ALICE TECHNOLOGIES

What the heck is generative construction?

Construction firms and owners who embrace this technology are saving precious time, resources and money on capital projects

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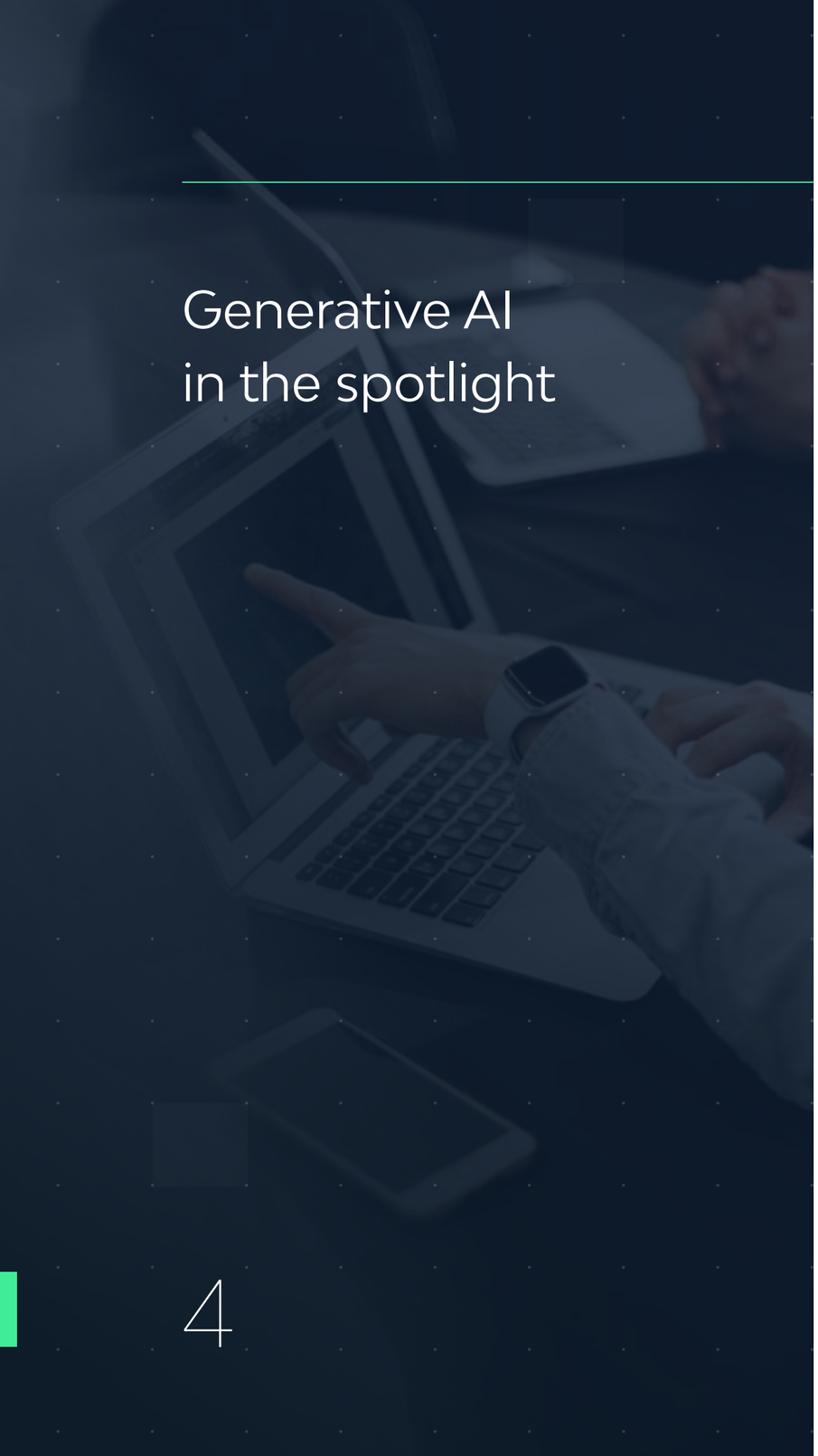


Generative AI in the spotlight

With the introduction of general purpose tools like ChatGPT and Google Bard, the topic of generative AI has recently received overwhelming attention in the media. Businesses have been quick to put these tools to work, testing their ability to do everything from writing legal documents to crafting social media posts. And while we are still only beginning to understand the capabilities and limitations of these products, it is already clear that generative AI is going to have a substantial impact on the nature of work in the years ahead.

