

# Leveraging Modular Construction Principles

Jaco Prins

Team leader BIM Engineers

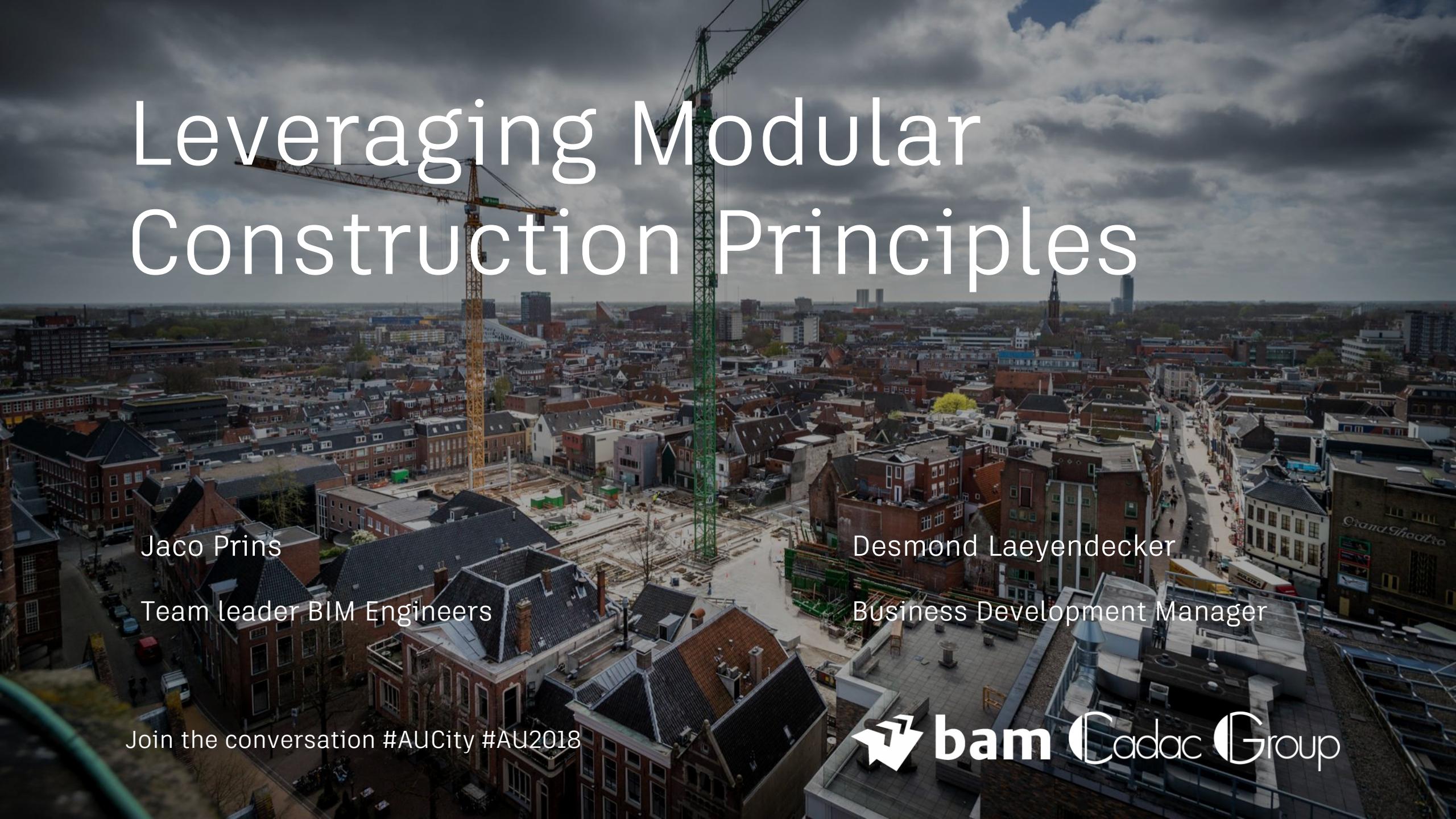
Desmond Laeyendecker

Business Development Manager

Join the conversation #AUCity #AU2018



# Leveraging Modular Construction Principles

Aerial view of a city with construction cranes and buildings, set against a dramatic sky with clouds.

Jaco Prins

Team leader BIM Engineers

Join the conversation #AUCity #AU2018

Desmond Laeyendecker

Business Development Manager

 **bam**  **Cadac Group**

# Today's Agenda

TRENDS  
CHALLENGES  
OPPORTUNITIES

## WHY

What trends and challenges do we see in the construction industry and within BAM today and what opportunities can explore

## MODULAR CONSTRUCTION

### WHAT

What can Modular Construction mean for us in addressing the industry challenges and opportunities

## BAM MEC

### HOW

Demonstrating how we have achieved our goals

## BEHIND THE SCENES

### THE TECHNOLOGY

Explaining the technology behind the success and Cadac Modules



## About the speakers

Jaco Prins - BAM

**Team leader BIM Engineers**

Studied Construction Technology @ TU Eindhoven  
Thesis: automation of ordering frames, doors, hinges, and locks from a BIM model without any errors.

Automating the Construction Industry

# Trends & Opportunities



# Royal BAM Group nv



Revenue 2017: € 6.6 billion



Adjusted result before tax € 63.3 million



Orderbook at year-end 2017 € 11.6 billion



Employees (average; in FTE) 19,720



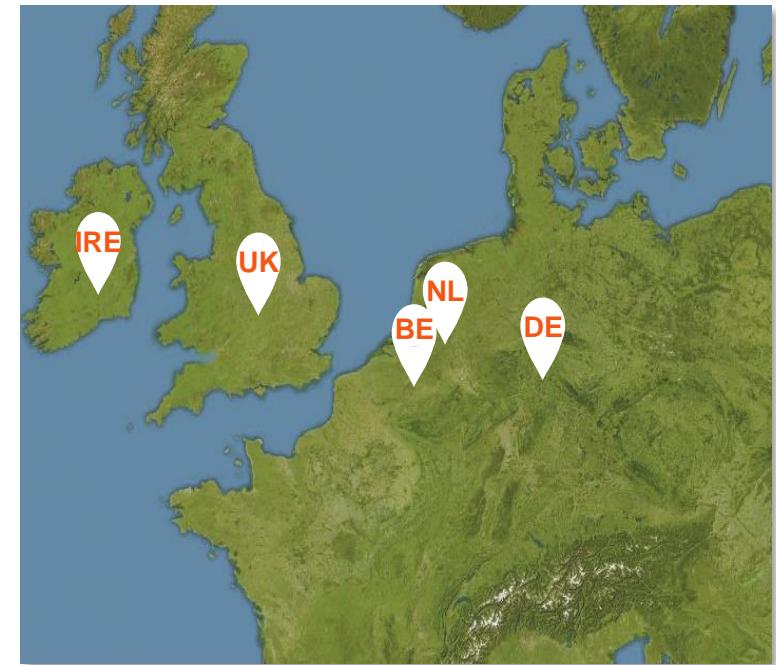
Operating companies 10



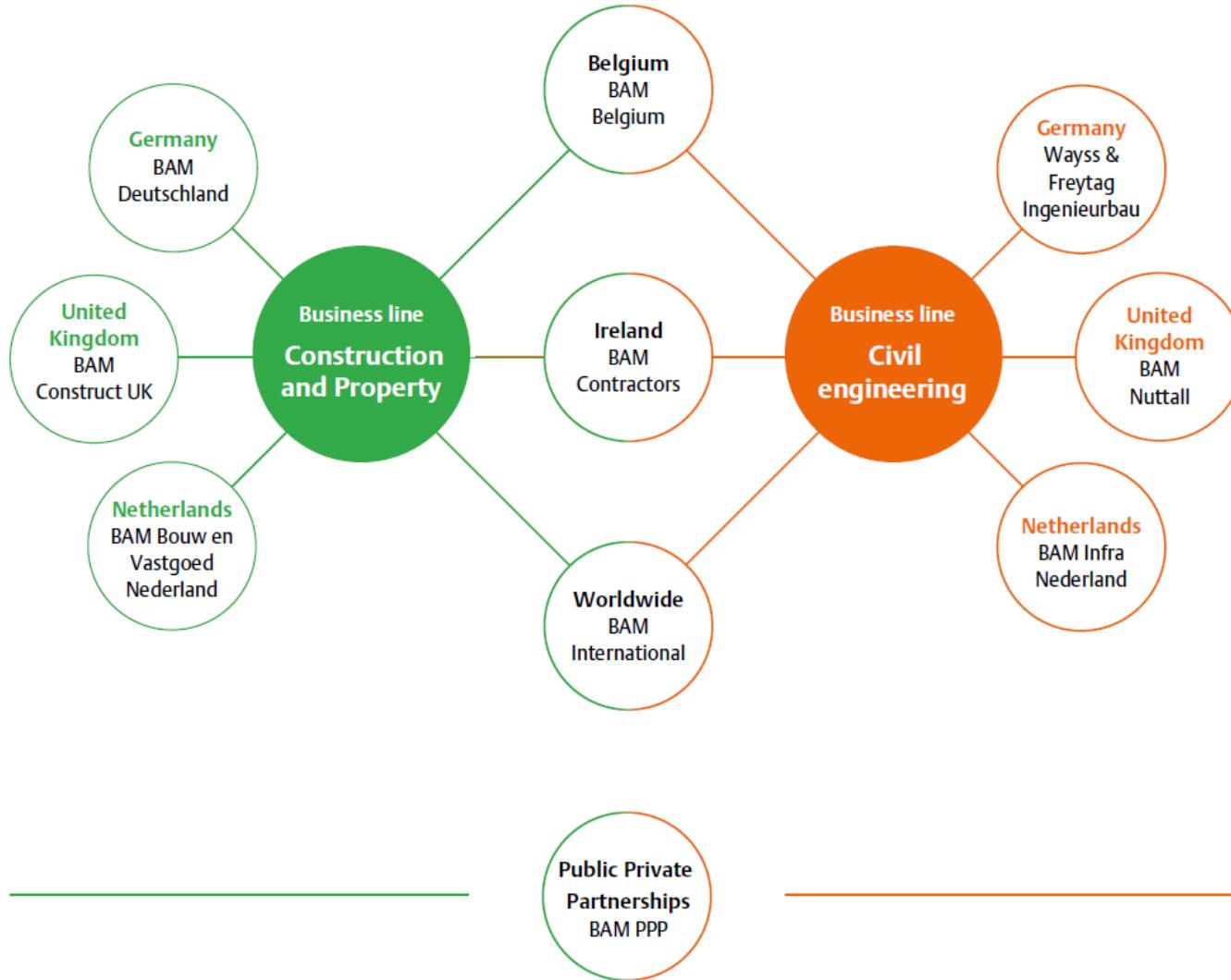
Countries 40 worldwide; 5 European home markets



Shares 275 million



# Royal BAM Group NV | organisation





Museum V&A Dundee  
BAM Construct UK



**ABN AMRO Pavillion (circular building), Amsterdam**  
BAM Bouw & Vastgoed



**Art Depot Museum Boijmans van Beuningen, Rotterdam**  
BAM Bouw & Vastgoed



**Museum of the Future, Dubai**  
BAM International and BAM Ireland



Construction represents  
**6%**  
of global GDP

Source: World Economic Forum<sup>2</sup>



By 2030, worldwide **construction output** is forecast to reach \$17.5Tn (\$2014), some 85% greater than 2014 levels

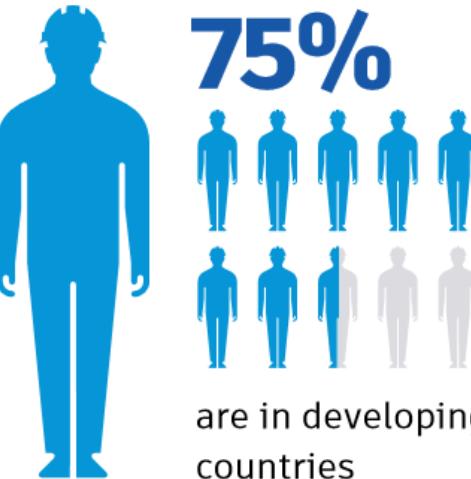
Source: Global Construction 2030<sup>4</sup>

In the UK, every £1 invested in construction delivers £2.84 of **economic activity**



Source: LEK Consulting<sup>3</sup>

There are up to  
**180 million** construction workers worldwide  
**75%** are in developing countries



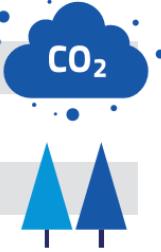
Source: Building and Woodworkers International, accessed <http://www.bwint.org/pdfs/WCProcurementFiona.pdf>

Today, our **built environment** utilises the world's:

Energy



Carbon dioxide emissions



Natural resources



Source: [Global Construction 2030<sup>4</sup>](#)



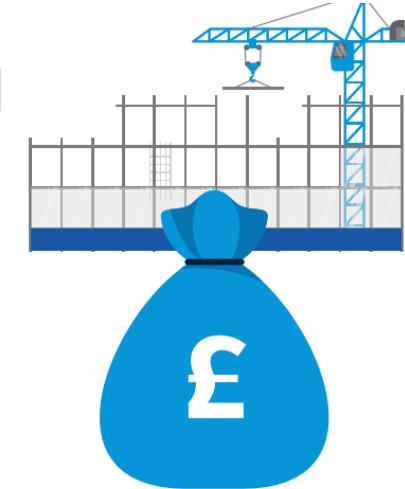
**Skills shortage** is common in many construction markets, with only the above **four** having excess labour due a downturn in those markets

Source: [Turner and Townsend International Construction Market Survey 2016](#)

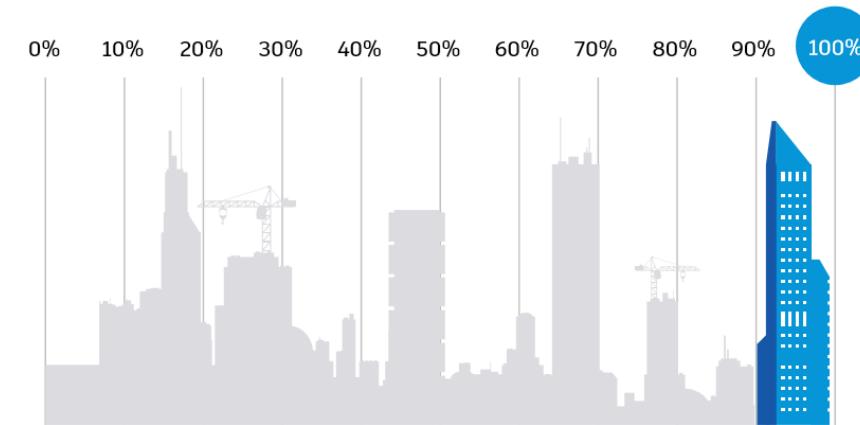
Average global construction project margins fell from an already low 6.3% in 2015 to

**6.1%**

in 2016



Source: [Turner and Townsend International Construction Market Survey 2016](#)

