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BYLD - BREAKING NEW GROUND FOR THE CONSTRUCTION INDUSTRY

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Abstract: *One of the core capabilities of sustainable mass customization is the mastering of a robust process design. The data driven building systems of BYLD are bringing a true "file-to-factory" process to the construction industry: Parametric project data models enable seamless transition between digital planning and digital production and gives the client all of the advantages of prefabrication without the planning overhead. The cloud based system enables decentralized production and production data sets can be pushed to any available CNC machine with capacity. System updates can be automatically deployed to any project in the pipeline.*

Key Words: ***construction industry, building, AI driven building design, sustainability, cloud-based, mass customization, decentralization***

1. INTRODUCTION

Realizing the promise of mass customization demands the management of the core capabilities solution space development, choice navigation and robust process design [1], with the latter being the capability that many companies underestimate and fail in [2]. Especially in complex technical environments like the construction industry the main objective of robust process design to control the additional cost resulting from the flexibility that is needed to build in order to serve its customers individually can mostly not be achieved [1][3]. BYLD-technology introduces a true „file-to-factory“ process to building construction. By consistently implementing algorithmic solutions the BYLD-construction-framework is steadily evolving while permanently offering absolute planning dependability. The cloud-based design of the BYLD-services enables deployment on modern cloud-computing-infrastructure.

BYLD-services can be accessed over the web and are developed for decentralized and distributed production. BYLD-services offer live access to project data-models and instant feedback to project changes while keeping them production ready at all times.

The BYLD-construction-framework offers end-to-end digital control for building construction making it the only construction system truly ready for AI driven building design.

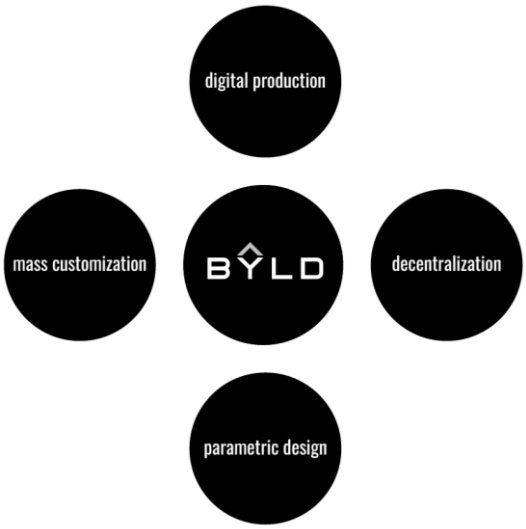

Fig. 1. The BYLD-principles

2. BYLD-TECHNOLOGY

2.1. What is BYLD-technology?

At the core of BYLD-technology is a specifically developped library of parametric construction elements. These dynamic construction elements are continually evolved and updated and can be configured to form almost any form of construction project from small scale housing to large scale office or industrial use development.

The BYLD-system unifies knowledge in the fields of design, structural engineering and fabrication into a robust eco-system, where the dynamic nature of the construction system setup enables pre-fabrication without the constraints of a rigid modular system.

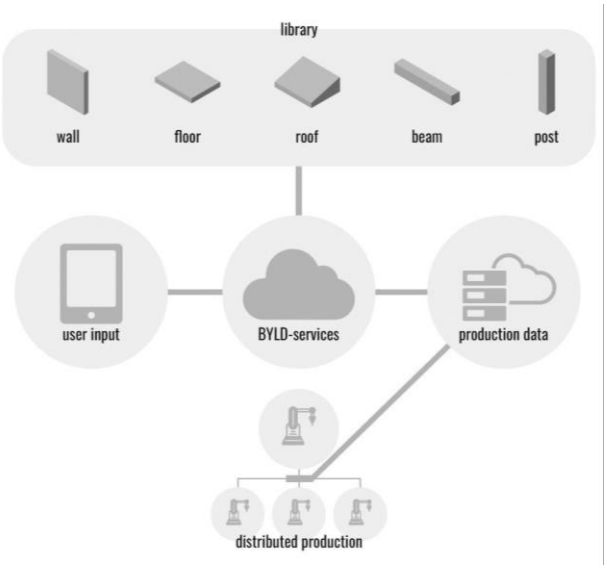

Fig. 2. BYLD technology

2.2. Multiresolution project editing

BYLD projects can be created and edited quickly. The multiresolution work-flow enables fast and precise planning. It allows users to jump between simplified responsive project model representations and production level model detail. Component parameters and modifiers can either be set absolute or relative. This enables parametric definitions of entire projects allowing users to store relational component information. Local changes can be made to one project component automatically triggering relevant updates to dependent building components. The project is always production ready. BYLD tools are always connected to BYLD fabrication logic at the backend. At user request production data is automatically generated and published to the BYLD fabrication network.

