to unpick the property and franchising relationships that had hitherto defined its operations while simultaneously building new relationships for virtual distribution. It's a prime example of a company where institutional relationships that had once been a competitive advantage became an insurmountable burden.

If we're to spot and prepare for disruption, it's more productive to focus on the verbs, the interactions between organizations, than the nouns, the organizations themselves. It's changes in institutional *arrangements*, not primarily *institutions*, that drive industry evolution; organizations are only disrupted if the new arrangements no longer require them. To stay ahead of disruptive change, it's thus essential to anticipate when potential disruptors could stimulate organizations to work together differently, and to position one's organization to surf the wave of these shifting relationships.

In this essay, we'll illustrate this principle with how some organizations in the construction industry are wrestling with technology-driven change—with considerable implications for the industry's future.[5]

A construction industry example: How technology is invalidating old assumptions

THE CONSTRUCTION INDUSTRY has, until recently, been remarkably stable over time. The building process has unfolded in much the same way since the time of the pharaohs: Materials such as bricks, girders, and windows are brought to the construction site and assembled piece by piece, while inspectors regularly tour the in-progress building to oversee quality and compliance. Manufacturers make the components, construction companies organize the logistics and assembly, contractors (typically) perform the work,[6] and regulators do the inspections, each carrying out its own well-defined role. It's long been seen as an industry ripe for disruption—and now, the disruption may finally be here.[7]



A confluence of technologies and tools, including digital twins, building information management (BIM) systems, parametric modeling, and flexible manufacturing, is making possible new techniques that are invalidating long-held assumptions about how construction should be done. A digital twin of a to-be-constructed building, for instance, allows engineering knowledge to be baked into the twin from the start rather than after an architect has designed the building. Previously manual outputs, such as diagrams showing how cranes should lift large assemblies, can be generated directly from the twin. 3D digital models of the building can be readily produced, enabling workers to use VR throughout the construction process (such as trades mapping on-site workflows) instead of just in architectural visualization.

The adoption of a digital-first process, known as Design for Manufacture and Assembly (DfMA), has resulted in an explosion of creativity and innovation across the industry as construction firms rapidly absorb new (to them) technology.[8] In DfMA, buildings are architected so that they can be divided into assemblies that can be quickly snapped together on site. These assemblies can be self-contained modules (bathroom pods are popular,[9] though entire apartment modules have also been used successfully),[10] standardized (and so mass-produced) structural components, or even large bespoke structural components.[11] Assemblies are manufactured off-site at a factory before being shipped to the construction site, where the building is constructed by quickly snapping together the completed components. Unlike the traditional approach of preassembling smaller building elements such as wall panels and stairways, the DfMA process allows buildings to be constructed in a modular fashion, with entire floors quickly put together as assemblies are lifted into place by a crane.[12]

DfMA's invalidation of old assumptions about how construction works is in turn invalidating assumptions about how organizations can most productively work together, both inside and outside the construction industry. For instance, the DfMA process splits the work of building between the construction site and off-site factories—between building products and the building itself.[13] The resulting blurring boundary raises new questions for which the building ecosystem will need to negotiate fresh answers. What, for example, qualifies as a building product—a tap, a sink, a bathroom pod, an apartment module?—to be certified versus a building whose construction is regulated? What construction regulations apply to a manufacturer that produces DfMA assemblies? Do these manufactured elements also need to be certified as building products? And what manufacturing regulations apply to a DfMA firm that brings the manufacturing capability in-house?

DfMA also calls into question the construction industry's relationships with regulators. Currently, regulators want to inspect physical buildings rather than digital plans in a BIM, even though it's possible to verify that digital plans meet regulation and then use statistical quality control techniques from manufacturing to verify that what was inspected was in fact built. The latter approach would be safer than sending an inspector to a site where they could suffer accidents; it would also be cheaper because the inspector could review a single digital exemplar of, say, 200 bathrooms instead of inspecting all 200 physical bathrooms.[14] But regulators have been slow to adopt this procedure, not because they don't have the technology to execute it, but because they need to learn to trust the new process and ensure that it provides them with the information they need.

