ARCHITECTURE, ENGINEERING & CONSTRUCTION

THE PRODUCTIZATION EFFECT

How integration-ready modules will transform the roles of general contractors, specialty contractors and the entire construction value chain

DASSAULT SYSTEMES

EXECUTIVE SUMMARY

Today's trade-based construction and assembly processes, even when performed off site, present massive execution risks. **Financial sinkholes** lurk wherever a trade may intersect with another trade.

Productization is a radically different approach that unlocks new levels of value and scalability for developers. At the core of this strategy are **integration-ready construction modules**, which incorporate multi-trade assemblies, standardized interfaces and generative variants. These modules organize into product lines that align with the business objectives of owners and general contractors (GCs). They are **managed independently** of projects (off-cycle) and enable immense variability across multiple projects.

As developers increasingly see the value of productization, GCs can **overcome disintermediation** by reframing their role as "prime integrators" of construction modules. A prime integrator delivers value to owners by managing virtual makers, orchestrating site logistics and mastering new approaches to procurement.

Specialty contractors can **enjoy new revenue streams** as "virtual makers." A virtual maker collaborates with designers, GCs and even directly with owners, digitalizing critical trade-based intelligence in an off-cycle phase. Their virtualized work product informs the design phase of virtual construction twins and scales across multiple projects.

Finally, microfactories are emerging as a **new category** of value chain players. These disruptors locally produce and deliver integration-ready modules to create new value pools in a rapidly evolving industry.

This white paper maps the path to productization and defines how GCs, specialty contractors and the entire construction value chain can leverage **virtual twins** on an end-to-end collaboration platform, transcend the limitations of classic industrialization and leapfrog to personalized construction.

FORCES OF CHANGE

Demand continues to grow for cost-efficient buildings, rapid delivery, customization and greater sustainability. Yet an ongoing **shortage of skilled workers** makes it impossible for GCs to satisfy the skyrocketing demand with existing processes.

Meanwhile, in response to an unprecedented ecological crisis caused in large part by the traditional development model, regulators are compelling the construction industry to **operate more sustainably**. Examples include the Green Building Energy Reach Code in Santa Monica, California and the French Environmental Regulation RE2020 which requires a dynamic lifecycle assessment and bio-sourced materials.

Mass production does not accommodate a localized market, does not offer sufficient variability, and is patently rejected by building owners and occupants who have been groomed to expect **hyper-customization** in the experience economy. As a result, standardization of the built environment offers limited market appeal.

This desire to deliver an experience is also pushing developers to seek closer collaboration with the designers, manufacturers and fabricators of building products, systems and modules. This allows developers to meet the challenge of hyper-customization while delivering a cohesive brand experience.

These forces are pushing all players in the construction industry ecosystem to rethink how they can best deliver value.

LIMITATIONS OF INDUSTRIALIZATION

Over the last decade, the construction industry has come to terms with the need to make significant changes. Most major players have taken steps to improve efficiency, borrowing lessons from manufacturing industries and adopting digital design, off-site construction and prefabrication strategies.

However, there are critical differences between high-volume, mass-production, industrialized manufacturing and one-off, hyper-customized, large-scale construction projects. These differences demonstrate the need for an altogether new approach to construction delivery.

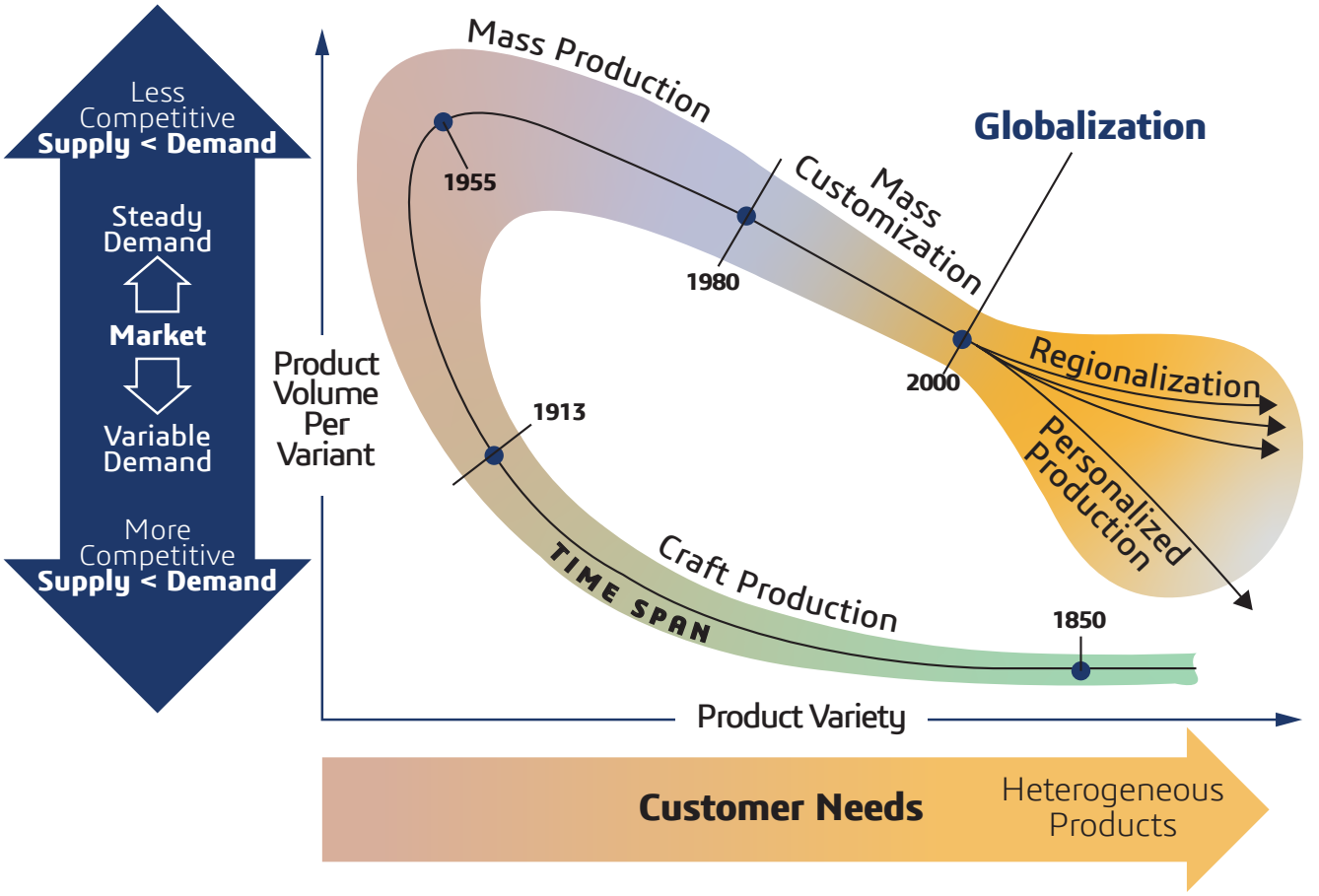
Lessons From the Industrial Revolution

Until the Industrial Revolution, craftsmanship was the sole solution for creating goods, including buildings. Each product was developed by hand, with the potential for quality to vary across goods produced.

With the advent of the Industrial Revolution, manufacturers were able to mass produce goods to satisfy demand with a high volume of product. The tradeoff is that mass production relies on component standardization and limited product variety to achieve cost efficiencies. This standardization at high volumes removes any opportunity for **personalized production**.

Manufacturers of mass-produced goods are now beginning to navigate this challenge as they recognize the limits of industrialization in their own context. The emergence of Industry 4.0 is meant to support manufacturers in harnessing data to drive **greater flexibility** in production processes and the mass customization of goods.

THE TRAJECTORY OF PRODUCTION STRATEGIES THROUGH THE INDUSTRIAL AGE



REFERENCE: "The drivers to new paradigms are market and society needs." ***The Global Manufacturing Revolution: Product-Process-Business Integration and Reconfigurable Systems*** by Yoram Koren (November 2010). Reprinted with permission from John Wiley & Sons.

From Mass Production to Personalized Construction

It is often said that the construction industry has been slow in boosting its productivity. Globally, "labor-productivity growth" in construction has averaged only 1% per year over the past two decades compared with 3.6% in manufacturing.[1] To be fair, the needs of the construction world are in direct opposition to the standardization that has driven the massive gains in manufacturing productivity.

An automotive manufacturing process may demand an investment of €1 billion in equipment and processes, which is recouped through a high volume of standardized goods. These processes would also harness the contribution of as many as 3,500 suppliers. Through the use of a digital twin, the factory might produce 30 to 50 vehicles each hour.

Construction players pushed to mimic the efficiencies of manufacturing have long recognized the drawbacks of mass production. The construction industry operates on a project-by-project basis within a fragmented and localized ecosystem. Each project faces unique site constraints and is customized to meet an owner's specific demands. Each project is delivered by a team of tradespeople who may be operating together for the first time.