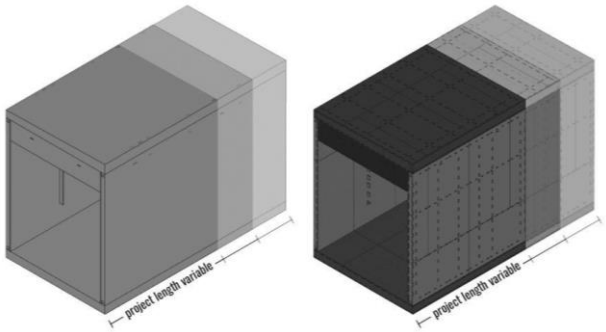

Fig. 3. low-res / high-res project model reacting to project level variable

2.3. Decentralized Production

Little to no requirements in terms of tools or mechanical skills make the BYLD system ideal for implementation of a partnership network model. The BYLD construction system relies on CNC-nesting machines with a cutting area of at least 1250x2500mm as the essential means of production. These machines are affordable and very common in generic carpenter's workshops. A common issue for business owners with CNC-machines is minimizing machine downtime. An on-demand job-supply platform has the potential to massively increase machine profitability for certified partner businesses by eliminating idle time. On order BYLD projects are automatically processed and production data is published to cloud storage. Partner businesses can then checkout available jobs and immediately start fabrication.

2.4. Technical composition of BYLD elements

The layer composition of BYLD elements is in principle a variation of timber frame construction. Two layers of plywood siding with a variable layer of insulation in between form a rigid sandwich-construction. A plywood lattice sets the distance between inner and outer shell and also transfers shear forces between the two layers. The quantity and even distribution of wood joints facilitates load distribution within components. BYLD components are designed and tested so breaking points are always located within the load transmitting board surface and never within the joints. This considerably eases structural calculations and simulations of component performance. Just like in timber frame construction the exterior shell of the building is shielded from the elements by the wind barrier. On the inside the building shell is sealed by a vapor barrier. Future development efforts will focus on increasing the vapor impermeability of the construction to avoid the need for an additional vapor barrier. This will further simplify the construction process and also create the opportunity to show the surface of the construction element on the building interior.

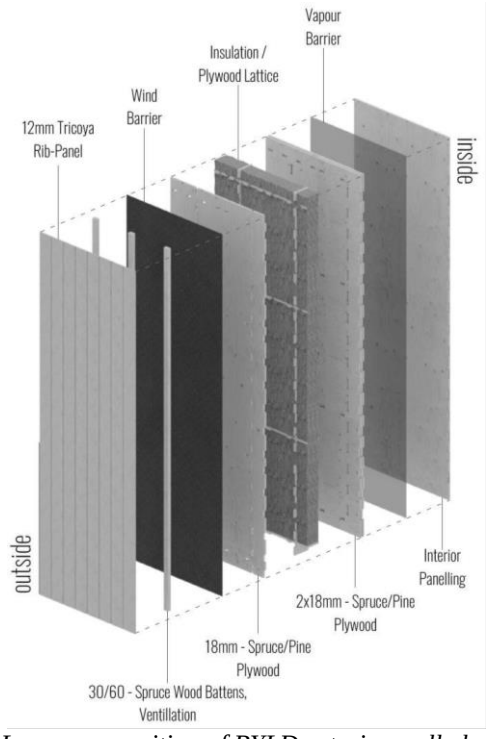

Fig. 4. Layer composition of BYLD exterior wall element

2.5. Why is BYLD-technology scalable?

- The BYLD-system is designed to offer the lowest possible threshold in terms of production facilities.
- BYLD construction elements are made from spruce or pine plywood. This is a sustainable and structurally high-performing raw material which is readily available in large parts of the world.
- BYLD production data can be pushed to any CNC-nesting-machine. These machines are relatively cheap, readily available and largely only running at a fraction of their capacity in carpentries the world over.
- The BYLD-system is not dependent on centralized, high investment, high-impact infrastructure. Distributed production enables fast, local, low impact fabrication.
- The construction elements are material efficient. All BYLD construction elements are thermally insulated and use only a fraction of the wood that is processed into today's mass timber elements.
- Assembly of BYLD construction elements has extremely low requirements in terms of skilled labour and tools.

3. DEFINING THE INITIAL BYLD PRODUCTS

3.1. Mobile Structures

Key factors introduced through BYLD-tech:

- Transforming the building process into a digital service experience.
- Use of web-based interfaces to make BYLD structures highly accessible and customizable.
- Plug-and-Play character of mobile structures already fit the nature of a digital service experience.
- High degree of automated fabrication enables customizability and planning dependability.
- Material efficiency makes BYLD mobile structures light and sustainable.
- The thermal performance of BYLD-developed wooden core insulated construction elements brings the quality of residential buildings to mobile structures.

Development opportunities for BYLD-tech:

- Small project scope and high project turnover enable fast feedback loops for process optimization.
- The technical complexity of mobile structures is equal to common residential use buildings. The small project scope affords the opportunity for incremental service evolution. The goal is to steadily integrate all of the essential construction services into the digital process.