Another issue for DfMA firms has been their relationships with banks. Banks rely on quantity surveying to manage lending risk. But quantity surveying conventionally requires walkthroughs at the build site, and because much of the fabrication in DfMA occurs off-site, the surveying can't begin until after at least some of the modules are brought to the site and assembled. Yet DfMA firms need some of the funds before the on-site build begins to support the manufacturing part of the process. The reluctance of many banks to provide these upfront funds has led DfMA firms to self-finance early projects or seek alternatives to debt finance.[15] In fact, banks have sometimes dismissed DfMA projects due to the smaller returns associated with a speedier construction project, without considering that the shorter timeframe allows a bank to fund more projects and therefore realize as much margin or more with more diversified risk.

It's also worth noting that embedding cost data and real-time construction updates into a building's digital twin could result in quantity surveying expertise being absorbed by the DfMA platform. Quantity surveying, in this case, could be done by the building's architect and engineer, or even the custodian of the digital model. The relationship between the quantity surveyor and the financier may then no longer be functionally required—but would banks trust anyone else?

The emerging DfMA industry is not being held back mainly by organizations' inability to absorb new technology.[16] The barrier is the challenge of updating the ecosystem's institutional arrangements—involving though not limited to contracting, debt finance, and regulatory compliance—to realize the opportunities the new approach provides. So far, these institutional arrangements have proved difficult to change. Unfavorable verbs are shaping the digital building industry's evolution.

An example of this is DfMA's difficulty in contracting with suppliers. A building might be designed to use steel framing. The DfMA firm constructing the building would like to buy the framing from a supplier, but they want to do so by exchanging digital information rather than paper forms, and they have very tight tolerances on the delivered product compared to those typical in construction. (Tight tolerances are essential to the success of the snap-together DfMA approach, as without them work migrates from the factory to the site, negating DfMA's speed, safety, and cost benefits.) Even if a supplier uses a digital process internally, the need to map between paper specifications generated from the DfMA firm's digital twin and the supplier's own internal digital tools creates inaccuracies and costs that could have been avoided. Consequently, DFMA firms struggle to find suppliers that can contract in the way they would prefer, making it easier to vertically integrate and bring the capability in-house.

If suppliers and DfMA firms could find ways to facilitate tight-tolerance digital contracting arrangements, then leading DfMA firms might unbundle rather than vertically integrate, creating a new industry in the process. But if vertical integration remains the more practical option, then the construction industry will forgo the cost, productivity, and innovation benefits that the development of a broadly based industry brings.

How to be ready for where an industry could go

DEVELOPMENTS LIKE THESE matter a great deal to organizations both within and outside an industry's accustomed bounds. They matter because seizing opportunities and avoiding risks associated with industry evolution—not least the risk of disruption—requires a sharp eye for how the relevant players' relationships could evolve. This is not a matter of trying to predict what will or may happen—the changes might well be unpredictable as new relationships are negotiated—but of keeping track of and readying oneself for the shifting possibilities for how these relationships could play out.[17]

To better recognize possibilities, it's helpful to ask whether an industry could evolve, be *disrupted*, to achieve the same or better outcomes through a different set of roles. One well-known way this can happen is intermediation, the creation of new intermediaries. The development of correspondent banking to enable smaller businesses to manage commercial relationships with overseas suppliers and clients is an example.[18] Another way is disintermediation, the elimination of no-longer-needed intermediaries. For example, e-commerce has enabled companies such as Dell to engage with customers directly rather than operating through established retail networks,[19] and the transition from physical to digital distribution of video has led to studios developing their own streaming services to connect directly with viewers.[20]

The challenge is in realizing when there *is* the potential for an industry to evolve, with a consequent shift in how organizations relate to one another. Indeed, while a technological innovation might trigger such a disruption, institutional innovation, or even just the realization that there is a better way, can also be a trigger. The development of US correspondent banking networks and the formation of the modern US payment system is an example of the former;[21] the development of the global multimodal container network is a great example of the latter,[22] as is the current transformation of the construction industry. We'll continue with the construction industry story as an example.