To date, technology has not yet addressed the realities of **fragmentation, localization and the need for personalized production** in construction. However, sustainability goals, increasing project complexity and technological advancements are opening the door for innovation and transformation. While the construction industry can learn from the efficiencies of high-volume manufacturing, its unique challenges demand a different approach to achieve creativity and scalability.

[1] "Reinventing construction through a productivity revolution" by Mckinsey & Company (February 2017)

Limitations of Prefabrication

Prefabrication is one strategy that has gained traction within construction and allows a team to mature from managing pure site-built projects, the vast majority of developments happening today, to an off-site manufacturing and assembly approach.

Moving construction processes off site into a prefab shop offers nominal advantages. The controlled environment permits work to continue regardless of inclement weather, quality is improved in a controlled environment, and skilled labor can be concentrated in the warehouse while unskilled labor can be deployed to perform on-site assembly.

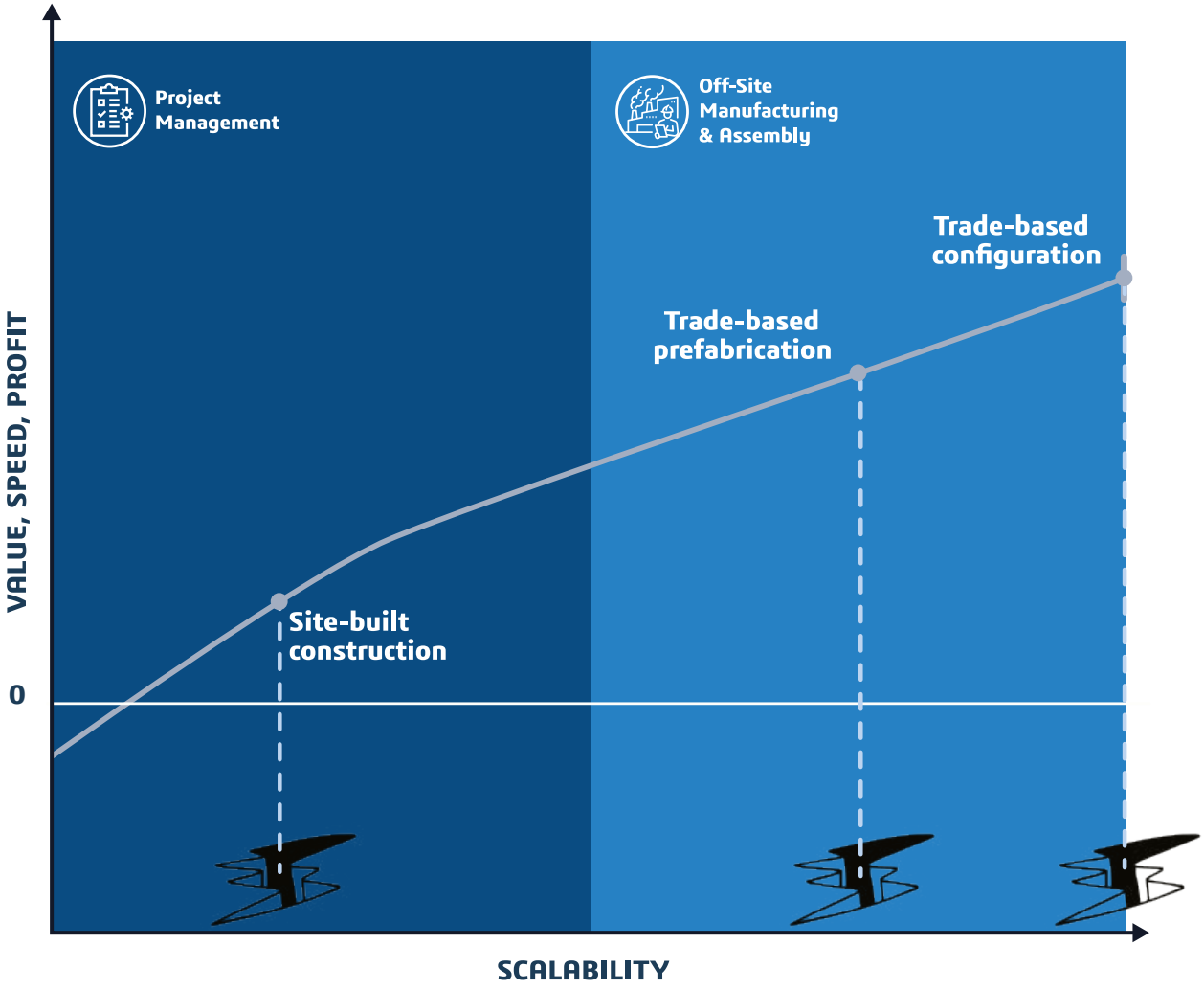
While prefabrication solves some logistical problems, it also carries some critical limitations. Prefabricated components are limited to a maximum size and weight since they still must be transported to the jobsite. This process creates two locations to control because some assembly work happens in the prefab shop, while other activities take place on the construction site. These logistical issues **increase the cost** of large, low-density prefabricated assemblies.

In addition, any construction and assembly process that keeps trades in silos will present **massive execution risks**, even when performed off site. The parts of a build that require attention from more than one trade – particularly in condensed areas where many components intersect – create and compound risks to the timeline, budget and quality. If one tradesperson is late to a task, or if a pipe is installed where a conduit needs to be, complications arise that impact all other trades.

These instances create "**financial sinkholes**" on construction projects. Once tripped, these sinkholes can threaten to sink the profitability of the entire development.

Financial sinkholes can impact off-site prefabrication operations and even modular configurations that rely on skilled labor to manage integration. As such, the trajectory of industrialization strategies fall far short of the full potential for scalability and value creation generated through an alternative approach.

FINANCIAL SINKHOLES LURK WITHIN TRADE-BASED STRATEGIES



From Building Information Modeling to Virtual Construction Twin

While building information modeling (BIM) was once considered a critical piece in driving project delivery efficiency, the truth is that BIM applications have not met the needs of GCs and specialty contractors. After more than a decade in use by architects and engineers, few construction companies can credit cost savings to BIM because the applications are not used in the field.

BIM's usefulness as a specifications solution for architects does not translate well to construction. A BIM model of a door, for example, may contain sizing, acoustic information, fire performance and other characteristics, but it will not include the granular definitions of components needed to make a purchasing list. As a workaround, contractors are likely to flatten the BIM model into a paper drawing and create a spreadsheet from which to order components.

A **construction virtual twin** provides a solution. This is a digital representation of the physical processes and components of a development. The virtual twin provides a structural view of a project for contractors and a systems view for managing the entire design, engineering and construction process. An end-to-end collaborative solution such as the **3DEXPERIENCE®** platform can link these diverse views together. Oversight into the entire design, engineering, product manufacturing and construction process is critical for orchestrating the project and ensuring design intent is manufactured and installed correctly.

Virtual twins also capture the reality of production and construction processes in real-to-virtual loops. The virtual twin incorporates real-world feedback from the field and updates the model based on what happens on site.

PRODUCTIZATION DRIVES RADICAL NEW LEVELS OF VALUE AND SCALABILITY

Today, technology is available to support a radically different approach to construction. Productization is a strategy for delivering hyper-customized, efficient construction solutions at scale. This approach uses virtual construction twins to enable the application of generative, configurable design strategies to the factory construction and management of modular systems.