Some of the most promising opportunities to make use of generative technologies are emerging in specific use cases or industries. The construction segment is one excellent example, and innovative general contractors and owners are already reaping the benefits of generative solutions.

But before we get into the use of such technology in construction, let's begin by defining a related topic: generative design.

02

What is generative design?

What the heck is generative construction?

Keith Meintjes of the product lifecycle management consulting firm CIMdata describes generative design as:

"an iterative design process that involves a program that will generate a certain number of outputs that meet certain constraints, and a designer that will fine tune the feasible region by selecting specific output or changing input values, ranges and distribution. The designer learns to refine the program (usually involving algorithms) with each iteration as their design goals become better defined over time."

By combining this process with computing power and Artificial Intelligence (AI) algorithms, which explore all the possible solutions (permutations) of a scenario and generate many alternatives in a short amount of time, a designer can examine the solution space thoroughly. Through this process, the designer can run numerous tests and learn from each iteration what works and what doesn't. That way, the designer has the best chance to arrive at the most effective and optimized design. Nature's evolutionary approach (genetic variation and selection) works in a similar way and has resulted in the emergence of a world of creatures optimized for their specific environments.

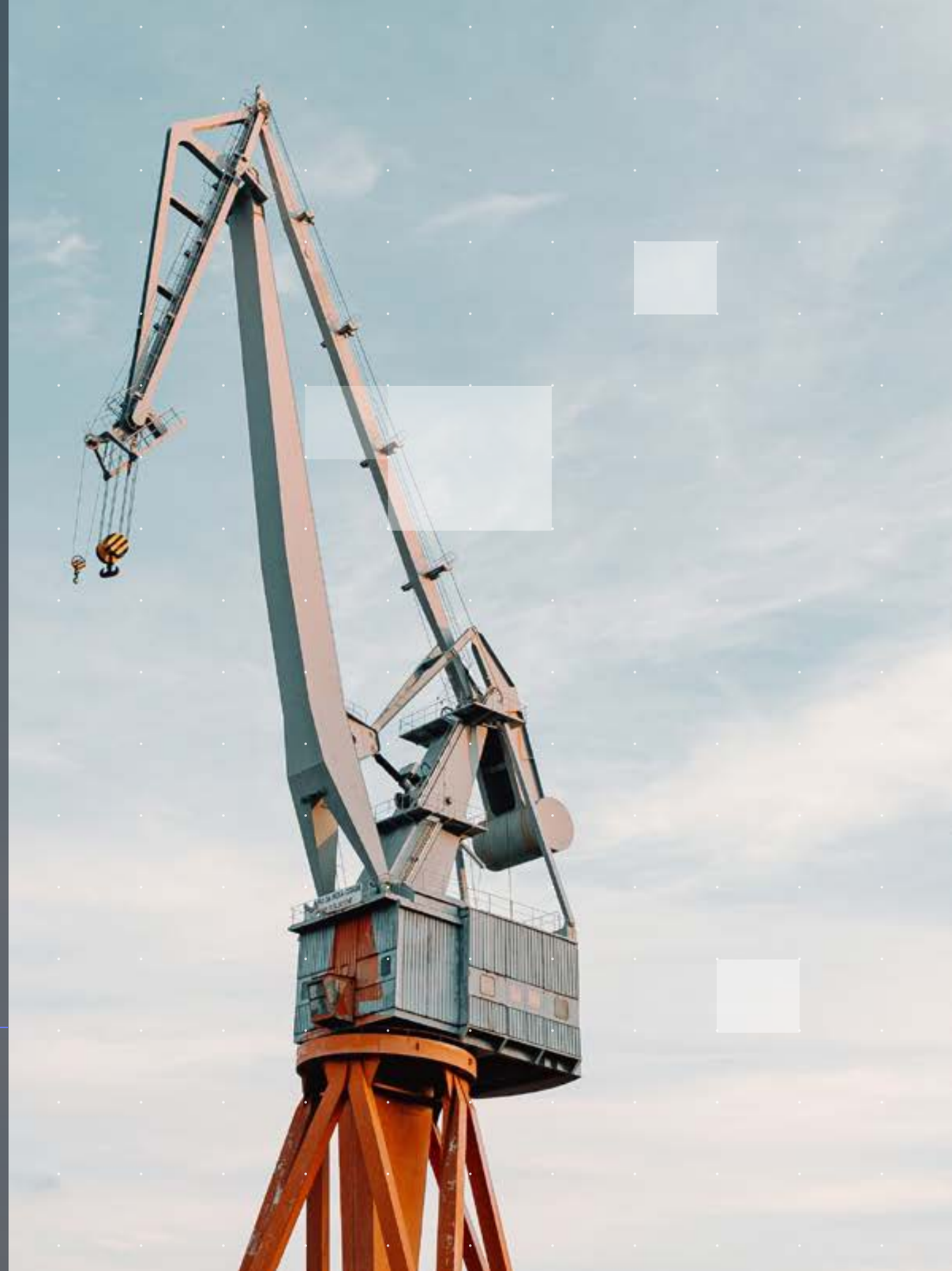
While much has been written about generative design, the topic hasn't received much attention in the construction space until recently. The main reason for this has been that design has been successfully parametrized. By employing computational and parametric models– sometimes coupled with artificial intelligence (AI) algorithms–engineers and architects have been able to create thousands of options by simply defining their design problem and, inputting basic parameters such as height, the weight it must support, strength, and material options.

