

Degrees of Parametrization:

Rewiring design-to-construction for prefab modular products

Alejandro Arruñada

FORUM
HOLZBAU
INTERNATIONAL

Tjiko

Technische
Hochschule
Rosenheim
Technical University of Applied Sciences





(Image courtesy of Tjiko)



(Image courtesy of Tjiko)



SOLA 300
SPIESEL

HOCHBAU

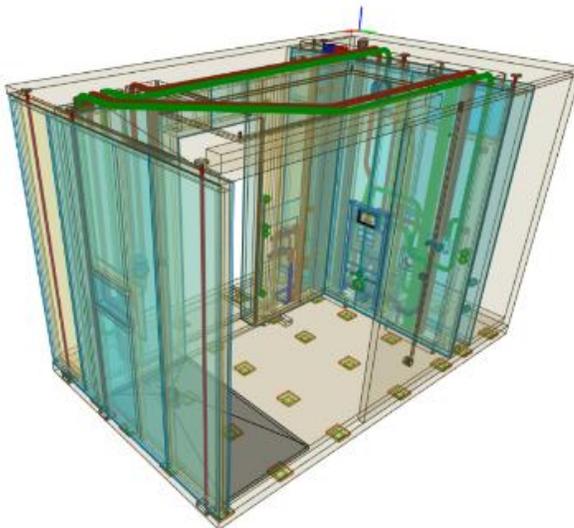
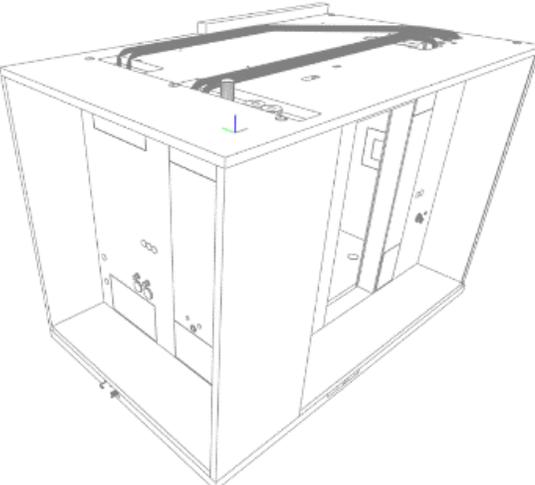
Tjiko

BayWa Baustoffe
Immer ein gutes Baugesühl
www.baustoffe.de

Vertrauenssache
Spezialistenberatung für Gewerbe- und Privatkunden
natürlich von BayWa

(Image courtesy of Tjiko)

Unique Modules



(Image courtesy of Tjiko)



