Whitepaper

The Building as a Product

Paradigm Shift for the Construction Industry

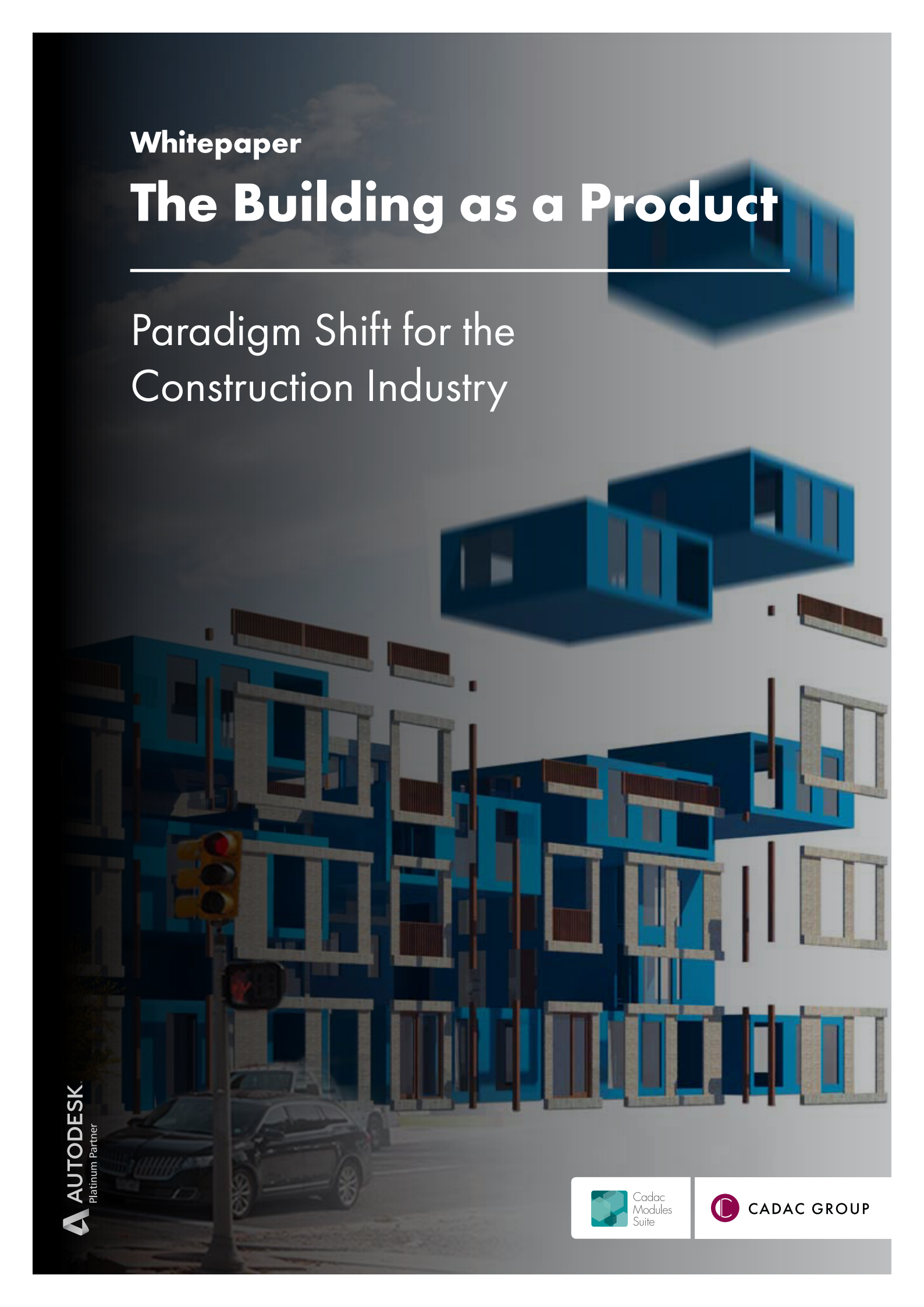

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Table of Contents

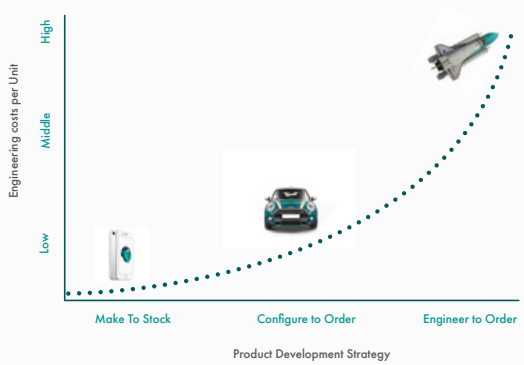
1. Introduction

The construction industry still thinks of buildings as unique and bespoke objects rather than as products that can be manufactured and assembled instead of being constructed. The fact that productivity, innovation and profitability in the construction industry is still far behind the manufacturing industry can easily be explained by looking at the way the manufacturing industry is organized. If we consider the manufacturing industry, we can categorize this industry by product strategy;

- If you build one-offs, you're an Engineering to Order (ETO) company like NASA building the space shuttle.
- If you build highly configurable products, you're a Configure to Order (CTO) company, like BMW building configurable cars.
- If you build off-the-shelf products, you're a Make to Stock (MTS) company like Apple building iPhones

Most manufacturing companies fit into one of these categories because it was a deliberate and strategic choice made by the people running them. Their choice is based on their ability to build or create certain products:

- Unique products (ETO)
- Highly modular and configurable products (CTO)
- High-volume consumer products for a large market (MTS)



As shown below, the engineering costs per unit are much higher for the Space shuttle than for the iPhone or a Mini.

