

VIK TOR

**Automate the boring,
Engineer the awesome!**
*White Paper for the
construction industry*

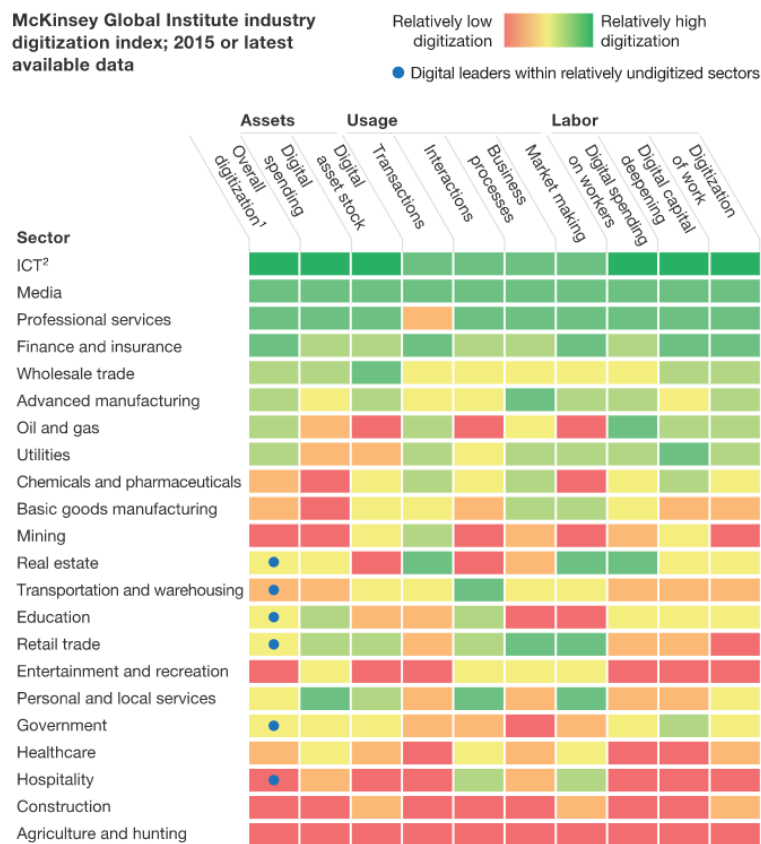


Introduction

Autonomous cars, algorithms that are trading stocks, people having conversations with robots and digital services from the valley make our lives easier. It is already part of many different industries and drives extreme productivity. Considering these benefits of digitalisation, there is huge potential in introducing this in the engineering and construction sector.



The engineering and construction industry spends way less on digital transformation than other sectors like aerospace or automotive.¹



¹Based on a set of metrics to assess digitization of assets (8 metrics), usage (11 metrics), and labor (8 metrics).

²Information and communications technology.

Source: AppBrain; Bluewolf; Computer Economics; eMarketer; Gartner; IDC Research; LiveChat; US Bureau of Economic Analysis; US Bureau of Labor Statistics; US Census Bureau; McKinsey Global Institute analysis

Figure 1. Retrieved from McKinsey²

¹ <https://www.mckinsey.com/industries/capital-projects-and-infrastructure/our-insights/imagining-constructions-digital-future>

² <https://www.mckinsey.com/industries/capital-projects-and-infrastructure/our-insights/imagining-constructions-digital-future>

So when the benefits are obvious, why have the engineering and construction industry not yet fully embraced new digital technologies? The reasons of lacking behind are understandable and have to do with the characteristics of the industry. But we have come to a time where there are increasing opportunities at hand for the sector to speed up digital transformation.

McKinsey Global Institute indicates that digital transformation can result in productivity gains of 14 to 15 percent and cost reductions of 4 to 6 percent.³

In this paper, first the reasoning behind and usefulness of digitalisation is explained. Followed by the different trends of digital transformation in the current society, to give an overview of what is going on. Then our view on digital transformation is given, together with our solutions on existing problems. Finishing the paper with how you can start today with your transformation.

Construction companies and digital transformation

A typical engineering and construction project involves not only multiple companies, but also different departments within a company. The brief time they spend on a project, is mostly too short to have the incentive to embrace new methods. The job should be done, and it is easier to use the methods you are familiar with than develop a new one, of which you don't know in advance if it will work.

³ <https://www.mckinsey.com/industries/capital-projects-and-infrastructure/our-insights/decoding-digital-transformation-in-construction>

