VIATECHNIK

Leading the built environment
in creating a better future, today

VIATechnik's VDC Maturity Curve

Leading digital transformation across the AEC industry

VIATechnik is on a mission to transform the built environment for a better future. We empower our clients through high-quality, high-velocity experiences consistently improving outcomes across design, construction, and operations of buildings and infrastructure. We advance our clients' digital journeys through our solutions spanning Virtual Design & Construction (VDC), Building Information Modeling (BIM), virtual & augmented reality, digital twins, enterprise software application development and more.

VIATECHNIK

BY THE NUMBERS

100 million+
square feet of digital models created

10
global offices

110
terabytes of building data

91.5%
Net Promoter Score

2500+
projects

437,000
Issues resolved

13x-400x
ROI from automation tools

180
Digital experts

300,000
hours of digital planning

GLOBAL PRESENCE

Chicago | New York | Silicon Valley | Boston | Denver | San Diego | Seattle | St Louis | Katowice | Manila

Getting to the Next Level in Project Planning: VIATechnik's VDC Maturity Curve

"It's just more data." … "More 3D and 4D and 5D or - who even knows? - 17D models." … "More acronyms." If that's someone's response when introduced to VDC, it might be time for them to take a step back and catch their breath.

Virtual Design and Construction (VDC) has been around since 2002, but it's still frequently misunderstood. Unfortunately, as we speak to stakeholders, we find that many of them think of it as essentially just another term for BIM or 3D modeling. Or they may see VDC as a loose set of aspirational goals. But equating either of these with VDC is like equating Excel with a financial plan. One is a tool; the other is the application of that tool. And far from a loose set of goals, adoption of that tool demands dedication. It entails development and implementation of a plan that does what well-defined, cohesive plans are meant to do – drive successful organizational outcomes.

VIATECHNIK

Do You Need VDC?

"At it's core, VDC is a tool to reduce variability and drive more predictable outcomes."

In theory, when owners and general contractors are working within a predictable framework, VDC would not necessarily be needed. By a "predictable framework", we mean: (1) the owner has well-defined needs that are unlikely to change, (2) the general contractor has internalized knowledge due to repeatedly building the same thing with the same team, or (3) the owner has experience working with not just the same company but also the same people on the same project type.

However, in reality, this perfect scenario almost never exists. This is why VDC is critically important to achieving results due to the variability, change, and complexity inherent to the construction industry. When the owner is working with complex stakeholders, or change is likely to occur in the late design stages, VDC can provide a framework to incorporate change while limiting disruption. Similarly, VDC can support team coordination when the individuals haven't worked together in the past. And VDC can always be of benefit when transparency and accountability are desired.

In a recent survey, over a third of AEC insiders listed VDC as the technology that "can have the greatest impact on improving productivity in the construction sector over the next three years."[i] Of course, in an industry like AEC, where so many projects are unique - and particularly complex - calculating an overall ROI for a specific input across projects can be a challenge.

So, while we can't supply a generalized ROI, we may be able to look at individual projects as representative examples of what is possible.

An academic report conducted a very thorough deep dive and analysis of the direct and indirect savings from using VDC for a multi-family residential project in Sweden. It found an ROI of 735%.[ii] Later in this paper, we will share another example of "VDC in Action", which highlights a similar story of success.

Yes, your mileage may vary. But the prospect of achieving comparably gaudy results just might hold the attention of the skeptics.

Across the industry, we see VDC being leveraged as the foundation for advanced construction means and methods, clearly driving improved outcomes. As an example, the use of offsite fabrication can be extended to many more components thanks to BIM and VDC and the precision they bring to mapping the surfaces to be fitted together. Prefabrication alone is seen as generating a stronger ROI by 70% of contractors surveyed. Yet prefabrication is only one benefit of implementing VDC and only one way it enhances ROI.[iii]

Not only does VDC help us see how all the physical parts of a project fit together, but it also enables us to see how the various stakeholders and their processes fit together. It allows for higher-quality, faster decision-making, and a frictionless experience when working with the built environment. And those benefits accrue to stakeholders from owners to general contractors to trade contractors. Owners benefit through lower costs and shorter timelines. General contractors can evaluate alternatives more rapidly and document designs more accurately. Trade contractors can work while facing less interference onsite.

So, What Exactly is VDC?

Virtual Design & Construction was coined by two Stanford professors, Dr. Martin Fischer and Dr. John Kunz, in 2002, as a way to leverage integration and digitization to improve how we organize, conceptualize, and execute design and construction.

Stanford CIFE VDC Definition

Virtual Design and Construction (VDC) is "the use of multi-disciplinary performance models of design-construction projects, including the Product (i.e., facilities), Work Processes, and Organization of the design - construction - operation team in order to support business objectives" (Fischer et al, 2004). VDC allows a practitioner to build symbolic models of the product, organization, and process (P-O-P) early before a large commitment of time or money is made to a project. Thus, VDC supports the description, explanation, evaluation, prediction, alternative formulation, negotiation, and decisions about a project's scope, organization, and schedule with virtual methods. The objective of VDC, therefore, is to use these virtual models of product, organization, and process to simulate the complexities of the construction project delivery, understand the pitfalls the project teams are likely to encounter, analyze these pitfalls, and address them in a virtual world before any of the construction work ever takes place in the real world.

Citation: A Guide to Applying the Principles of Virtual Design & Construction (VDC) to the Lean Project Delivery Process, by Atul Khanzode, Martin Fischer, Dean Reed, & Glenn Ballard

The seeds of this idea reach back to 1976 and a paper by Stanford Professor Boyd Paulson, entitled "Designing to Reduce Construction Costs."