Offer

Concept Study

Shop Drawings

Supply

Production

Installation

Close
Out



Offer

Concept Study

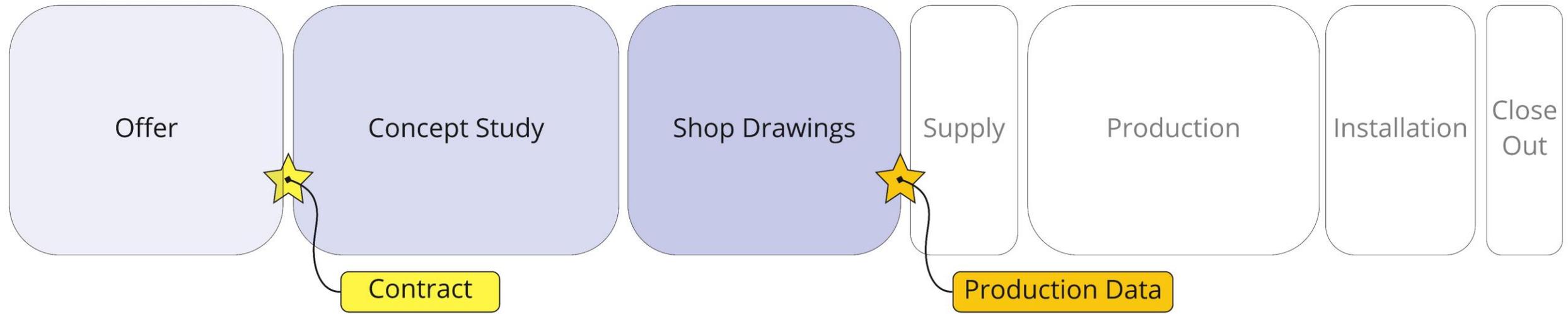
Shop Drawings

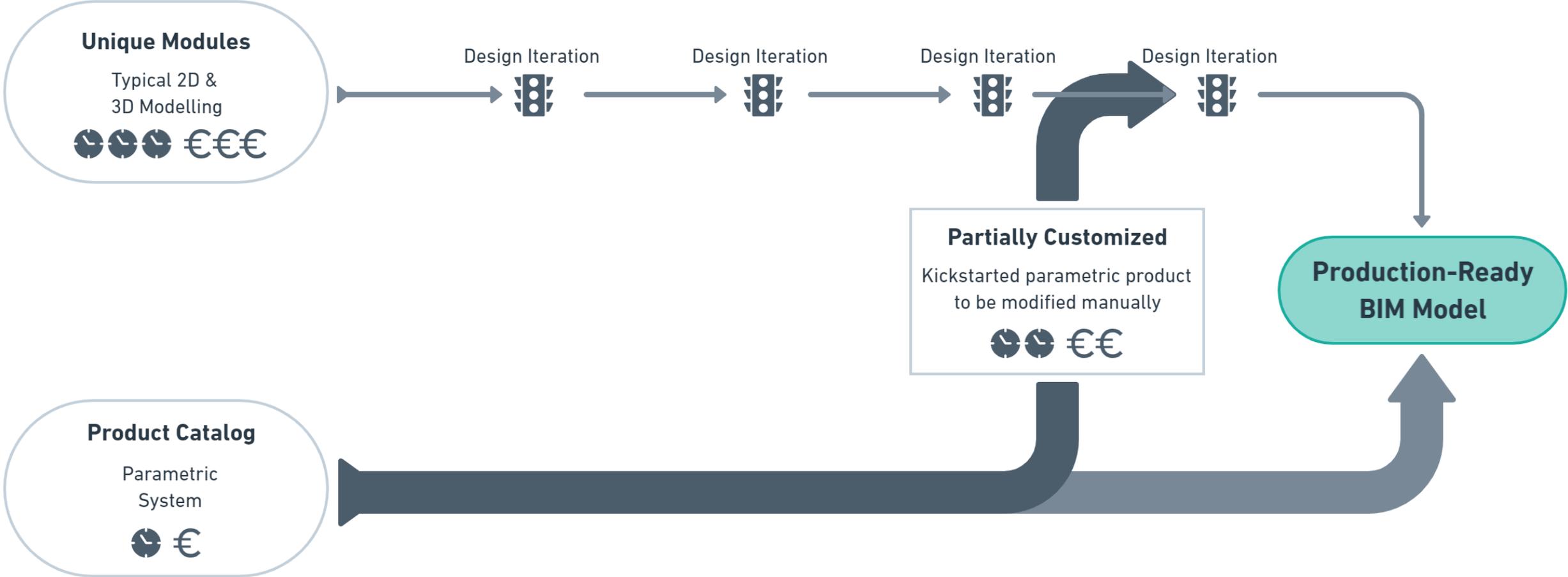
Supply

Production

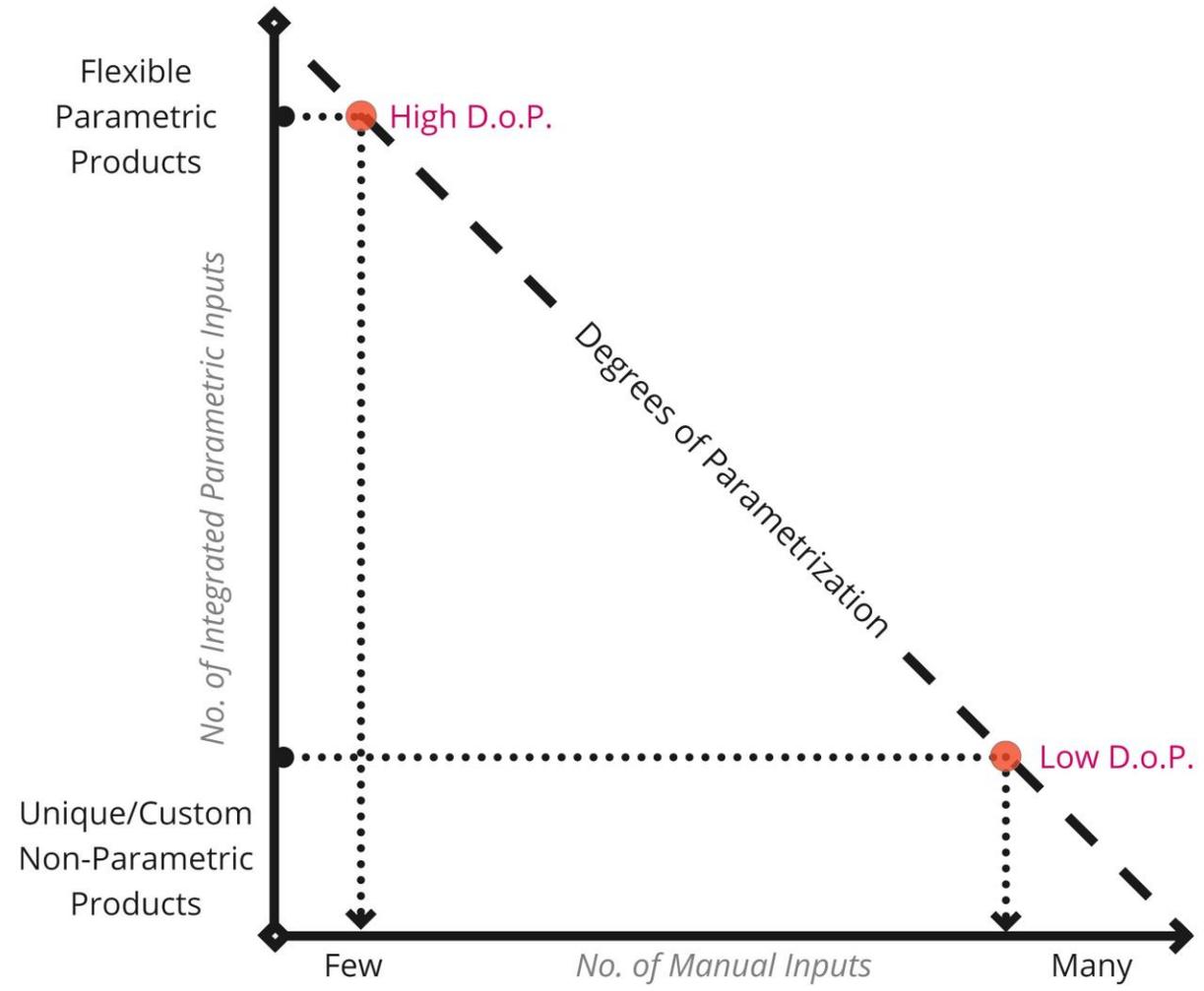
Installation

Close
Out





Degrees of Parameterization

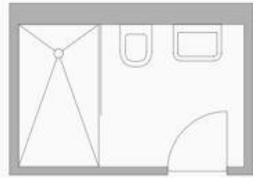


Das TJIKO—BAD

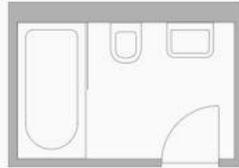
DAS BAD ALS FERTIG ANWENDBARES PRODUKT



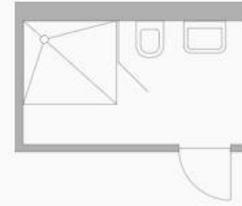
I2 →



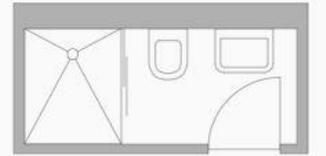
I3walk-in →



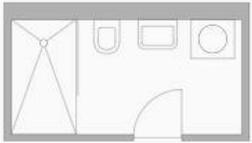
I3relax →



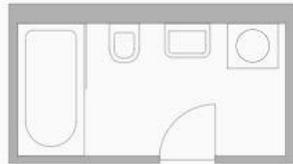
I3open →



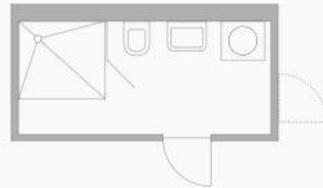
I3slide →



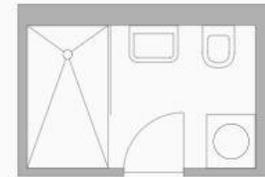
I4walk-in →



I4relax →



I4open →



L4walk-in →

Das TJIKO—BAD

DAS BAD ALS FERTIG ANWENDBARES PRODUKT

ZERMATT



Zeitlos und naturverbunden –
unser Edles



HOLZDECKE



FLIESE



Laufen
Kartell Waschtisch
800 x 400 mm,
weiß



Grohe
Einhandmischer Waschtisch
Essence M-Size
hard graphite gebürstet



Grohe
Geruchverschluss
hard graphite gebürstet



Hellestra
LED Wandleuchte Glax in
schwarz-matt,
Transparent-antiflick, 1200mm



Laufen
KARTELL Wand-Tiefspül-WC
spülwanne
370 x 545 mm,
weiß



Geberit
SIGMA30
Befestigungsplatte für
2-Mengen-Spülung
schwarz matt



Grohe
Bürstengarnitur Essentials
Wandmontage
hard graphite gebürstet



GROHE
WC-Papierhalter
ESSENTIALS ohne Deckel,
hard graphite gebürstet

DUSCHE



Grohe
Euphoria
Wandstangen-Set Massage
900 mm, mit Ablage,
hard graphite gebürstet



Grohe
Fertigmontagegestell Wanne
Essence für SmartBox
hard graphite gebürstet



Grohe
Kopfbrauset Set Rainshower
Cosmo 380mm



Grohe
Stabhandbrause Sens 1
Kopf- und Handbrause
hard graphite gebürstet

BADEWANNE



Grohe
Euphoria
Wandstangen-Set Massage
900 mm, mit Ablage,
hard graphite gebürstet



Grohe
Fertigmontagegestell Wanne
Essence für SmartBox
hard graphite gebürstet



Diana
M200 Stahl-Einbauwanne
180x90 cm,
schwarz gebürstet

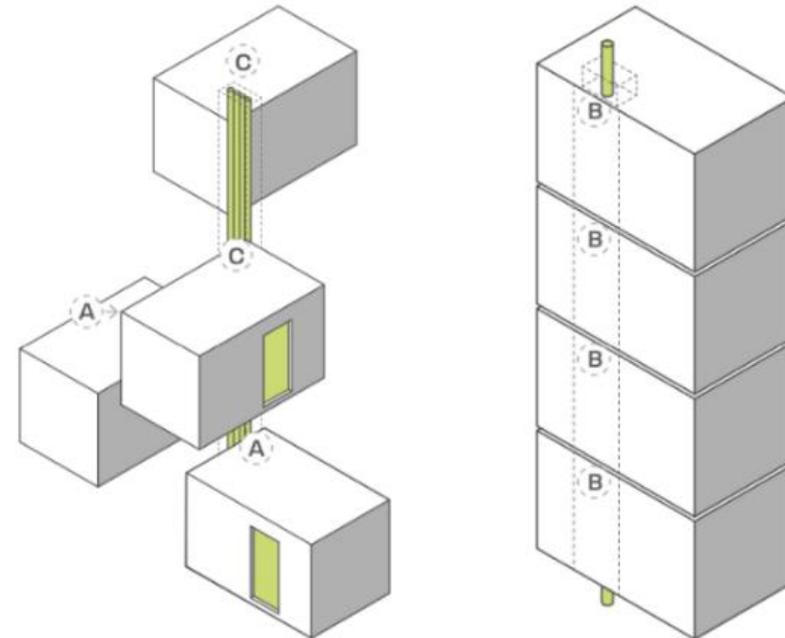
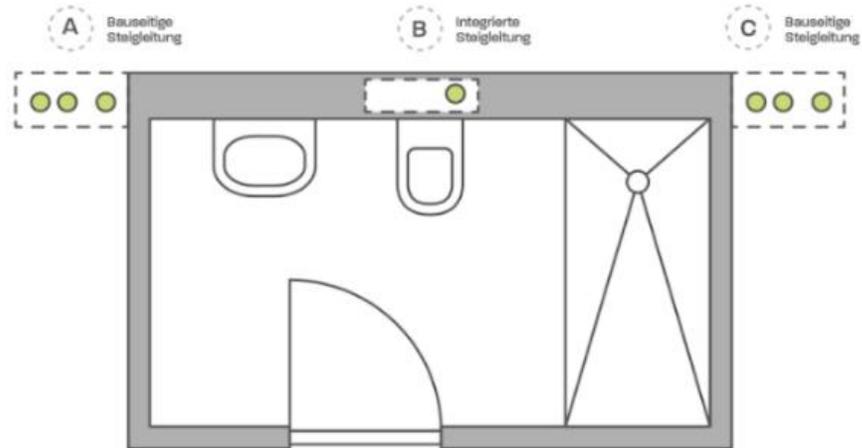
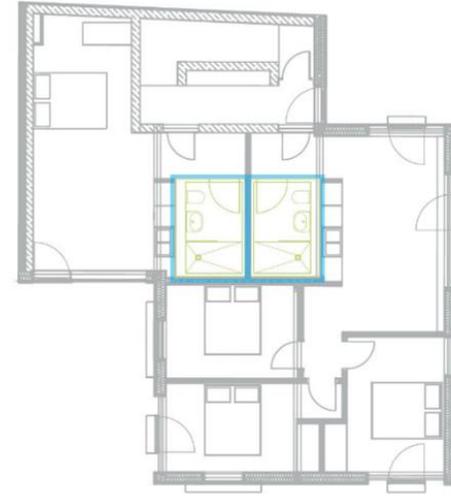