[1]Meintjes, Keith. ""Generative Design" – What's That? - CIMdata"

03

What is generative construction scheduling?

And how does it differ from products like ChatGPT?



What is generative construction scheduling?

And how does it differ from products like ChatGPT?

Generative construction scheduling is a technology that parametrizes project data to automatically generate construction schedules and optimize work sequences and resource allocation, based on user-defined rules, objectives and constraints.

And this is a big deal for a number of reasons. One of the most important of these is the fact that this is an automatic process. You do not have to manually build a schedule in P6 or Excel anymore.

Generative AI products like ChatGPT create a wide variety of different output types, from musical scores to photographs to business plans. With generative construction scheduling, however, the output is much more tightly defined: an optimized construction schedule for a particular project. It is a usable schedule and plan that a project team can execute.

Another important difference between these technologies is that generative AI uses deep learning algorithms and neural networks to analyze and learn patterns from existing data and then generate new content based on those patterns. Generative scheduling, on the other hand, parametrizes your project data and uses algorithms and optimization techniques to explore the entire solution space and automatically generate schedules and sequencing options.

04

Construction: many inputs, many outcomes

What the heck is generative construction?

Construction: many inputs, many outcomes

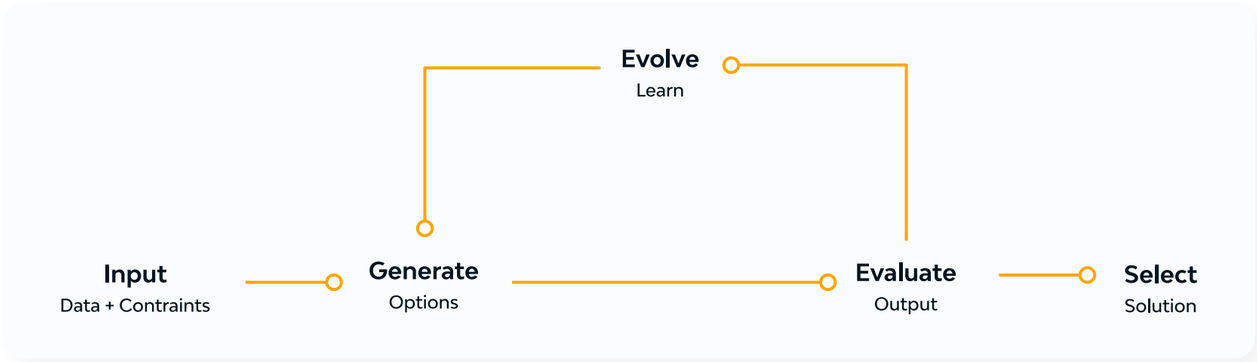
Construction not only involves project scope (the design and metadata) but also planning, cost estimates, scheduling, equipment, labor, sequence … and the list goes on. These factors constitute the ingredients that come together to influence how a construction project plays out. And with so many inputs, the number of possible outcomes is enormous. To color the point with some basic math, let's assume a simple geometry with four construction zones, some basic types of equipment and materials and think about how many construction strategies are mathematically possible:

= 405,504 ways to build

So, how much of the solution space are we actually investigating before we submit that schedule or that cost proposal?

If we take a step back and try to think about how many questions are involved in a construction project, we'll probably end up with a headache. Given the complexity involved, all the details to keep track of, and all the disciplines interacting, it seems as if the ability to do virtual "what if" experiments — to experiment with rules and assumptions — is paramount before we build something for real.