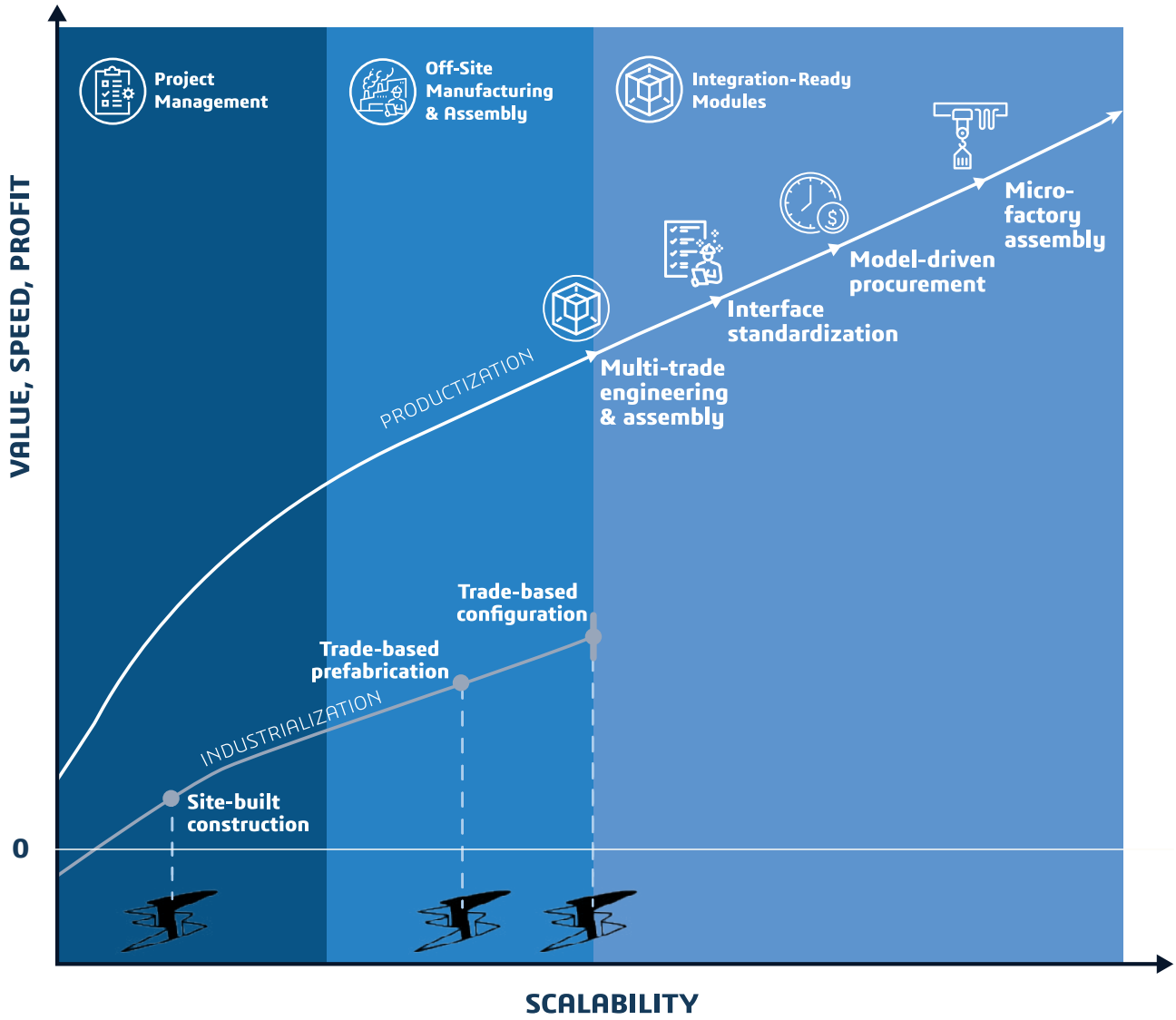
In contrast to off-site manufacturing that preserves trade-based workflows, productization delivers to the construction site "integration-ready modules" that offer substantial gains in quality, speed and versatility.

Integration-Ready Modules: Rethinking the Core Elements of Construction

Modularization is a key concept in productization, yet it is often misunderstood. A recalibrated take on modularity reveals how these elements can be easily configured across a platform without sacrificing creativity. Modules can be much more sophisticated than mobile trailers, as is the misconception in the United States.

In the automotive industry, we see that vehicle production gains cost efficiency because each vehicle is an assembly of standard, modular components that can be engineered en masse. However, cars all take the same general form. Buildings, on the other hand, are approached as one-off projects, each with a unique shape. Uniformity is not achievable in construction — nor should it be the goal. No one wants the same building as their neighbor and variation between site requirements makes this idea impractical.

MODULARIZATION SIGNIFICANTLY OUTPERFORMS OFF-SITE MANUFACTURING & ASSEMBLY



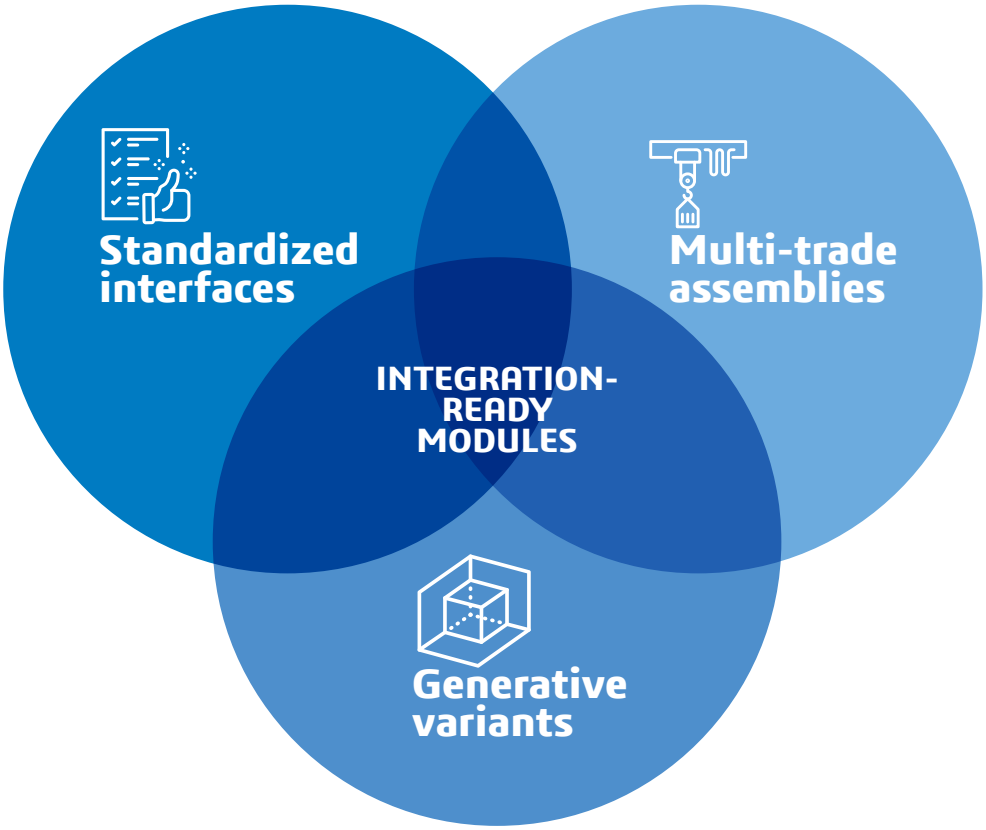
Uniformity is not achievable in construction — nor should it be the goal.

A modular approach to building design offers a high degree of configurability. It also enables the engineering of building systems outside of a project cycle, increasing scalability and cost efficiency.

We can already see construction productization in action on a small scale with elevators, which have been integrated into buildings as complete assemblies for decades. In essence, an elevator is a module that contains a complex array of components and systems. Taking an "everything is an elevator" mentality can give birth to a whole new industry of multi-trade, integration-ready construction modules.

An integration-ready module is one that includes standardized interfaces, multi-trade assemblies and generative variants.

THE 3 ELEMENTS OF INTEGRATION-READY MODULES



Standardization of module interfaces, enabled by the decoupling of trade-based knowledge from physical tasks, allow for widely-available unskilled labor to perform installations.

Multi-trade assemblies remove interference between trades and the associated costs.

Generative design ensures sufficient variability to satisfy the unique requirements of each construction project.

Standardized Interfaces Accelerate Installations

Interfaces are the mechanisms by which a module connects to another module or to the larger build. Integration-ready modules must allow for interchangeability, with flexible outcomes and a wide range of end-product variants.

Construction modules can offer great value with standardized interfaces. By decoupling trade-centric knowledge from the physical tasks of the construction job, module interfaces can be designed such that unskilled labor can perform **on-site installations at scale**.

Much like consumers are able to insert a standardized electrical plug on a home appliance into a wall outlet without the support of an electrician, any laborer can be trained to install construction modules with standardized interfaces without the need for tradespeople on site.

A Multi-Trade Approach Avoids Financial Sinkholes

Integration-ready modules proactively and seamlessly incorporate components traditionally installed by trades. Eliminating interference between trades during the assembly phases and reducing the number of interfaces to manage will remove the risk of financial sinkholes.

The goal is to design and engineer multi-trade modules to be cross-trade functional well in advance of the manufacturing, assembly and installation phases. This design minimizes the need for trade specialists during later phases.

Inputs for integration-ready modules can be defined with the help of specialty contractors, who in this value chain are recast as **virtual makers**. (See Specialty Contractors Become Virtual Makers of Modules below.) Collaborating at the design stage is an opportunity for tradespeople to offer more value and generate greater revenue within a virtualizing industry.

With a **modular strategy**, GCs are responsible less for subcontracting tradespeople and more for configuring a project based on the owner's requirements. (See GCs Deliver Value as Prime Integrators of Modularized Systems below.)