Grohe
Stabhandbrause Sens 1
Kopf- und Handbrause
hard graphite gebürstet

(Image courtesy of Tjiko)

Das TJIKO—BAD

DAS BAD ALS FERTIG ANWENDBARES PRODUKT

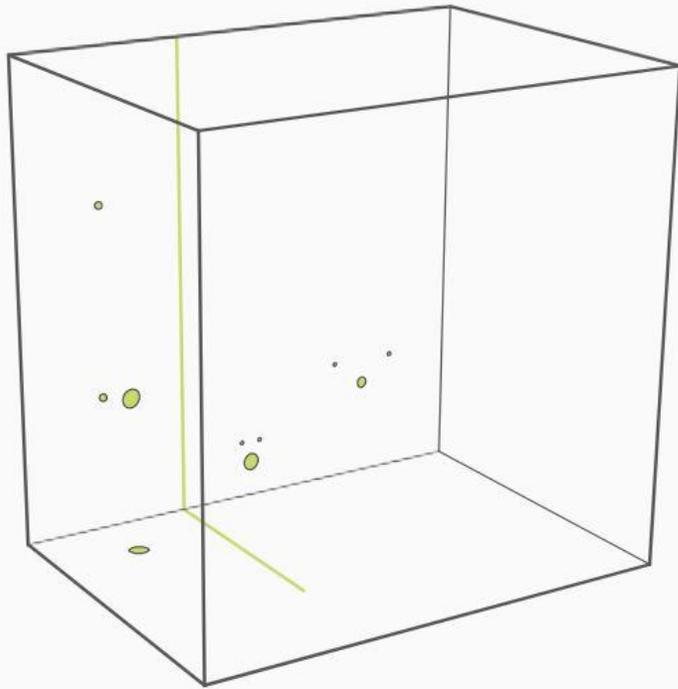


(Image courtesy of Tjiko)