The main steps for model-based approaches include defining the objectives (or articulating the questions), inputting the constraints and requirements, generating review and selecting solutions.



Where the concept of "generative" appears is when we start talking about planning and scheduling – terms that can cause heated discussions in the construction domain. But what's the difference between them?

The ability to do virtual "what if" experiments — to experiment with rules and assumptions — is paramount before we build something for real.

Morgan Hays,

VP of Product at ALICE Technologies

Succinctly put:

What is Planning?

Planning is forming a list of:

Operations, along with their precedence relationships, durations, and other resources requirements e.g equipment

VS

What is Scheduling?

Scheduling is taking that list of operations and:

Assigning start (and end dates) to each operation, such that no constraints are violated

05

Generating construction scheduling options

What the heck is generative construction?

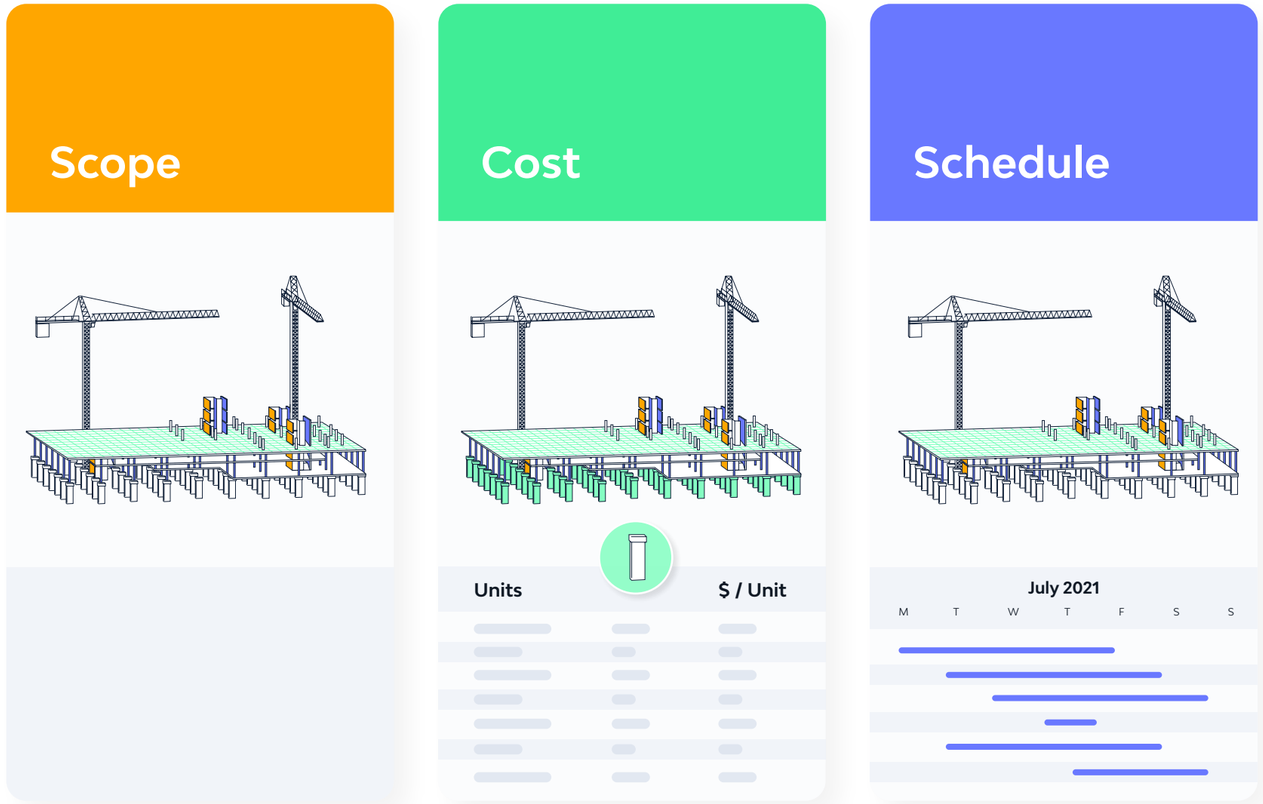
Generating construction scheduling options

In a parametric model-based system like ALICE, the popular construction optioneering platform, planning and scheduling are distinct phases. The first one (planning) is governed by the user (human) and the latter (scheduling) is done by the machine. This process happens thousands of times, generating multiple solutions that do not violate the planning constraints. Simply put, the user, by utilizing their experience and knowledge, is focused on ironing out the project objectives, as well as the constraints and limitations that can throw the project off either in terms of budget or completion timeline. Essentially, they are formulating a problem model and making sure it encompasses the necessary complexity. The computer does the hard work, or in other words the "number crunching," by solving that problem over and over again ... in minutes.