Though the details have yet to be worked out, it's certain that data will be central to any digital construction ecosystem. BIM is core to DfMA operations: Firms collaborate internally around their BIM, using it to capture engineering knowledge, maps of environmental data, building designs, workflows, the programs for numerically controlled tools, financial and project management data, and more. A digital building process would enable similar modes of collaboration with external organizations (from suppliers through partners to clients and regulators). Firms might find real-time access to detailed BIM data as valuable, if not more valuable, than the physical item itself,[23] as it would enable them to more effectively manage the risk of stop-work orders.[24] And finally, close digital collaboration across the entire life cycle of a building—from first conception through construction and operation to disassembly and recycling—is likely to be a key enabler of a sustainable construction industry.

Collaborating effectively with an external organization, from contractor to client to partner to regulator, will mean sharing some of this data. At the low end, this might mean a construction firm sending the digital design and contract specifications for a door (the digital door) to a door manufacturer and receiving back the physical door with the (digital) specifications of what was built along with the (digital) invoice and compliance paperwork. At the other extreme, partners such as construction and architectural firms may share complete or nearly complete architectural details. Financiers may require access to detailed as-built data stored in the digital twin to support quantity surveying, while regulators could use detailed access to engineering, architectural, and as-built data to ensure that the building will be and has been built to code. And finally, a version of the digital twin might be archived to facilitate managing the building across its complete life cycle.

The question then is: How can parties best share this data? An obvious approach would be to create a new intermediary, an organization or organizations responsible for hosting the data and controlling access to it.[25] One possibility is for a regulatory agency to act as or create the intermediary due to its interest in accessing detailed BIM data to manage compliance. Similarly, the desire to create an archive might prompt the regulator to co-opt or create a regional planning office to host the data. Both of these alternatives would result in a government-run BIM repository in each geography.

Astute industry observers may consider this possibility unlikely, however. Governments and regulators have historically taken a hands-off approach to regulation, stepping in only when problems are identified, and are more apt to demand access to the data rather than host it themselves. If this pattern holds, the digital building industry could consolidate around several largely incompatible cloud platforms globally. These may be new platforms, or they might grow out of existing BIM or construction management platforms. Few firms would be likely to work across platforms other than when contracting for commoditized building products and not the more valuable assemblies.

Another possibility is that a private organization may step into the gap. If money can be made from acting as a data-hosting intermediary, an organization that realizes this early could capture first-mover advantage, establishing itself as the entire industry's de facto data repository and coordinator, one that works across multiple DfMA platforms. Its success in doing so would depend greatly on being able to persuade the other ecosystem players to trust it with their data and grant it an oversight role.

Yet another possibility is that each organization in the digital construction ecosystem will manage its own data repository, either in an on-premise solution or in their cloud platform of choice, but with common data interchange standards. Subsets of the repository could then be exported and imported to facilitate communication. This is the pattern of data-sharing made popular by the Git platform used by Linux and many other open-source projects.[26] A construction firm could, for example, tag the design, engineering, and financial data associated with a particular type of door and then push the data to a contractor. After fabricating the doors, the contractor would push updates back to the construction firm as well as sending the completed doors. A regulatory officer might head to the design firm's office to certify a bathroom pod design in VR, with the final design and certification details for the inspected pod tagged and pushed to the regulator. When construction is completed, the required design and engineering specification reports would be tagged and pushed to the local regulator's archive service.

A regulator that sees the industry evolving in this direction would be able to get a head start on considering what requirements could effectively oversee this data-sharing activity for accuracy and transparency. An industry association that wants to promote this approach could encourage its members to adopt interoperable systems. And organizations that find value in sharing data directly with each other could work together to discover more and better ways to use it.

Negotiating our way into the future

INDUSTRIES EVOLVE WHEN their participants find new and better ways to work together. If we're to understand, and so influence, the shape of our future industry, it's critical to understand how potential disruptors can drive shifts in organizational relationships and what those shifts might entail. This understanding does more than position organizations to sense and plan responses to significant industry change. It also gives them the chance to steer their industry in a more productive direction for all.

Industries evolve when their participants find new and better ways to work together.

To return to our construction example one last time, updating the institutional arrangements holding DfMA back could create a wholly new industry that is more agile, scalable, flexible, productive, and innovative than what exists today. Modernizing risk management approaches can simplify access to finance. Decoupling regulation from the old building process can foster innovation by expanding the types of situations that regulators consider acceptable.[27] Addressing regulatory compliance can improve quality and drive bad actors out of the industry. And speeding construction's integration with manufacturing could open up whole new markets to organizations in both industries, as well as unlock productivity benefits through finding more efficient and effective ways of interacting.