Das

TJIKO—BAD

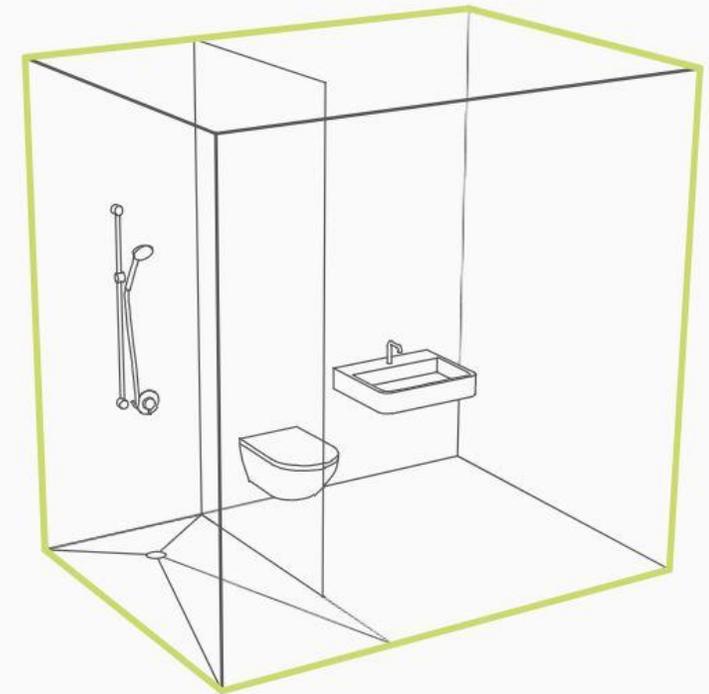
DAS BAD ALS FERTIG ANWENDBARES PRODUKT



MODELL



KONFIGURATION

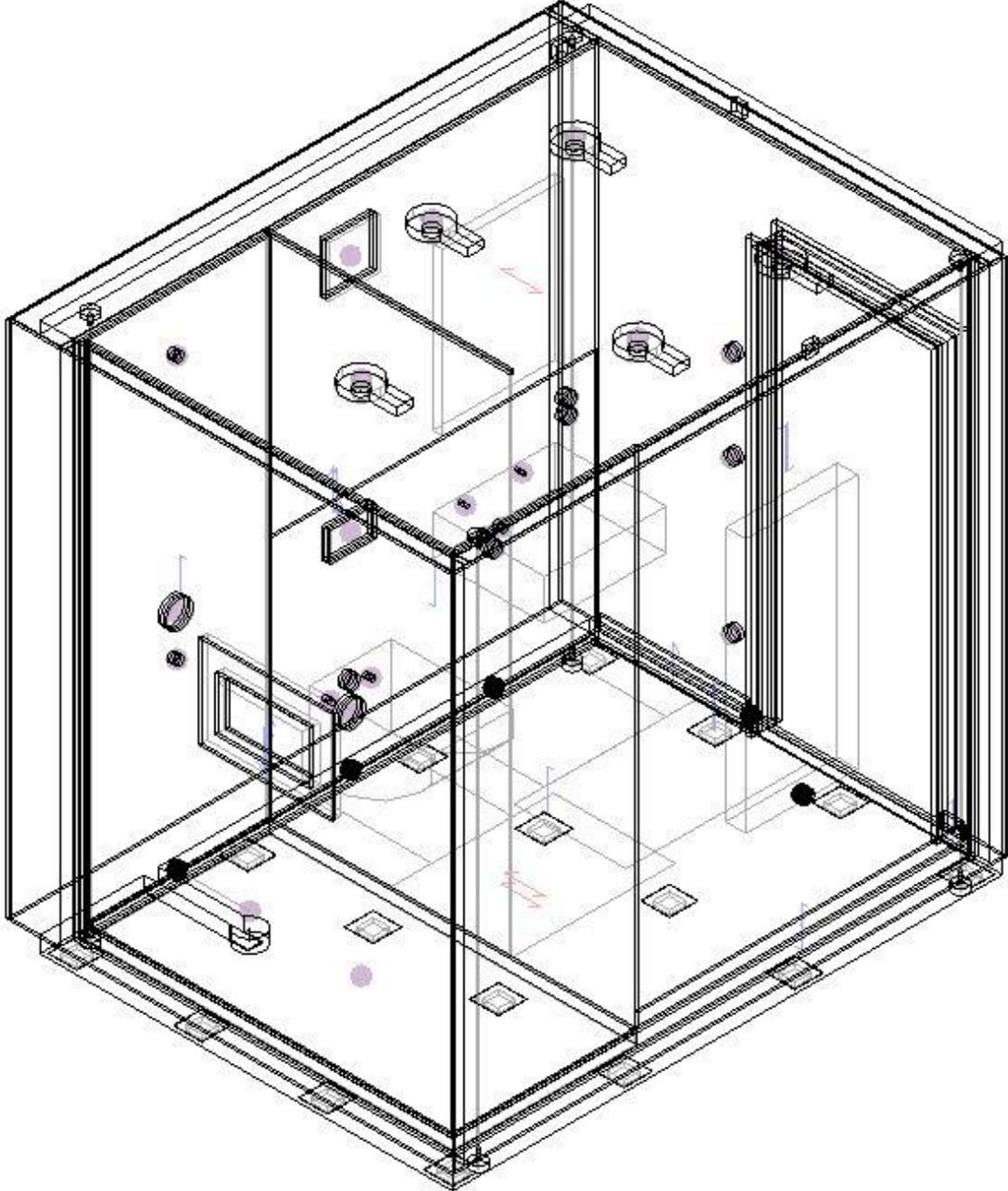


IHR TJIKO BAD

Instrumentation

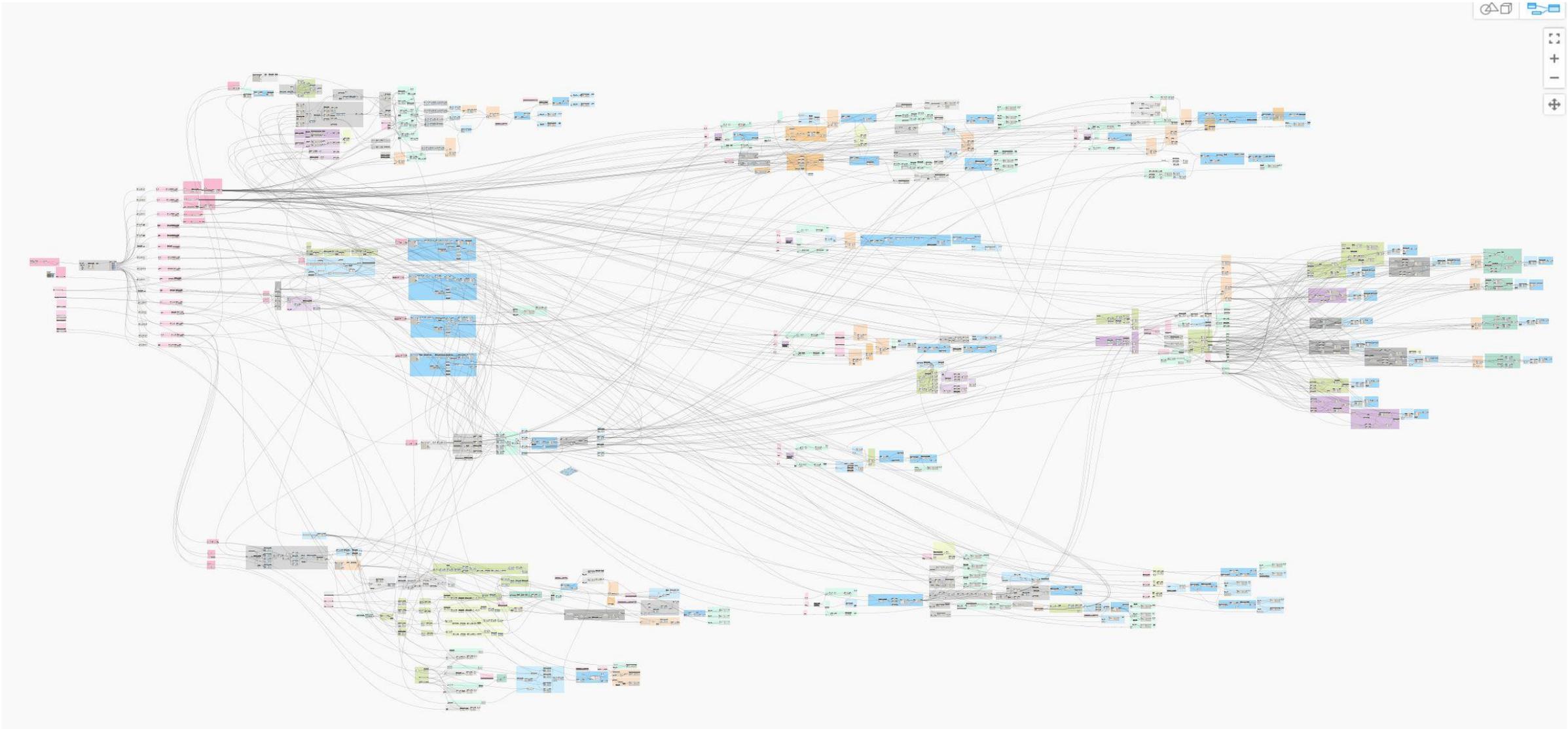
ModSpecs					
PRODUKTAUSWAHL					
1. Project-Typ	2. Modell		4. Merkmale		6. TitleBlock Eingänge
Standard	i4 walk-in		Tür an (Untere Wand) Wand A ? oder (Rechte Wand) Wand D ?		Projektnummer und Name
			Wand D		XXX Projekte
3. Design Line			Dusche oder Badewanne oder keine		ProjektnummerTyp/Custom/Modul/Standard/Typenbezeichnung-Spiegelun-Fort/Nummer
ZERMATT			Dusche		i4w.A Zermatt
Slots	Artikel		Dusche oder Badewanne Größe		Architektonischen Zeichnungen ID Nummer
Waschbecken Familie	Waschbecken_Standard_550x600mm		900x1800mm		N.A.
Waschbecken Instanz	Waschbecken_Standard_550x600mm		Beleuchtungskonzept: Anzahl der Reihen - LED-Leuchten		Bearbeiter
Waschbecken Bohren Familie	Waschbecken_AP-Bohrungen_Rechts		2 Reihen		Alex Arrunada
WC Familie	WC_Standard_400x600mm		Nische		Datum
WC Instanz	WC_Standard_400x600mm		Dusche_WiedlNische_Standard		13 October 2021
WC Bohren Familie	WC_Bohrungen_Standard				
Dusche oder Badewannen Familie	Dusche_Standard_Links				
Dusche oder Badewannen Instanz	900x1800mm				
Dusche oder Badewannen Bohren Familie	Dusche_UP-Bohrungen_mitKopfbrause				
Heizkörper Familie	Heizkörper_Standard_550x1260mm		5. Abmessungen		Konstruktion Montagearten
Heizkörper Instanz	Heizkörper_Standard_550x1260mm		Innenhöhe (Standard = 2500mm)		Wand A (Boden)
Heizkörper Bohren Familie	Heizkörper_Bohrungen_Standard		2500		SD
Tür Familie	Drehtür_Standard		Bodenbauhöhe (mit BauenSystem) (100-300mm) Standard = 100mm		Wand B (Links)
Tür Instanz	Drehtür_Standard_885x2032mm		100		SD
Tür Bohren Familie	Tür_Bohrungen_111Links		Aussenbreite (basierend auf dem Duschkonzept)		Wand C (Oben)
Waschmaschine Familie	Waschmaschine_Standard_Rechts		2196		SE
			Aussenlänge (max 4000mm)		Wand D (Rechts)
			Eingabe in Dynamio		SD

Instrumentation

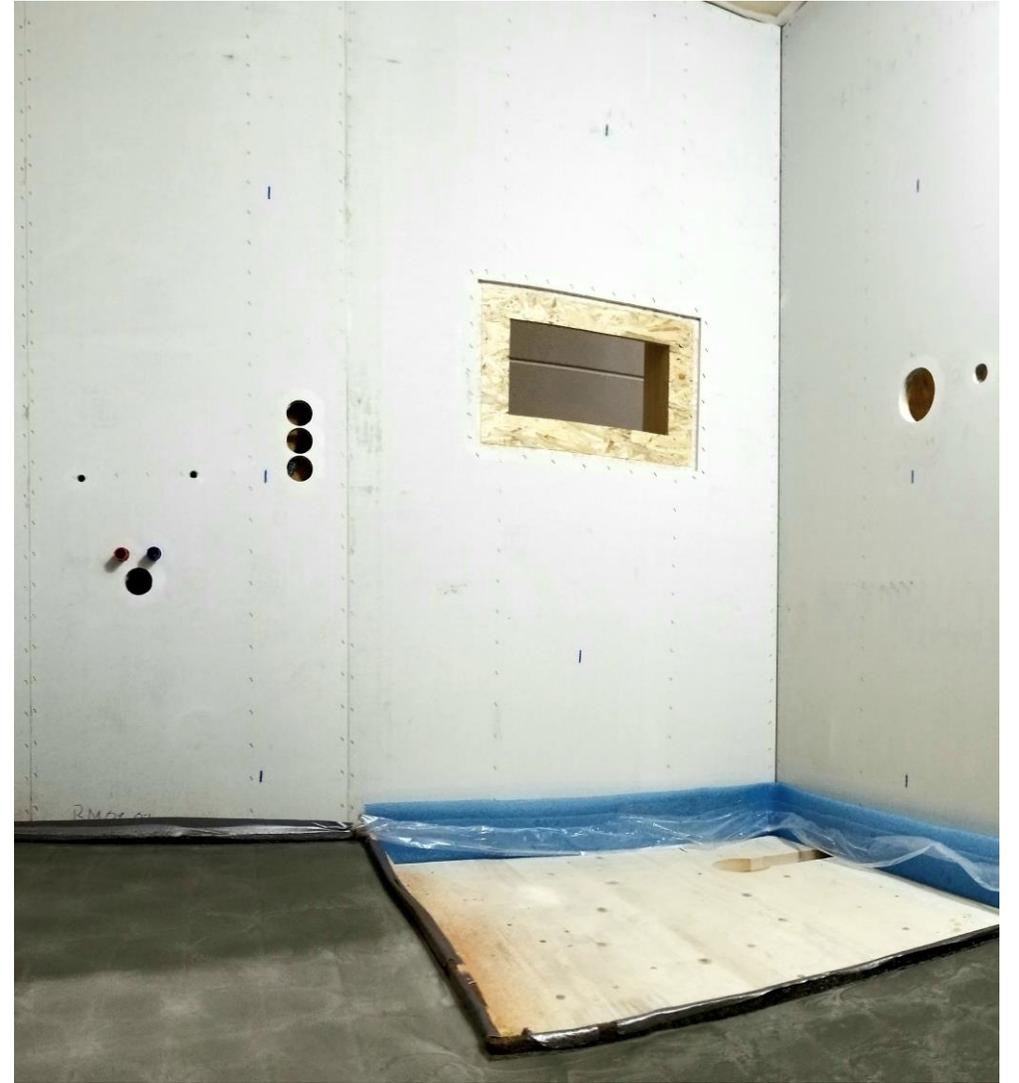
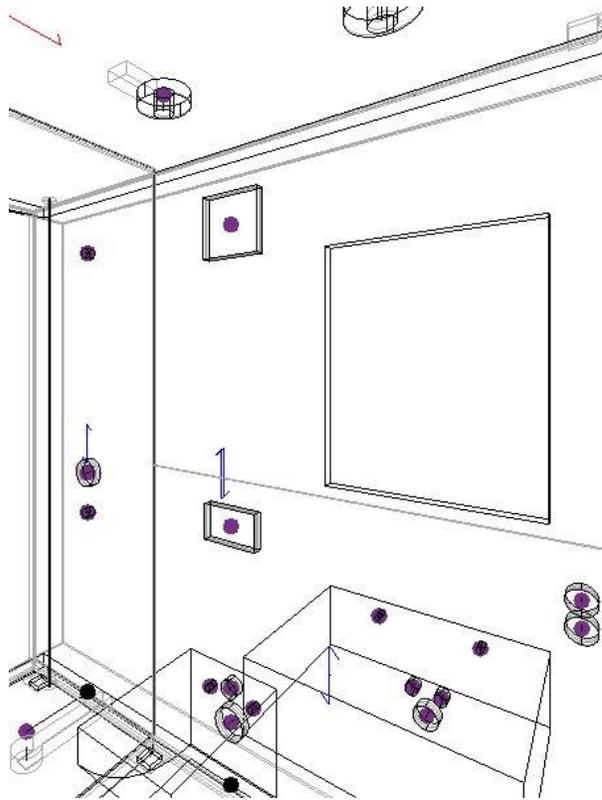
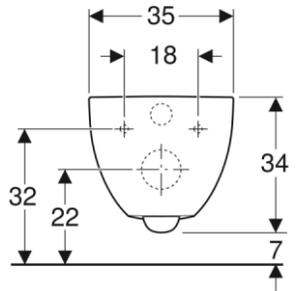