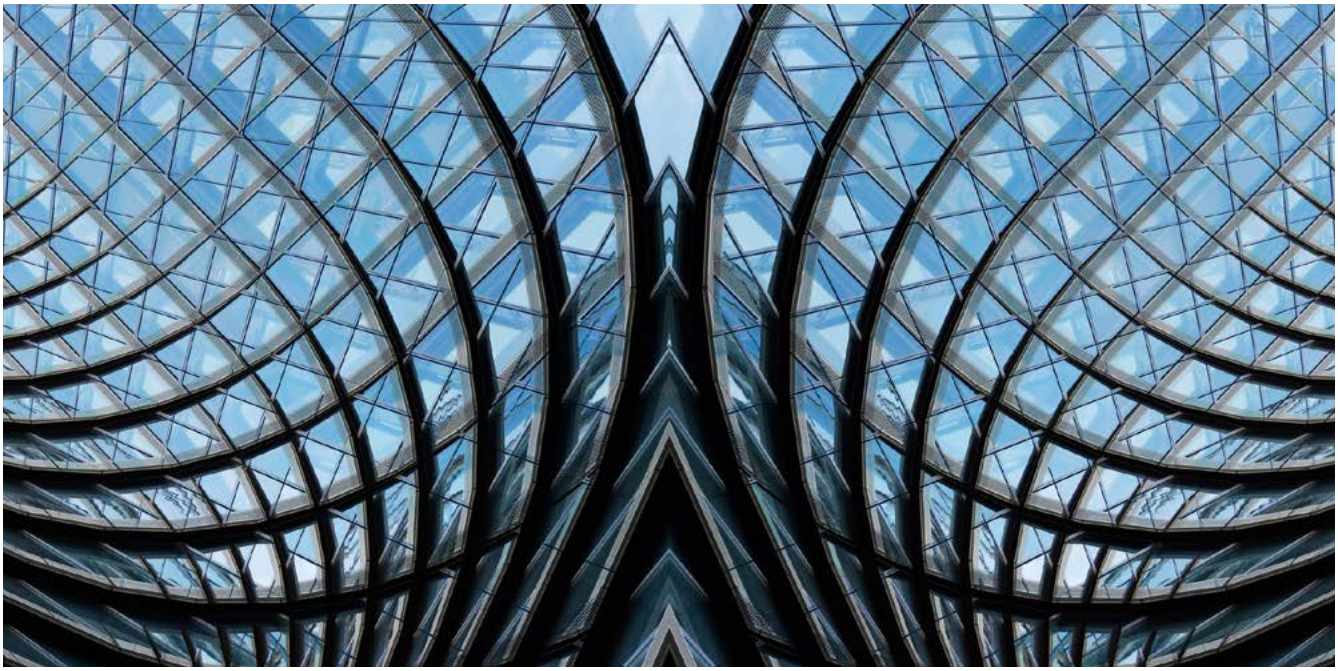
Generative Design Offers Variability

Recall that one critical difference between designing a car and designing a building is that a building's shape must evolve drastically from one project to the next due to site constraints and project-specific requirements, whereas a car's shape, size and purpose are relatively fixed.

Automotive manufacturers can spend billions of dollars to engineer and virtualize automotive production methods to strengthen process efficiency. To date, the required investment has not been cost effective for singular construction projects that may last 18 to 48 months. The time required to virtualize the process and optimize assembly has not been compatible with the payoff.

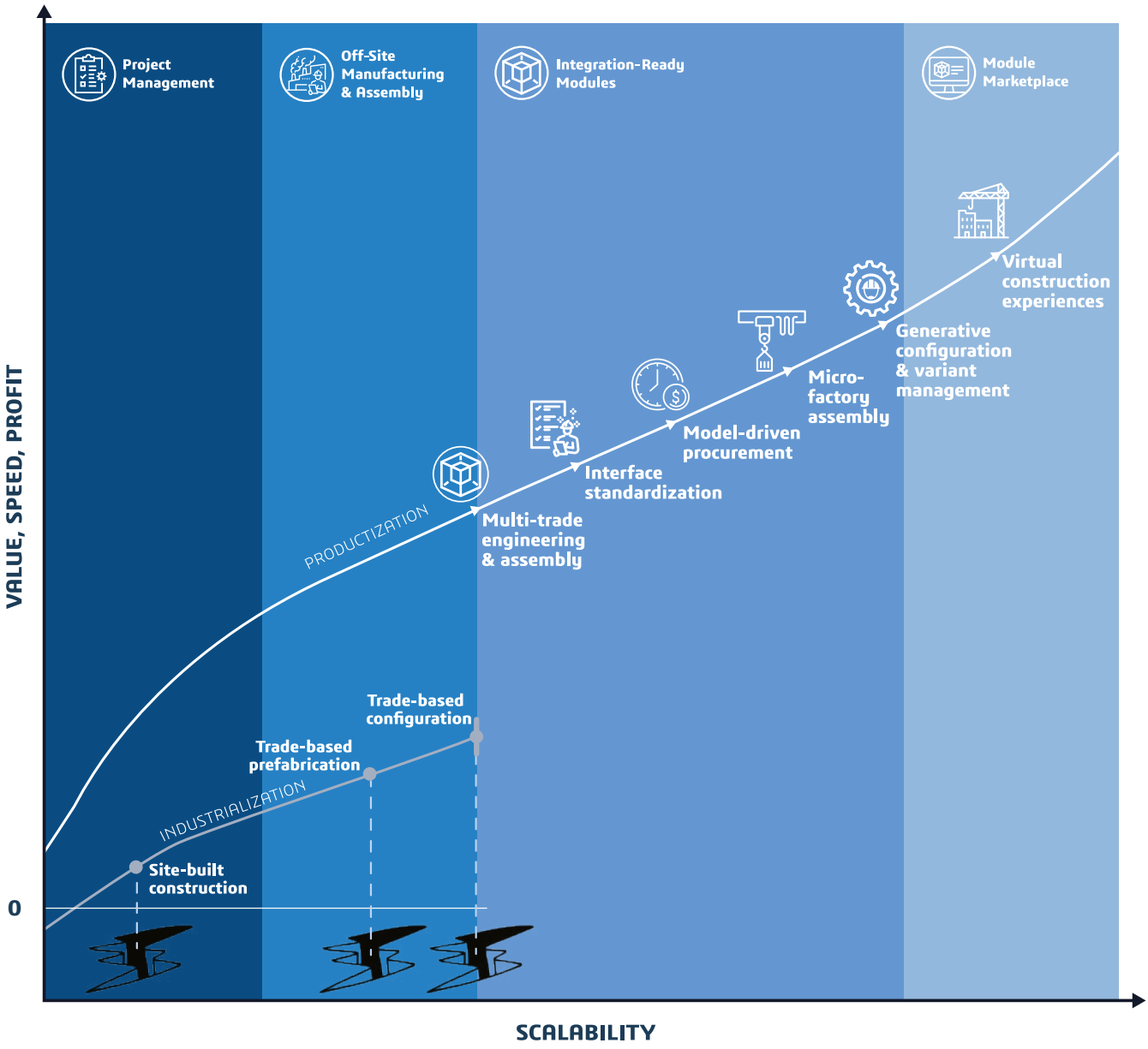
This is where generative design becomes essential. The design tool manages engineering limits while allowing for **flexibility** in the modular approach. Generative designs can be **simulated faster than real time** due to concurrent simulation. In addition, this process automatically generates the full level of detail required to adequately simulate performance or perform construction virtually. The generated design reflects the level of detail required for constructability analysis and even procurement lists, bill of materials (BOMs) and manufacturing instructions.

Together, modularity and generative design create variability allowed by geometric changes in the end shape. In fact, because end-product geometry is not standardized, this modular approach can ultimately provide a **net increase in overall creativity** in tandem with a marked increase in constructability. Through the application of generative design, a tailor-made shape can be built using standard components made of integration-ready modules selected from product libraries.



PRODUCTIZATION VS. INDUSTRIALIZATION IN CONSTRUCTION

Productization drives more value, offers more scalability and bypasses financial sinkholes triggered by trade-based interference.



Advanced Modularization Techniques

With integration-ready, multi-trade modules, the construction virtual twin-based approach can ultimately extend upstream to realize **model-driven procurement**, as well as **microfactory-powered** manufacturing and assembly processes.

Standardized interfaces reduce the complexity of materials needed on site and support procurement automation. Microfactories are structured to service multiple construction clients by manufacturing customized modules with standardized interfaces. Using a microfactory drastically reduces the cost of designing, manufacturing and assembling these custom building blocks. (See Microfactories Enter the Scene below.)