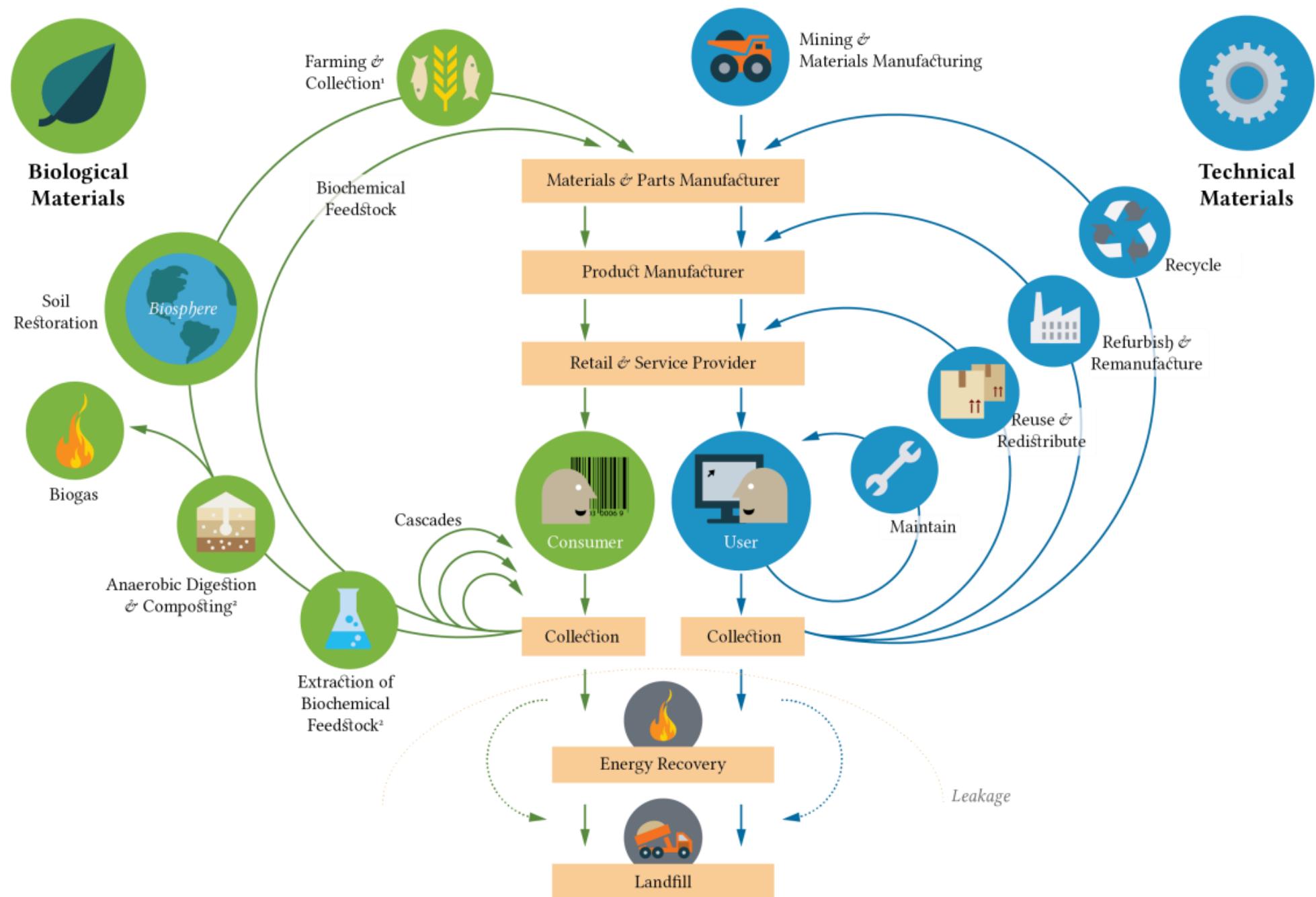


Just a **quarter** of construction projects in the last three years came **within 10%** of their original deadlines

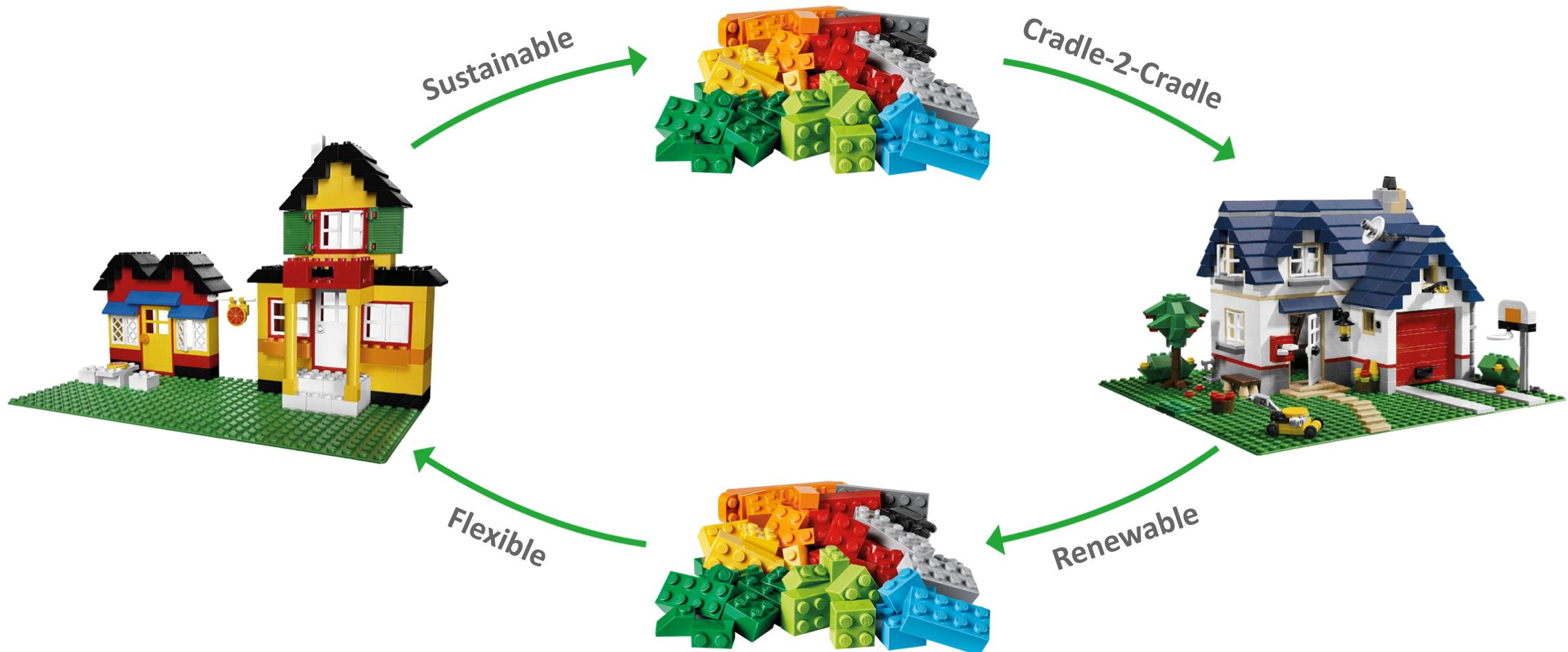
Source: [KPMG, Climbing the Curve, 2015 Global Construction Project Owner's Survey](#)



A closed system...