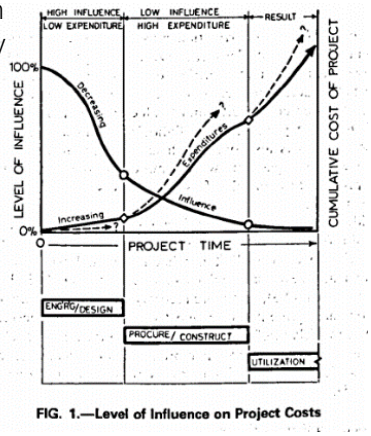
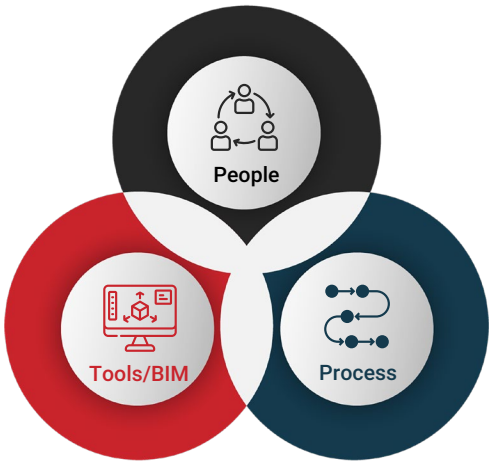


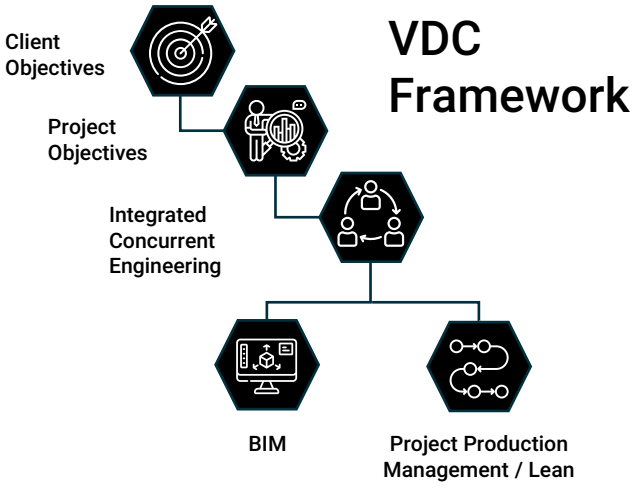
FIG. 1.—Level of Influence on Project Costs

In this paper, Paulson identifies a structural problem in the industry: in early phases, when the project costs are still low, decisions are made that have extraordinary effects on the final cost of the project, yet traditionally, little attention is paid to such implications during this time. It is therefore critical, as Paulson puts it, to "assure that construction and... operations thinking is strongly injected in the conceptual, preliminary, and detail design processes."

The concept of shifting effort from one end of the project design cycle to the other—that is, integrating various disciplines at the earliest possible stage—is the core principle of what would become integrated project delivery (IPD) as the strategy for creating better projects and VDC as the method for executing the strategy.

So, how exactly does VDC do this? To answer this, we will walk through the VDC Framework, adopted from Stanford University's Center for Integrated Facilities Engineering (CIFE). Not surprisingly, VDC is about people. But if we bring the best people together on a project, they can only do so much, without the right tools. The key tool leveraged in the VDC process is BIM. But the best people with the right tools will not achieve anything in a poor workflow. And research has shown that processes are more likely to be followed if they are created by the people in the workflows (for example, lean methodologies like pull planning). But the best people, tools, and processes won't matter unless they are focusing on the right things.





"The VDC Framework as adopted from Stanford Center for Integrated Facilities Engineering (CIFE)"

VDC Heightens in Importance due to Growing Challenges in Cost Planning

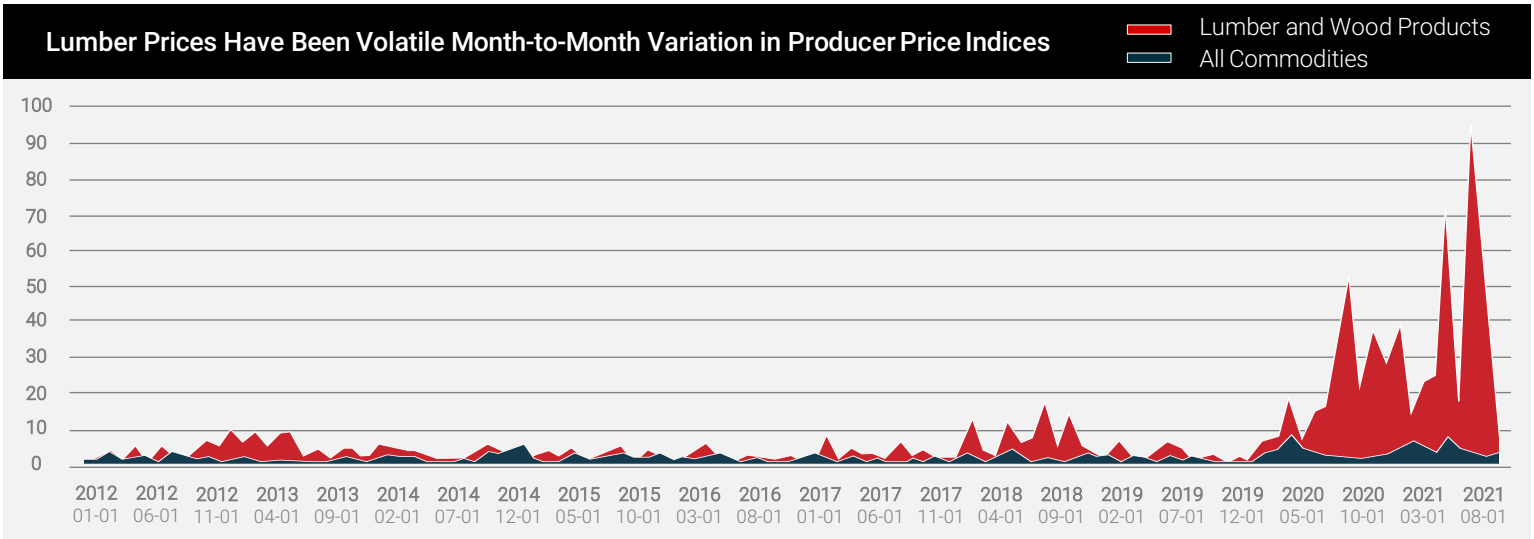
It's no secret that every industry has struggled with supply chain issues in recent years. Lumber is among the commodities whose prices have skyrocketed as a result. But the extreme nature of this recent surge may obscure the fact that the construction industry has always had to deal with volatile prices, more so than almost any other. For example, the graph below shows that volatility, by comparing the month-to-month change in the Producer Price Index for Lumber and Wood Products to the PPI for all commodities. The last two years aside, the volatility has always been intense. From the beginning of 2012 through the end of 2019 – before the recent surges - the average monthly swing for lumber was 3.1 points, versus only 1.1 points for all commodities.

That kind of volatility makes cost planning far more difficult and puts the profitability of individual construction projects at risk.

Cost planning is also made more difficult by the growing number of complex projects worldwide. A recent academic study found that cost overruns are often related to design changes, and that "Change in a project's design could be part of a construction project's nature because of its *inherent complexity and uncertainty*."[iv] (Emphasis added.) According to a recent academic literature review, "Many studies have shown that project success is dependent on the complexity of a project and that traditional project management methods are not enough to properly address this complexity."[v]

So, how does VDC become part of the solution to the challenges of cost unpredictability? VDC starts with objectives, and through the integration of people, process, and technology, allows the team very early in a project, and with a high level of certainty, to answer critical questions like what you want, how much you want, and when you need it. This certainty thereby flows down through the supply chain making it possible to lock in the best prices. By working with better information, we've reduced variability.