The construction industry represents an interesting dilemma in this respect. Nearly all construction companies act like an Engineer to Order company (each building is unique). But they are unable to spend enough money and time in engineering to make sure that they get it right the first time. As a consequence, almost every construction project overspends or under-delivers. On the other hand, most customers demand a unique building but are unwilling to pay for the costs involved. The construction market wants Space Shuttles for the price of a Mini. There is only one way to get out of this dilemma:

1. If you want a Space Shuttle, you need to pay for a Space Shuttle,
2. If you want a Mini, the choice you get is limited.

> "The construction market wants Space Shuttles for the price of a Mini."

In the end, every company in construction ultimately has to decide what they want to do - design and build unique buildings (ETO) or design and build highly configurable modularized buildings (CTO) that can be manufactured offsite and assembled onsite.

2. Modularity

If we start thinking about buildings as products that are made out of other products, we need to think about the basics of modular design and live with design constraints that are associated with it. A design with a lump of clay in mind is fundamentally different from a design with Lego© in mind. Even though the comparison with Lego© has been made a million times in this context, it is still very appropriate.

The people designing the first Lego blocks could never have imagined what their modular system could evolve into over time, but they learned from customer demand and kept on improving their modular system over and over again. The picture below illustrates the incredible development Lego, as a modular concept, has gone through over the years.

Without modularity, it is very hard to learn and improve because you will be re-inventing the wheel.

Classic Lego

Lego Technic

Developing and improving modules takes time, perseverance and focus. It requires a determined approach and a strategic market selection just like car manufacturers do. Different types of customer demand require different types of modules.

Just like in manufacturing, where we see research and development departments constantly improving products and the way they are manufactured, the construction industry should invest in product development as well and not only think in terms of one-off projects.

There are different strategies in use to define modules. Whichever strategy is applied, the development of these modules generally requires the joint efforts of multiple engineering disciplines, and a different approach from the one the organization is accustomed to. The development of a module follows the development of a product and is subject to lifecycle management. Requirements are set, specifications created, and design process starts. During the design, the manufacturability should always be an important design principle.. New processes are introduced in the organization: change management, new module introduction, quality management, supply chain management, but also decommissioning and recyclability evaluations. And since the module will likely be produced more than once, a cost price improvement process is no luxury either. The design and implementation of these processes is new for most companies and often requires outside assistance.

When sufficient modules are available, unique buildings can be assembled. The whole building can obviously not be completely assembled from modules since it has to fit into an existing environment. The lacking parts still need to be constructed in a traditional fashion. Some of those 'engineer to order' parts are candidates for a new module in the future.

What about 3D printing?

With 3D printing, we could potentially manufacture anything and we would no longer be bound to the shapes that we see in construction nowadays. We could actually start designing a building with a lump of clay in mind and computers could come up with bizarre organic shapes that distribute gravity in an elegant and organic fashion and we would still be able to build it.

In reality, the development of 3D printing has evolved gradually since the early 80's and it is expected to mature in the next decades. One of the biggest challenges for 3D printing is production speed and volume and both are crucial in construction. This is why mainstream 3D printing for the construction industry will probably mature last. In the coming decades, traditional manufacturing methods, in conjunction with modular building products, can make a huge difference in construction well before 3D printing will.

3. Configure to Order

When we succeed in approaching a building as an assembly of parts, and when we succeed in approaching those parts as modules, we can make the transition from an 'engineering to order' process to a 'configure to order' process. Construction companies should behave more like a Configure to Order company and assemble unique buildings onsite using highly modular components that are pre-fabricated offsite. Only then will they be able to predict costs, mitigate risks and deliver a high-quality product on time.

When comparing CTO and the ETO based solutions, the price, time and risk aspects will in fact be to the benefit of the CTO solution and the design freedom to the benefit of ETO. It's up to the customer to decide and it is up to the companies in construction which market they want to serve.

Essential in the transition is an explicit choice for ETO or CTO in the sales phase. It is tempting to offer a CTO and end up with an ETO project for the price of CTO. This must be avoided. The possibilities and limitations of the CTO solutions should be clear and well defined on the sales side and should be strictly guarded.

Two separate core processes emerge when implementing CTO: the module development and improvement process and the process to combine these modules into buildings. The first process delivers the building blocks for the second process. The second process delivers most of the final product. Often, small corrections or justifications are added manually.
It would be naïve to believe that every building can be completely 'configured to order'. We consider 80% modular and 20% custom to be realistic. Again, the analogy to the car industry applies. There is a market for standard cars, one for configurable cars, and there is a market for engineer to order cars. For example, Ferrari has an excellent configurator to configure your car, all based on standard choices, plus a 'Tailor-made' program where anything goes. They made the deliberate choice to separate the 'configure to order' and 'engineer to order' products and processes. Obviously, an engineer to order Ferrari has a heftier price tag. You can always go for a standard Fiat instead.

4.Summary

New technology enables new ways of working and the fast-paced world demands fast-moving people and companies. If companies stick to what they know, they will probably not be successful and lose their competitive edge. Being competitive is all about making choices, investing in digital maturity and the modular concept is probably a life-saving choice for the construction industry today. Working faster and digitally cannot be mixed with traditional, labor-intensive construction processes. When we are willing to learn the valuable lessons from the manufacturing industry, then the way we design, collaborate and assemble buildings will change rapidly.

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