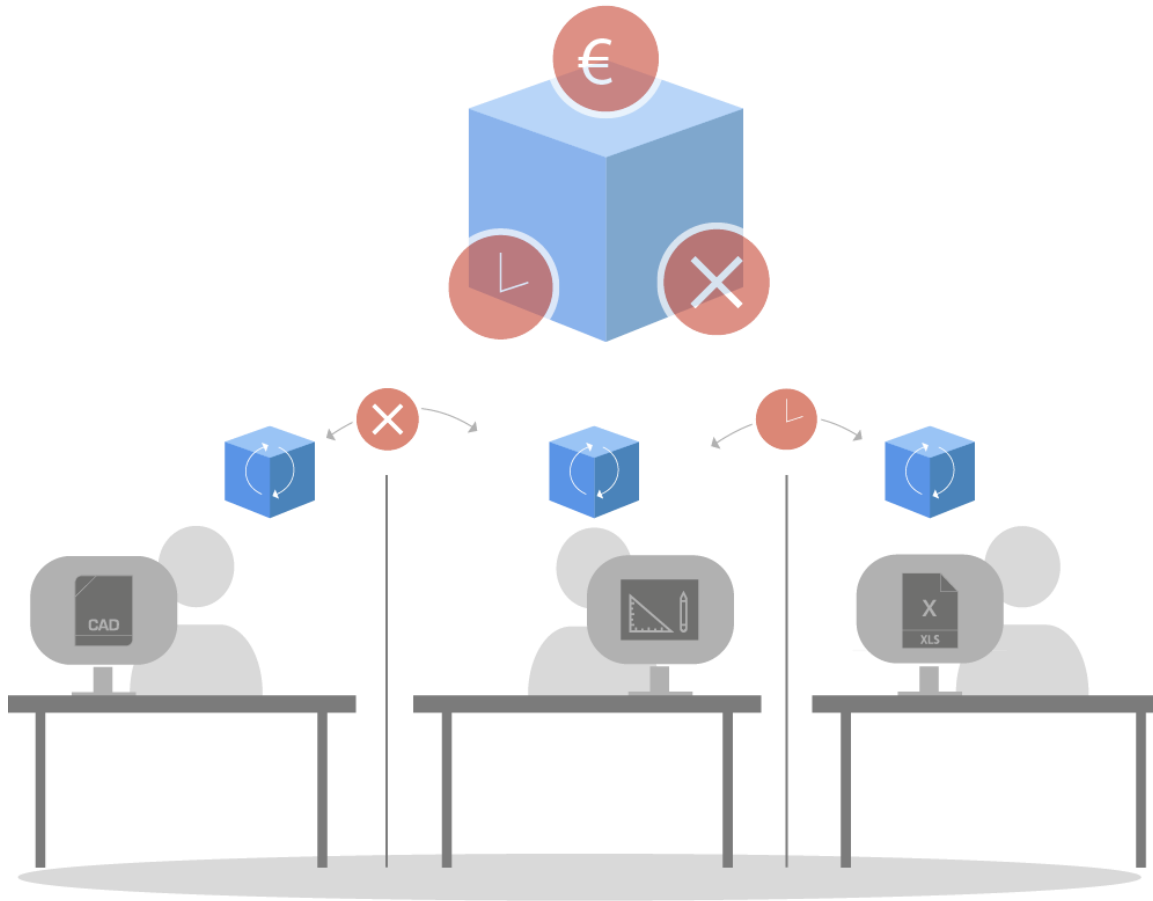


Figure 2. Schematic overview of involved and current interactions during a project.

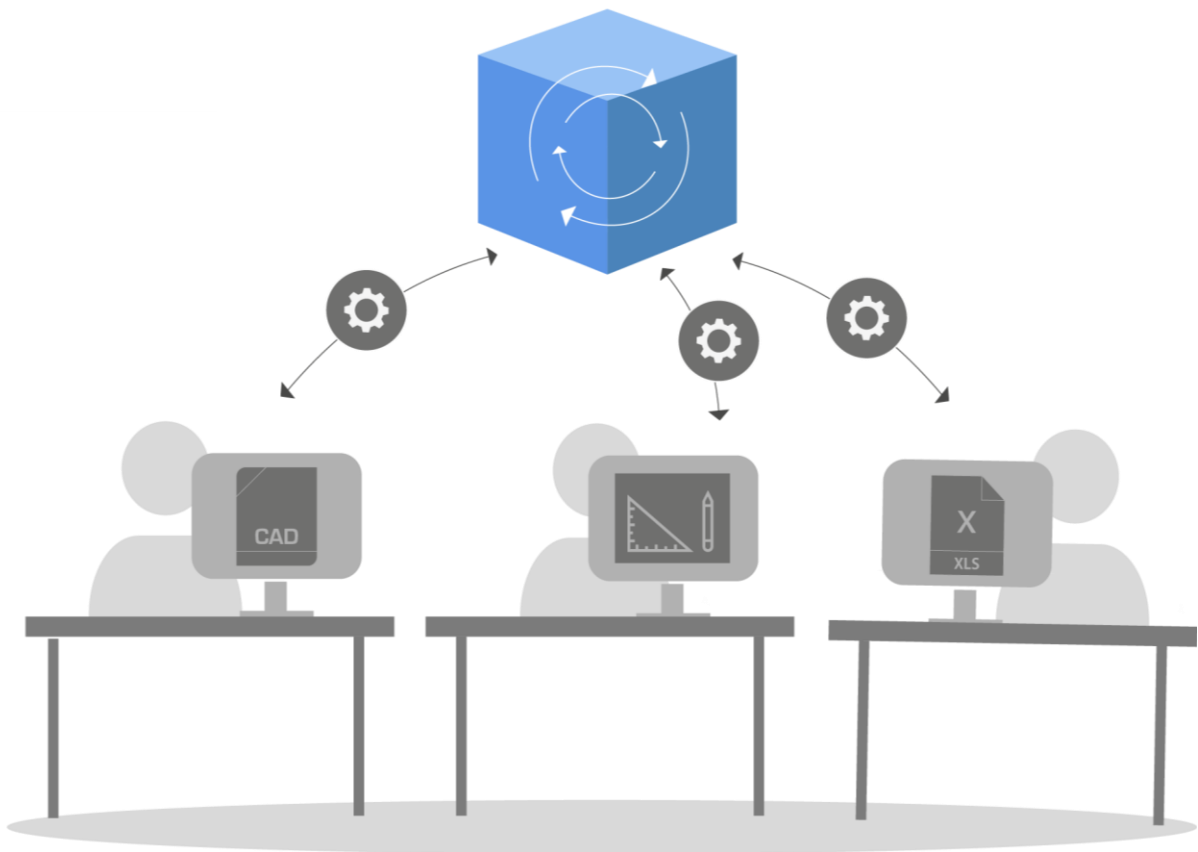
Moreover, projects vary greatly, which makes the construction companies struggle to develop tools and methods that can be applied regularly. And, with the uncertainty about reusability, there is also a battle with the limited R&D budgets within the construction industry. They spend way less on digital transformation than other sectors like aerospace or automotive.