Lumber Prices Have Been Volatile Month-to-Month Variation in Producer Price Indices



The Case for VDC

Mature VDC goes beyond the modeling of the physical components of the building – spaces, elements, and systems - to model, visualize, and/or analyze organizational groups and the process itself, in the form of activities and milestones. While BIM is typically a critical building block, using it outside the VDC framework is like laying a foundation without ever building a house on that foundation. Even in its best solo application, BIM-driven projects don't model the organization or the process. VDC modeling is summarized as the POP model (Product, Organization, and Process). *(See the box to the right.)* In addition, BIM alone doesn't integrate information and processes from across disciplines in terms all can readily understand.

A study by Stanford University, where the concept of VDC was first introduced, in 2002, evaluated the impact of varying levels of VDC application on 40 projects.[vii] They classified the projects as either VDC1 (only Product Modeling was applied), VDC2 (Product and Process Modeling was applied), or VDC3 (Product, Process, and Organizational modeling was applied). The projects were each evaluated in terms of the resulting improvement in results (small, medium, or dramatic). Of the 40 projects, none were VDC3; 13 were VDC1 and 27 were VDC2. Despite the small sample sizes, the difference in outcomes was clear. *(See the image on the next page.)* One in four projects that included the application of Process Modeling saw a dramatic improvement, whereas none of the projects that only applied Product Modeling saw a dramatic improvement.

> The **Product** model defines building elements such as Floors, Walls and Beams; the **Organization** model defines organizational groups; and the **Process** model defines activities and milestones.
>
> - "Virtual Design and Construction: Themes, Case Studies and Implementation Suggestions," John Kunz & Martin Fischer, Center of Integrated Facilities Management, Stanford University

The reasons become clearer when some of the individual benefits of VDC are broken out. In a 2007 survey of all types of stakeholders, over half the sample agreed that there's value in implementing VDC for architects, general contractors, and subcontractors. Over nine in ten felt that owners receive value.[viii]

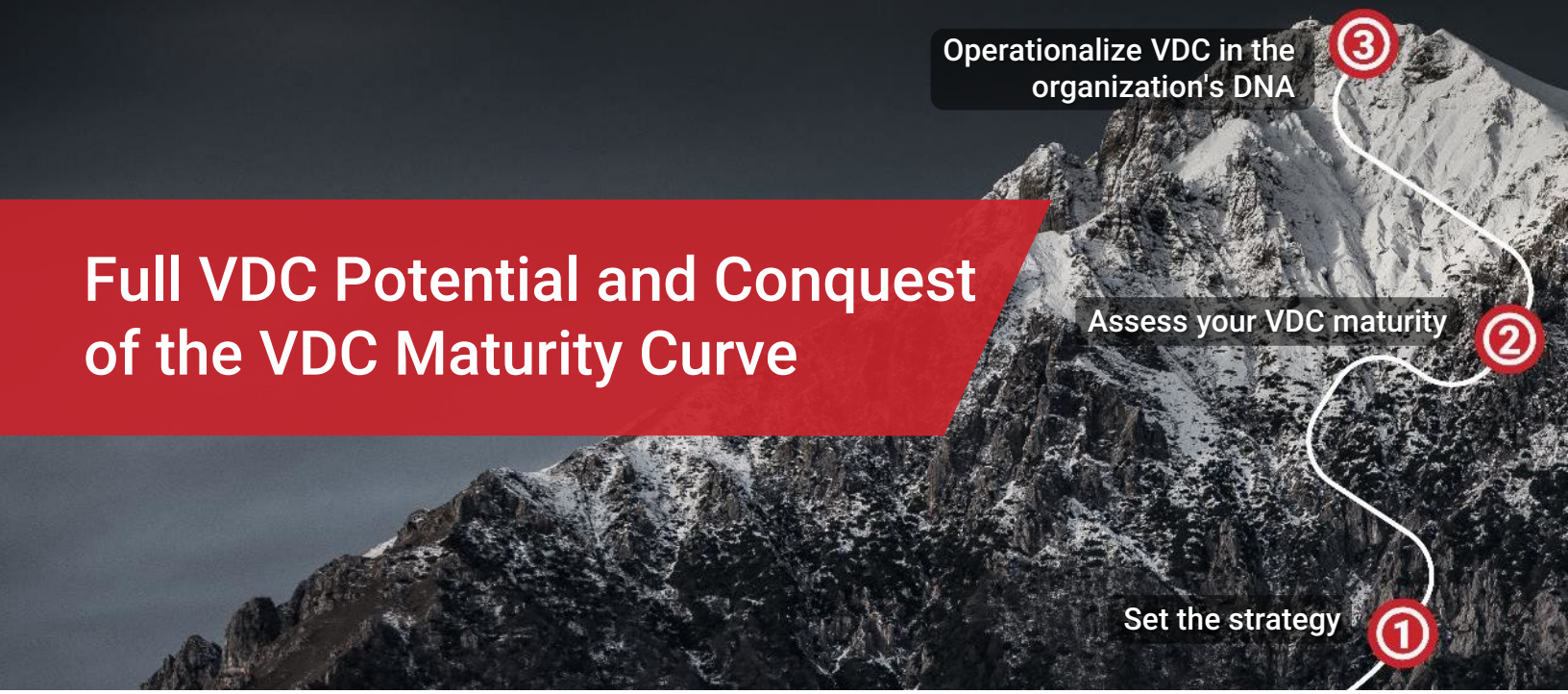
The survey also found that:

- One in four respondents attributed an improvement in the number of unbudgeted change orders to using VDC, with the large majority of these reporting an improvement of 10% or better.
- Almost half reported an improvement in response latency during design and/or construction, with over a quarter of these reporting a reduction of one week or greater.
- About 15% saw improved monthly cost performance, with half of these citing an improvement of 10% or better.

Improvement Associated with Varying Levels of VDC Application

In a study by Stanford University, one in four projects where a more mature level of VDC was executed (as defined by both Product and Process Modeling) saw a dramatic improvement in project outcomes.