(Image courtesy of Tjiko)

Instrumentation



(Image courtesy of Tjiko)



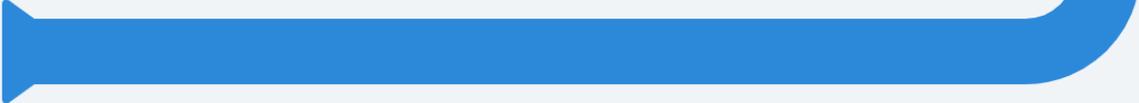
(Logo courtesy of hsbcad)

(WC Drilling Pattern Image courtesy of Geberit, n.d., Rest courtesy of Tjiko)

AutoCAD + hsbcad
Typical 2D & 3D Modelling
+
hsbStickFrame
hsbCLT



hsbcad "Bridge"



**Production-Ready
BIM Model**

Revit + hsbcad
Parametric System
+
hsbCLT

Proof of Concept

- Step 1
 - Fill-Out Excel Sheet
 - Generate Model in Revit
 - Export to .ifc (Basic Model)

Step 1 Measurements

Step 1 Criteria	Correct?
•Dimensions / Technical Details	<input checked="" type="checkbox"/>
• Asset Placements	<input checked="" type="checkbox"/>
• Drilling Placements & Parameters	<input checked="" type="checkbox"/>

Stage Duration	
 Run 1	00:03:58
 Run 2	00:07:11
 Manual Steps	00:02:08
 Total Time	13 Minutes 07 Seconds

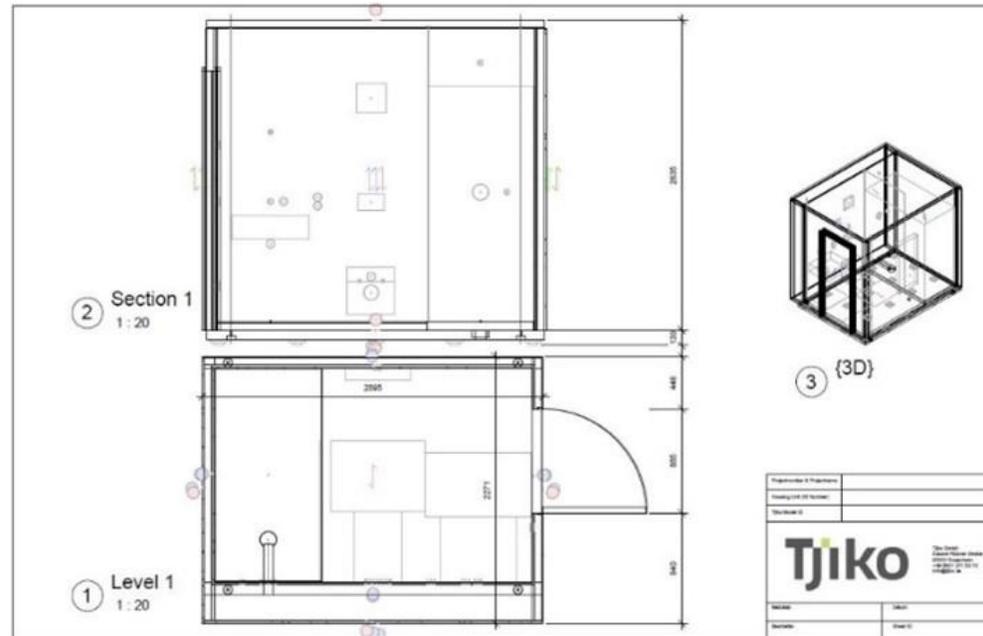
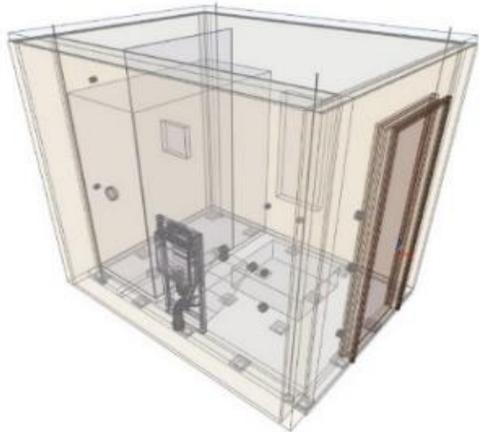
 80 Generated Instances
in 2 Runs

 2 Generated Files
in 5 Steps

 3/3

 in 13:07

Basic Set of Deliverables



IHR PREISVORTEIL DURCH TJIKO

	Fertigung bauseits	Tjiko Badmodul
Fußbodenaufbau	273,48 €	✓
Wände und Vorsatzschalen	2.190,55 €	✓
Deckenkonstruktion	605,44 €	✓
Vollformatfliesen / Malerarbeiten	2.683,56 €	✓
Heizung / Lüftung / Sanitär	5.680,57 €	✓
Elektro	1.270,00 €	✓
Preis Bad	12.401,20 €	11.961,00 €
+ Badplanung	720,00 €	+ Transport 400 €
+ Baukoordination & Vergabe	600,00 €	
= Gesamtpreis	13.721,20 €	12.361,00 €

Unter dem Strich ist Tjiko 11% günstiger
 - Einsparung durch Industrielle Qualität
 - Vorzeitige Nutzungsaufnahme

Proof of Concept

- Step 2
 - Add hsbcad TSLs
 - Export from Revit as .hmlx
- Step 3
 - Import to Autocad as.hmlx
 - Complete model via manual 3D-modelling
 - Export to .ifc (Detailed Model)

Step 2 Measurements

Step 2 Criteria	Correct?
•Dimensions / Technical Details (*7)	<input checked="" type="checkbox"/>
• Asset Placements (*7)	<input checked="" type="checkbox"/>
• Drilling Placements & Parameters (*7)	<input checked="" type="checkbox"/>



Step	Items Created	Duration
Manual Setup	18	00:02:23
Script 1 & Manual Inputs	60	00:01:23
Script 2 & Manual Inputs	3	00:00:23
Script 3 & Manual Inputs	7	00:00:35
Script 4 & Manual Inputs	6	00:00:30
Script 5 & Manual Inputs	1	00:00:26
Script 6 & Manual Inputs	3	00:00:33
Script 7 & Manual Inputs	3	00:00:23
Manual Export	1	00:00:49
Total Time	102	08 Minutes 25 Seconds