This results in departments that keep on doing their own part of the design, with poor structured communication between departments. Information sharing is delayed and not universal. Therefore, they often work from different versions of reality. With the digital transformation this problem can be solved, and even more. For instance, now it is difficult to capture and analyse data. But it is important to do so, since in procurement and contracting, analytics on historical performance can lead to better outcomes and risk management.

Different approach

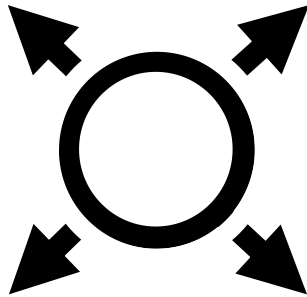
So, the opportunity to improve the company's performance is by means of increasing the implementation of digitalisation. Due to the limited R&D budgets, large diversity, limited knowledge and relatively brief periods to implement, it requires a different approach. This approach is not about installing a total overarching IT solution which will be suitable for every project. This approach is about implementing the right centralized (reusable) system that facilitates collaboration and analysis and provides understandable insights to all key players. This system should be built quickly with tools that can be controlled by a team of relevant domain experts and low-code developers which are preferably the domain experts. To make it even more powerful, standard machine learning and artificial intelligence should be easily implementable by these developers. This fits with the global trends which are identified as the main technology trends.

Figure 3. Schematic overview of involved and wanted interactions during a project.

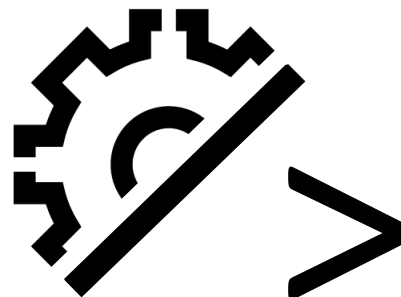


Technology trends for a different approach

Gartner, the world's leading research and advisory company defines that hyperautomation and democratization are two of the 10 major strategic technology trends that will drive disruption. These trends facilitate the digital transformation within the construction industry.



Democratization



Hyperautomation

Democratization

Gartner defines “Democratization of technology means providing people with easy access to technical or business expertise without extensive (and costly) training. It focuses on four key areas – application development, data and analytics, design and knowledge – and is often referred to as “citizen access,” which has led to the rise of citizen data scientists, citizen programmers and more.”

The target for the democratization trend could be any person inside or outside the enterprise including customers, business partners, corporate executives, sales experts, assembly line workers, professional application developers, and IT operations professionals.