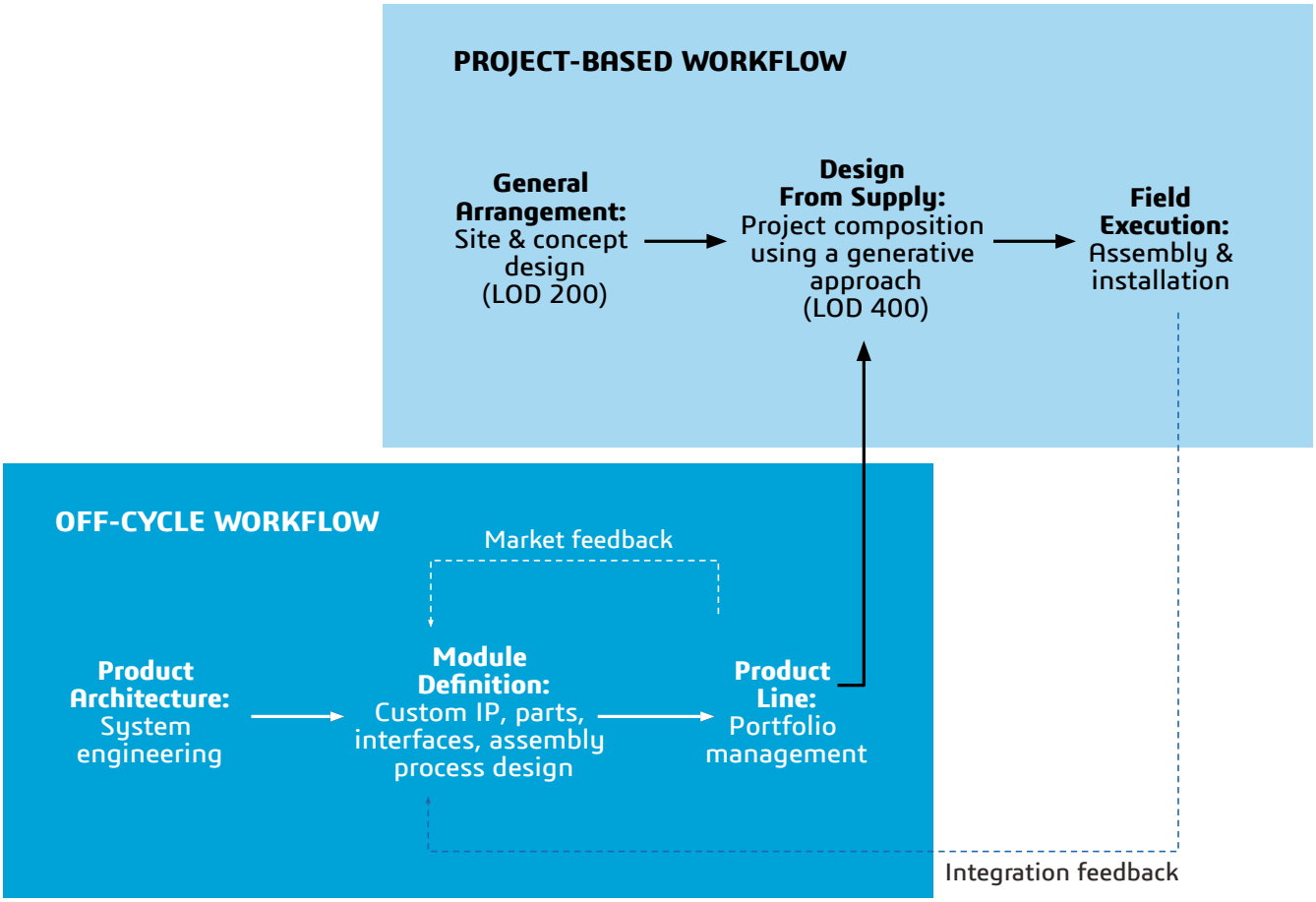
With the growing adoption of integration-ready modules, generative configuration and variant management will open the door to a **construction module marketplace** complete with virtual construction experiences.

Product Lines and Portfolios

With productized modules comes product lines and product portfolios. Servicing the value chain involves the evolution of product lines geared toward various customer use cases. To be profitable and scalable, product lines are best managed off cycle — independently of any given construction project.

Productization in Action

How to supply integration-ready construction modules independently of a defined project:



With a product architecture established, the off-cycle product management team iteratively improves on the construction module definition. A module definition includes parts, interfaces, assembly instructions and other intellectual property (IP). Module variations are organized into a portfolio of product lines.

Once a project is commissioned, the design team creates a high-level design, then generatively composes a detailed model from the available portfolio of pre-defined modules. Finally, the modules are manufactured on demand, near the site and assembled using existing installation instructions. Feedback from the integration experience is incorporated into the module definition for future projects.

IMPLICATIONS OF PRODUCTIZATION ON CONSTRUCTION ROLES AND RESPONSIBILITIES

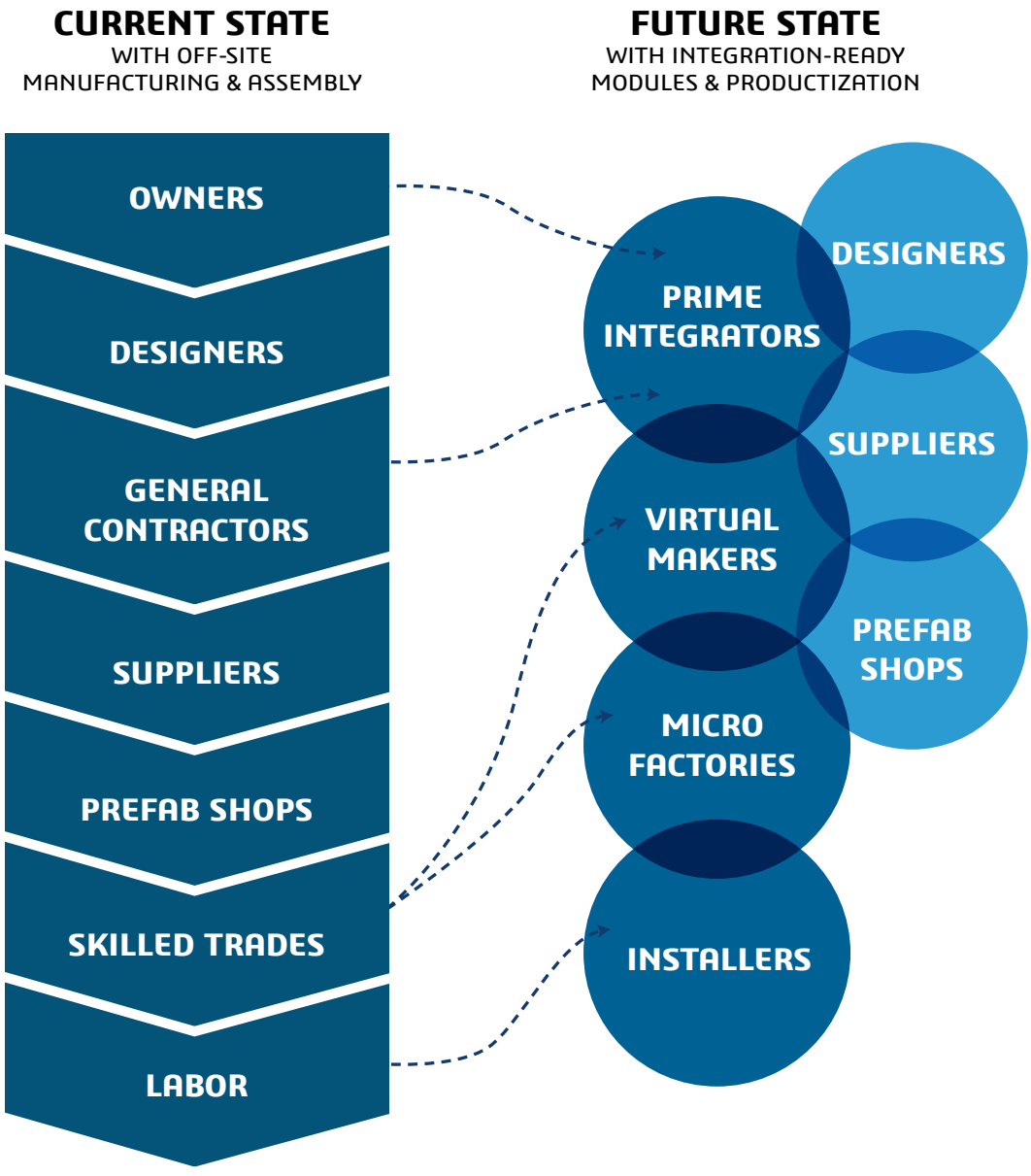
Today, each construction project is managed as a discrete effort and building models are still commonly delivered as drawings. GCs analyze the drawings, itemize the parts needed, order them from suppliers and ship them to a site where they are installed by craftspeople.

With off-site manufacturing and assembly, parts are first shipped to a prefab shop and pre-assembled so tradespeople are not running into each other. Some specialty contractors can work indoors. Processes have industrialized, the work is somewhat more efficient, but the traditional sequencing of processes remains the same.

In the near future, construction will be organized like a multi-tier manufacturing chain, which is exponentially more scalable. What does this transformation mean for the individual players within the construction value chain?

In The Next Normal in Construction, McKinsey & Company projects that GCs risk losing 20% to 25% of their value in a fully productized value chain in the coming years and specialty contractors risk 9% to 13% of their already modest slice. By resisting change, GCs will be **disintermediated** from the building delivery process. They will find themselves competing against module manufacturers and the firms that partner with them. In contrast, those who embrace productization and adapt as follows will retain the most value and demonstrate the most resilience through the transformation of the industry.

THE EVOLUTION OF THE CONSTRUCTION VALUE CHAIN



Owners Reorganize the Value Chain

Owners are increasingly collaborating directly with module manufacturers to define their requirements and create custom components to achieve specific business outcomes. Owners of **data centers** frequently produce their own modules to shorten time to market. Likewise, large **hotel chains** work with bathroom pod manufacturers to deliver a differentiated brand experience.