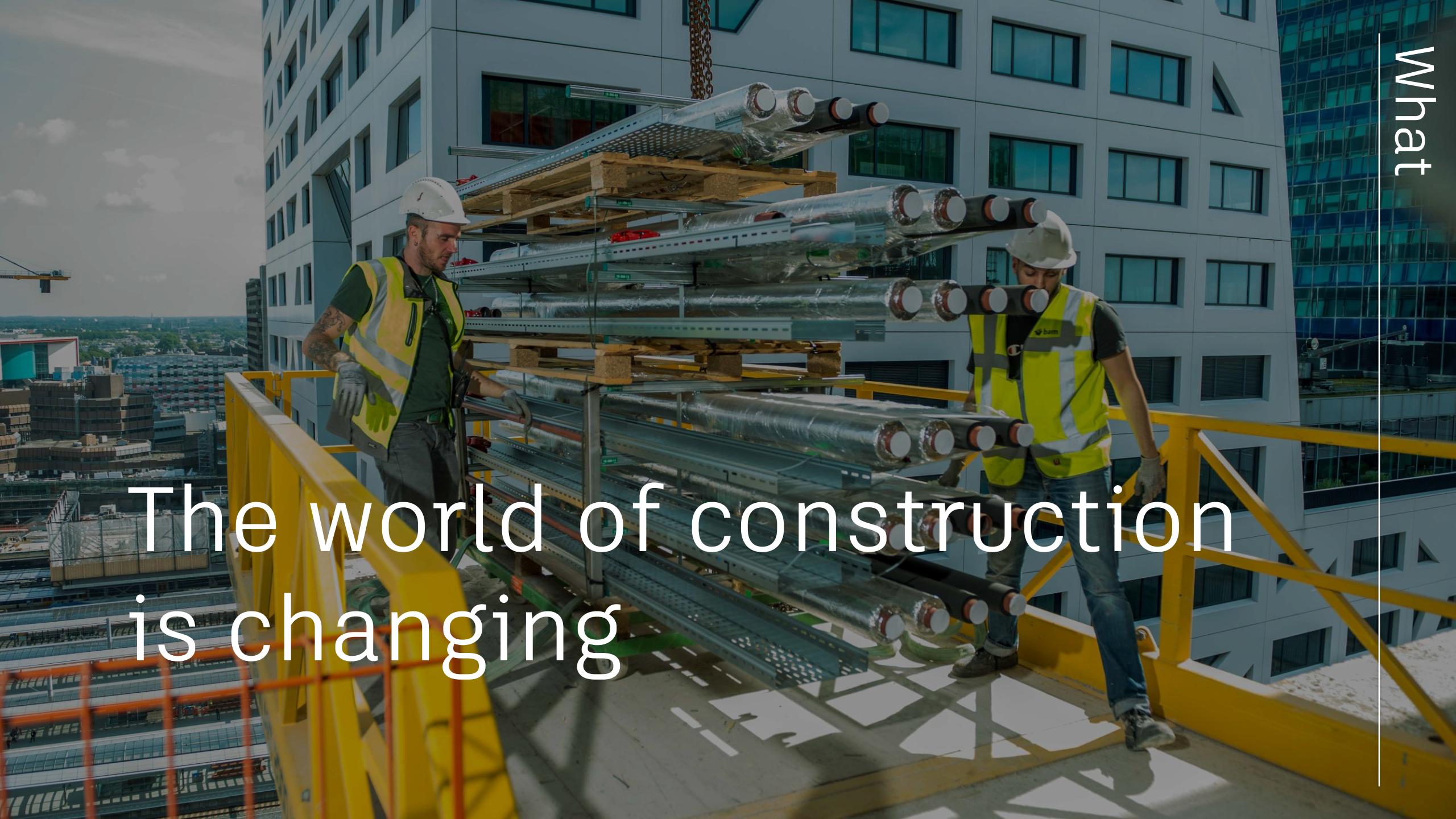


# Todays modularity = Tomorrows Circularity

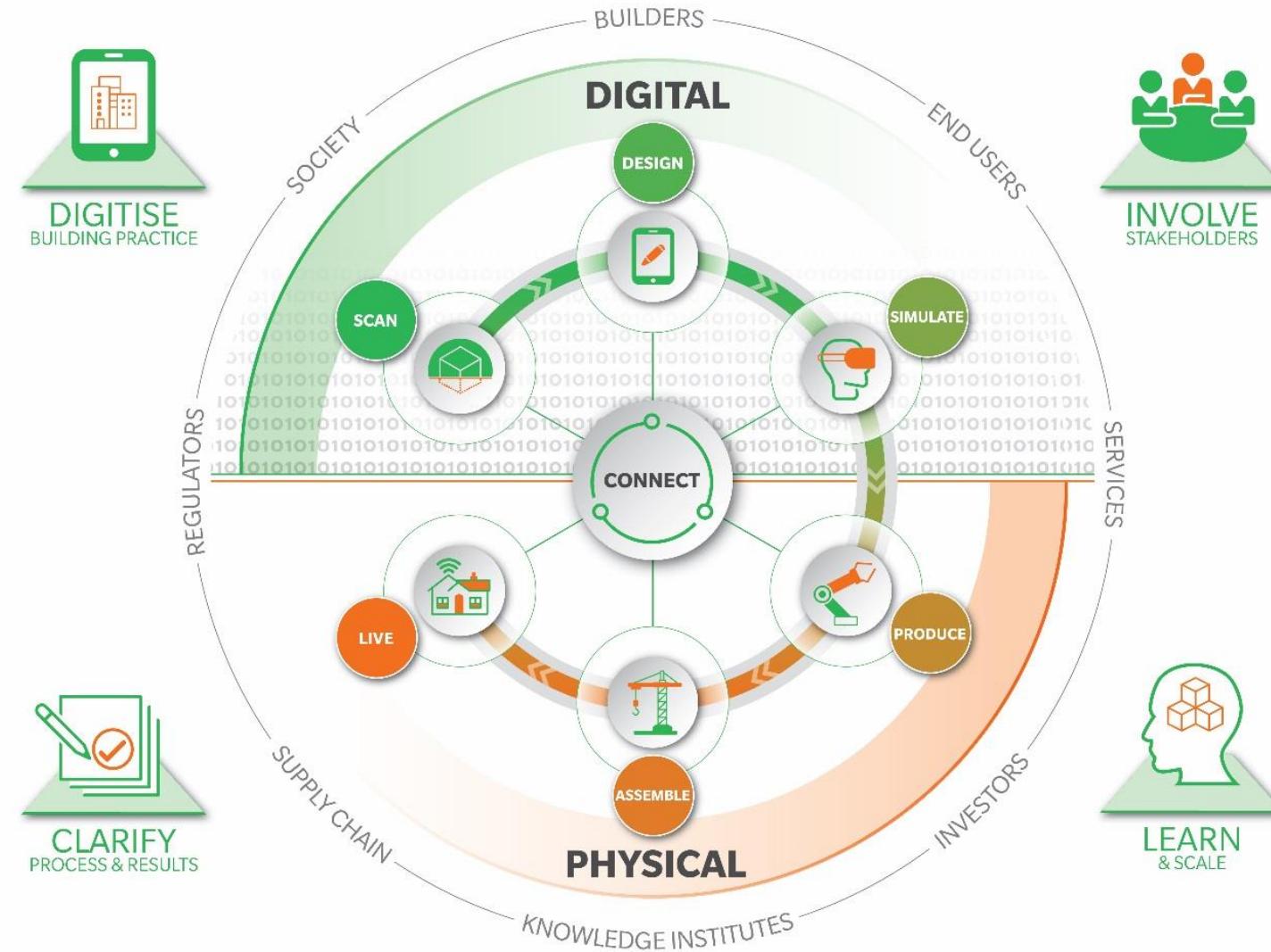


What

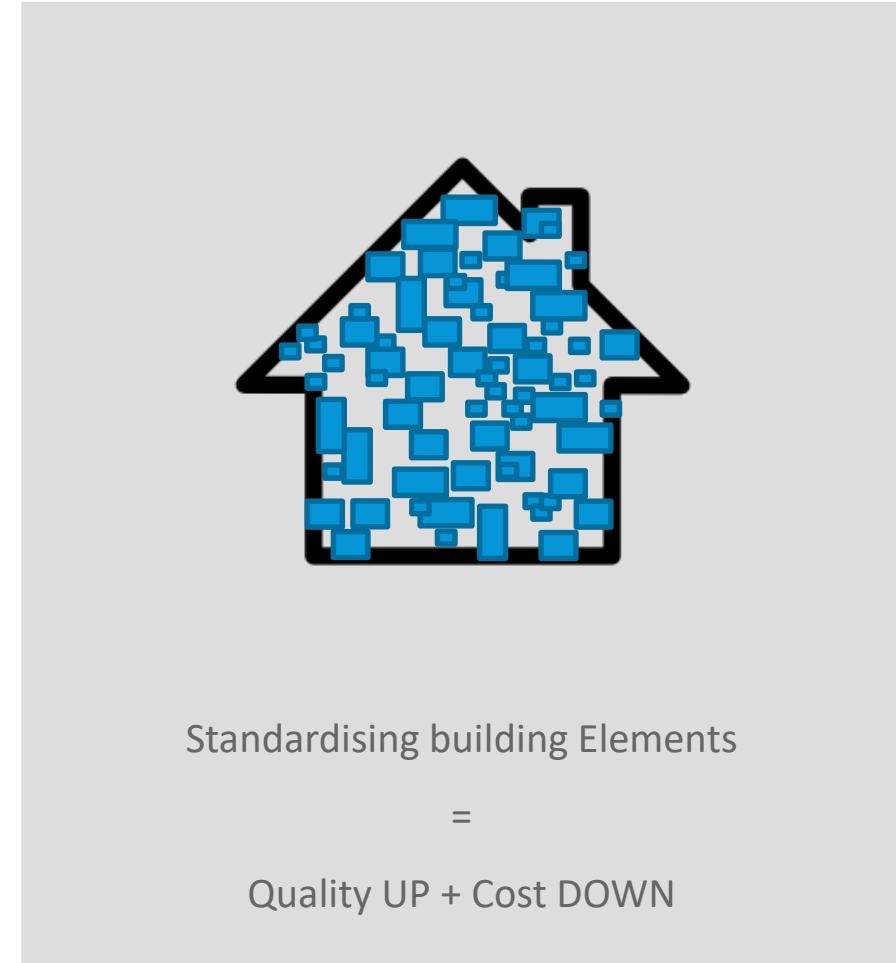
The world of construction  
is changing



# Royal BAM Group's Digital Transformation

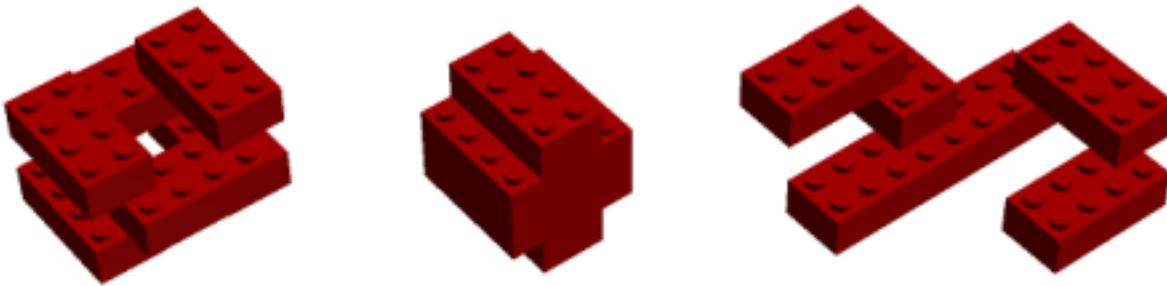


# A new building can be up to 80% modular



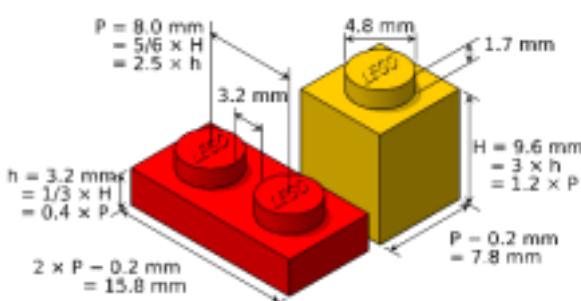
# Modular Construction

- The LEGO® concept
- Standardised blocks – multiple configurations
-  6 blocks > 915.000.000 configurations



# Modular Construction

## Standard LEGO® configuration rules



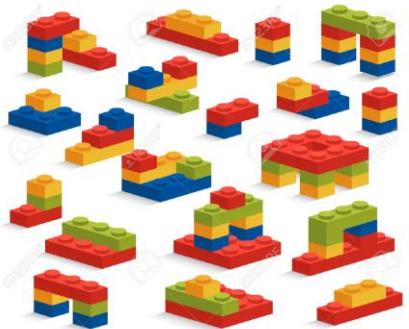
## Block type specific parameters

Keyword	parameter_name	config_string
DATA_DICTIONARY	B_CLUSTER_ROWID	0
DATA_DICTIONARY	B_CLUSTER_USER	0
DATA_DICTIONARY	B_INDEX_ROWID	WITH FILLFACTOR = 75
DATA_DICTIONARY	B_INDEX_USER	WITH FILLFACTOR = 75
DATA_DICTIONARY	B_STORAGE	
DATA_DICTIONARY	MYTABLES_MODIFIED_INDEX	WITH FILLFACTOR = 75
DATA_DICTIONARY	MYTABLES_MODIFIED_TABLE	WITH FILLFACTOR = 75
DATA_DICTIONARY	STATE_LINEAGES_INDEX	WITH FILLFACTOR = 75
DATA_DICTIONARY	STATE_LINEAGES_TABLE	WITH FILLFACTOR = 75
DATA_DICTIONARY	STATES_INDEX	WITH FILLFACTOR = 75
DATA_DICTIONARY	STATES_TABLE	WITH FILLFACTOR = 75
DATA_DICTIONARY	VERSIONS_INDEX	WITH FILLFACTOR = 75
DATA_DICTIONARY	VERSIONS_TABLE	WITH FILLFACTOR = 75
DATA_DICTIONARY	XML_INDEX_TAGS_INDEX	WITH FILLFACTOR = 75
DATA_DICTIONARY	XML_INDEX_TAGS_TABLE	WITH FILLFACTOR = 75
DATA_DICTIONARY	XML_TAGS_PK_INDEX	WITH FILLFACTOR = 75
DATA_DICTIONARY	XML_TAGS_TABLE	WITH FILLFACTOR = 75
DATA_DICTIONARY	XML_TAGS_UK_INDEX	WITH FILLFACTOR = 75

## Element Generator



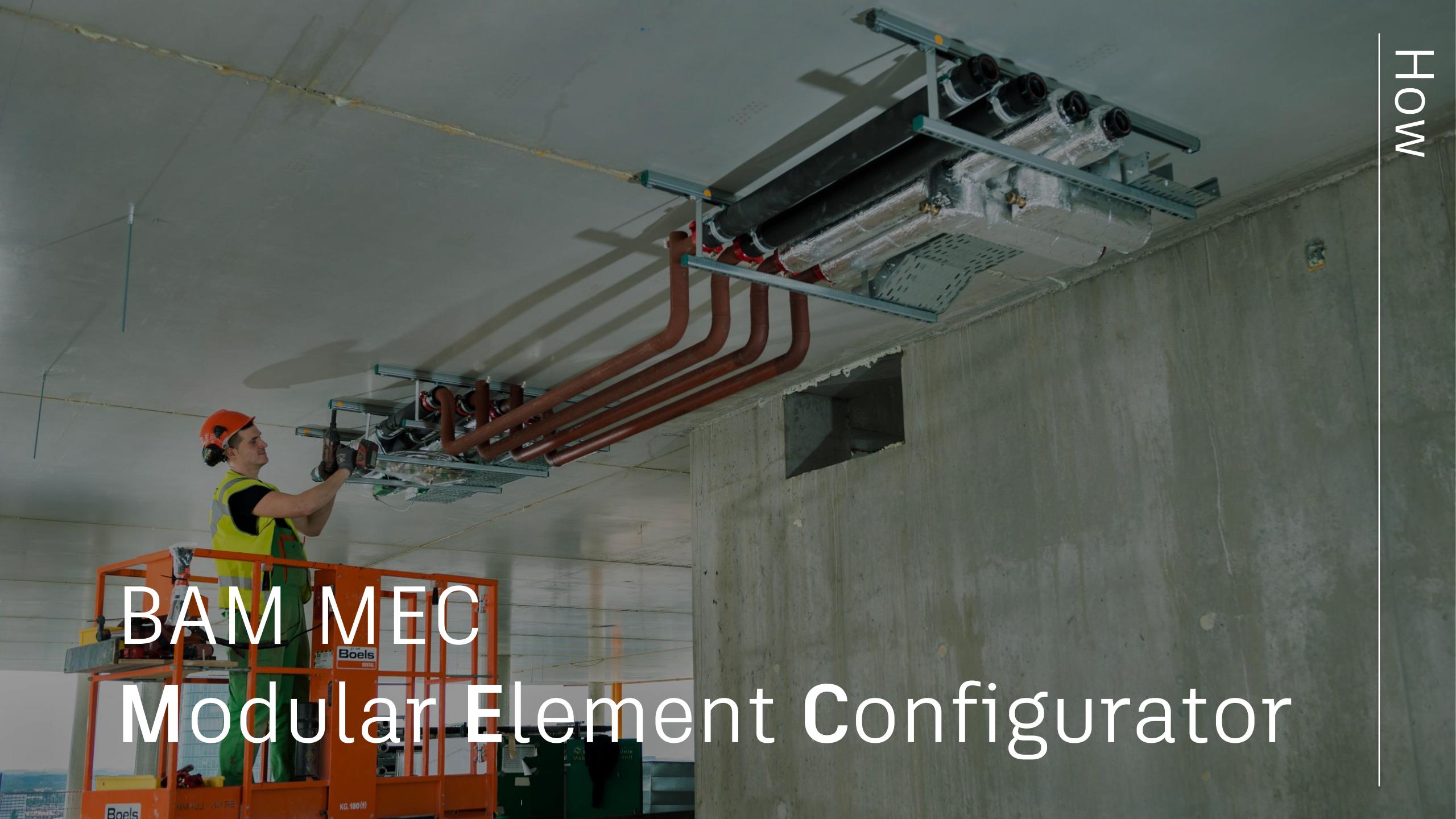
## Various Configurations



HOW

# BAM MEC

## Modular Element Configurator



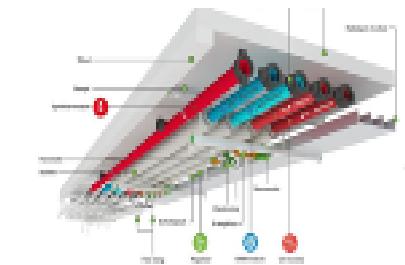
# What is BAM MEC

- Various standard modules
- Numerous variations by combining modules
- 1.000.000.000+ configuration possibilities
- Some combinations are allowed, others are not