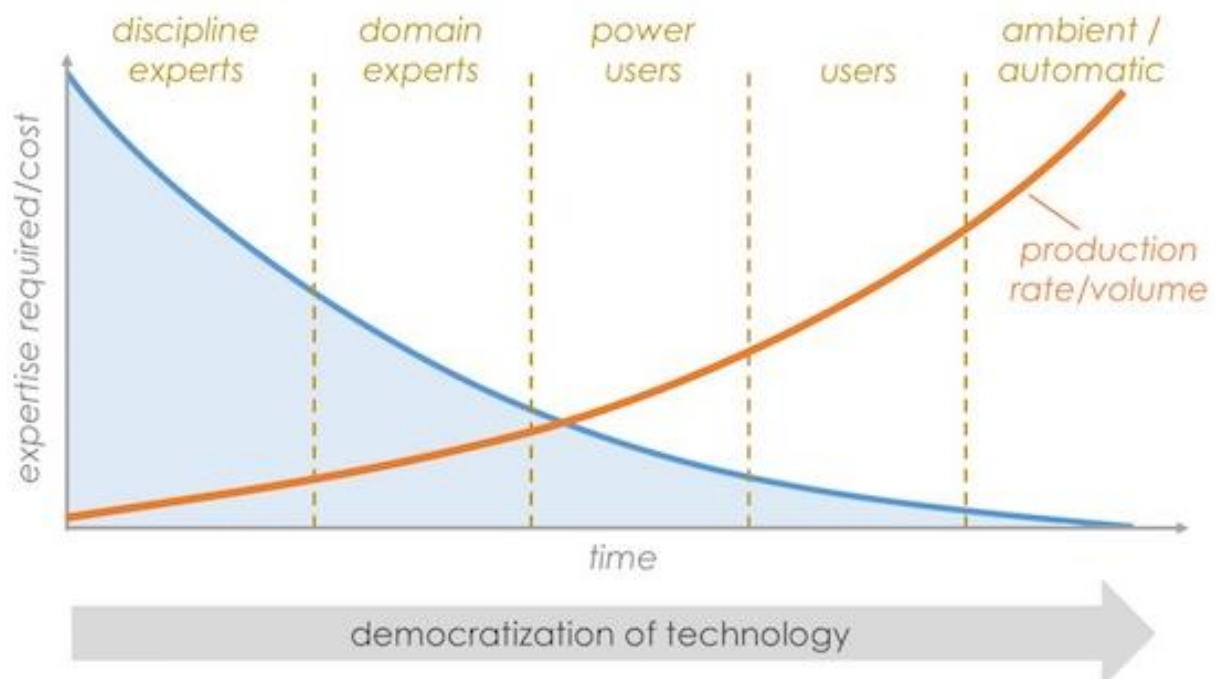
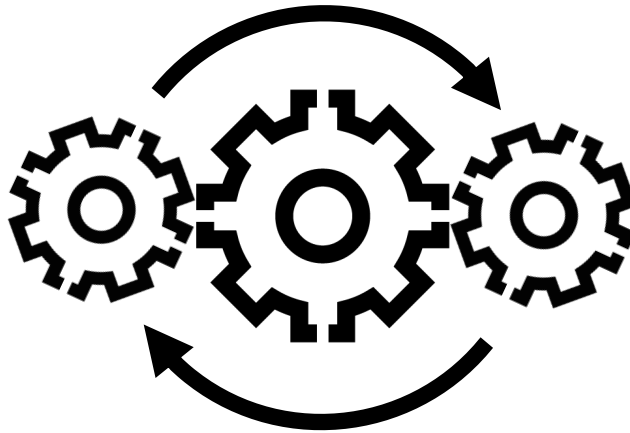


Figure 4. Retrieved from Chiefmartec⁴

⁴ https://cdn.chiefmartec.com/wp-content/uploads/2018/05/democratization_martech_volume.jpg

Hyperautomation

Gartner defines “Hyperautomation deals with the application of advanced technologies to increasingly automate processes. Hyperautomation extends across a range of tools that can be automated, but also refers to the sophistication of the automation (i.e., discover, analyse, design, automate, measure, monitor, reassess.)”.



In simple terms, hyperautomation refers to the mixture of automation technologies that exist to augment and expand human capabilities.

What is the difference between hyperautomation and regular automation?

Where automation often refers to robotic process automation, hyperautomation covers the system of technologically advanced tools, combining them creating a new way to work.

Hyperautomation not only refers to the implementation of tools to manage tasks, it also involves interaction and collaboration between humans, as well. Humans are vital in making decisions and interpreting data and applying logic using the technology.

Therefore, hyperautomation provides your business and its leaders with:

- » Increased employee satisfaction and motivation
- » Increased team collaboration
- » Greater productivity
- » Advanced analytics
- » An educated workforce
- » Automated processes
- » Increased employee capacity
- » Instant and accurate insights
- » Greater compliance and reduced risk

Technology trends in the construction industry

Multiple developments in the construction and engineering industry that tie in with these trends became more or less daily practice, but still lack the full potential to disrupt the industry on a solitary basis. Two of these are BIM and parametric/generative design.

(B)IM

(B)IM is the most bespoke software that has a lot of characteristics of democratization but is limited in hyperautomation. (Building) Information Modelling (BIM) is a digital representation of physical and functional characteristics of an object. It also provides access and insights to information for different personas within an organisation. BIM files can be exchanged to support decision making. These functionalities make it a very powerful tool.

McKinsey specifically mentions that BIM will gain much more popularity in capital projects. For these cases BIM is evolving from inclusion of design data to scheduling, costs, energy, life cycle and more. In case of smaller projects, BIM is less effective, due to the required implementation time. This directly exposes the limitations of BIM.

In practice all elements of business operations from compliance applications to vendor component specification should be streamlined and integrated into one single system, making it time consuming. Moreover, different levels of training are also required. If the in-house project manager does not have the required skill, the organization has to hire a special BIM manager that may increase the cost again. Specific challenges such as time/speed, flexibility and familiarity will still function as a barrier. This is the barrier that prevents full democratization.

Characteristics of hyperautomation are not incorporated into a Building Information Model. It only functions as an information model where information is extracted and pushed back.

Parametric and generative design

Parametric design has few characteristics of democratization and hyperautomation. Generative design has much more hyperautomation characteristics.

“Parametric design is a process based on algorithmic thinking that enables the expression of parameters and rules that, together, define, encode and clarify the relationship between design intent and design response.” (WIKI)⁵

“Generative design is a design exploration process. Designers or engineers input design goals into the generative design software, along with parameters such as performance or spatial requirements, materials, manufacturing methods, and cost constraints. The software explores all the possible permutations of a solution, quickly generating design alternatives. It tests and learns from each iteration what works and what doesn’t.” (Autodesk)⁶

In other words, generative design is a more advanced version of parametric design. The inclusion of Artificial Intelligence makes it a learning system and relevant for the hyperautomation category. It helps to find the solution within the boundaries which are defined. In case of manufacturing it is mainly applied in designing objects with material, manufacturing and cost constraints. Due to the resulting extreme geometries it is also linked to 3D printing. It can also be effectively implemented in e.g. master planning.