Some developers have vertically integrated with module manufacturers to tightly align construction and integration knowledge directly into the product development process. For example, bathroom module manufacturer SurePods was acquired by WND Ventures, the corporate venture arm of DPR Construction. "SurePods prefabricated bathrooms are sized, designed and accessorized to meet the owner's precise requirements, then built under controlled factory conditions. Consolidating the talents of eight separate trades, the finished product comes ready to hook up and inspect."[2]

GCs Deliver Value as Prime Integrators of Modularized Systems

GCs are already well aware of the drawbacks of a trade-based approach. They deal directly with coordination and sequencing optimization challenges and cross-trade interference, which are rising with sustainability regulations increasing the number of interfaces. Their dependence on trades puts a limit on development scalability; there is always a need for at least one tradesperson to touch each system.

Integration-ready, multi-trade modules remove the risks to a GC's construction timeline and budget (the aforementioned **financial sinkholes**). However, these modules still must be staged and installed in the building in the most efficient manner.

As productization takes hold, a GC's role morphs into one of chief assembler, head of module procurement, logistics and installation — in other words, the "**prime integrator**." In this way, GCs overcome the threat of disintermediation and continue to deliver value to owners.

A prime integrator will manage and collaborate with virtual makers (specialty contractors that have virtualized their craft) to ensure multi-trade modules meet owners' expectations. Integration excellence also requires proficiency in orchestrating site logistics and mastery of new approaches to procurement.

Digitalizing and Virtualizing Processes

The first step in preparation of this shift is determining how to virtualize each basic building block within a module. GCs can do this by disassembling basic building blocks and defining these blocks step by step. With this understanding, design collaborators need only configure the existing block to fit inside a building's unique geometry each time a new project arises.

For example, if considering a room as one block or module, disassembly would begin with a systems approach to identifying structural components, doors and windows, mechanical, electrical and plumbing engineering (MEP) systems, finishing elements and all other components. The next step is to understand the dependencies and interfaces between these components. From there, it becomes possible to identify the various parameters for variability with which each one of those interfaces must comply.

By incorporating information from the architect on what is needed and why, the solution is also able to define how to construct this component: Where cuts or drilling may be needed, for example. From this system, GCs can produce a processing list and make a work order that can be sent directly to a localized factory close to the construction project.

[2]"WND Ventures" by WND Ventures, LLC (2022)

Shared **innovation**

Bouygues: A Construction Giant Takes the Step from BIM to Virtual Twin

As a global leader in sustainable construction, the French company Bouygues Construction has made a long-term commitment to push the industry to become more efficient and sustainable. To achieve this goal, Bouygues leverages the **3D**EXPERIENCE platform from Dassault Systèmes to support digitalized processes, improve knowledge sharing across the value chain and explore the potential of construction virtual twins.

By connecting all stakeholders across the value chain, the company is empowered to take on even more complex and ambitious projects. "**The platform allows us to meet our goals in terms of modernizing the business, while being able to support our clients on projects that are both unique and increasingly complex,**" said Marie-Luce Godinot, deputy CEO of Bouygues Construction.

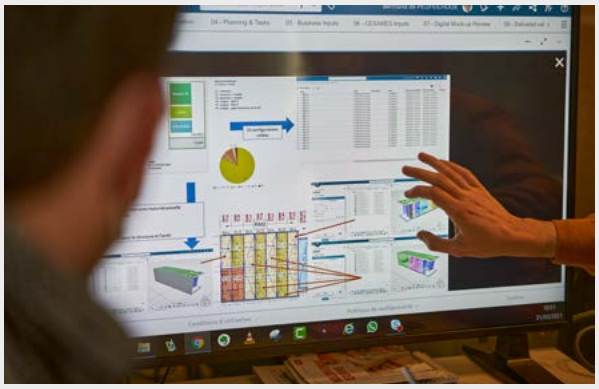
Frédéric Gal, program director of business transformation at Bouygues Construction, explains the value of digital continuity to the business. All data related to a construction project, from the design to execution to operation and maintenance, will be located in a virtual twin on the **3D**EXPERIENCE platform.

"The objective of the virtual twin is to deliver on the promise of construction before construction," Gal said. **"It means we can adjust for irregularities, demonstrate constructability and avoid mistakes on-site. Once the design is finished, questions are no longer raised about its integrity."**

The company is benefiting from CATIA's powerful parametric and modular capabilities and automated product templates to manage complex custom designs. At the same time, it can easily connect with architects' concept models authored in other design solutions to ensure each project is as unique as it was intended to be.

"**By creating business rules within CATIA, we can adapt the configuration to our specific needs, speed up and automate some tasks,"** Gal said. **"With CATIA, our designers can customize clients' homes on demand and our builders can bring them to life using very productive industrial methods."**[3]

Photo © Bouygues Construction



With all data centrally stored on the **3D**EXPERIENCE platform, Bouygues Construction can make fast, confident decisions.

[3]"Bouygues Construction" by Dassault Systèmes (January 2022)

Defining and Integrating Construction Modules

In an optimized design and construction process, the virtual twin captures the architect's intent: The types of materials desired, styles of rooms, types of constraints to address, et cetera. The construction team can then assemble the building based on a list of integration-ready modular systems identified in the virtual construction twin.

With this approach, the GC (as **prime integrator**) orchestrates the work from virtual makers, prefab shops and microfactories, and determines the construction experience needed to deliver and install productized modules in the field.

ASSEMBLY OSM

Assembly OSM: A Modular Strategy in Action

New York-based Assembly OSM, founded by SHoP Architects co-founders Bill and Chris Sharples, was established as a modular construction company. The team engineers components and sub-assemblies (structural steel chassis; unitized facades; wall, floor and ceiling cassettes; mechanical, electrical, plumbing and environmental systems; kitchen, bathroom and casework pods; building cores with elevators and stairs) to fit a single platform of infinite combinations.

These individual modules can take a wide range of different dimensions and shapes, enabling tremendous variability in building type, size and layout. Buildings are designed by Assembly OSM as a 3D digital twin that embodies the dimensions and materiality of every single component. Components are manufactured by the company's supply chain. Products are assembled by Assembly OSM and then "stacked" on the jobsite by the company's general contractor partners.

Each end result aims for high-quality performance, high-end aesthetics, sustainable materials, and highly cost-effective delivery and operating expense. Projects also benefit from a significantly reduced time to completion due to the pre-engineering.

A rendering of the still under-wraps future full building project. (Photo courtesy of Assembly OSM)

Post-modular residential pods click together like Legos, according to Assembly OSM. (Photo courtesy of Assembly OSM)

Specialty Contractors Become Virtual Makers of Modules

Today, specialty contractors capture value only after they have installed the physical product. This arrangement subjects these subcontractors to the same potential financial sinkholes around budget and timeline faced by GCs.

With the adoption of productization, specialty contractors will see their business model evolve as they embrace new roles and revenue streams by shifting to so-called "**virtual makers**." Virtual makers contribute to the virtual twin by applying trade-specific knowhow in the upstream design and simulation phases. They collaborate on a single model of a construction project in a virtual environment along with fellow specialty and general contractors — and are compensated accordingly for their time, expertise and continuous access to their virtual creations and intellectual property.

It's important to note that as the productization transformation unfolds, specialty contractors have the opportunity to ***continue*** to offer existing trade-based services at the off-site manufacturing and assembly phases. The newfound virtual maker role will be a second function to perform as industry-wide change progresses in the coming years. Over time, the physical installation work will take a backseat to the virtual work.