**Clean Walls**

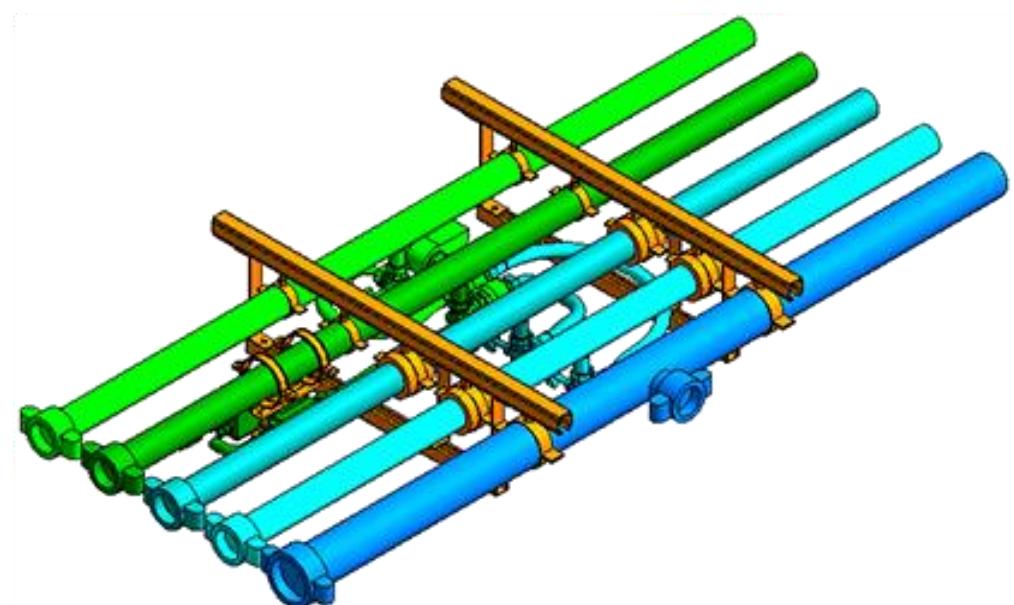


**Distribution rack**



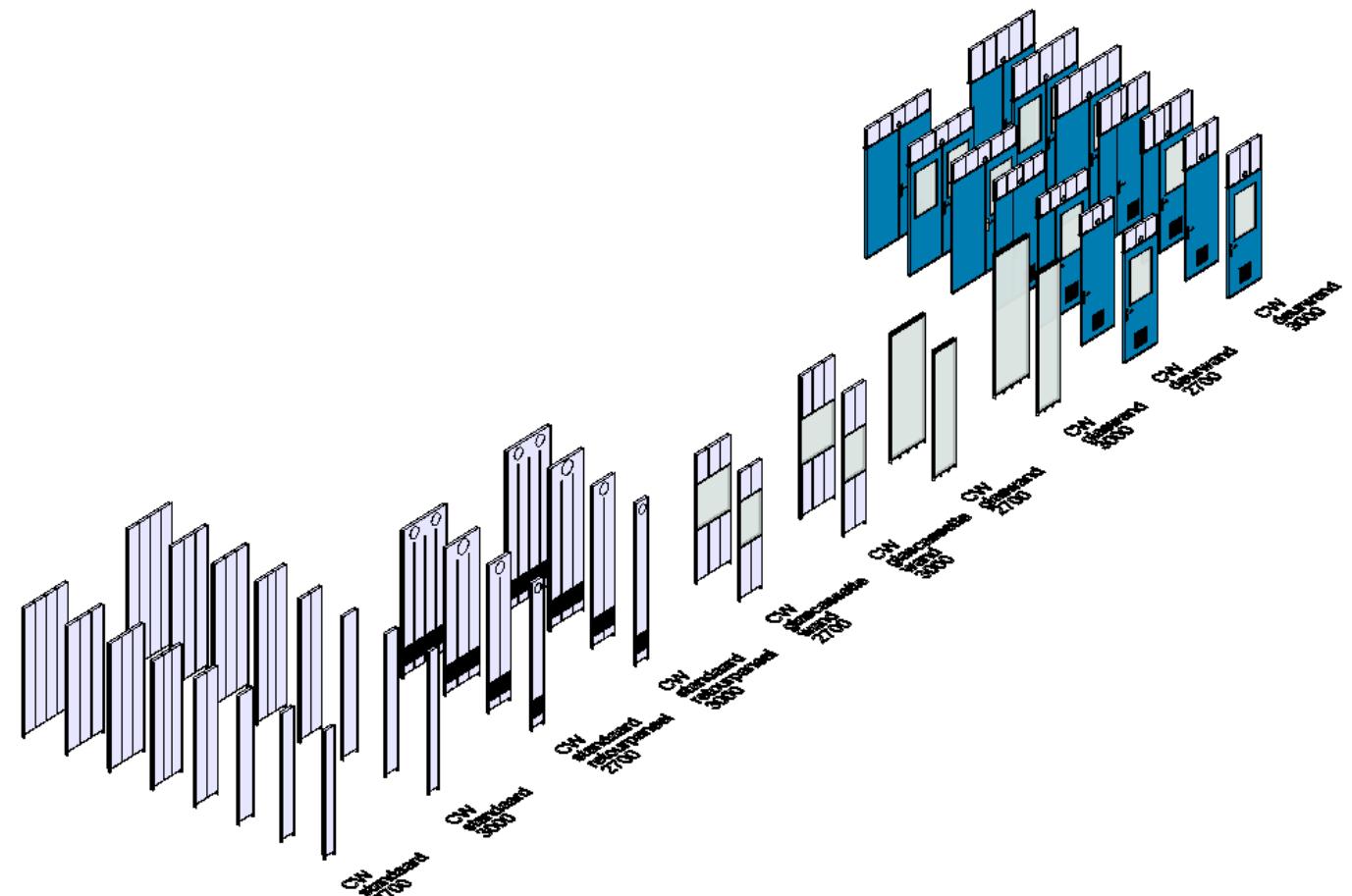
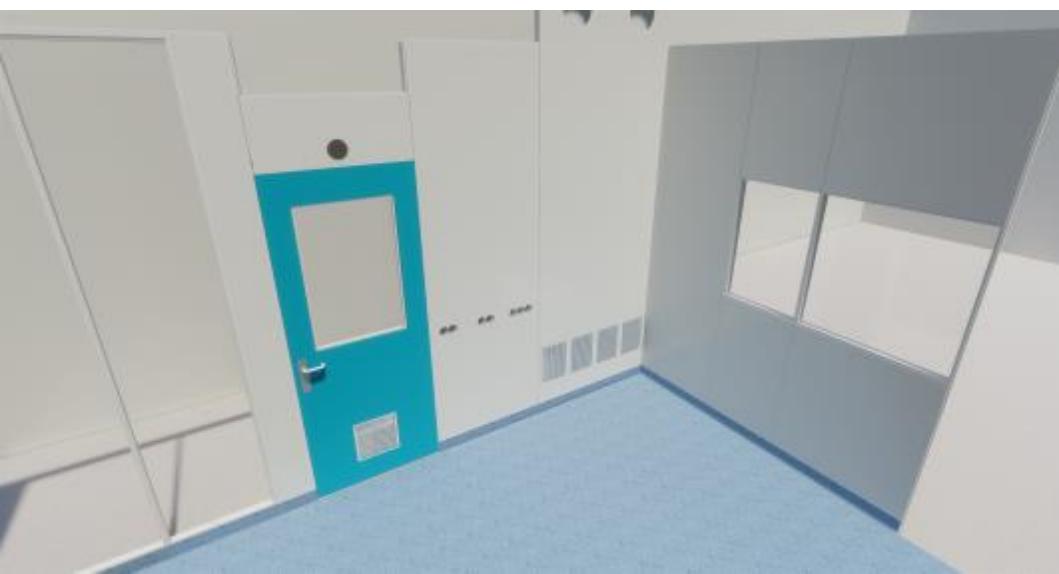
# Why BAM MEC?

- Elements are 100% correctly configured, in one take!
- Generated elements only require correct placement within the model
- Consistent data & status across all projects



# Application: Concepts

- Clean Walls
- Element types



# BAM MEC

- How we configure the modules

bam Modulaire Elementen Configurator

PROJECTS » WORLD TRADE CENTE... (2018-03-1006) » CONFIGURATIONS » ??? (DISTRIBUTIEBAAN16)

Save Save as Export Export JSON

KEUZEMENU ▾

ELEMENT TYPE ▾

MODULES ▾

CV \*

GKW \*

Kabelgoot \*

Sprinkler \*

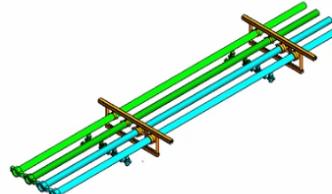
AFMETINGEN ▾

CV \* DN50

GKW \* DN50

LEIDINGISOLATIE ▾

CV leidingen





Welcome Bill Designer

WTC - Utrecht



Shell - Den Haag:

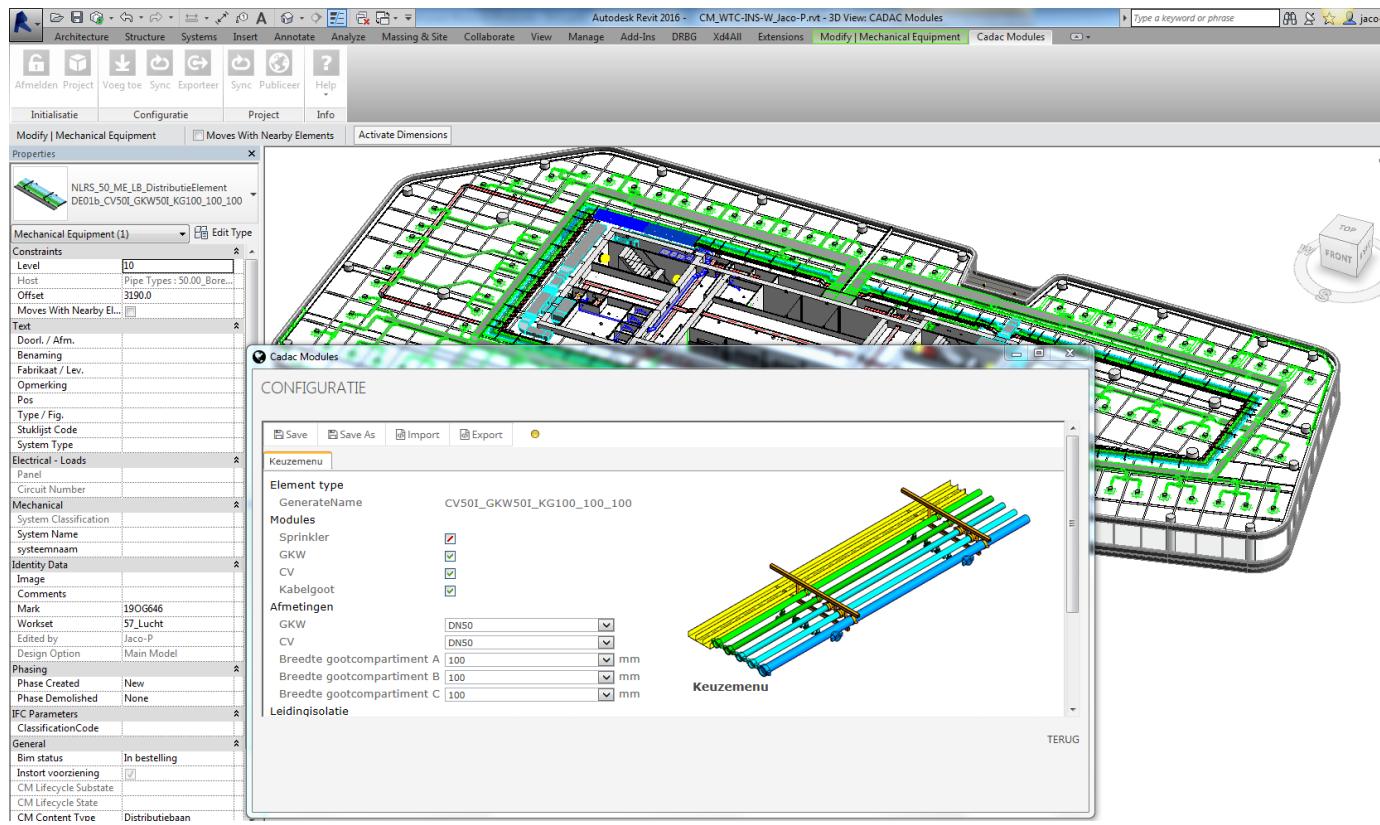


Océ - Venlo



# BAM MEC

- How we load the configuration into Autodesk Revit



Autodesk Revit 2018.3 - Not For Resale Version - WTC.rvt - 3D View: CADAC Modules Coordination

Type a keyword or phrase

File Architecture Structure Systems Insert Annotate Analyze Massing & Site Collaborate View Manage Add-Ins Quantification Site Designer Bimforce TheModus Model Extender Extensions Modify Cadac Modules Precast Cadac TheModus

Logout Project New Edit Insert Update Export Set to submit Sync Publish Reset Cloud Help

Initialize Configuration Project Manage Info

Project Browser - WTC.rvt

Views (TheModus (discipline))

- 1. Modelling
  - Architectural
    - Coordinate
      - 3D Views
        - CADAC Modules
        - CADAC Modules Coordination**
  - Mechanical
    - CV-installatie
      - Floor Plans
        - Level 10
- 1. Werk
- 2. Plot
- Legends
- Schedules/Quantities (all)
- Sheets (all)
- Families
- Groups
- Revit Links

Properties

3D View LOD 000 Modelleren coordinatie 3D

3D View: CADAC Modules Coordination

Graphics

View Scale	1 : 100
Scale Value 1:	100
Detail Level	Fine
Parts Visibility	Show Both
Visibility/Graphics Overrides	Edit...
Graphic Display Options	Edit...
Discipline	Architectural
Show Hidden Lines	By Discipline
Default Analysis Display Style	None
Visible In Option	all
Sub-Discipline	Coordinate
view soort	1. Modelling
Sun Path	<input type="checkbox"/>

Text

Verdieping doorsnede

Properties help

Apply

1 : 100

57\_Lucht

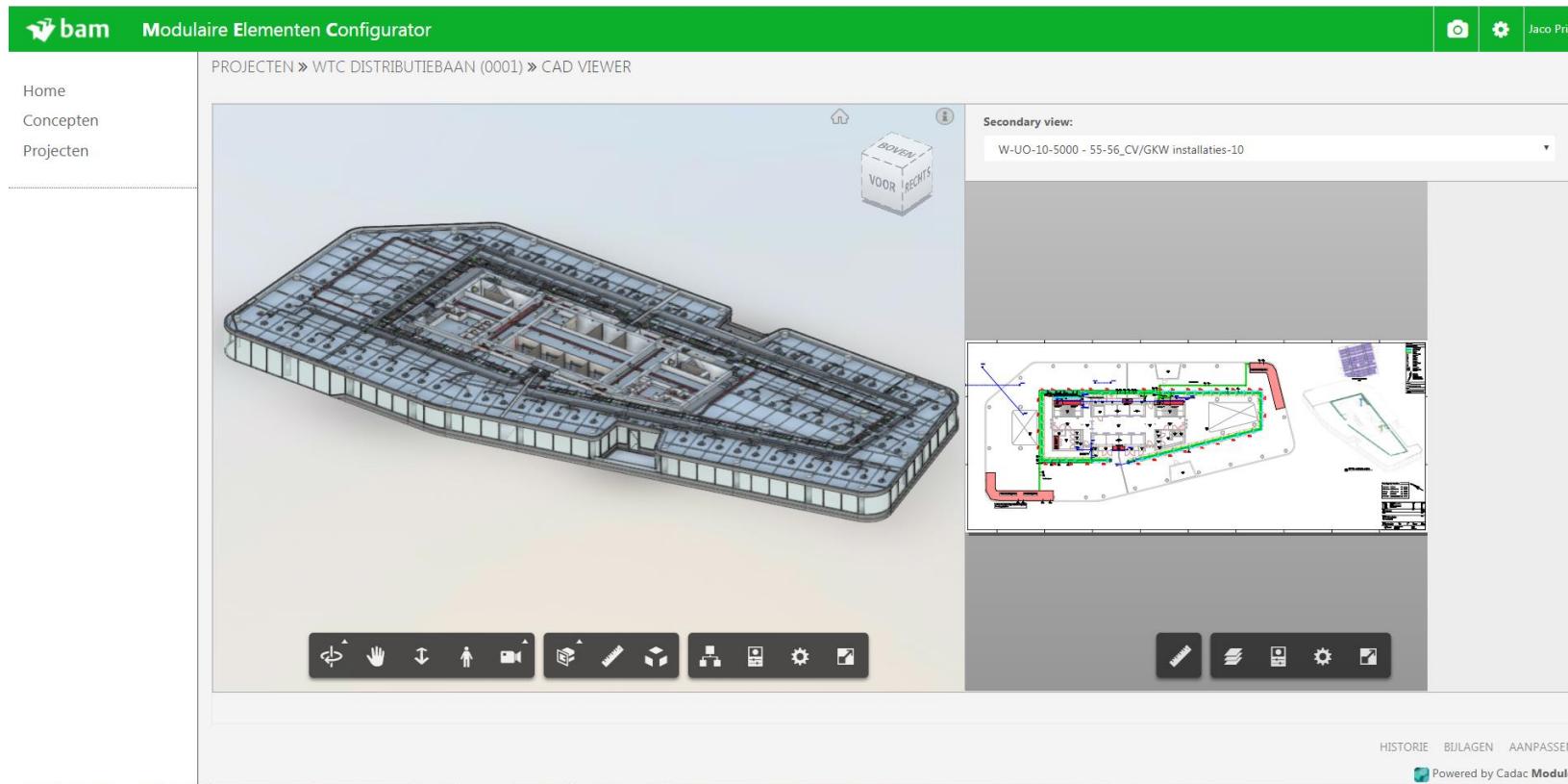
Main Model

Exclude Options Editable Only

Click to select, TAB for alternates, CTRL adds, SHIFT unselects.