⁵ https://en.wikipedia.org/wiki/Parametric_design

⁶ <https://www.autodesk.com/solutions/generative-design>

Generative design experiences an intermediate growing interest according to Technavio⁷. A compound annual growth rate of 16% is expected during the period 2019–2023. Technavio is one of the most influential market research and advisory firms in the world.

The challenge in generative design is the utilization of the full potential in a traditional engineering environment. Designers which are not familiar with programming of this type of logic will experience a barrier. Furthermore, it is relevant to determine if the task should have this advanced level of automation. In that sense it is very limited in democratization.

A new technology trend for the construction industry

Another trend which already entered other industries will make it possible to fully adopt the benefits of democratization and hyperautomation. This will come from the low- and no-code online application platforms.

Low-code and no-code online application platforms

An online application development platform contains all characteristics of democratization and hyperautomation.

Application development is the development of a computer program which is designed to help people to perform activities. In this case it is focused on building custom applications to perform tasks within a small or big engineering and construction project.

Application development platforms enable the development of custom applications. Such platforms enable developers of different experience levels to rapidly create online applications that incorporate a graphic user-interface, ability to gather and process data, integrate with other disciplines and provide the end-user insights. According to Gartner, low-code application platforms will be responsible for more than 65 percent of all app development activity by 2024.⁸ The implementation of this type of software is still limited in the construction industry.

⁷ <https://www.technavio.com/report/global-generative-design-market-industry-analysis>

⁸ <https://www.gartner.com/doc/reprints?id=1-1FKNU1TK&ct=190711>

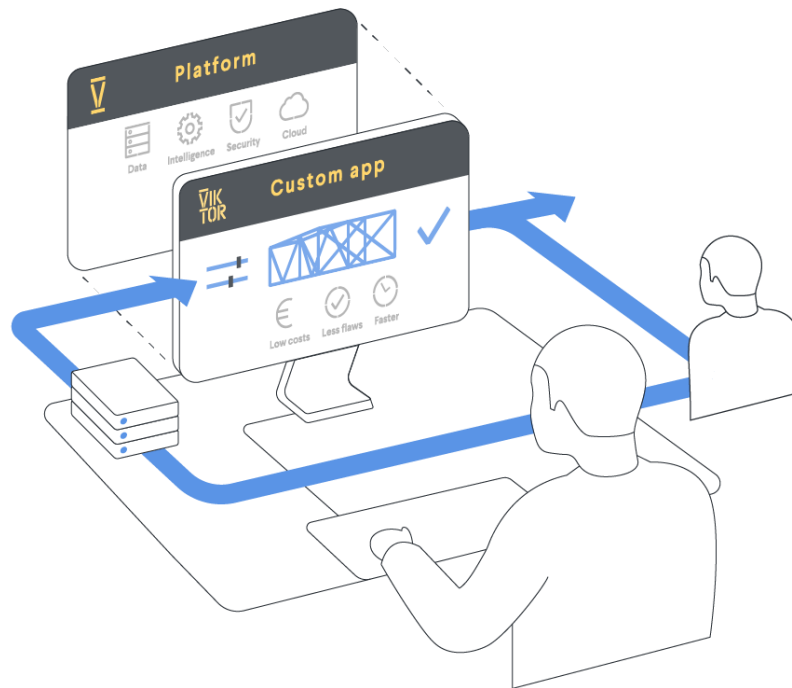


Figure 5. Schematic overview of a low-code application platform.

The type of apps can be distinguished in *Internal apps*, *outside facing apps* and *legacy app replacement*. An internal app could be for instance the analysis and cost optimisation of a foundation. Two initially separate, not directly integrated disciplines, are combined into one computer program and e.g. made accessible to the sales department. An outside facing app for instance provides a client the ability to make an initial design of a bridge and get pricing and delivery feedback. Legacy app replacement could be rebuilding your Excel tools as such, that you get a better revision control and ability to distribute.

Low-code for the construction industry

Our approach is implementing the right centralized system that facilitates collaboration, analysis and provides **understandable** insights to all key players. This system is easily set up with the desired tools, and can be controlled by a team of domain experts and low-code developers. The easy implementation of standard machine learning and artificial intelligence by these developers, makes it even more powerful.

We focus on seven value drivers:

1. Rapid and easy application development
2. Centralize and distribute data and tools
3. Integrate and automate
4. Find the best solution. Fast!
5. Capture knowledge into assets
6. Provide understandable insight
7. Make work joyful

Rapid and easy application development

To empower the adoption of digitalisation in construction project, where time is of the essence, the application development time should be very short.

We enable Rapid Application Development which is a form of agile software development methodology that prioritizes rapid prototype releases and iterations. The adoption of this methodology is facilitated by the ability to quickly design, build, deploy and manage applications.