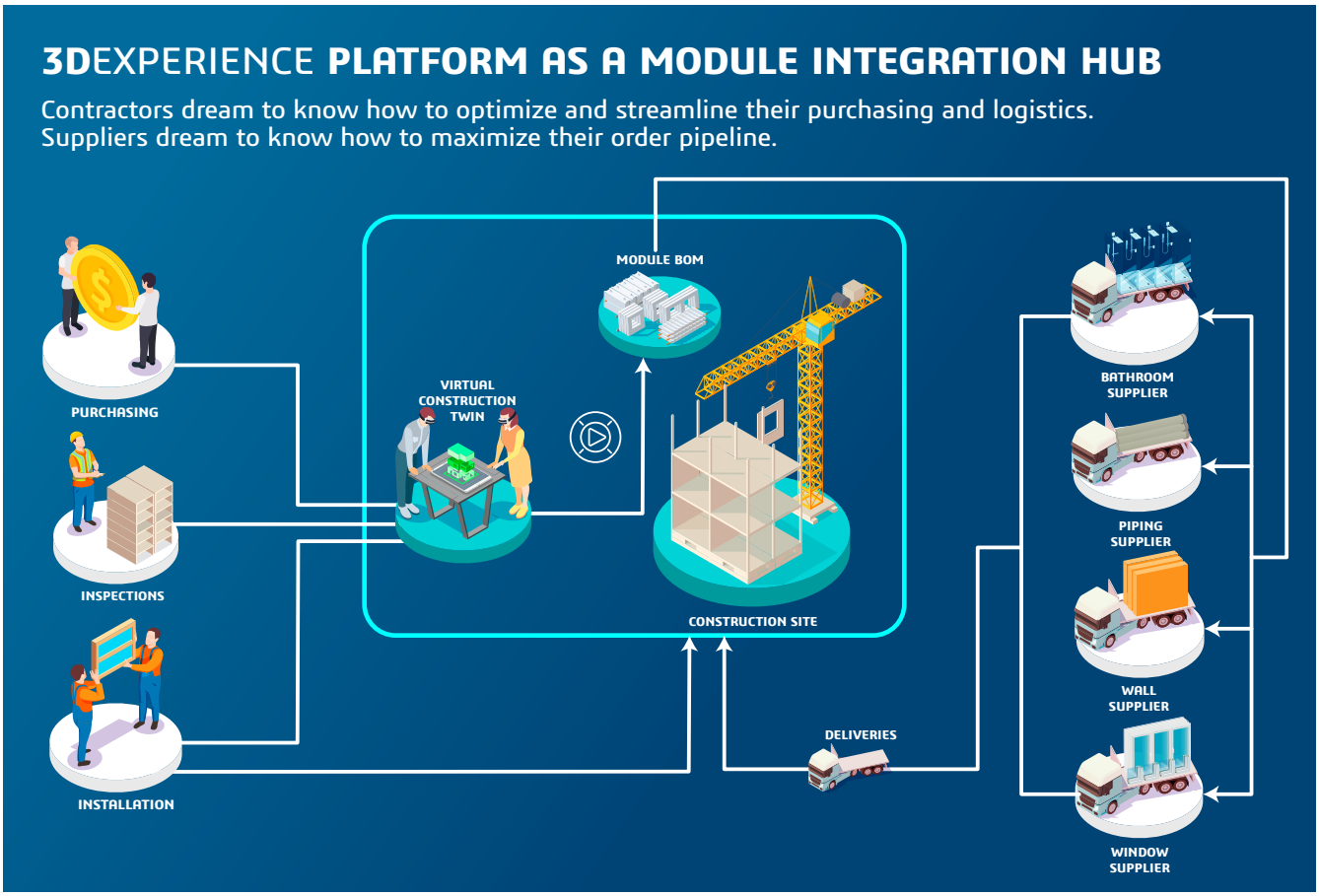
Virtual makers are positioned to collaborate more strategically with owners and GCs and to contribute to a more successful construction outcome. An experience-based understanding of trades is incredibly valuable and contractors can be compensated proportionately for contributing this knowledge upstream. With the rules of a trade virtualized and integrated into a virtual twin of construction, specialized skills can scale.

How to Become a Virtual Maker

As module interfaces are standardized, trade-based knowledge will be less and less necessary on site. However, greater upfront engineering knowledge provided during the design stage can actually drive development of more sophisticated solutions. By decoupling engineering from production, construction teams invest in more advanced products.

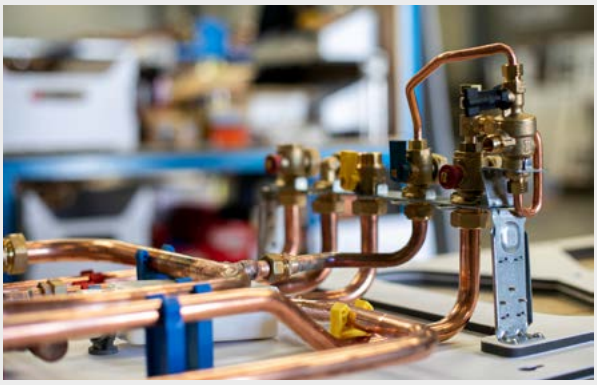
For many specialty contractors, there is already a push to digitally capture the knowledge of tradespeople retiring or otherwise leaving the workforce. This knowledge is a key source of efficiency. Looking at a broader scale, this **digitalization of knowledge** enables this new business model for specialty contractors.

With productization, specialty contractors can provide their virtual knowhow to the GC and module configurators at the earliest possible moment. In this way, specialty contractors are no longer "too late to the game" on projects to drive true value. Virtualizing their knowhow allows them to offer trade-specific knowledge through solutions such as BIM plugins that inform project constructability. It also allows specialty contractors to capture value from this process prior to product installation.



FLOVEA:
A Success in Interface Standardization for Generative Plumbing Solutions

FLOVEA was launched to solve founder Thierry Mignot's challenge in finding skilled plumbers to work in the field. Instead, Mignot turned to manufacturing boiler backsplashes and other plumbing elements. The product is light, easy to ship and assemble. And because the boiler offers an easy interface between the plumbing and heating system, it reduces the need of skilled laborers.



Jet Contractors:
4,000 Unique Parts Comprise a Complex Solution to a Unique Design Challenge

Jet Contractors is a fully integrated group that operates in Morocco and across Africa offering 30 years of expertise in engineering, procurement, manufacturing, construction and historical knowledge. The team uses innovative tools to create complex shapes and architectural designs for public infrastructure, residential, industrial and service-oriented programs, including metal works of art.

On the **3D**EXPERIENCE platform, Jet Contractors started with a geometry and generated 4,000 unique parts to encase a double-curved architecture. With CATIA's xGenerative design tools, the team referenced shared geometries and parameters to generate a whole assembly.

The model aided the manufacturing and assembly processes, reducing risk while increasing productivity and quality. The developers understood how the design performed in virtual twin experiences, enabling automated processes through production and lifecycle management.

Orange Côte d'Ivoire headquarters under construction.

Unique double curved parts of the façade.

Manufacturing and assembly of double curved parts of the façade.

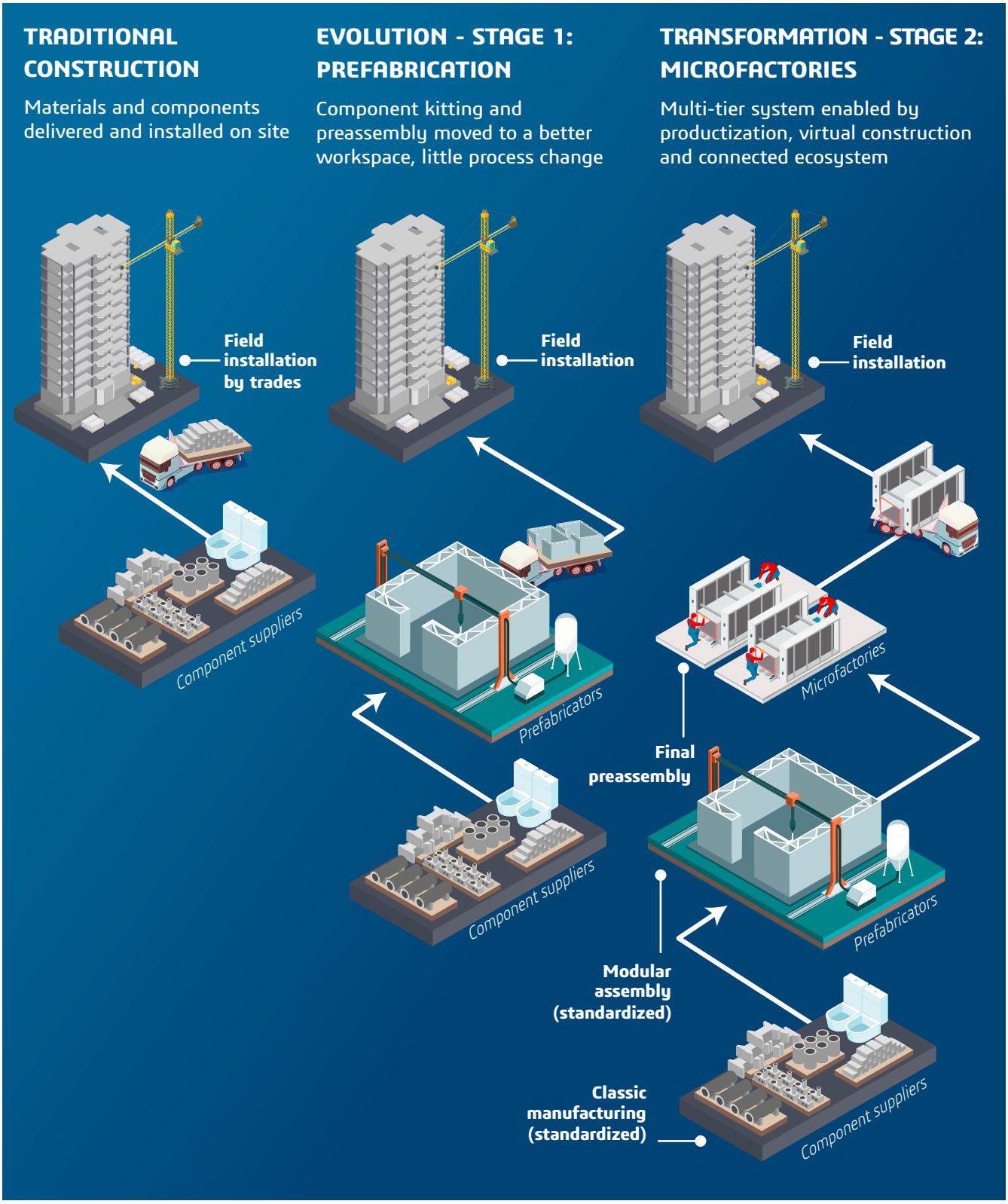
Microfactories Enter the Scene

Microfactories are a new category of value chain players. A microfactory is a popup manufacturing facility located within a short distance of the construction site that fabricates parts and multi-trade assemblies into integration-ready modules.