VIATECHNIK



Full VDC Potential and Conquest of the VDC Maturity Curve

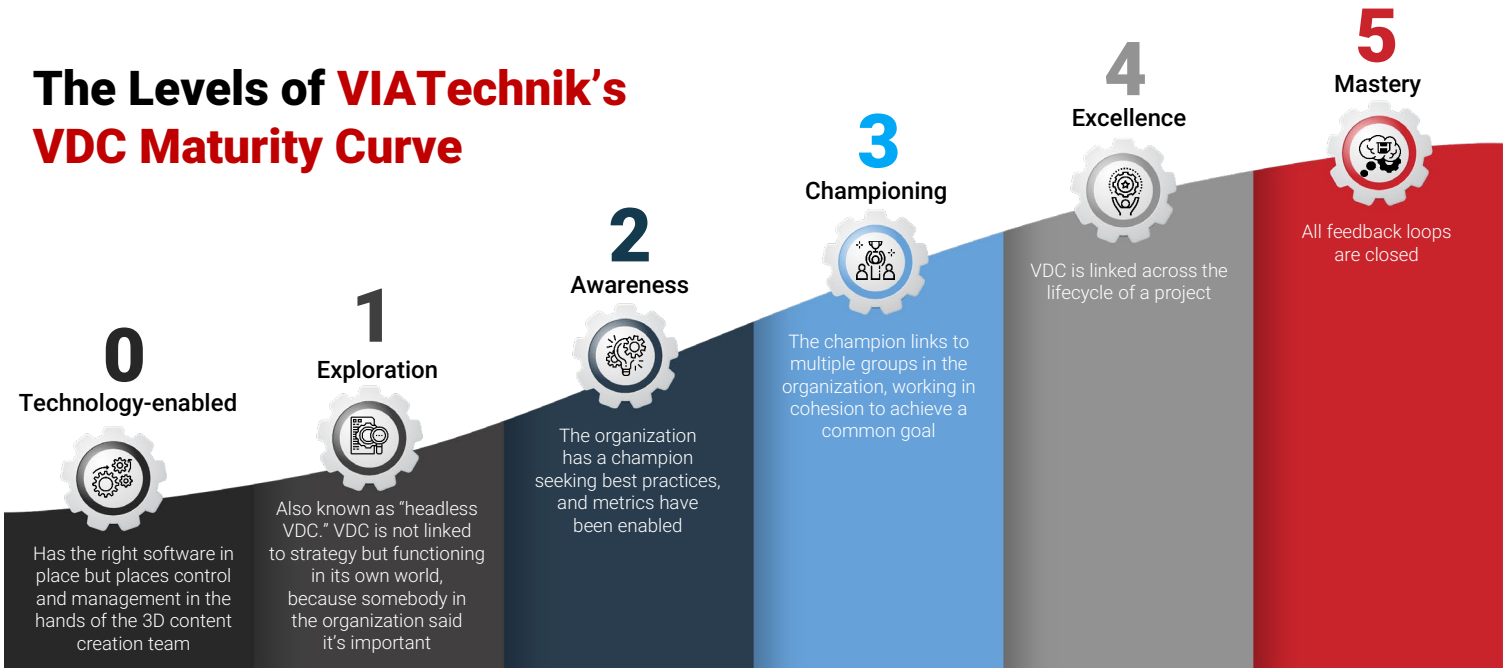
The path to the pinnacle of VDC program maturity covers a multi-stage ascent for a team, a project, and the company. But before taking even the first step on that journey from BIM to full VDC potential, an organization's culture must be prepared. After all, those who intend to climb Mt. Everest are advised to prepare for at least a year before even setting foot on the mountain's base. Achieving VDC maturity may not be tantamount to reaching Everest's summit; but then again, maybe it is.

The onus is on senior leadership to take initiative in a three-phased approach, of which the actual climb is only the second phase:

Phase I: Setting the foundation - Focus on alignment to the organization's business strategy.
This, in particular, must start at the top. The business strategy must be clearly specified and communicated to all in the organization. Goals and strategies must be aligned. Metrics for success must be established, and the facts needed to support those metrics must be identified, collected, and organized into a database.

Phase II: Break down VIATechnik's VDC Maturity Curve in order to assess where a program is and where it can go. See the image below. It's important to understand the current state to be able to define the path forward.

The Levels of VIATechnik's VDC Maturity Curve



Phase III: Support the VDC journey – Determine how VDC can be operationalized into the DNA of the project/real estate portfolio.

Set up pilot projects as a way to test what VDC execution means for your organization. Think people, process, and technology. This could look like the following:

People: How can you align stakeholders towards the common objectives, bringing in the right people, with the right information, and the right time?

Process: How do your existing processes need to evolve to allow VDC to thrive?

Technology: What technology stack gives you the level of control and insights you need to meet your objectives?

Take a look at the below 3-month roadmap for an idea of how this could play out in your organization.

Strategy, Champions, and VDC Maturity Assessment Form the Foundation

In month one, it's critical to ensure clear understanding of the business strategy throughout the organization. This is also the time to identify champions in the organization. Then the company should be assessed as to its level on the VIATechnik VDC Maturity Curve.

Month 1

Goal Setting & Technology Set Up

In month two, goals must be established. This is also the time to determine which tools are right for your organization. All too often, the idea of integration is overlooked, but integration, including technology and data integration, is fundamental to successful VDC execution. Platforms like VIATechnik's Babylon (design automation intelligence), Precogs (predictive insights & data driven learning platform), Thread (digital supply chain integration), and Voyager (integrated digital twin solution) were designed with this in mind.

Month 2

Pilot Implementation

In month three, it's time to implement the pilot. Things may not always go as planned, but where some may worry about losing their way entirely, a well-prepared organization with a solid plan will feel confident about where they're headed and how they'll get there.

Month 3

VIATECHNIK

Challenges & Opportunities to Advancing VDC Maturity

The road to VDC maturity will no doubt be filled with challenges. But where there are challenges, there is opportunity for firms who can differentiate from the pack. VIATechnik recently conducted a survey on digital transformation across leading AEC firms.

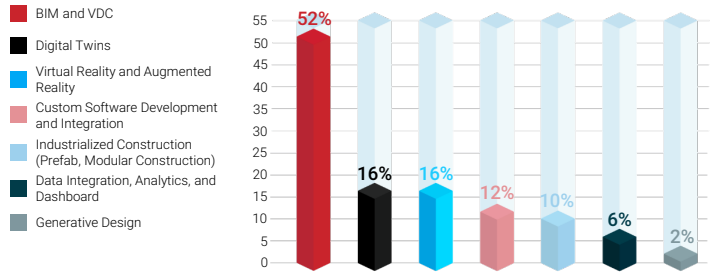
When asked which construction technologies or innovations their organization is investing in, BIM and VDC surfaced as the primary area of investment in over half of the respondents. The primary benefits of this investment included 1) reduced operating costs 2) improved client satisfaction 3) reduced development time for new products or service offerings 4) better talent recruitment and retention and 5) increased revenue.