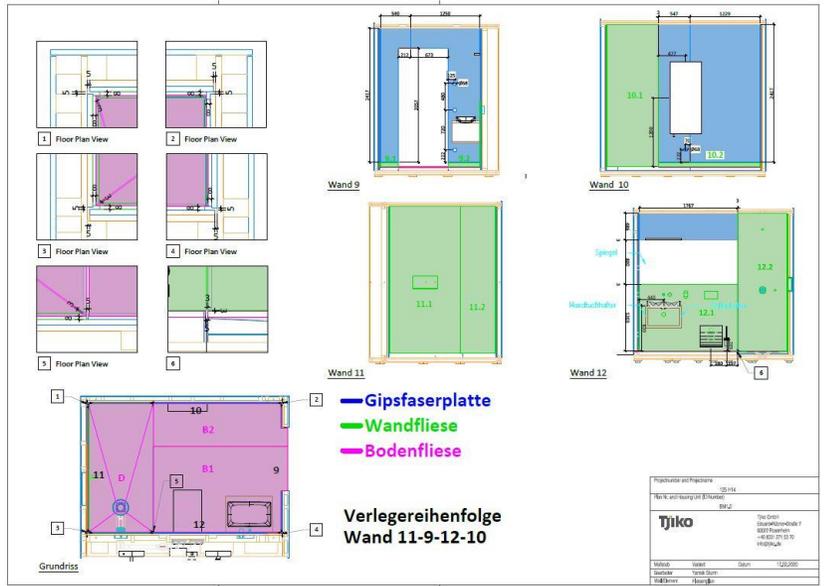
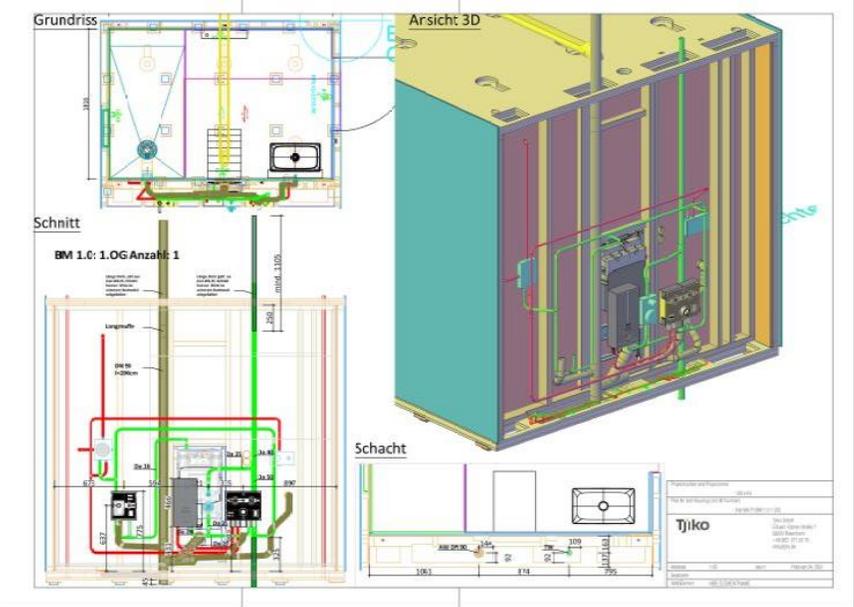
 **85** Generated Instances
in **7 Runs**

 **2** Generated Files
in **5 Steps**

 **21**/**21**

 in **08:25**

Production-Ready Deliverables

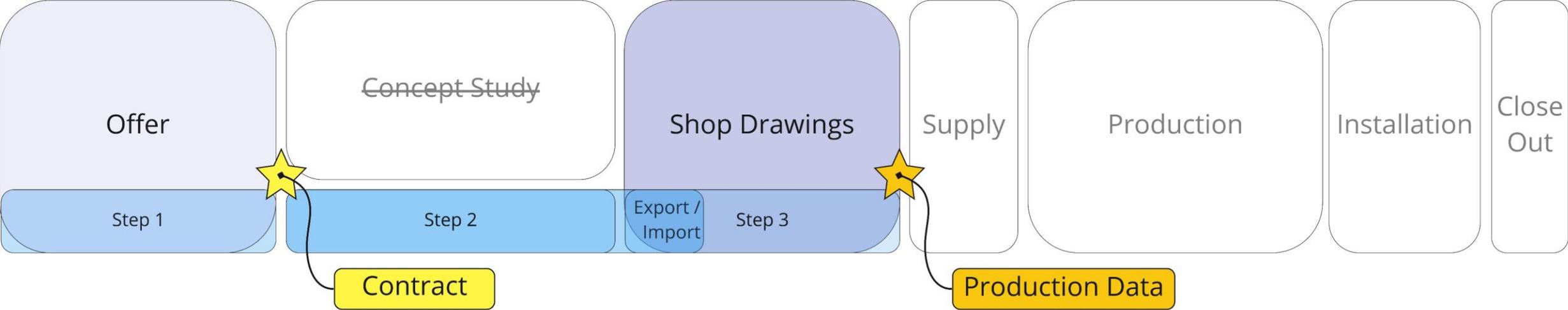


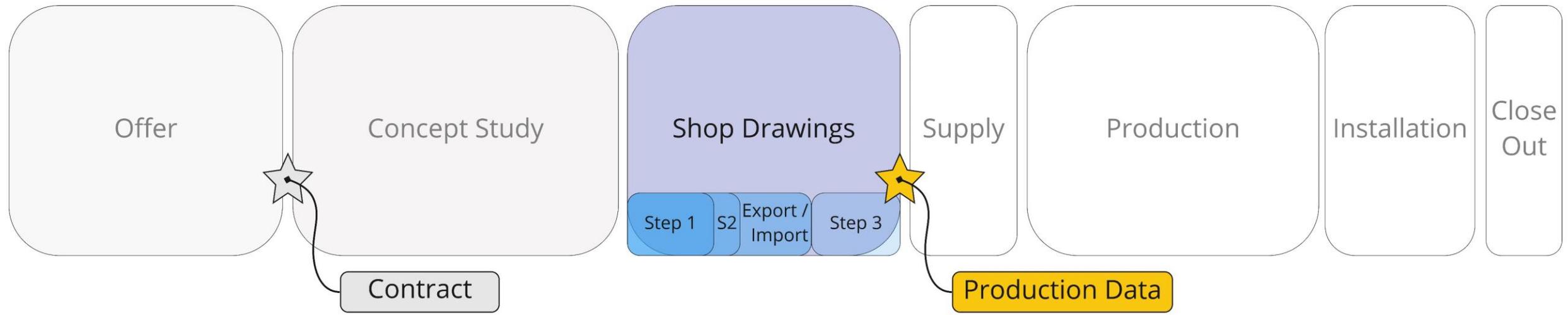


(Images courtesy of *Tjiko*)