These new arrangements are not necessarily something that can be designed. The new ways organizations need to interact in will be complex and nuanced enough to make it impossible to identify all that they need to accomplish in advance. Moreover, reifying current practices in a platform based on new technology might have the unintended consequence of holding the industry back. Ecosystem participants will need to negotiate the new arrangements, by trial and error, and hopefully with an eye to the broader benefits. In this negotiated future, it's working together that will enable us to grow the pie by transforming our industry for the better.

In this negotiated future, it's working together that will enable us to grow the pie by transforming our industry for the better.

Endnotes

1. We assume that industries only evolve in response to disruptive technologies.
2. COVID-19 being an obvious example, with the lockdowns that many countries instituted dramatically changing social interactions and so spending patterns. Some firms were unable to respond and folded, others managed to weather the storm, while a few responded creatively and grew. Others saw quite the opposite, with the lockdowns bringing a huge growth in demand. For more on the creative responses to the global pandemic, see Peter Evans-Greenwood et al., *Unshackling the creative business: Breaking the tradeoff between creativity and efficiency*, Deloitte Insights, April 9, 2021.
3. A great example of this is how social changes virtually eliminated the wearing of hats. The fashion for hats peaked in the 1920s and then slowly started to weaken. Over the course of one year in the late 1950s many cities went from most people wearing hats to few. There's no single reason why. Some claim that the hat reminded them of their time in the military during WWI or WWII. Others think that the shift to covered transportation (cars, etc.), where you took the hat off, means that hats were no longer needed. The nail in the coffin (in the United States) might have when JFK was inaugurated hatless. See Preston Schlueter, "Why did men stop wearing hats?," *Gentleman's Gazette*, June 28, 2021 or *Guardian*, "Readers reply: when and why did men stop wearing hats?," August 29, 2021.
4. Chavi Mehta, "Oracle bets on cloud boom for upbeat profit forecast," *itnews*, March 11, 2022.
5. The following discussion draws heavily on the experience and industry knowledge of Damien Crough, cofounder of prefabAUS and one of the pioneers of the Design for Manufacture and Assembly process.
6. Some construction firms are self-performing, in that they have the trades required on payroll rather than engaging contractors.
7. The shift from the conventional construction process to a digital one was discussed by the authors in Peter Evans-Greenwood, Robert Hillard, and Peter Williams, *Digitalizing the construction industry: A case study in complex disruption*, Deloitte Review, July 2019.
8. Many of the technologies were developed in other industries, but the traditional construction process made adoption challenging. The shift to a digital-first construction process has removed these barriers, resulting in an explosion of creativity and innovation. For example, using VR to map on-site workflows was always a potentially valuable exercise, but not so valuable that it warranted developing the 3D models required to support the exercise. However, if we already have a suitable model, then the cost of mapping workflows in VR plummets.
9. Bathroom pods became the first success story for off-site modular construction, as bathrooms are the most complicated room (due to plumbing) and so the room with the most to benefit from a manufacturing-based approach. They now represent a distinct building product category and are in common use in high-rise construction.
10. Little Hero, in Melbourne, Australia, is an early example of this "whole apartment module," or "unitised," approach. The building consists of 58 single-story apartment modules and five double-story apartment modules over eight floors. See Tharaka Gunawardena et al., "A holistic model for designing and optimising sustainable prefabricated modular buildings," conference paper, ICSBE 2012 - International Conference on Sustainable Built Environment, 2012 or Evans-Greenwood et al., *Digitalizing the construction industry*.
11. This is the foundation of the Hickory Building System, which divides each level of a high-rise building into a set of assemblies that contain all structural and engineering components, including the external façade.

12. It's common to lift one assembly every eight minutes, allowing an entire floor to be assembled in only a few hours. Once a floor is complete the floor below is weather-proof, enabling the trades to go through to finish the rooms. This is also why DfMA construction is safer than a conventional approach, as there are no live edges.

13. A building product is any material, certified (regulated) product, that could be used in the construction of a building. Traditionally this was restricted to mass-produced building materials and hardware (such as taps). DfMA blurs this line between product and building by enabling the use of custom manufactured products.