An abundance of challenges, however, were cited as presenting barriers to organizations undertaking their digital transformation efforts, of which VDC is at the core. Over one in three firms cited that overcoming reliance on traditional more manual processes is still the biggest barrier. But even those firms that can overcome the inertia problem facing the construction industry, there are still the challenges of dedicating budget, building up the right 'in-house' skills, and putting the right technology stack in place (as shown by the figure on the right).

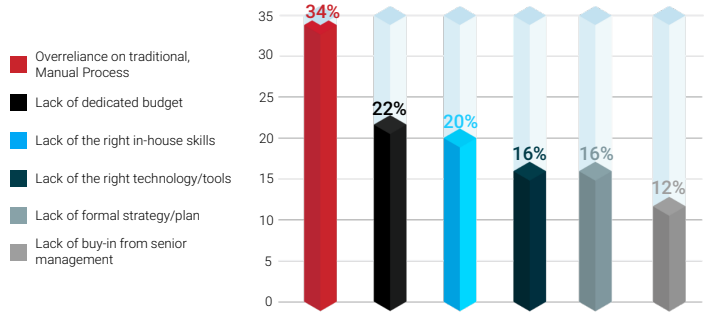
There is nonetheless a tremendous amount of determination to drive the organization forward through digital transformation. When asked what respondents believe to be the most critical steps required to succeed in digital transformation, the following rose to the top: involving all departments in crafting the strategy, investing in team training, and investing in the right technologies.

This is where the VDC Champion, a change leader with passion, vision, persistence, people skills, and organizational savvy, comes in.

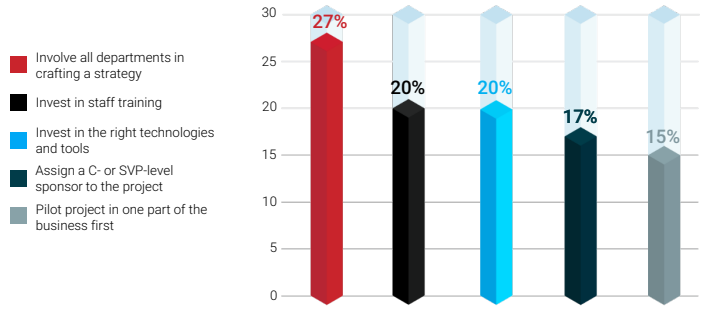
Which construction technologies and innovations are your firm investing in?



Challenges that organizations experienced in undertaking digital transformation



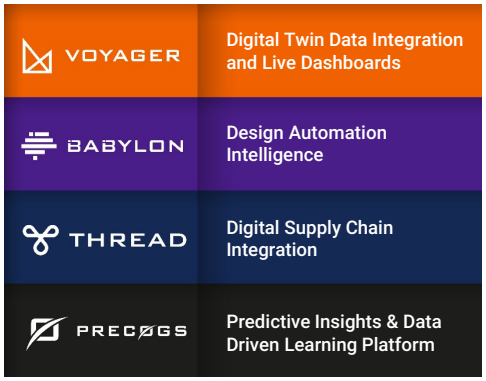
Most critical steps to succeed in digital transformation



VIATECHNIK

The VDC Champion Checklist

The organization must choose its VDC champions wisely. Those with passion for the end state will no doubt emerge as candidates first. But by now it should be clear that being a VDC champion requires not only passion but also vision, persistence, people skills, and organizational savvy. The VDC champion must also choose the suite of tools that's right for the organizational culture, strategies, and objectives. It's critical that there is a strategy for how the tools and the data collected throughout the project will integrate, which is where tools like VIATechnik's Voyager, Babylon, Thread, and Precogs can come into play.



The VDC Champion Checklist

Strategy & Goal Alignment

- [ ] Articulate the company strategy
- [ ] Establish client (owner) objectives
- [ ] Establish project objectives

Metrics for Success

- [ ] Define key metrics
- [ ] Define your controllable factors

Interim Goals

- [ ] Set up interim goals
- [ ] Tie metrics to interim goals

People

- [ ] Enlist your executive champions
- [ ] Align with stakeholders

Technology

- [ ] Identify and fill technology gaps

Move Towards the Future

- [ ] Define the ideal future state
- [ ] Identify pilot projects to accelerate learning
- [ ] Measure, tweak, repeat

THE VDC CHAMPION CHECKLIST

As a champion of VDC within your organization, you must have a clear vision for the future, be metric- driven, and integrate people, process, and technology. Are you ready to champion VDC on your projects and across your organization?

Articulate the company strategy

How clearly is your company strategy understood across the organization? It might be time to talk to your C-Suite to better understand the company strategy and clearly articulate how the strategy should flow through the organization and what exactly it means for individual teams and projects.

Establish client (owner) objectives

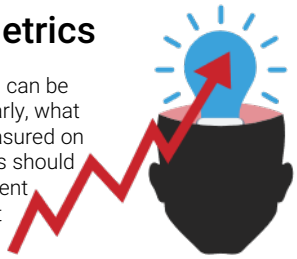
At the end of the day, construction projects are built for the owner. It's important to move past the obvious assumptions and ask the owner how they define success. What are their goals and objectives for the organization, and how does this project align with that?

Establish project objectives

Where are the critical risks on this project? Where are the opportunities for improvement and advancement? When the project is complete, how will the team know if they were successful?

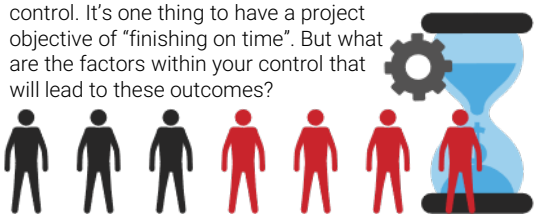
Define key metrics

What can be measured can be improved. So, define early, what key metrics will be measured on the project. The metrics should be clearly tied to the client (owner) and the project objectives established.



Define your controllable factors

It's important that the VDC champion really understand what is within the project team's control. It's one thing to have a project objective of "finishing on time". But what are the factors within your control that will lead to these outcomes?



Set up interim goals

Achieving transformation through VDC takes time. It's important to set up interim milestones to show stakeholders early success and continue to build momentum. These interim goals will also be milestones that help us flag of course correction is necessary.

Tie metrics to interim goals

We're nothing without our metrics. So, remember to tie those key metrics to your interim milestones, too. Learning along the journey is paramount to success.