‘The ability to build applications within weeks makes it possible to realize a ROI within the same project.’

Paulus Eckhardt, Director Design & Engineering and Process
Information Management at Ballast Nedam Infra Projects

We enhance flexibility, adaptability and iteration speed thus empowering developers to implement adjustments during the development process. We encourage code reuse and collaboration to reduce room for error, coding and testing time.

Centralisation and distribution of data, models and analysis

The creation of a design/solution is a collaboration of multiple people from different disciplines, departments and companies. Everyone, every department and every organisation have their own way of working and use their own parameters and data. Everyone is necessary and all processes are interrelated. This means that if one person changes a variable, everyone must do so. Resulting in all needing to be assessed and reanalysed, giving a lot of (re)work to do.

A central point/database in which the most important/useful parameters and calculation/design processes are defined is therefore key. Then everybody will use the same input, no misconceptions can occur, and everybody will have the most recent version of the design(parameters). Which increases efficiency tremendously.

Our approach is to set up such a structure in which the processes that are interrelated get coupled in multiple networks where VIKTOR can act as a minor or a major network. In the end you get an overall system in which the relevant processes are coupled and only the most relevant parameters are shared. Close to centralisation stands integration.

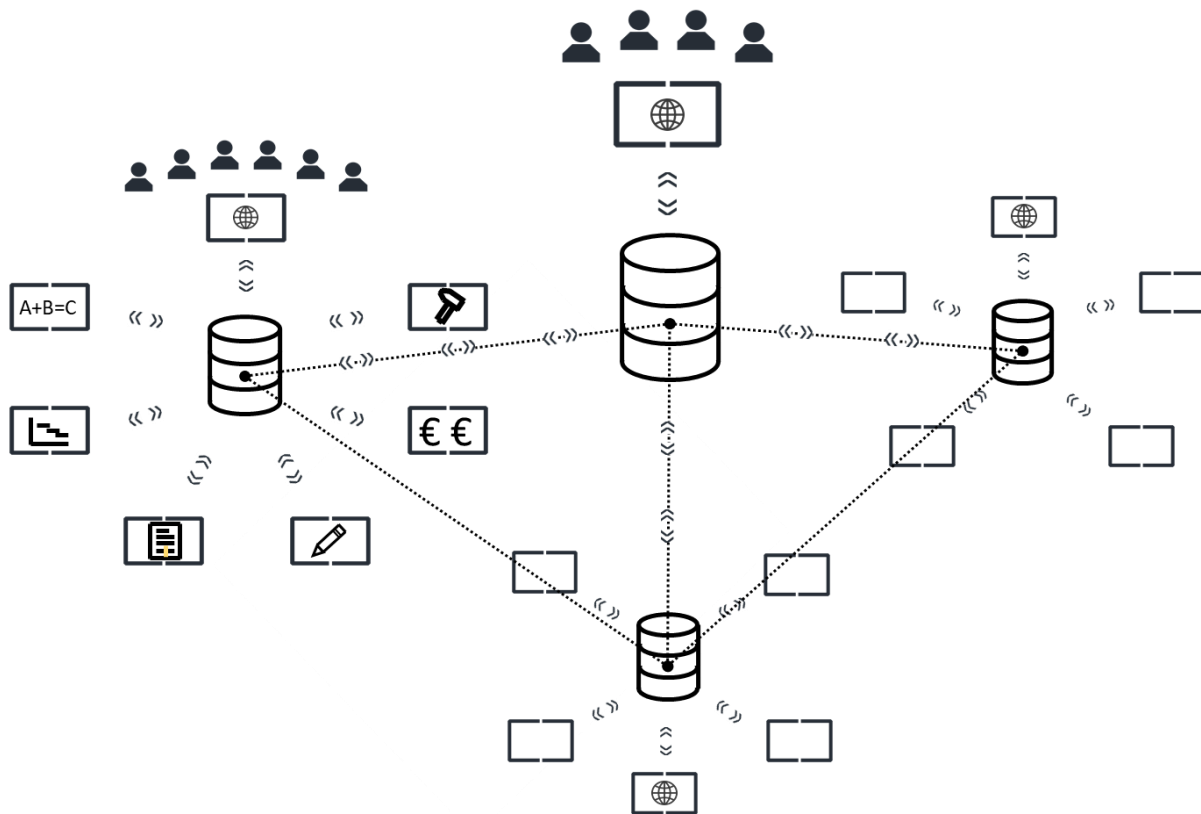


Figure 6. Schematic overview of the network structure.

‘Centralisation and distribution of data, models and analyses was key for uniformity in our processes.’

Ikbal Kelkitli, Coastal Engineer at BAM Infraconsult

Integration and Automation of processes

Although every project is unique and requires another approach, there are steps that must be done each time. This can be testing different parameters in a certain design, do the same type of calculation or use the same software programs. This is repetitive work and not the most interesting to do. Besides the tedious character of repetitive work, it is also mostly not efficient. To get a smoother, quicker and better process, you have to start with automation.

Being able to not only use one program at the time, but direct multiple software programs from a central point creates numerous benefits. Multiple autonomous software programs are normally not able to talk to each other. This means that you have to control them separately. With digitalisation it becomes possible to create a platform in which multiple software programs are coupled to a central point, from which they can be executed simultaneously. This integration decreases the amount of risks and increases the efficiency.