Distinct from prefab shops, which simply move trade-based processes off site, microfactories are distributed manufacturing operations that can be structured to service multiple construction clients through standardized components and modular platforms.

Once manufactured, the locally-produced, integration-ready, multi-trade modules are transported a short distance to the construction site for installation by unskilled laborers.

Microfactories are creating new value pools in a changing industry.



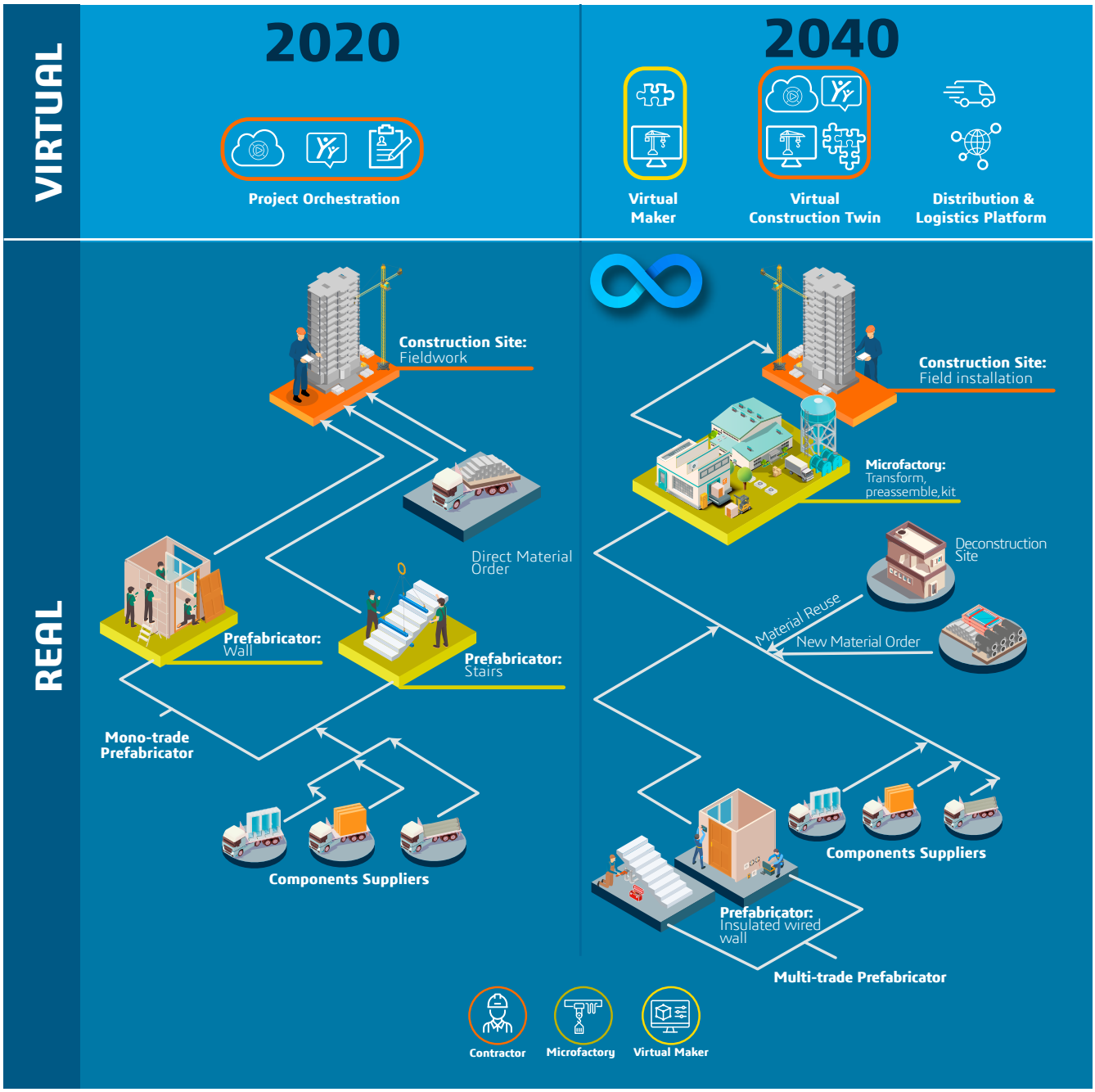
CONCLUSION

The construction industry is facing extreme demands for speed, sustainability and customization. The only way to meet these demands is to break free of the constraints of today's trade-based prefabrication and subcontractor coordination mentalities.

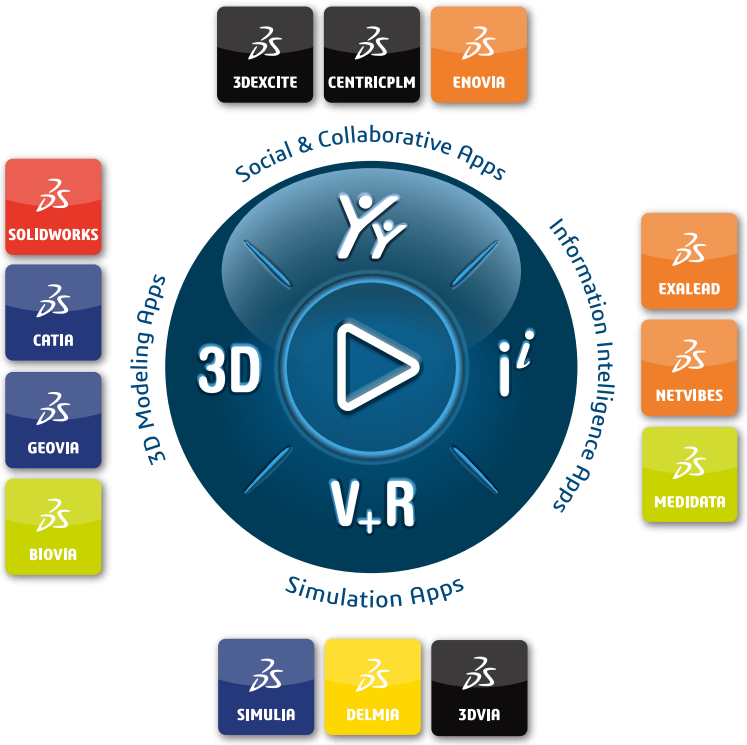
Productization drives more value, offers more scalability and bypasses financial sinkholes rampant in trade-based industrialized processes. As productization becomes more widespread, construction value chain players will reorganize and collaborate more closely through virtual twins. GCs will serve as prime integrators of multi-trade modules. Specialty contractors will morph into virtual makers. Microfactories will become more prevalent.

Forward-thinking business leaders are already adjusting their business models around virtualized processes, digital deliverables and off-cycle product management. Construction teams will ultimately maximize value with integration-ready construction modules that include multi-trade assemblies, generative variants and standardized interfaces.

The **3DEXPERIENCE** platform offers the functionality necessary to support construction virtual twins, productization and integration-ready modules.



Contact Dassault Systèmes today to learn more about how to prepare for the construction industry of tomorrow.



Our **3D**EXPERIENCE® platform powers our brand applications, serving 11 industries, and provides a rich portfolio of industry solution experiences.

Dassault Systèmes, the **3D**EXPERIENCE® Company, provides business and people with virtual universes to imagine sustainable innovations. Its world-leading solutions transform the way products are designed, produced, and supported. Dassault Systèmes' collaborative solutions foster social innovation, expanding possibilities for the virtual world to improve the real world. The group brings value to over 250,000 customers of all sizes in all industries in more than 140 countries. For more information, visit **www.3ds.com**.

Europe/Middle East/Africa
Dassault Systèmes
10, rue Marcel Dassault
CS 40501
78946 Vélizy-Villacoublay Cedex
France

Asia-Pacific
Dassault Systèmes K.K.
ThinkPark Tower
2-1-1 Osaki, Shinagawa-ku,
Tokyo 141-6020
Japan

Americas
Dassault Systèmes
175 Wyman Street
Waltham, Massachusetts
02451-1223
USA

DASSAULT SYSTEMES | The **3D**EXPERIENCE® Company