14. Cheaper both in terms of labor and capital, as there is less effort and fewer delays waiting for sign-off.

15. An obvious example is having the client finance construction, which occurred with early cross-laminated timber constructions.

16. Firms typically adopt new technology if they can see sufficient demand to justify the investment. Building is a low-margin business populated by many small suppliers who are unable to justify large investments in technology. This doesn't mean that investment is impossible though. For example, many Australian construction suppliers are currently aggressively investing in technology on the back of biggest building boom in 10 years, as they have the orders to justify the investment. This is compounded by the bushfires of 2020, creating a timber shortage and so additional impetus for steel framing firms to automate, as without automation they will be unable to service all the demand in the market, leaving money on the table.

17. Firms need to identify and invest in *possibilities* until one or more of them mature into *actualities*, at which point the full weight of the firm can be brought to bear. See Peter Evans-Greenwood and Giselle Hodgson, *Strategy and the art of the possible: How listening to the business ecosystem can turn unpredictability into opportunity*, Deloitte Insights, July 2022.

18. John A. James and David F. Weiman, "From drafts to checks: The evolution of correspondent banking networks and the formation of the modern U.S. payments system, 1850-1914," *Journal of Money, Credit and Banking* 42, no. 2/3 (March-April 2010): pp. 237–65.

19. Direct-to-consumer business models have a spotted history. Disintermediating the retail networks can provide a cost advantage, but the manufacturer then needs to engage customers directly. Direct-to-consumer models only work if the savings from disintermediation outweigh the costs of needing to engage customers directly, the firm's customer acquisition costs. In some cases, such as Dell, this economic equation for their product segment works and the firm is a success. There are many instances where this isn't the case. Disintermediation is not an unalloyed good.

20. We note that replatforming an existing intermediary—moving it to a new technology or operational platform—may modernize operations but does not represent an evolution of the industry and is unlikely to be disruptive. Nor is it an example of disintermediation. Ride-sharing is a case in point. The first ride-sharing firms used mobile applications, rather than radios, to support dispatch; the mobile application provided them with the location of each driver enabling the closest driver to be assigned to a ride, rather than relying on drivers to select rides. Similarly, passenger visibility into the driver assigned and their current location created an additional incentive for drivers to pick up the passenger they had accepted. The disruption welling from ride-sharing was due to a willingness to ignore regulation and social convention while investing aggressively in an attempt to elbow out incumbents and capture the market.

21. James and Weiman, "From drafts to checks."

22. Marc Levinson, *The Box: How the Shipping Container Made the World Smaller and the World Economy Bigger*, second edition (Princeton: Princeton University Press, 2016).

23. Similar to how logistics firms recognized the value in tracking information in addition to shipping fees.

24. Building regulators are trying to eliminate poorly performing industry participants, who are unable or unwilling to deliver quality buildings that meet codes and regulations. Real-time data of already-built construction projects can allow regulators to enforce stop-work order to prevent problems developing, orders that would require significant costs to fix to get the project through to an occupancy permit, which is when the developer realizes its profit. The question of sharing data between the partners almost disappears as building code and regulatory compliance become the most important deliverable to ensure profitability.

25. We note that putting the data *on the blockchain* is the recreation of an intermediary, not disintermediation. While the blockchain is distributed in operation—with multiple hosts—the development of the solution will be centralized, requiring the creation of an institution and associated governance framework.

26. Git is a tool for managing versions of a set of digital documents, initially for computer code though it is now used for a wide variety of document types. It uses a peer-to-peer model where users can create repositories and then export and import differences (changes to sets of files).

27. The brick tax in the United Kingdom is a great example of regulation holding back innovation. To tax brick production the UK government hired inspectors to count manufactured bricks as they were drying in the sun, with provision for some of the brick breaking before they could be used. This had the perverse effect of forcing brick makers to use a process that resulted in the bricks being air-dried. An innovation which avoids air-drying, such as kiln drying to reduce production time and so cost, is illegal in this tax regime. The fixed provision to breakage means that any new process, even one which does include air-drying, is penalized as it is likely to have higher breakage rates until production problems have been eliminated. The repeal of the brick tax resulted in an explosion of innovation in the brick making industry.

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