# BAM MEC

- Accessing the model through the online portal



## Welcome Bill Designer

WTC - Utrecht

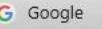


Shell - Den Haag:



Océ - Venlo



Cadac Modules Portal  Google

https://modulesaccept.cadac.com/portal?projectId=3b020b74-70aa-41a1-9b46-3ac78d5f2d81&Language=en#/projectpublications

bam Modulaire Elementen Configurator

Home Concepts Projects

PROJECTS » WORLD TRADE CENTE... (2018-03-1006) » PUBLICATIONS

+ New publication

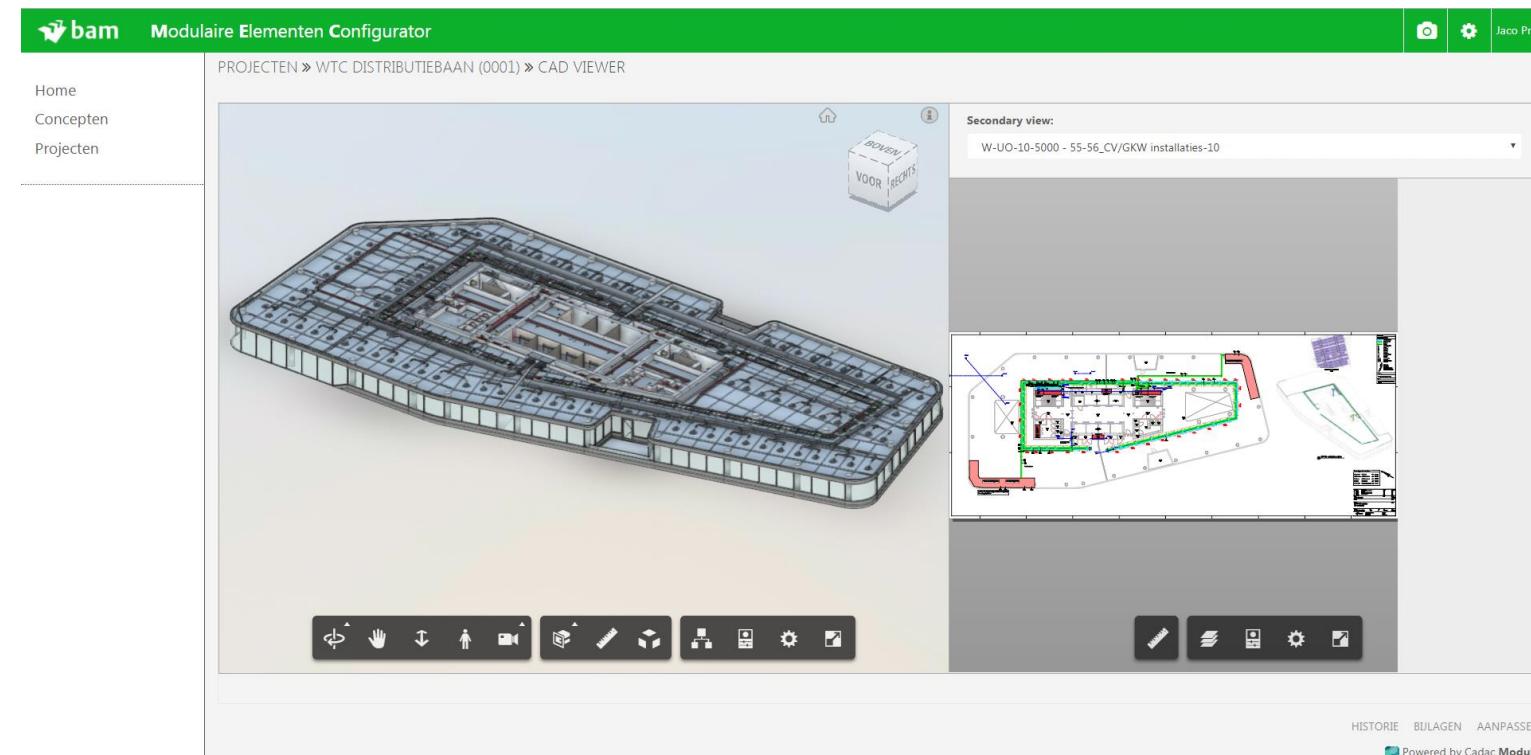
Search

DISCIPLINE	PHASE	PUBLISHER	TIMESTAMP	FILE NAME	TYPE	VERSION	STATE
<input type="checkbox"/> Coordination	New	bramaekens@cadac.com	14-6-2018 11:06	WTC.rvt	Publish	1.0	

Powered by Cadac Modules

# BAM MEC; Online Portal

- Status always accessible
- Four-eyes principle [Peer Review]
- Full Element History available

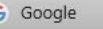


MODEL  
WTC.rvt (14/06/2018 11:06:49)

ELEMENT TREE STRUCTURE  
By Lifecycle

- ▼ 01. Engineering
- ▼ 10
  - ▼ NLR5\_50\_ME\_LB\_bochtelelementbinnen\_mob\_BAM  
BE41\_CV50RW30\_GKW50AF2\_KG24\_DVD
  - ▼ NLR5\_50\_ME\_LB\_distributieelement\_mob\_BAM  
DE01a\_CV50RW30\_GKW50AF2\_KG24\_DVD\_3600  
DE01b\_CV50RW30\_GKW50AF2\_KG24\_DVD\_3600  
DE02a\_CV50RW30\_GKW50AF2\_KG24\_DVD\_2700
- ▼ 02. Production
- ▼ 10
  - ▼ NLR5\_50\_ME\_LB\_aftakelementbinnen\_mob\_BAM  
AE61\_CV50RW30\_GKW50AF2\_KG24\_DVD



Cadac Modules Portal  Google

https://modulesaccept.cadac.com/portal?publishId=2d13d8d9-345b-4d95-aa34-94ab253af6e6&projectId=3b020b74-70aa-41a1-9b46-3ac78d5f2d81&Language=en#/projectpublications

 **Modulaire Elementen Configurator**

Home Concepts Projects

PROJECTS » WORLD TRADE CENTE... (2018-03-1006) » PUBLICATIONS

+ New publication

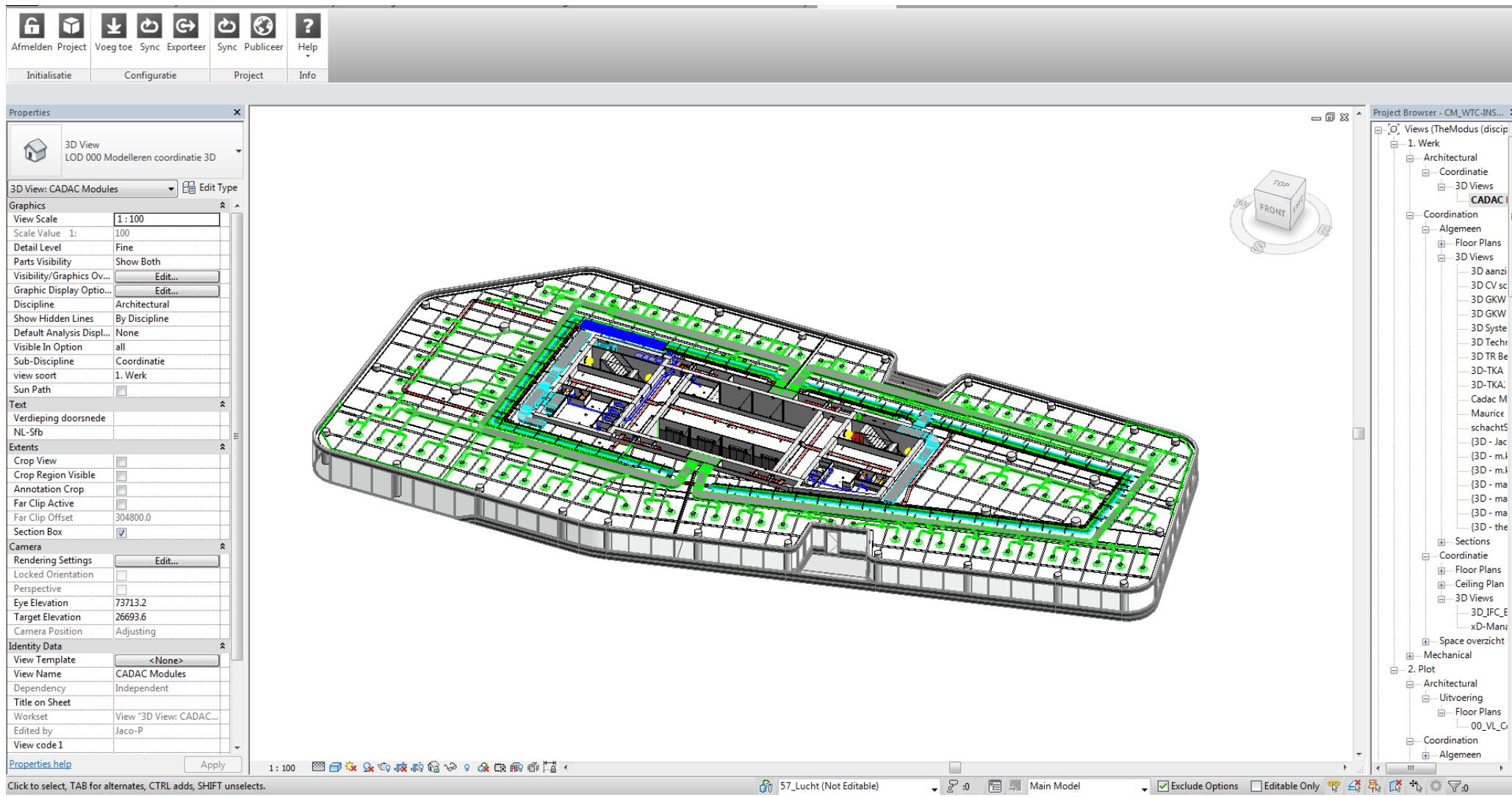
Search

DISCIPLINE	PHASE	PUBLISHER	TIMESTAMP	FILE NAME	TYPE	VERSION	STATE
<input type="checkbox"/>  Coordination	New	bramaekens@cadac.com	14-6-2018 11:06	WTC.rvt	Publish	1.0	



Powered by Cadac Modules

# Status in model



Autodesk Revit 2018.3 - Not For Resale Version - WTC.rvt - 3D View: CADAC Modules

Type a keyword or phrase

File Architecture Structure Systems Insert Annotate Analyze Massing & Site Collaborate View Manage Add-Ins Quantification Site Designer Bimforce TheModus Model Extender Extensions Modify Cadac Modules Precast Cadac TheModus

Logout Project New Edit Insert Update Export Set to submit Sync Publish Reset Cloud Help

Initialize Configuration Project Manage Info

Project Browser - WTC.rvt

Views (TheModus (discipline))

- 1. Modelling
  - Architectural
    - Coordinate
      - 3D Views
        - CADAC Modules**
        - CADAC Modules Coordination
        - CADAC Modules Lifecycle
    - Mechanical
      - CV-installatie
        - Floor Plans
        - Level 10
  - 1. Werk
  - 2. Plot

Legends

Schedules/Quantities (all)

Sheets (all)

Families
  - Air Terminals
  - Annotation Symbols
  - Cable Tray Fittings
  - Cable Trays

Properties

3D View LOD 000 Modelleren coordinatie 3D

3D View: CADAC Modules

Graphics	View Scale 1 : 100
Scale Value 1:	100
Detail Level	Fine
Parts Visibility	Show Both
Visibility/Graphics Overrides	Edit...
Graphic Display Options	Edit...
Discipline	Architectural
Show Hidden Lines	By Discipline
Default Analysis Display Style	None
Visible In Option	all
Sub-Discipline	Coordinate
view soort	1. Modelling
Sun Path	<input type="checkbox"/>

Text

Verdieping doorsnede

Properties help

1 : 100

57\_Lucht

Main Model

Exclude Options

Editable Only

The image shows a 3D view of a building's interior, specifically a floor plan with a central corridor and various rooms. The view is oriented diagonally, showing the layout of the rooms and the paths between them. The floor plan is overlaid with a network of pipes and ducts, representing the building's HVAC system. The pipes are color-coded, and some are labeled with text and numbers. The view is set to a scale of 1:100. The properties panel on the left shows the view is a 3D View LOD 000 Modelleren coordinatie 3D, and the discipline is set to Architectural. The properties panel also includes settings for view scale, detail level, parts visibility, and visibility/graphics overrides. The status bar at the bottom shows the scale as 1:100 and the view name as 57\_Lucht.

# BAM MEC | Behind the scenes

**Desmond Laeyendecker**

Business Development Manager – Cadac Group

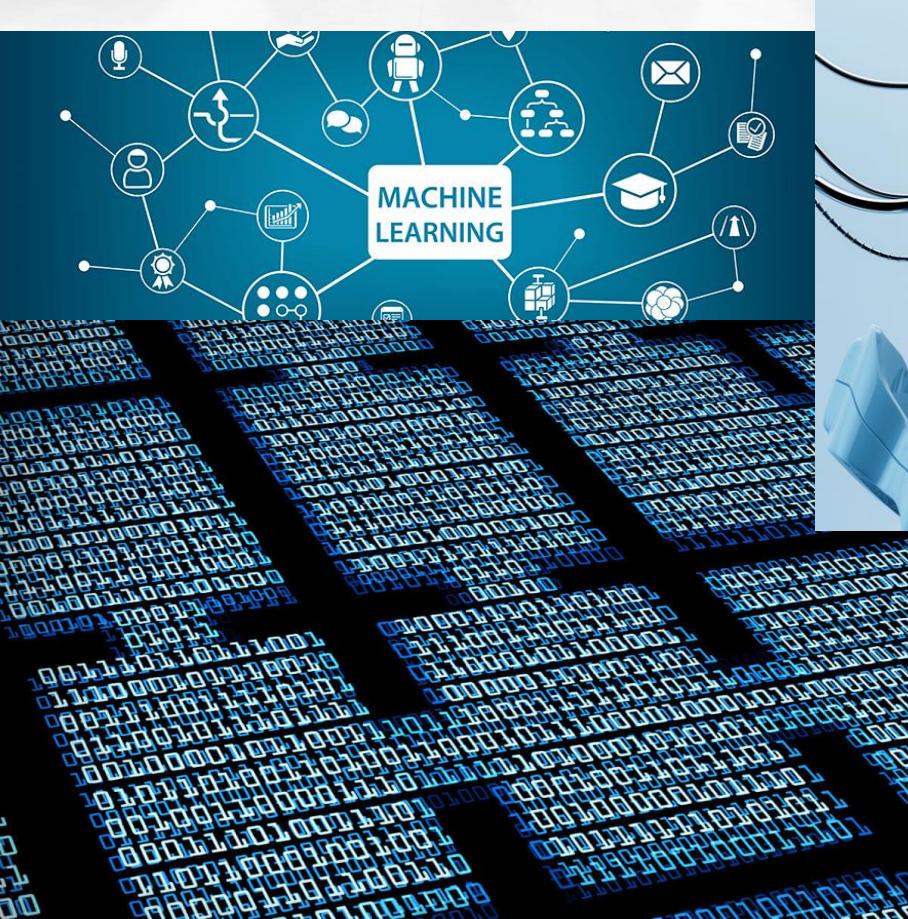
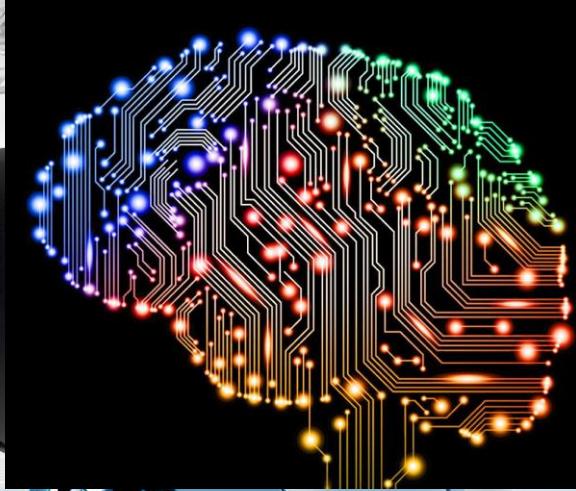


## About the speakers

Desmond Laeyendecker – Cadac Group  
**Business Development Manager**

Always looking to improve our customers  
business processes using the latest innovations  
and software solutions

Supporter of MORE | BETTER | LESS



Cadac Group

[www.cadac.com](http://www.cadac.com)