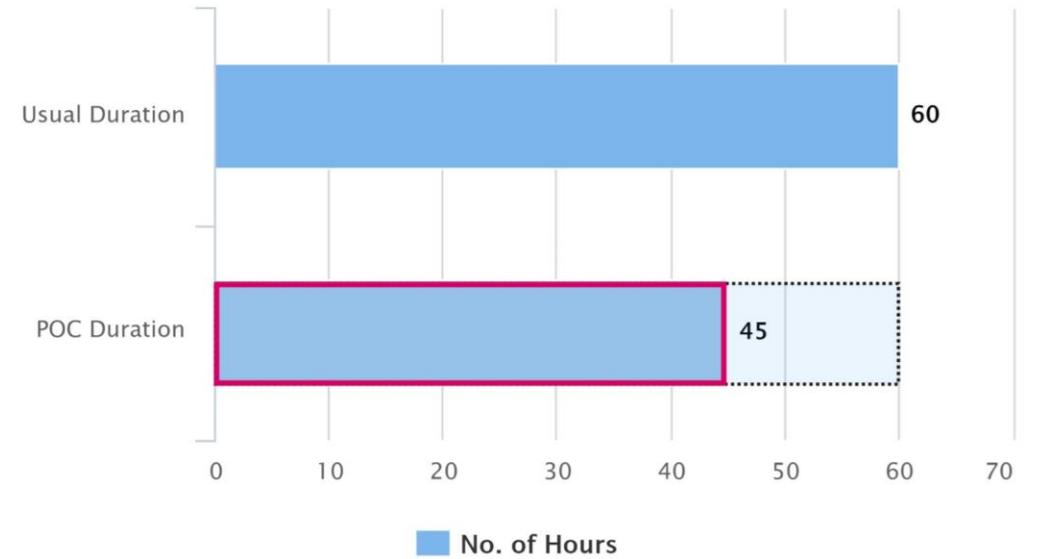








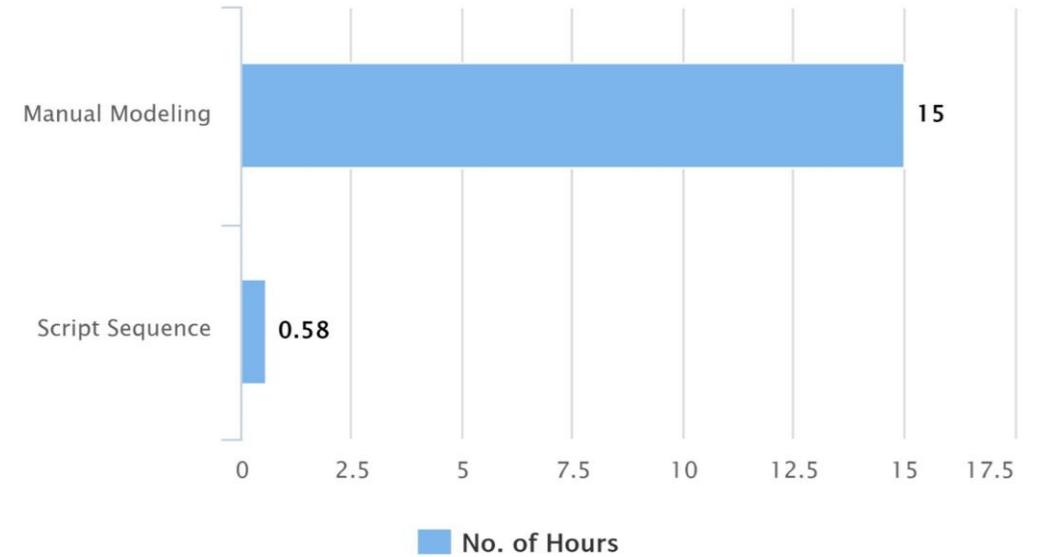
Process	Tasks	Approx. Duration
D.o.P. Sequence	<ul style="list-style-type: none"> • Kickstart 3D • Export Basic Plans & .ifc 	00:35:32
Manual Modeling	<u>Finalize:</u> <ul style="list-style-type: none"> • 3D Modeling • Detailing • Shop Drawings 	* Approx. 45:00:00
TOTAL		*Approx. 45:35:32



🕒 From **60 Hours**
 * by Manual Modeling

⚡ To **45 Hours**
 🏠 by using D.o.P Sequence

Process	Tasks	Approx. Duration
D.o.P. Sequence	<ul style="list-style-type: none"> • Kickstart 3D • Export Basic Plans & .ifc 	00:35:32
Manual Modeling	<u>Finalize:</u> <ul style="list-style-type: none"> • 3D Modeling • Detailing • Shop Drawings 	* Approx. 45:00:00
TOTAL		*Approx. 45:35:32



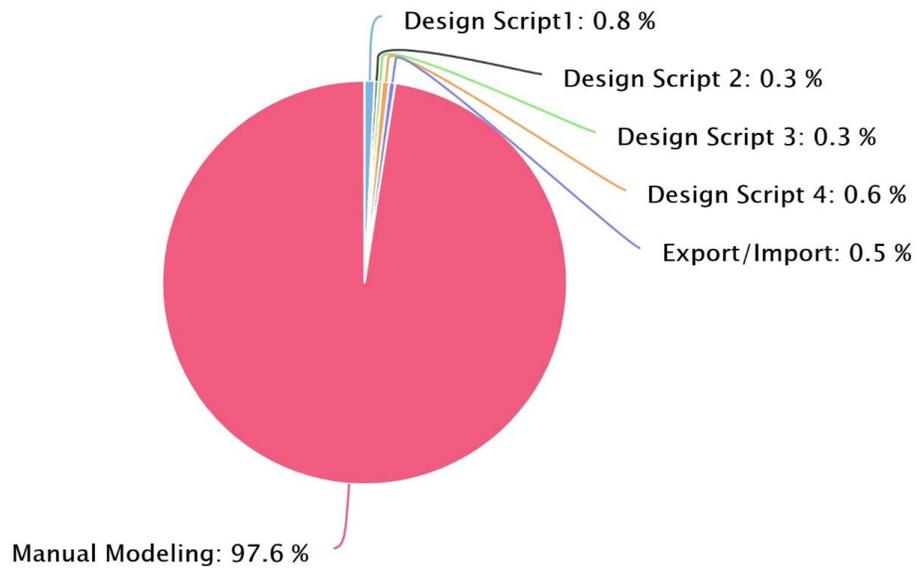
 **15 Hours** of Manual Modeling

 Replaced by a workflow lasting

 **35 Minutes**

>> Scope of Work is completed approx.

25x faster



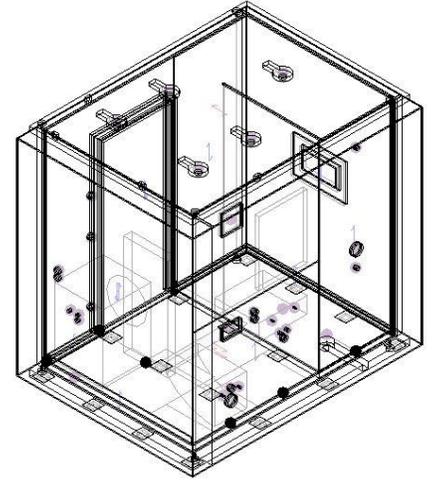
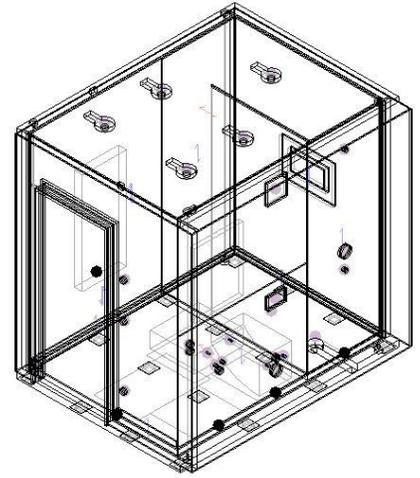
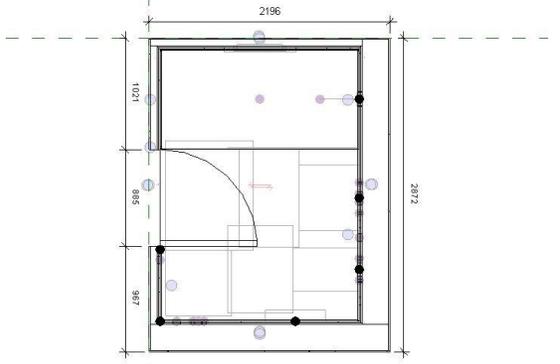
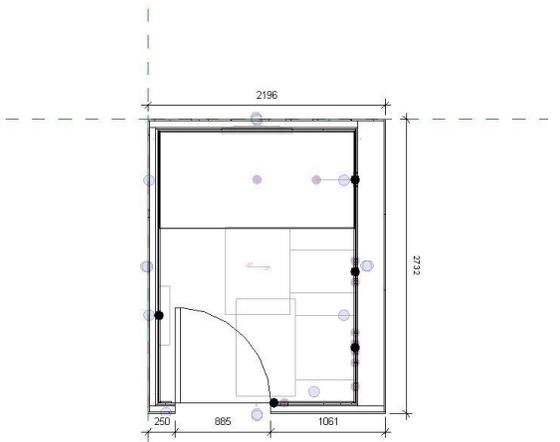
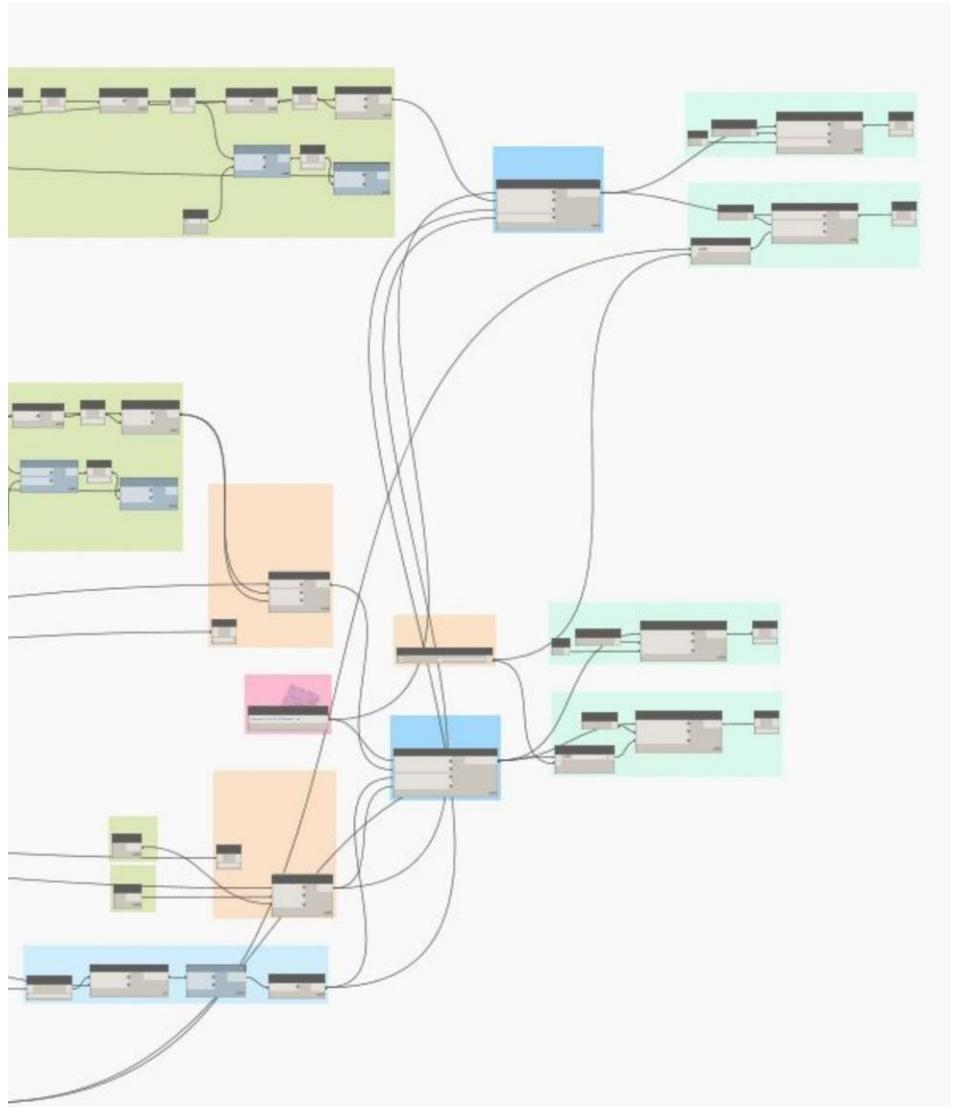
Phase 3	%	Duration
Design Script 1	0.8%	00:11:42
Design Script 2	0.3%	00:04:11
Design Script 3	0.3%	00:04:42
Design Script 4	0.6%	00:08:11
Export/Import	0.5%	00:06:46
Manual Modeling	97.6%	*Approx. 45:00:00
TOTAL	🕒	45:35:32