‘Numerous integrations with different software packages and algorithms enforced automation to a whole new level.’

Richard Reurings, Engineer and engineering manager at Voorbij Funderingstechniek

Find the best solution. Fast!

Automatization doesn't have to be very complicated. Even the simplest calculations can be automated, so instead of 4 done manually, the computer can do a 1000 for you in the same time. Therefore, it will take a person a lot more time to find the best or optimal solution. Time which probably does not exist, so the optimal solution is not found for a project, only the solution that is 'good enough'. With an automated process the optimal solution can be found! Next to that, the computer can do more complex stuff than a person would ever be capable of manually.

A lot of software programs work fine but give a program input data for a single calculation can take some time. This is why automating the input files is also a very effective way to get to the optimal solution. Getting the best solution manually is possible but takes a lot of time. With the help of digitalisation and automatization a lot of time can be saved to get to the optimal solution.

‘VIKTOR gave us the ability to use advanced algorithms to explore thousands of options instead of a few.’

Jurre Blauw, Senior Developer at G&S Vastgoed

Capture knowledge into assets

The design process within companies is often quite difficult and requires specific knowledge. This knowledge is coming from employees with a lot of experience in the field, who know exactly which steps have to be taken, in which way and what the risks are of certain decisions. This knowledge is hard to capture, especially on paper.

When they leave, the company has got a problem. It is hard to completely transfer all the knowledge to new people, without good documentation or computers to help with that. With digitalisation, collecting and capturing this knowledge becomes easier. The different steps don't have to be written out but can be captured in an application. The risks can be implemented as conditions and calculation can be done automatically.

‘We stopped with distributing knowledge via spreadsheets and stepped up to a more professional, fool proof and secure way.’

Harry Westra, Chief Operation Officer at Grootlemmer

Get the best insights

It is also difficult that not all members of the team have, or sometimes nobody has got the complete view of the project. They know their own parts and maybe the ones of a direct colleague, but not of everyone since it is way too much work to understand and keep up to date with all various processes going on within one project.

With the connection between different departments, new insights can be obtained. Relations that weren't visible before are now exposed. It also increases the amount of design variations that can be made. Therefore the chance on risks decreases a lot and chance to find the optimal result increases enormously.

'By means of a digital twin of our movable bridge and live environmental data we have gotten insights into the best way to solve clamping issues during the summer'

Mozafar Said, Asset Manager at Gemeente Rotterdam

Make work more joyful

To get a smoother, quicker and better process, you have to start with automation. Having a computer which can do the repetitive, boring work for you, having your software programs connect, and having a lot more efficiency, means you got time to do the exciting stuff.

‘The luxury of having a tool that takes over 80% of the work, quickly becomes your standard.’

Jaap Wierenga, Lead Engineer Waterbouw at Heijmans Infra

The VIKTOR platform

The VIKTOR platform is a web-based platform on which online applications can be built. These applications are developed using a very widely used programming language: Python. In an application, Python is used to program professional and business knowledge. One of the specific functionalities of the VIKTOR platform is the integration of all relevant data sources and software programs.



With the help of the platform, the data and analysis results are centralized and made available to the relevant persons by using a dashboard through authorizations. This gives everyone more insight and the right up-to-date information. Professional and business knowledge is also guaranteed in this way.

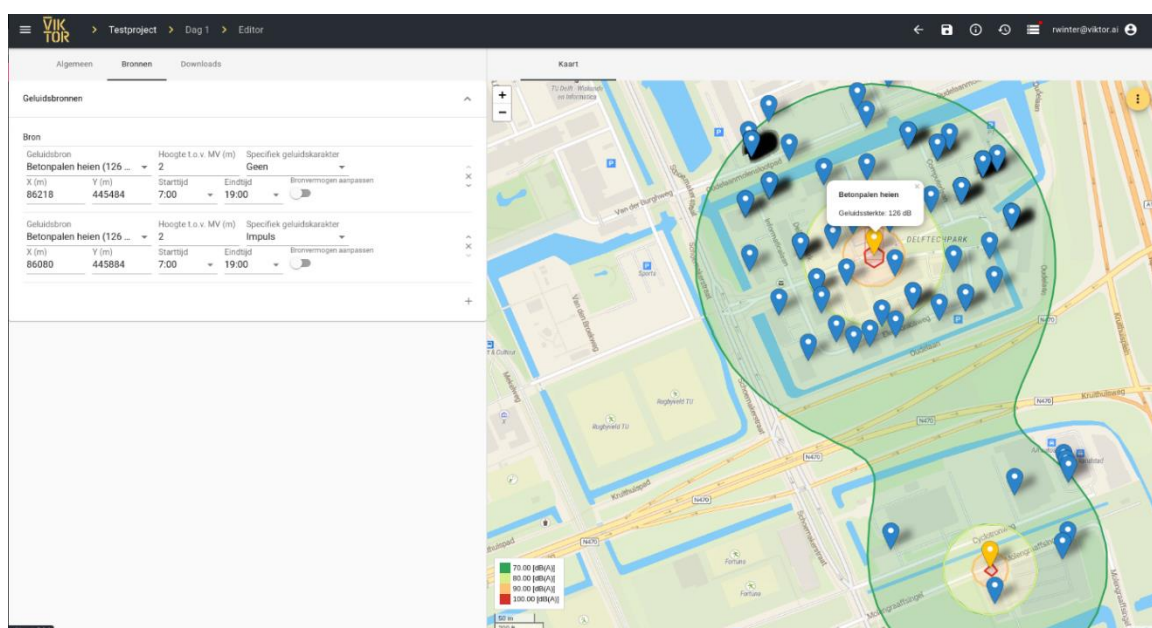


Figure 7. An example of a VIKTOR application.