# Enabling Digital.

- Autodesk Platinum & Microsoft Gold Partner
- 30+ years of expertise
- Cadac. Enabling Digital.
  - Supporting businesses in their digital transition
  - Integrate Processes and Solutions
  - Optimise processes to help achieve business goals
  - Your digital design as a single source of truth

**“** We translate your objectives into a structured and manageable process.

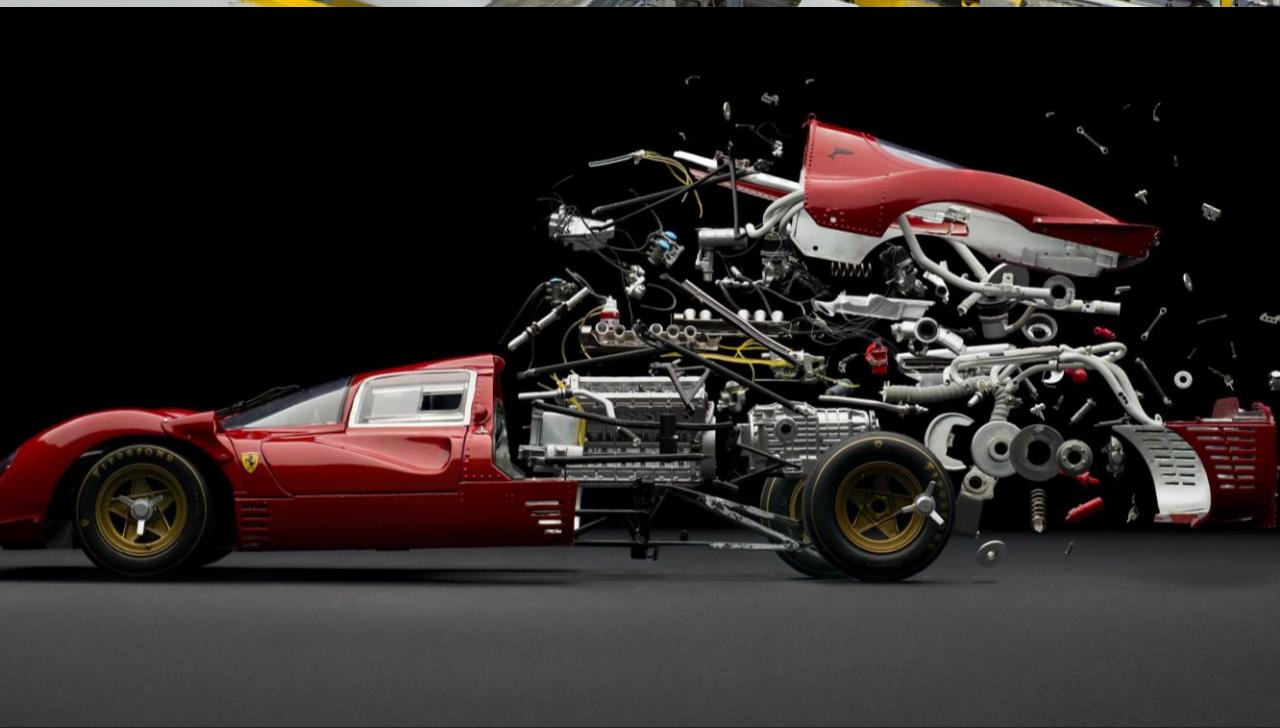


Jan Baggen  
Chief Executive Officer  
Cadac Group Holding



Cadac Group

[www.cadac.com](http://www.cadac.com)



Cadac Group

[www.cadac.com](http://www.cadac.com)

PROJECT: Hannover Hbf  
MODEL: Gesamtkoordinaten

A linked SharePoint document is opened in a filtered view.

From here a user can open the file.

The screenshot shows a SharePoint library interface for the project 'Hannover Hbf'. The library is titled 'Stahlbauarbeiten'. A modal window is open, showing a list of files under the heading '31 ALU BI HO-V0 A [2345253]'. The file 'P170825-SKELETT-00001-02.pdf' is highlighted with a red box. The SharePoint interface includes a ribbon with 'Office 365' and 'SharePoint' tabs, a navigation bar with 'BROWSE', 'CADAC ORGANICE APPS', 'FILES', and 'LIBRARY' buttons, and a search bar. The library list shows columns for 'Name', 'Document Description', 'Document Type', 'Asset', 'Description', 'Modified', and 'Modified By'. A red box highlights the 'Edit Links' button in the ribbon and the 'New' button in the library toolbar. The bottom right corner of the modal window has a red box around the 'Save' button.

PROJECT: Hannover Hbf  
MODEL: Gesamtkoordinaten

Electrical Inc. - 03 - All Files

https://cadacorganice.com

Apps Ziggo Sport Total

Office 365 SharePoint

BROWSE CADAC ORGANICE APPS FILES LIBRARY

Hannover Hbf EDIT LINKS

Search...

1 SHARE FOLLOW

Miel Scheepers

Stahlbauarbeiten

Home Libraries

Betonarbeiten

Stahlbauarbeiten

New Upload Sync Share More

01 - All Deliverables 03 - All Files 04 - All Documents ...

Find a file

SAVE THIS VIEW

Lists

Assets

Locations

Contacts

Recent

Recycle Bin

EDIT LINKS

31 ALU BI HO-V0 A [2345253]

File

P170825-SKELETT-000273.pdf Certificate

P170825-SKELETT-000274.pdf Certificate

P170825-SKELETT-00001-02.pdf Testreport 12-08-2017

P170825-SKELETT-000276.pdf Certificate

P170825-SKELETT-000234.pdf Test report 12-12-2016

P170825-SKELETT-000567.pdf Test report 14-12-2016

P170825-SKELETT-000567.pdf Certificate

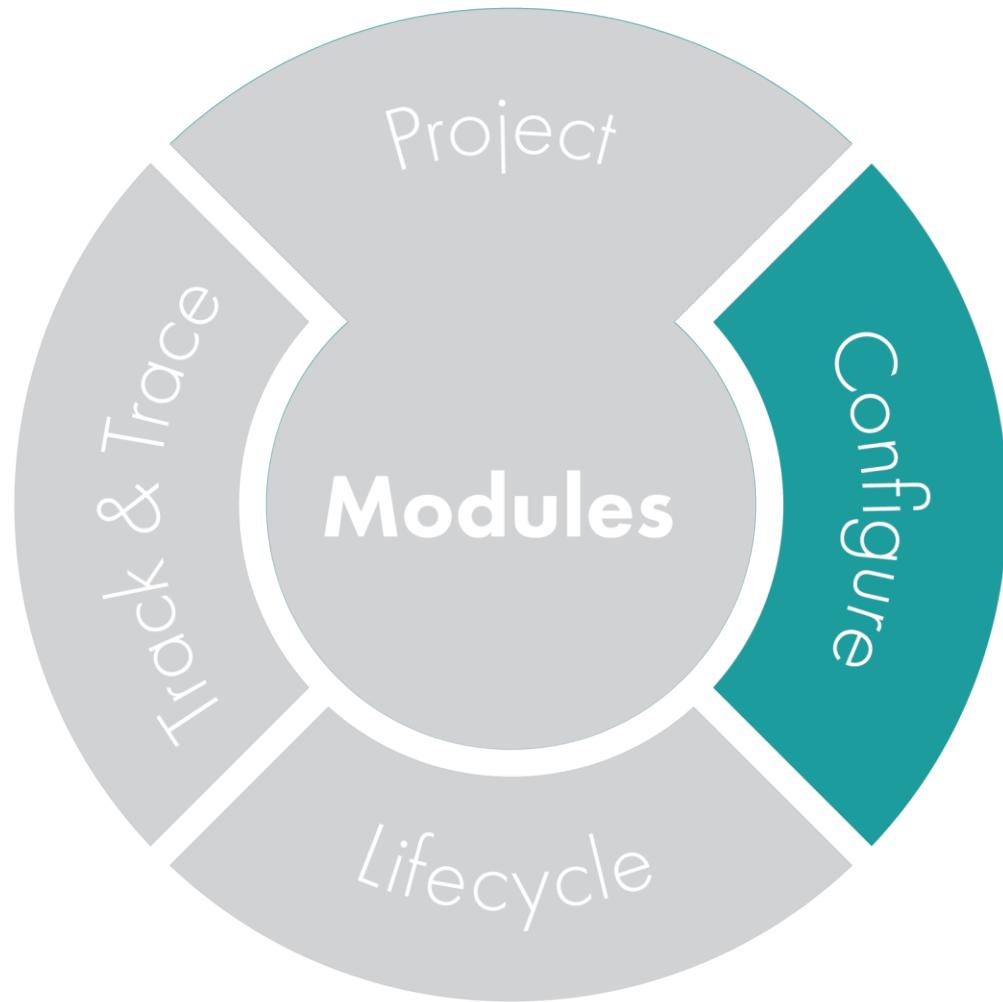
P170825-CONS-000678 version new 02-04-2017.pdf Certificate

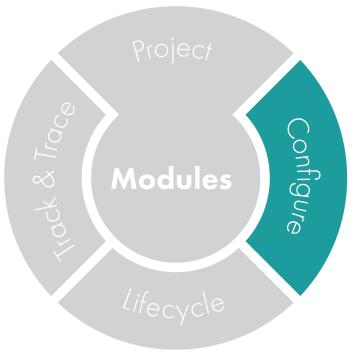
P170825-CONS-000456.pdf Specification

P170825-SKELETT-000457.pdf Specification

P170825-CONS-000458.pdf Specification

CHANGE PROJECT/MODEL CREATE LINK





Cadac Modules Portal <https://modulestest.cadac.com/portal?conceptId=9673d2ab-8bf4-4822-8f1b-3a4c2d69f112&projectId=0dcdda87-a546-4656-9f9f-9d0782bf6e60&language=nl#/configurationviewer>

Cadac Modules

CONFIGURATIE >> 1000-AIRHEATER\_NOC360

Opslaan Opslaan als Importeren Exporteren Bijwerken viewer

KLANT UITVOERING TECHNISCHE INFORMATIE AFMETINGEN ACCESSOIRES ROOKGASAFOER BOM

LUCHTSTROOM ▾

Luchtstroom

BEDIENING ▾

Schakelaar: Geen

Thermostaat: Optitherm (Klokthermostaat)

Ruimtevoeler:

MONTAGE ▾

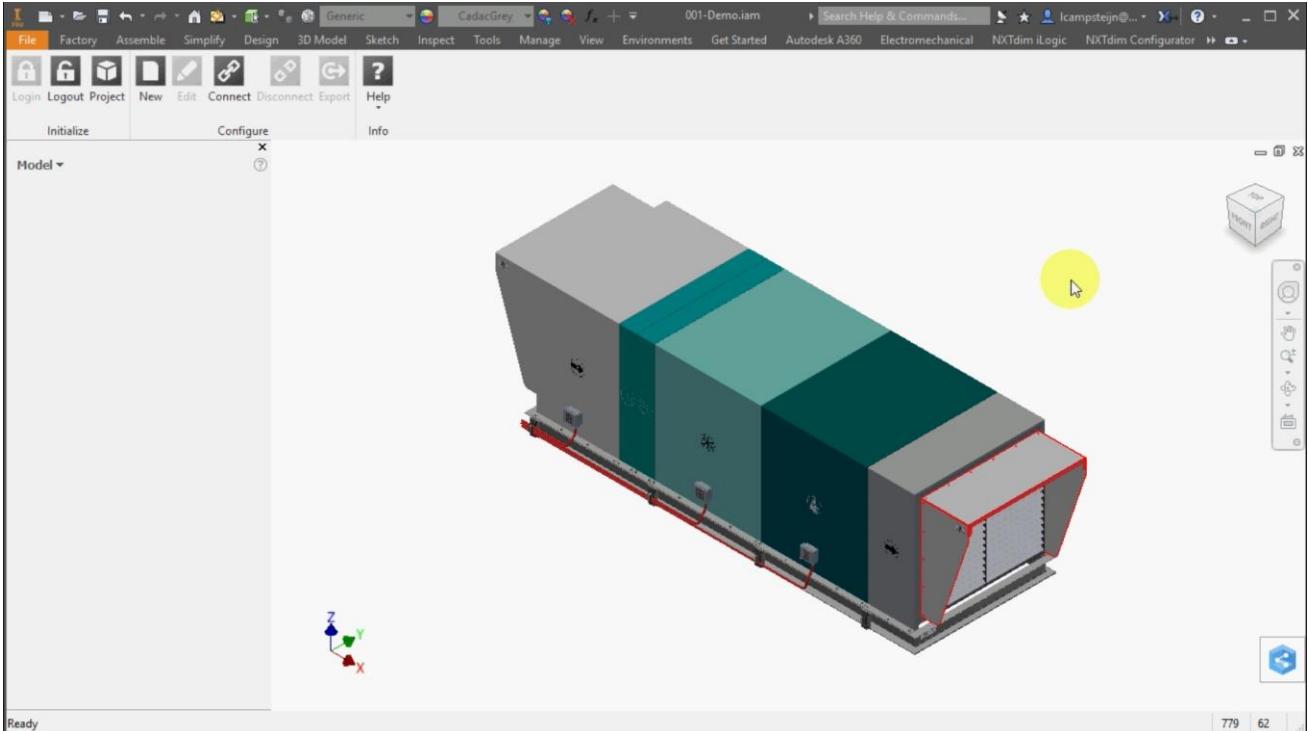
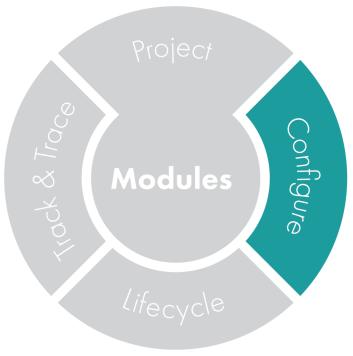
Front view of the air heater unit with louvres and a control panel.

Front view of the air heater unit with louvres and a control panel.