3.2. B2B - supply of structural elements

Key factors introduced through BYLD-tech:

- Transforming the building process into a digital service experience.
- Partner companies can receive direct access to element configuration. A BYLD web-shop enables either per element orders or the configuration of entire structures.
- A consistently automated fabrication process enables supply of prefabricated elements without restrictions to element count or dimensions. This frees customers from the limitations of conventional modular systems forming the foundation for most suppliers of prefabricated construction elements.

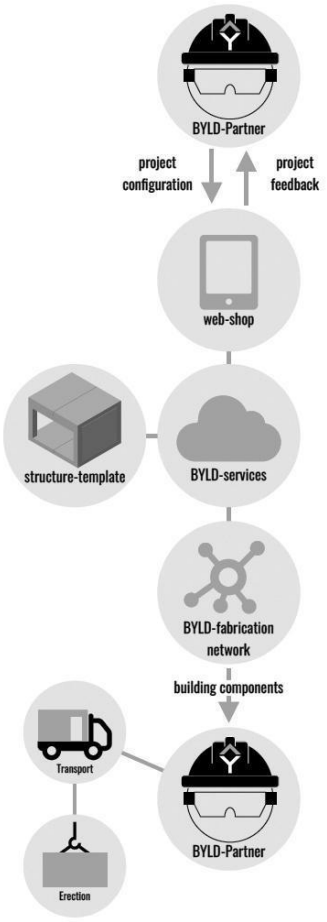

Fig. 5. B2B - supply of structural elements

5. GROWING THE BYLD SERVICES ECOSYSTEM

The objective of BYLD operations is to drive automation in the building industry. By inducing disruptive change to the way buildings are designed, fabricated and erected the building industry as a whole can move towards a more sustainable, more efficient and more affordable future. BYLD intends to lead the construction business away from the practice of producing a series of prototypes and towards the implementation of an integrated digital solution for construction.

On the journey to a state of full automation of building design and construction it may be useful to organize the status of BYLD-services into multiple tiers characterized by corresponding milestones:

Tier 1: The BYLD construction elements. A working library of dynamic construction elements is already established and their performance has been developed and

tested for application in one to three storey buildings of residential or commercial use.

Tier 2: BYLD infrastructure supports access for partner businesses to configure and place orders for mobile structures or small shell constructions with limited editing capabilities.

Tier 3: BYLD construction elements and structures offer sophisticated editing interfaces that support configuration of integrated installations. BYLD shell structures come pre-installed with piping or prepared for on-site installation of prefabricated piping runs.

Tier 4: A number of predefined building typologies can be parametrically configured to fit the individual project brief. These enable tailored project solutions with no planning overhead. An entire building can go straight from file to factory.

Tier 5: Application of machine learning for AI driven building design.

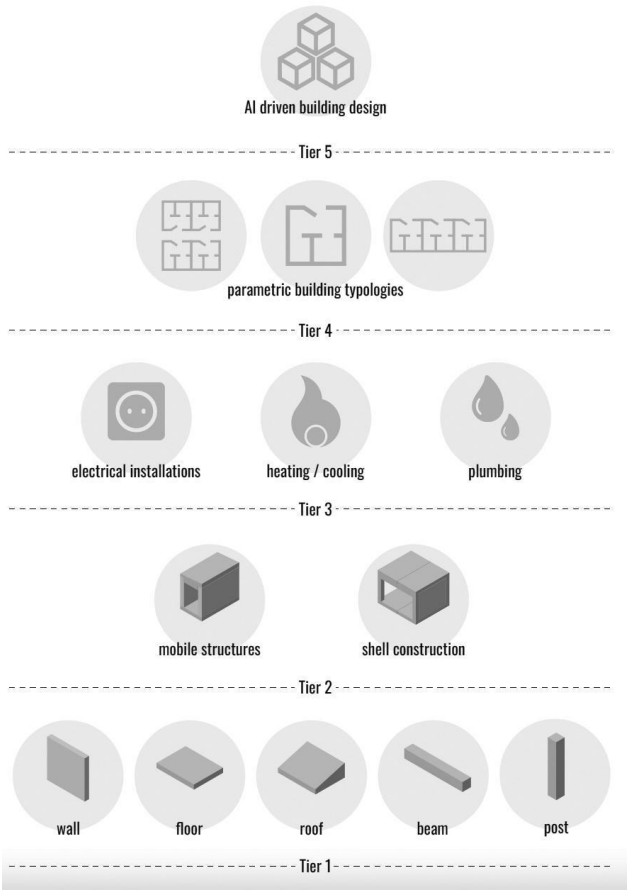

Fig. 6. Status of BYLD-services in tiers characterized by corresponding milestones

5. SUMMARY

BYLD-technology introduces a true „file-to-factory“ process to building construction with a digital and connected solution for building construction at it's core. The BYLD mission is the development of a robust, scalable framework supporting design and production for buildings where tackling digital production is the key to bringing the construction industry into the digital era. Cumbersome plan management and versioning, redundant planning processes as well as slow and error prone communication between planning departments have long been the norm of building construction. Now more than ever the goal must be to make building more efficient, more sustainable and more affordable.

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