What does it cost?

The cost of automation strongly depends on the size and complexity of the existing design process. In addition, it is of course cheaper when the application is developed internally. If you don't have the time or if you lack the knowledge, VIKTOR integration partners make customized applications in a sprint from around 120 hours. Since the benefits of automated engineering are enormous, you quickly earn back the costs, often within just one project.

How to start

Suppose you want to (partly) automate your engineering process. Where do you start? It is important to start with a good process analysis that provides insight into the design process. Which processes are conducted by which person, for what purpose and in which system? You then define the purpose of the desired application and describe it on the basis of user stories. A user story contains the functionalities from the perspective of the end user. How does this person use the application and what data does he or she put in the system? The development can then best be carried out via an agile process, in short sprints in which the application is directly tested and validated by the end user.

What's next?

By understanding the goal and purpose of engineering automation, you now want to automate your engineering processes. It is important to start with a good analysis that provides insight into the design/engineering processes. Starting with studying the company to determine which processes are taking place and which are suitable for automation. The goal is to gain insight into how you can automate quickly, effectively and successfully. More information about this analysis can be read in the [business analysis guide](https://viktor.ai/business-analysis-guide/)⁹.

Thereafter, you have hopefully a much clearer picture of the possibilities for automation inside the company. With the insights you gained from this business analysis, you will be one step closer to a more efficient and better performing company. The next step would be to do a process analysis, in which a specific engineering process is analysed a lot deeper and a plan for an automated process is made. More about the process analysis can be read in the [process analysis guide](https://viktor.ai/automated-engineering-process-analysis-guide/)¹⁰.

Want to know what other companies thought of the business & process analysis? How they have implemented the results in an application? Or how they use engineering automation in practice? Take a look at our [customer cases](https://viktor.ai/1/customer-cases/)¹¹.

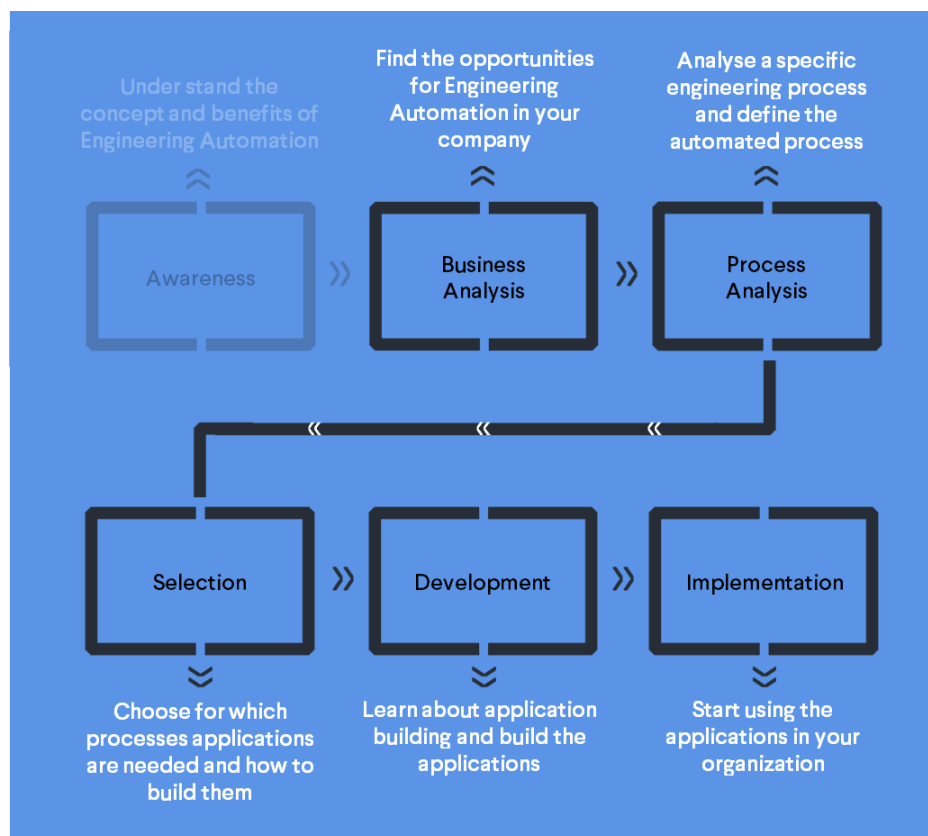


Figure 8. The steps for automation.

⁹ <https://viktor.ai/business-analysis-guide/>

¹⁰ <https://viktor.ai/automated-engineering-process-analysis-guide/>

¹¹ <https://viktor.ai/1/customer-cases/>



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