# Features

- Configuration Management
- Configure Elements Online
- Configuration Import & Export
- Connect & Sync 2 CAD
- Create Documents

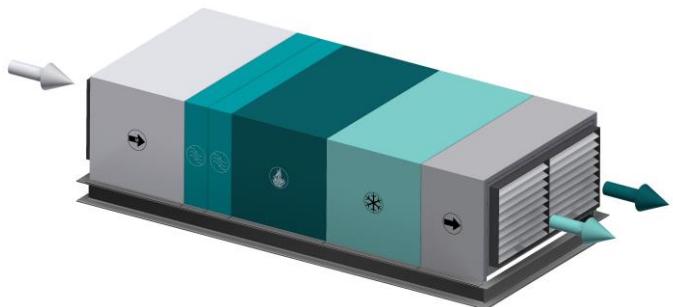
# Configure Elements or Assemblies



**Tools:** Cadac Modules Configure

**Role:** Product Manager  
Manufacturer

**Geometry + Product data**



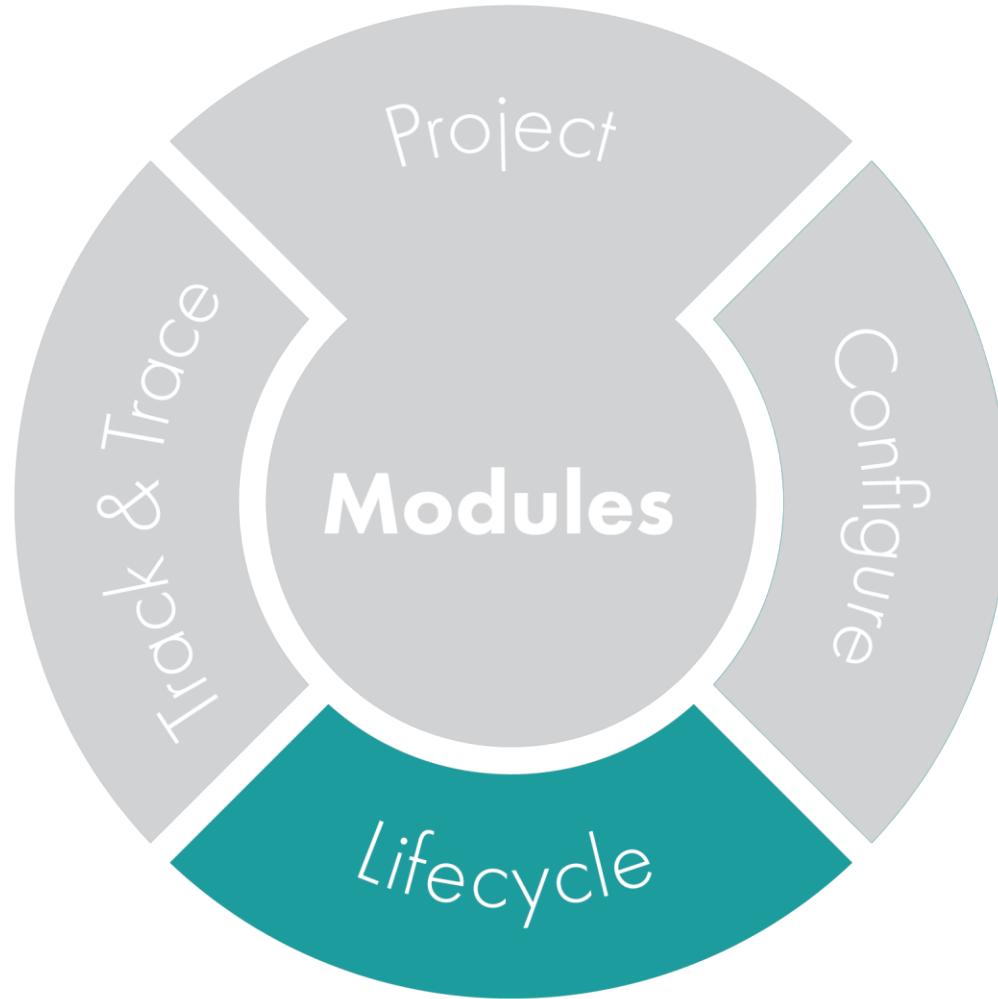
**Tools:**

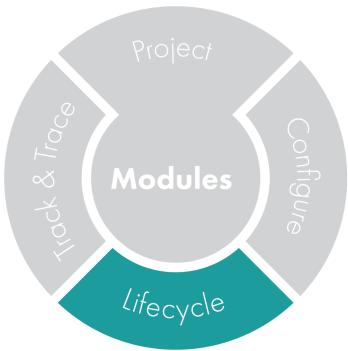


Sync Configuration code

Powered by **Configit**®

**Role:** Revit Modeller  
BIM Manager





Cadac Modules Portal +

modules.cadac.com/portal?publishId=2c237ae0-ab9e-434f-acfb-2c11b84f395e&projectId=0ba514b7-6c61-4b06-b637-1953e651bdd&language=en-us#elementhistory

**Cadac Modules for JB Construct.**

PROJECTS > CADAC AEC MAIN OFFICE (2017-203) > ELEMENTS > 1062 X 2396 FIXED (31 ALU BI H1-V0 A) > ELEMENT HISTORY

Bjorn Ramaekers (Admin)

Home  
Concepts  
Projects

Element Details  
Element History

TIMESTAMP	PREVIOUS STATE	ACTION	CURRENT STATE	EXECUTED BY	COMMENT	CHECK STATE	CHECK LIST
2-6-2017 10:50:18	05. Commission	Checksum Invalid	05. Commission	bramaekers@cadac.com		Invalid	
1-6-2017 15:14:48	04. Construct	Approved	05. Commission	bramaekers@cadac.com	Thanks for the good work. Enjoy the building!	Valid	Open
1-6-2017 15:13:38	04. Construct	Properties edited	04. Construct	bramaekers@cadac.com	Marked for review	Valid	
1-6-2017 15:11:14	03. Order	Approved	04. Construct	bramaekers@cadac.com		Valid	
1-6-2017 15:08:32	03. Order	Properties edited	03. Order	bramaekers@cadac.com	Marked for review, Delivery Date, Construction date	Valid	
1-6-2017 15:04:28	02. Procurement	Approved	03. Order	bramaekers@cadac.com		Valid	
1-6-2017 13:34:21	02. Procurement	Properties edited	02. Procurement	bramaekers@cadac.com	Marked for review, Supplier, Construction company	Valid	
1-6-2017 13:29:09	01. Design	Approved	02. Procurement	bramaekers@cadac.com	Well done as well!	Valid	
23-5-2017 13:11:59		Lifecycle started	01. Design	bramaekers@cadac.com			
23-5-2017 12:46:39		Published	01. Design	bramaekers@cadac.com			

Element Properties

GO BACK

Powered by Cadac Modules.

Reject

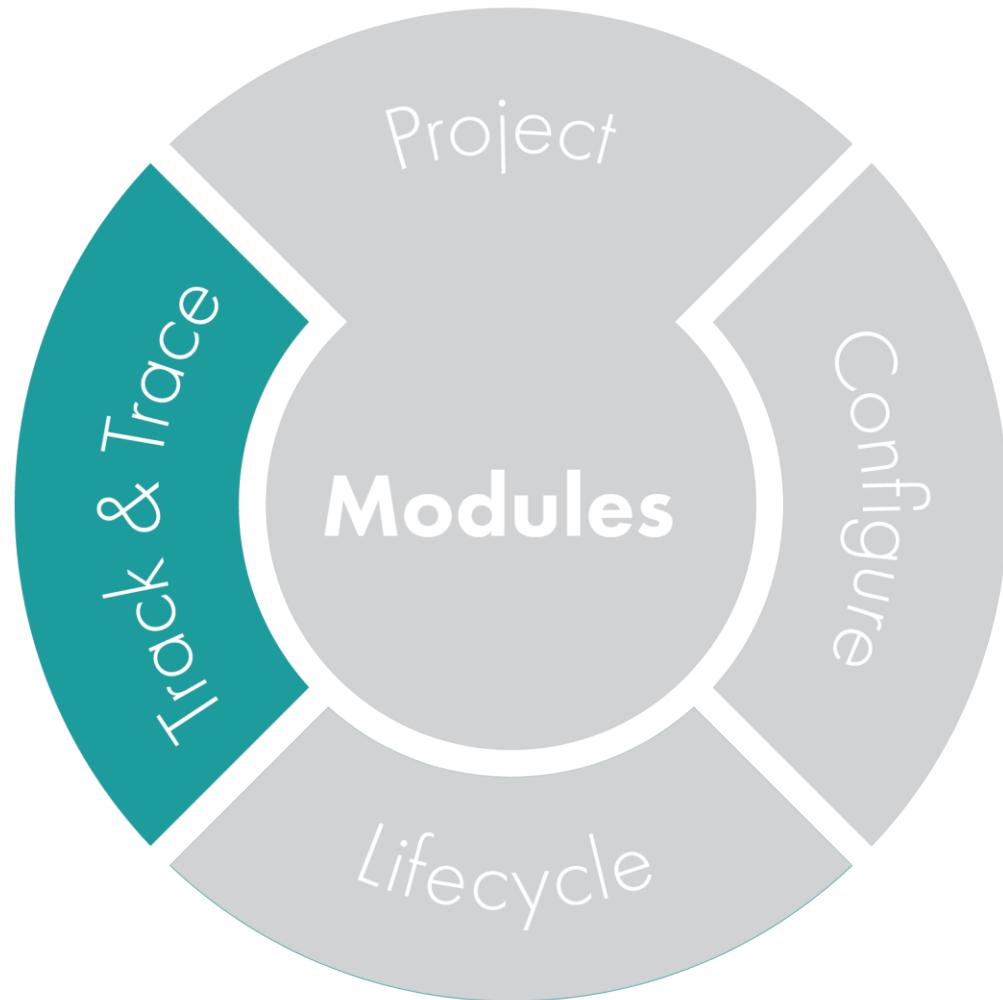
Reject

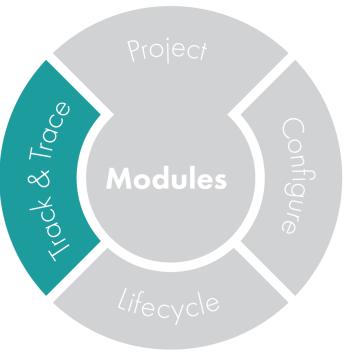
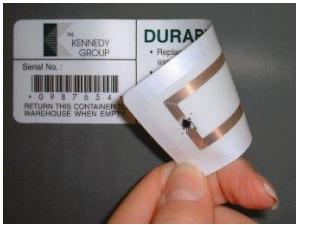
Reject

Reject

# Features

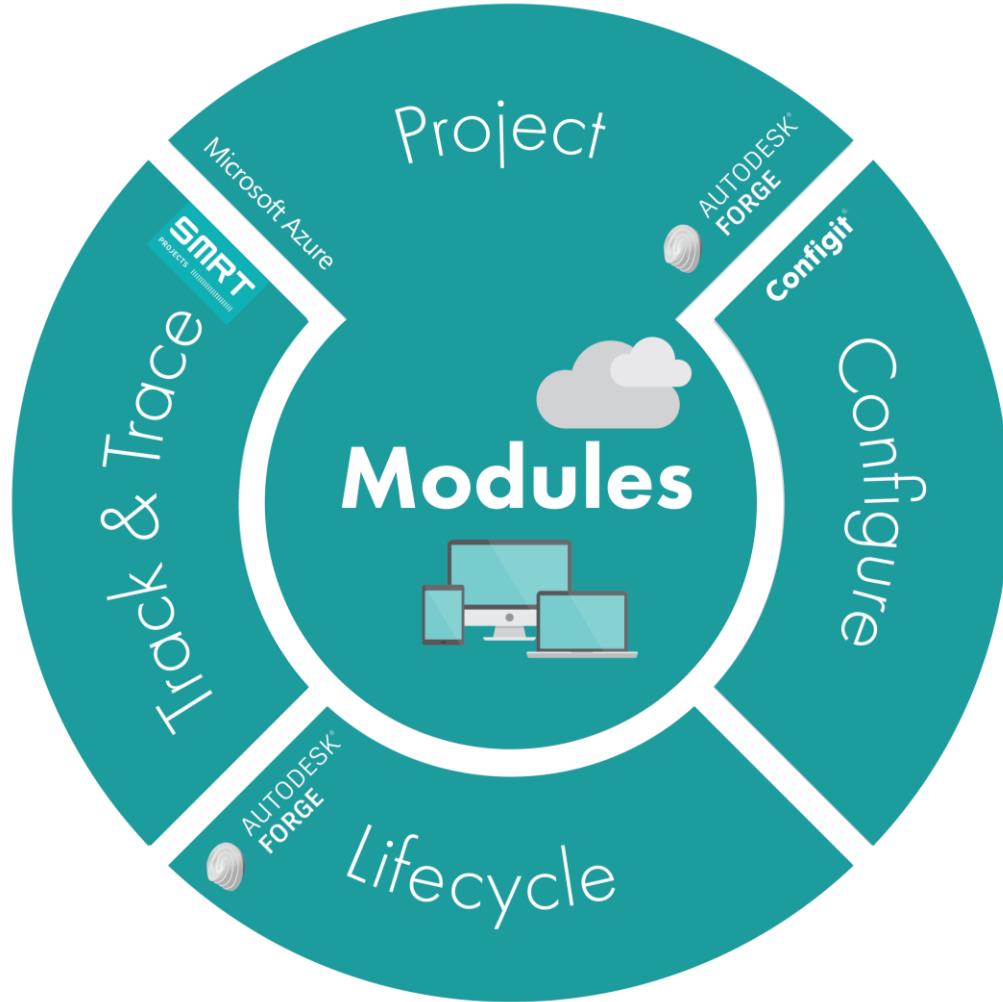
- Element Lifecycle (BIM level 3)
- CAD Integration
- Element Audit Trail
- Lifecycle State Interference
- Connect-2-Autodesk Revit
- Connect-2-AR+





## Features

- Connect 2 Lifecycle
- ID Management
- QR-code | RFID
- Element Validation
- Checklist
- Attachments

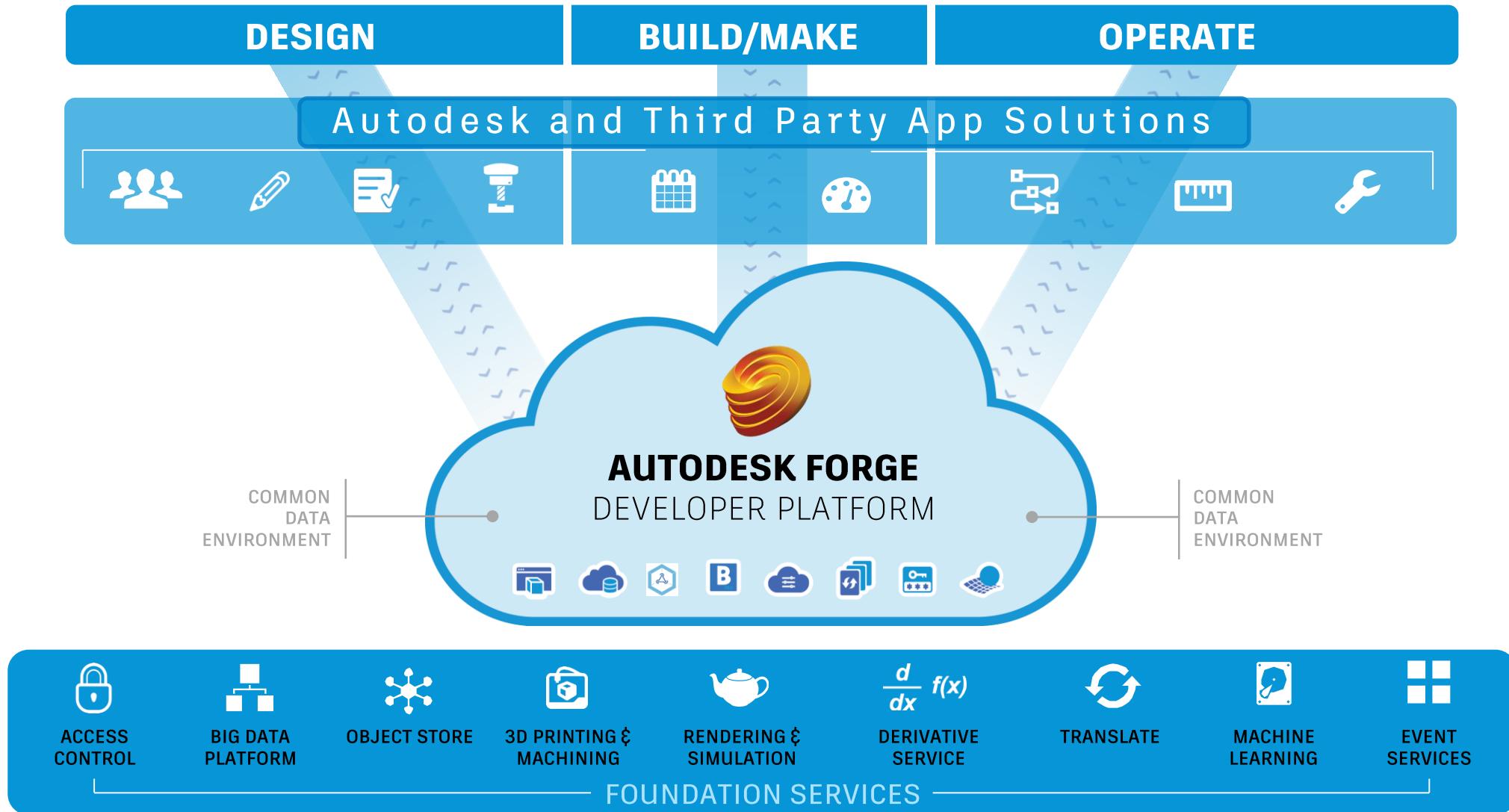




AUTODESK® FORGE

With Autodesk Forge  
you can do pretty  
much anything!