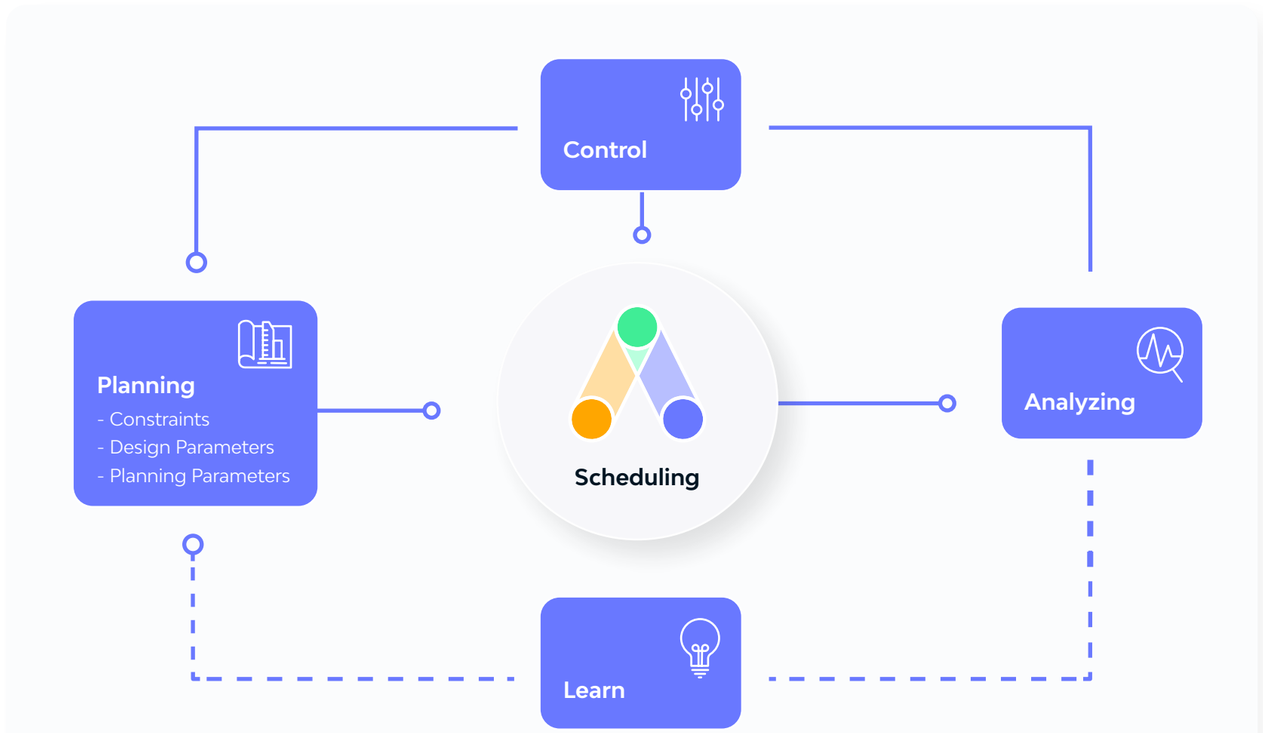
Ultimately, a multitude of solutions that include schedule, cost and other KPIs are generated, which the user can evaluate and proceed accordingly, either by:

- Selecting a solution from the generated set
- Changing the parameter values and generating a new solution set
- Changing the problem constraints and generate a new solution set

As a result the conceptual process model for construction transforms from something rigid, static and linear...



...into something dynamic that allows value engineering and insight generation through iterative learning.



Hence, the main goal of the project controls team is no longer to producing a schedule or an estimate.

The focus shifts more strategically into considering what parameter values will result in the schedule metrics desired by the project team and stakeholders.