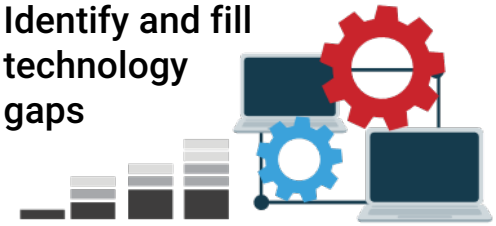
Align with stakeholders

Remember, "VDC is about people". Who are the stakeholders, internal and external, to your organization, that are necessary for success?. VDC outcomes hinge on bringing the "right people, with the right information together at the right time". Critical to your role as the VDC champion is making sure this happens.

Enlist your executive champions

This stakeholder gets his/her own special spot on the checklist. Why? Simply put, your organization cannot and will not move forward without executive buy-in and leadership. Show them this whitepaper. Ask how they would like to see success measured. Ask them what milestones need to be hit for additional corporate resources to be invested in this journey.

Identify and fill technology gaps



What hardware and software stack will need to be used to ensure your success? Good information is a cornerstone of the VDC framework. What tools should be used, and how should these tools be integrated to give you the information you need to make decisions across the project lifecycle?

Define the ideal future state

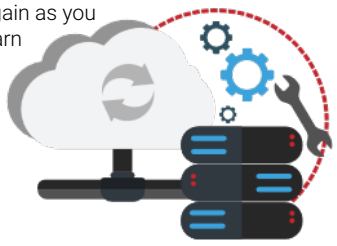
Visualize what success looks like in your organization. What are the process flows, and what are the tools in place in this ideal future? It's important to think about the transitions that need to get underway now in order to realize this future state.

Identify pilot projects to accelerate learning

VDC is a journey. Set up short pilot projects, with stakeholders who are brought into this process, as a way to test out new technology or new workflows. Pilot projects accelerate learning.

Measure, tweak, repeat

And here we are, back to metrics. Look at your metrics to gauge how your VDC journey is progressing. Repeat your success. Make changes to what is not working. And go through this checklist again as you continuously learn and improve.



VDC in Action

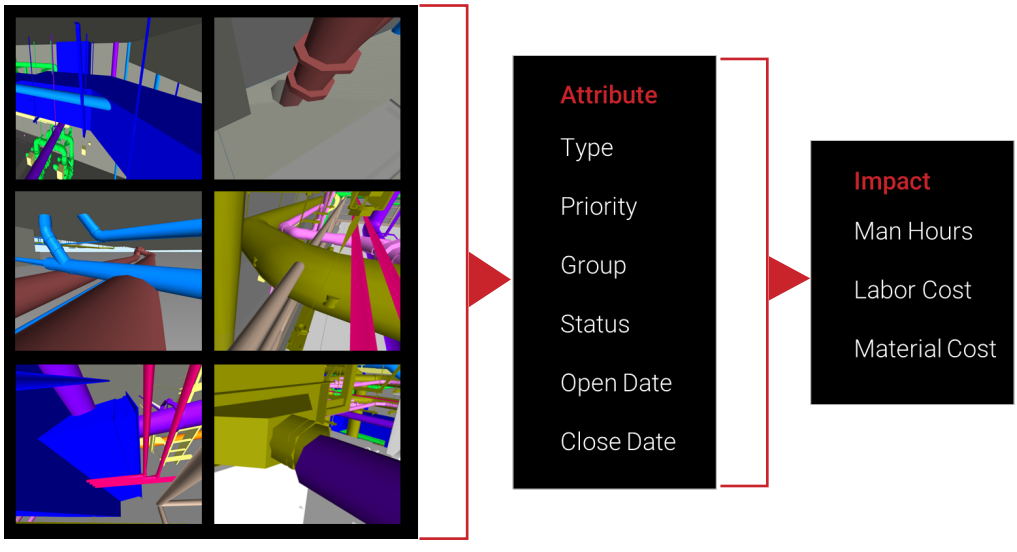
Now let's take an inside peek into what VDC looks like in action. On a large-scale wastewater treatment plant, VIATechnik implemented a holistic VDC process to drive better outcomes. This project involved a four-story new construction solids processing building.

In line with the VDC framework, we started with the client and project objectives in mind. The main challenge that the owner wanted to solve was eliminating rework in the construction field, which was a problem faced on their past projects. The VIATechnik team tracked all issues electronically via BIM Track, a BIM collaboration platform, and utilized a VDC workflow to target this specific goal of rework reduction.

To avoid rework, VIATechnik would 1) need to eliminate clashes between systems virtually and 2) enable prefabrication of certain systems so that work onsite was reduced. The team tailored the VDC Execution Plan to these two objectives and focused heavily on improvements across mechanical, electrical, plumbing, fire suppression, and process piping systems.