# The Forge Ecosystem



# Autodesk Forge – Main Services

## VIEWER API



Viewer

- 2D /3D viewer for Web browser or Mobile device
- Smooth Model navigation and Interactions (Section, Measure, Walk, Explode)
- Review object meta data
- Extension Framework for Search, Markup and Hyperlinks

## DATA MANAGEMENT API



Data Management API

Access and move files and data unified and consistently within Autodesk or with 3<sup>rd</sup> party environments

- Get project, folder & file lists
- Navigate : Folders, files versions & relationships
- Search & Filter project & file lists
- Upload and download files

## MODEL DERIVATIVE API



Model Derivative

Share designs in different formats, and extract valuable metadata

- Converts 2D/3D files to web and mobile viewable format
- Converts designs into formats (.stl, .step, .iges & .obj)
- Extract object hierarchy trees, properties
- Create different-sized thumbnails
- Conversion of Revit to IFC and DWG

## AR/VR API [BETA]

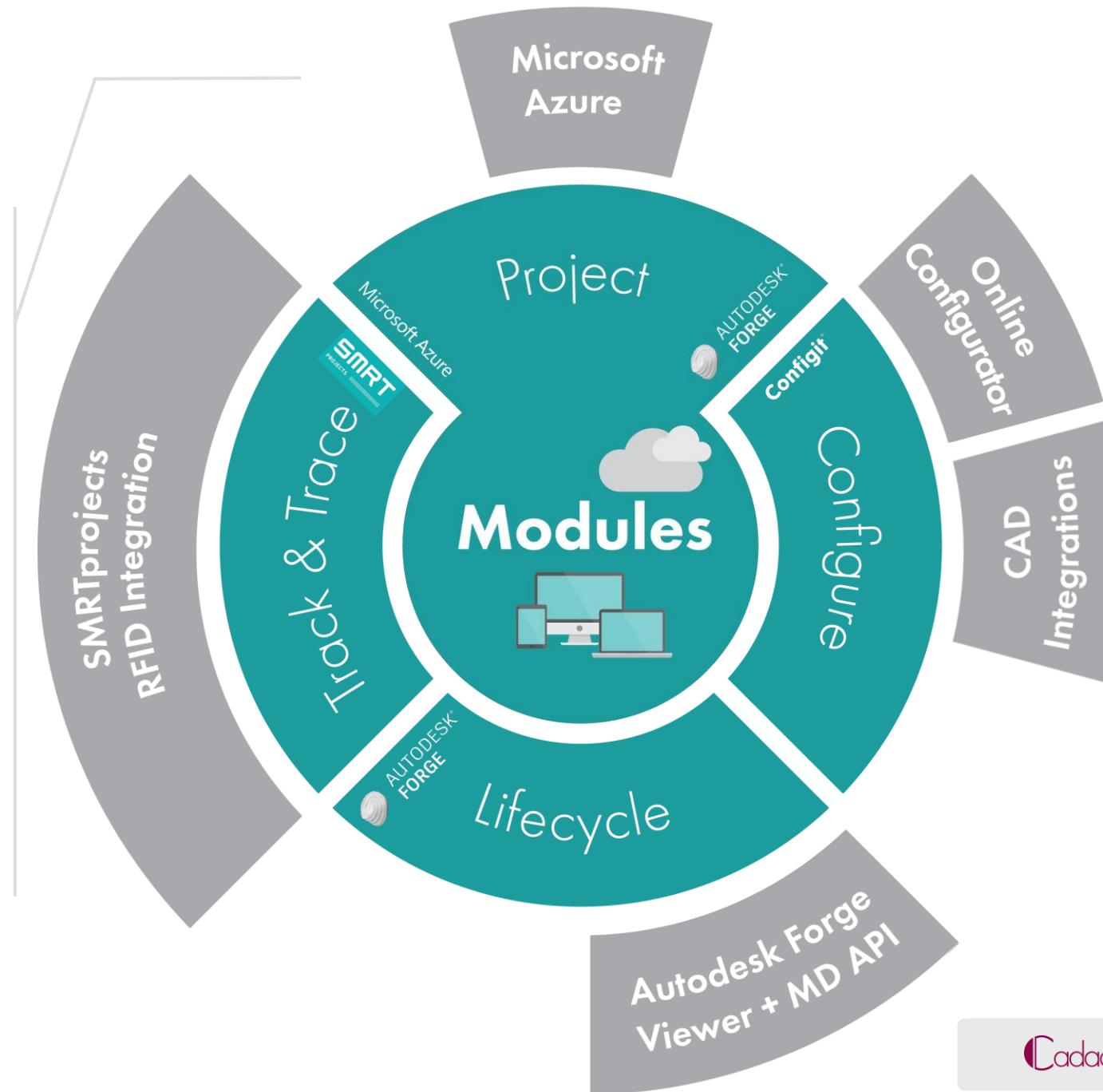


AR/VR API

Automate publishing of CAD content into your AR/VR Authoring pipeline

- Unity / Unreal / WebVR

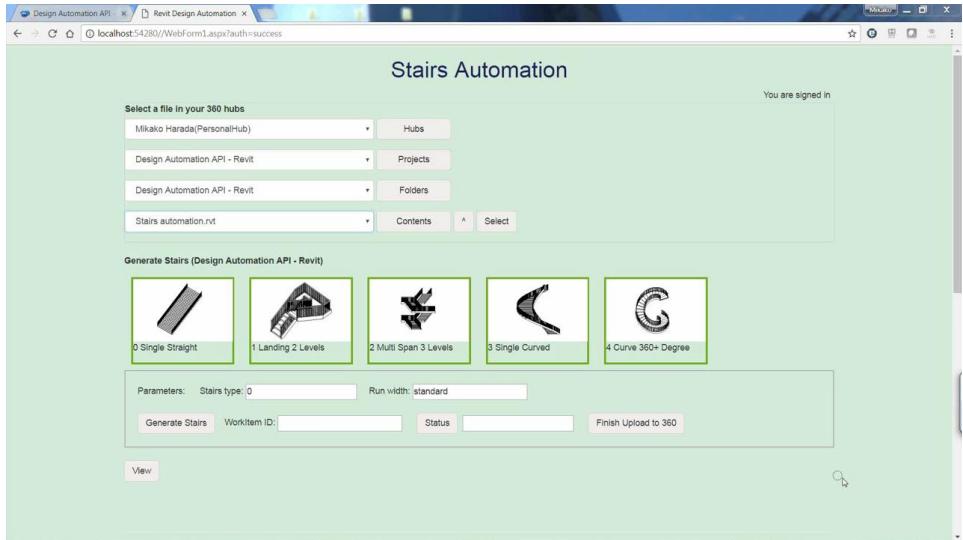
- ERP
- MS
- SharePoint
- BIM 360 API's
- FMIS
- Estimation
- Planning
- Innobrix
- ....



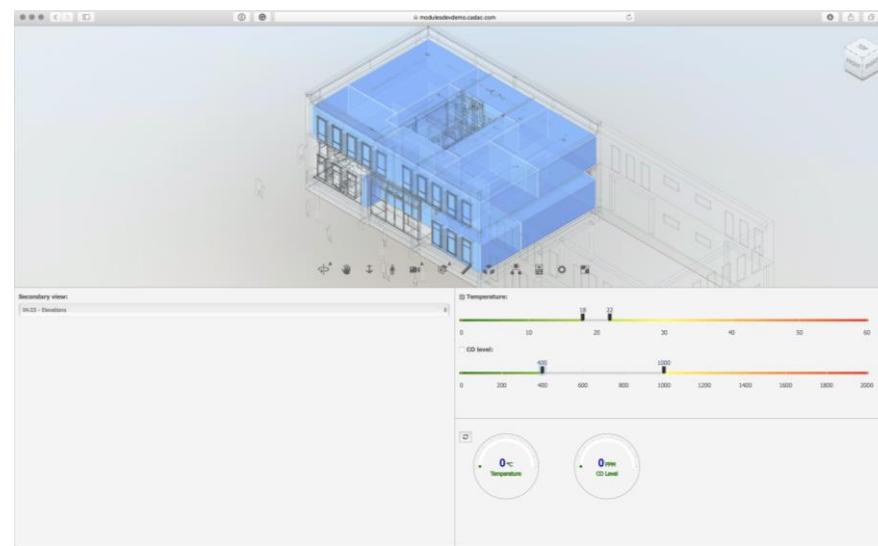
## Platform Features

- Modular
- SaaS
- Single Sign-on
- AD integration
- Custom UI
- Secure 256 bits Encryption
- ISO 27001

# What we are also doing



A screenshot of a web-based application titled "Stairs Automation". The interface includes a sidebar for selecting files from "360 hubs" and a main panel for generating stairs. The main panel shows five icons representing different stair types: 0 Single Straight, 1 Landing 2 Levels, 2 Multi Span 3 Levels, 3 Single Curved, and 4 Curve 360+ Degree. Below these are "Parameters" for "Stairs type: 0" and "Run width: standard". A "Generate Stairs" button is at the bottom, along with "Workitem ID:", "Status", and "Finish Upload to 360" buttons. A "View" button is also present.

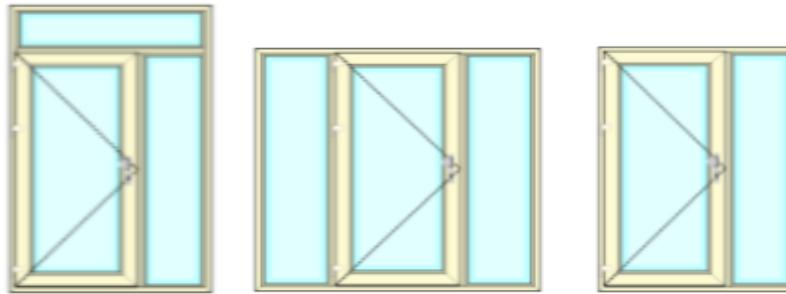


What else will  
we do in the future?

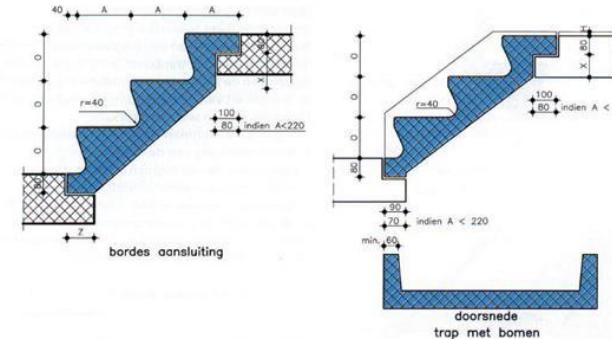


# What else will we do in the future?

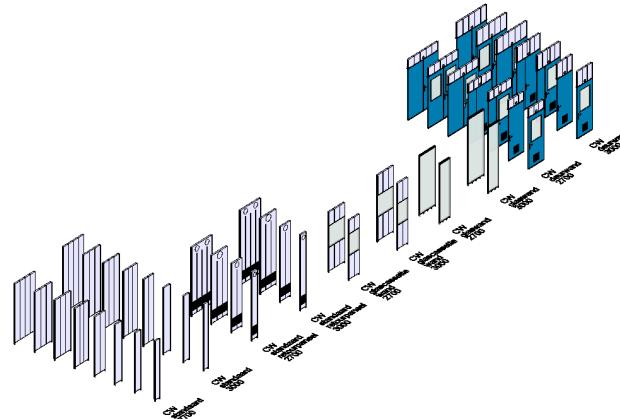
## DOORS



## PRECAST STAIRS



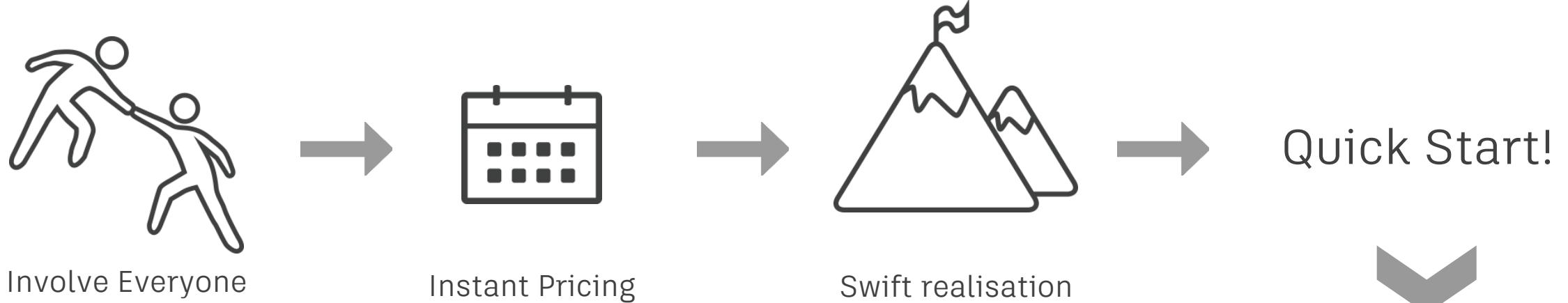
## CLEAN WALLS



## STANDARDIZED HOUSING



## To sum up: the value for BAM



# What have shown you today

## MODULAR CONSTRUCTION PRINCIPLES

- Standardize to Modules
- Configure to Elements
- Various and Numerous

## BAM MODULAR ELEMENTS CONFIGURATOR

- Configure the elements
- Design with the elements
- Construct and track the elements

## THE CADAC MODULES PLATFORM

- Innovative technology platform
- Current and Future capabilities
- Endless possibilities for integration with other platforms [e.g. Autodesk BIM 360]



WOULD YOU LIKE  
TO KNOW MORE?

[www.cadac.com/AULondon](http://www.cadac.com/AULondon)

A silhouette of two people climbing a rocky mountain at sunset. One person is helping the other up. The sky is filled with orange, yellow, and blue hues. The ocean is visible in the background.

# Thank you for your attention!

# Any questions?

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