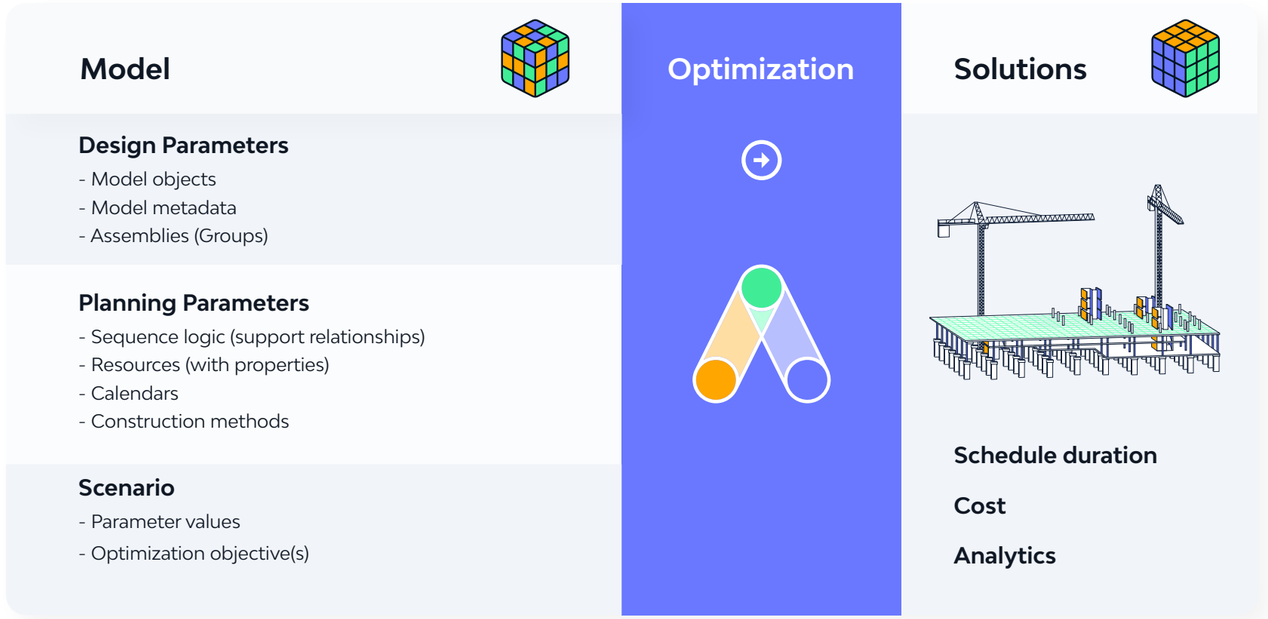
06

Parameterizing the construction process model

What the heck is generative construction?

Parameters are independent variables that are controlled by the user and their values - if unknown - can be estimated based on historical data or experience-based observations. Parameters express the functional dependence between the input and the output. Therefore, minimal changes to the input are automatically propagated throughout the system and ultimately to the end product (schedule metrics).

At a high level there are 3 main types of parameters: design, planning and scheduling parameters. The first 2 types (design, planning) constitute the main source of input and their values are determined by the user. The values for the scheduling parameters are changed and determined automatically by the algorithm in the background... which produces the numerous solutions with different metrics (duration, cost and analytics).



When a particular value for each parameter is selected, that constitutes a scenario. Thus, the user can assess the effects of a “scenario” (parameter values) on the metrics of interest and explore new scheduling options simply by changing the parameter values and clicking on a button. A more detailed list of of the various parameter types:

Planning parameters

- Sequence Logic (Support relationships)
- Resources (with properties)
  - Labor
  - Equipment
  - Cranes
  - Materials
  - Custom properties
  - Production Rates
- Calendars
- Recipes
  - Operations
  - Precedence

Design parameters

- Model objects
- Model metadata
- Assemblies (Groups)

Scheduling parameters

- Sequence
- Duration

Final Thoughts

The shift to generative construction scheduling will require industry professionals to approach problems in new ways. They'll need to think and approach problems differently, and that will need to become a standard operational practice within their organizations.

The technology-based solutions that enable generative construction scheduling and support decision making are powerful, but technology in itself will only get us so far. People and processes are the remaining ingredients required to enable companies to make the transformation from conventional to digital.

ALICE TECHNOLOGIES

ALICE Technologies is the creator of the world's first construction optioneering platform. Founded in 2013 based on research from Stanford University, ALICE helps contractors and owners to reduce risk and plan, bid, and build capital projects more efficiently.

The company works with large customers in the infrastructure, commercial, and industrial construction segments, companies such as Bouygues, Align JV, Hawaiian Dredging Construction Company, and Implenia. Headquartered in the U.S., ALICE also has significant operations in the Czech Republic, the U.K., and India.

Request a Demo

www.alicetechnologies.com