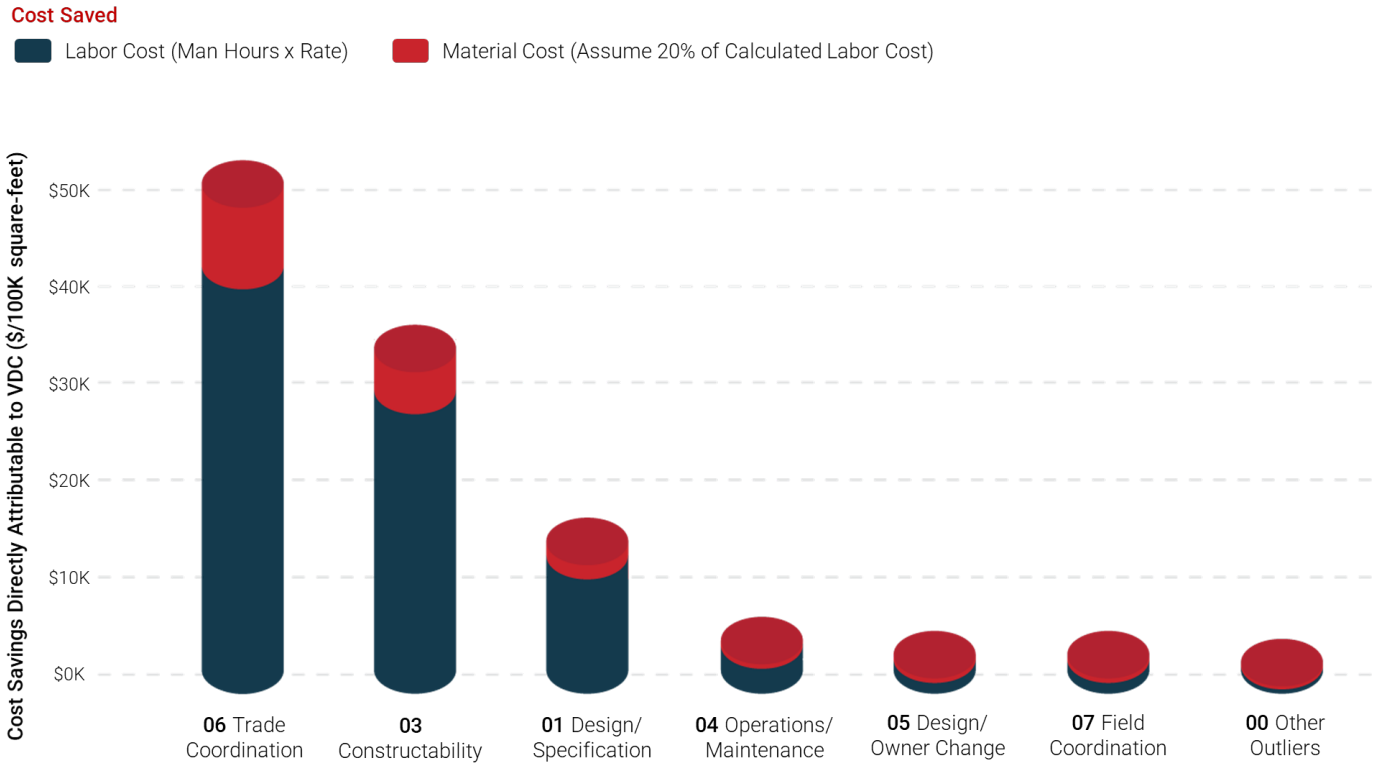
Two important factors for achieving the rework reduction goal were clash detection and issue management. For every issue, 6 attributes were tracked including Type, Priority, Group. Status, Open Date, and Close Date. These 6 attributes (represented in the below figure) were analyzed to determine the impact they had on the project, focusing on the avoidance of man hours, labor cost, or material cost.

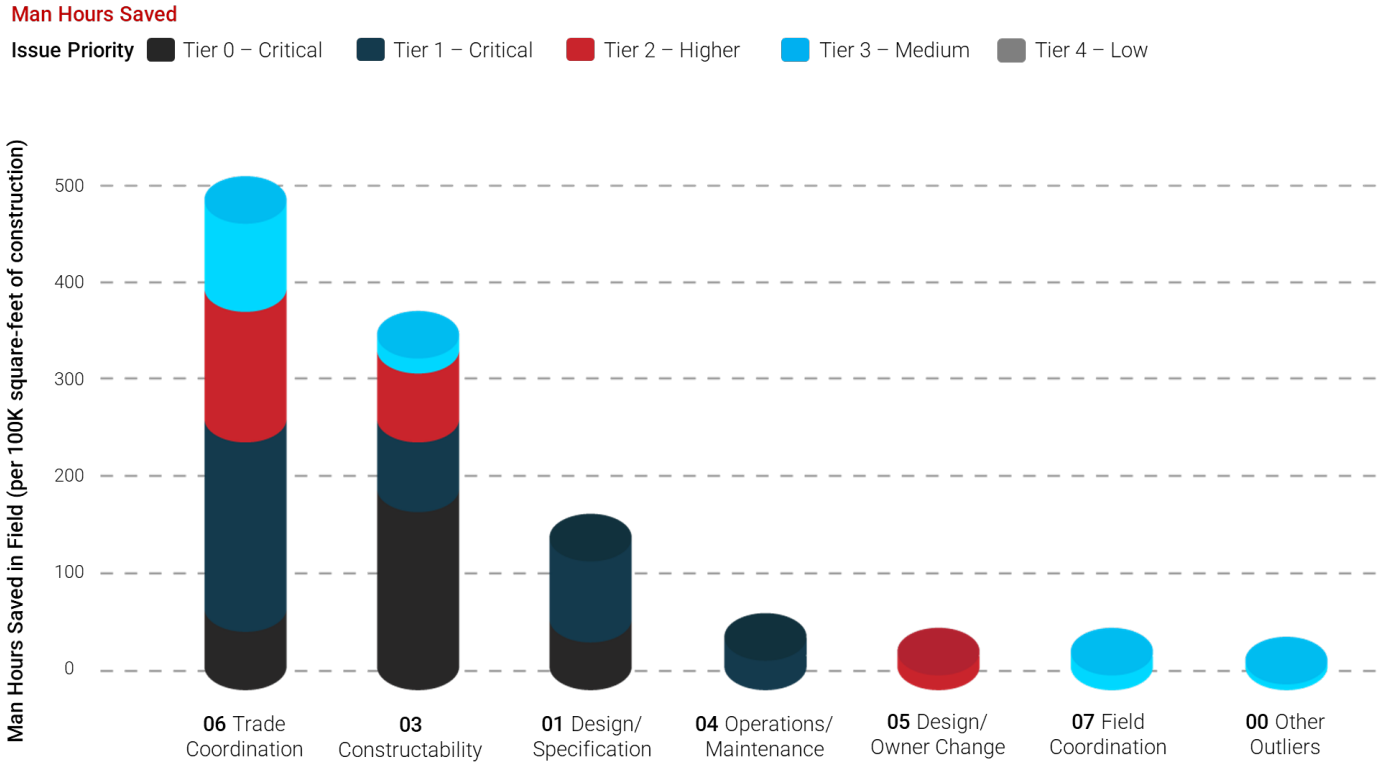
This regimented issue tracking process was a key focus of the team's Integrated Concurrent Engineering (ICE) sessions held between stakeholders. An on-site Big Room was set up dedicated to the VDC process. Throughout the project, the team focused on "getting the right people, with the right information, together at the right time." With data and metrics at their fingertips, the team was able to focus their efforts on issues that would have the greatest opportunities for improvement and the largest downstream impacts.



The Impact of VDC

Did all of these efforts in fact result in eliminating rework and produce a cost and time reduction? The impact to the project, in terms of manhours saved and cost avoidance, was quantified as seen in the below charts. The case for VDC became clear to all stakeholders involved in the project – from workers in the field, to C-suite leadership at the wastewater treatment plant.





Recap

VDC isn't necessarily the right approach for all companies in all situations. But in those circumstances where it's beneficial, it's really beneficial. Of course, VDC must be used well in order to achieve the best results. That requires a culture that's committed to the ideals of VDC, and that may well require senior leadership to drive change throughout the organization.

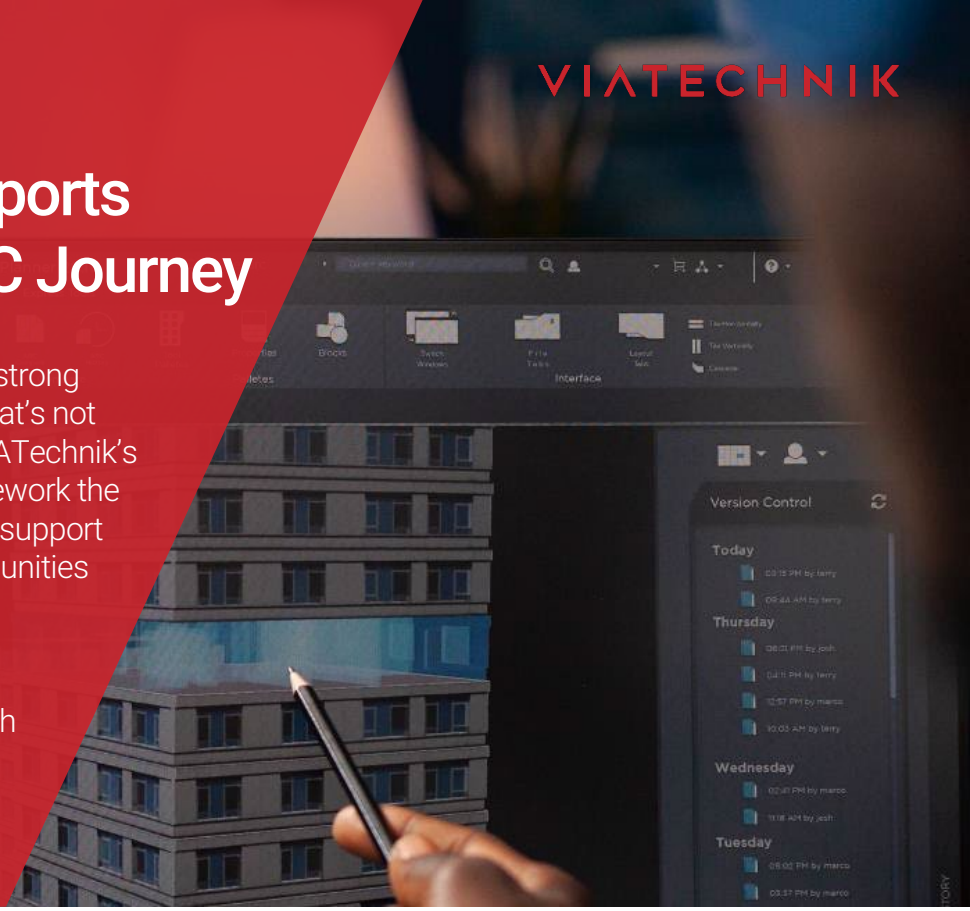
We hope these perspectives and these frameworks have been useful.

VIATECHNIK

How VIATechnik Supports Leaders on Their VDC Journey

Our team will work with you to establish a strong foundation, assess what's working and what's not working, determine where you stand on VIATechnik's VDC Maturity Curve, establish goals, and rework the process. We'll develop a plan and timeline, support the implementation process, create opportunities for quick wins, and measure success for a wider rollout.

We do this through our 3-pronged approach of Strategy, Execution, and Enablement.



Strategy

Digital transformation consulting and advisory linked to corporate strategy

At VIATechnik, we work with our clients to align their digital transformation strategy to their corporate strategy. We bring a fresh perspective to the discovery and stakeholder engagement process, crafting solutions that uniquely position our clients to advance their digital journeys.
We develop digital transformation roadmaps and establish enterprise and project-level standards for VDC, BIM, and digital twins. And we lay out the data analytics approach, including identification and/or development of sources for all the necessary data.

Execution

Develop and implement tools to drive value across the organization

We are experts in executing digital transformation across areas such as BIM, VDC, VR/AR, and deploying software solutions to ensure a high level of quality and success on our clients' projects and across their enterprise. Our team partners with our clients to execute technology on their projects to increase the pace of scale, overcome adoption barriers, and attain measurable results.

- BIM will be the foundation for any digitally delivered project. Your project goals & objectives will determine whether 3D, 4D, 5D, and/or 6D BIM workflows are right for you.
- Our digital fabrication work includes creating digital models of construction modules that are procurement and factory-ready.
- We offer custom software development and integration. BIM software is only the beginning. Our custom applications include automation, machine-learning modeling, and visualization tools.
- We are masters of data integration and analytics. Our platforms include Babylon, Precogs, Thread, and Voyager.

Enablement

Enable the organization to achieve digital transformation through education and data feedback loops

Through data feedback loops and team education, we enable our clients' organizations to realize the value of their digital transformation efforts, embedding technology and innovation in how they drive their businesses forward.
VIATechnik's training approach is a collaboration between Stanford University's VDC course developers and VIATechnik University (VTU). Through the Stanford VDC Certificate, we provide a hands-on learning experience to help individuals and organizations migrate to digital workflows for their capital projects. VTU's curriculum includes BIM processes, technology, and trade-specific knowledge focused on constructability and building codes..

Reach out to us to partner on your VDC journey today.
engineers@viatechnik.com
312-462-1060

VIATECHNIK

Trusted by owners, general contractors, trade contractors, material suppliers, and many more.

References

[i] "Rethinking productivity across the construction industry: The challenge of change", The Economist, Intelligence Unit, 2015

[ii] "The Impact of BIM/VDC on ROI: Developing a Financial Model for Savings and ROI Calculation of Construction Projects," Salih Sen, KTH Royal Institute of Technology

[iii] "Prefabrication and Modularization: Increasing Productivity in the Construction Industry", McGraw Hill Construction

[iv] "Construction Projects Cost Overrun: What Does the Literature Tell Us?", International Journal of Innovation, Management and Technology, Vol. 8, No. 2, April 2017, Abdulelah Aljohani, Dominic Ahiaga-Dagbui, and David Moore,

[v] "Construction Project Complexity: Research Trends and Implications", Journal of Construction Engineering and Management, February 2017, Lan Luo, Edward J. Jaselskis, Qinghua He, Jianxun Xie

[vi] "Virtual Design and Construction: Themes, Case Studies and Implementation Suggestions," John Kunz & Martin Fischer, Center for Integrated Facilities Management, Stanford University

[vii] "A study of virtual design and construction implementation and benefits using a Bayesian approach," L. Rischmoller, M. Fischer, J. Kunz, Stanford University, 2012

[viii] "VDC Use in 2007: Significant Value, Dramatic Growth, and Apparent Business Opportunity," Brian Gilligan & John Kunz, Stanford University