Process	% of Total Workload	% Duration
D.o.P. Sequence	25%	2.4%
Manual Modeling	75%	97.6%
TOTAL		100%

Summary of Planning Durations

Scenario Comparison	Planning Costs Comparison	PM Work Package (40-Hour Weeks)	Batch-Size*
Unique Module	100% (default value)	1 Project Manager for 5 Weeks	Batch-Size 10
D.o.P. Tool at Phase 3	7% Reduction	1 Project Manager for 4.5 Weeks	Batch-Size 10
D.o.P. Tool at Phase 1	Approx. 62% Reduction	1 Project Manager for Approx. 2 Weeks	Batch-Size 4

Rewiring

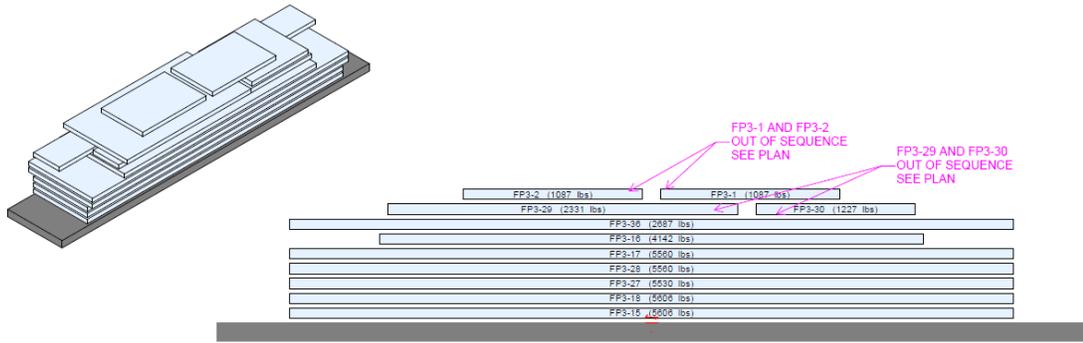




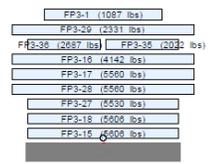
(Image courtesy of Tjiko)



(Image courtesy of *Timberlyne*)



CLT TRUCK 1									
Panel Name	QTY	Panel Zone	Phase Created	CLT Truck Number	Sequence Number	Panel Thickness	Panel Width	Panel Length	Total Weight (lbs/CLT)
FP3-35	1	Zone 2 - Floor	Phase 2	1	1	6 7/8"	4' - 0"	30' - 1 1/2"	2027.59
FP3-36	1	Zone 2 - Floor	Phase 2	1	2	6 7/8"	4' - 0"	40' - 0"	2693.86
FP3-16	1	Zone 2 - Floor	Phase 2	1	3	6 7/8"	10' - 0 1/4"	30' - 0"	4157.11
FP3-17	1	Zone 2 - Floor	Phase 2	1	4	6 7/8"	10' - 0 1/4"	40' - 0"	5563.43
FP3-28	1	Zone 2 - Floor	Phase 2	1	5	6 7/8"	10' - 0 1/4"	40' - 0"	5563.42
FP3-29	1	Zone 2 - Floor	Phase 2	1	6	6 7/8"	10' - 0 1/4"	19' - 4"	2332.87
FP3-30	1	Zone 2 - Floor	Phase 2	1	7	6 7/8"	8' - 4"	8' - 9"	1229.63
FP3-27	1	Zone 2 - Floor	Phase 2	1	8	6 7/8"	8' - 4"	40' - 0"	5537.29
FP3-18	1	Zone 2 - Floor	Phase 2	1	9	6 7/8"	8' - 4"	40' - 0"	5613.01
FP3-15	1	Zone 2 - Floor	Phase 2	1	10	6 7/8"	8' - 4"	40' - 0"	5613.01
FP3-2	1	Zone 2 - Floor	Phase 2	1	30	6 7/8"	6' - 6 5/16"	9' - 11"	1089.1
FP3-1	1	Zone 2 - Floor	Phase 2	1	31	6 7/8"	6' - 6 5/16"	9' - 11"	1089.1
Grand total	12								42509.43



① Level 1 GLB 4
1/8" = 1'-0"

② North GLB 4
1/8" = 1'-0"

③ West GLB 4
1/8" = 1'-0"

8'x30' Truck

Phase 1 GLB 4										
Bundle-No	Part-#	Phase	Column	Layer	Height	Length	Width	Weight		
B9	GLB3-01	Phase 1	Right	2	1.5	14.23	0.73	498.60		
B9	GLB3-02	Phase 1	Left	2	1.25	14.23	0.56	327.19		
B9	GLB3-07	Phase 1	Right	2	1.25	9.84	0.56	221.13		
B9	GLB3-08	Phase 1	Left	2	1.25	9.84	0.56	219.54		
B9	GLB3-09	Phase 1	Right	2	2	3.52	0.90	459.01		
N/A	GLB3-03	Phase 1	Left	1	2.00	19.68	0.73	983.86		
N/A	GLB3-04	Phase 1	Left	2	2.625	20.00	0.90	1588.22		
N/A	GLB3-11	Phase 1	Right	1	3.5	20.00	0.90	2078.33		
N/A	GLB3-14	Phase 1	Left	1	3.5	20.00	0.90	2032.83		
N/A	GLB3-27	Phase 1	Left	1	3.5	6.01	0.90	614.63		
N/A	GLB3-29	Phase 1	Right	1	3.5	6.01	0.90	614.65		
N/A	GLB3-31	Phase 1	Left	2	1.25	7.36	0.56	154.97		
								Total Weight	8812.31	
								Total Weight with Dunnage	9252.929	

SHEET

007

GLB 4

TIMBERLYNE

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CUSTOMER INFORMATION:
 Owner

PROJECT INFORMATION:
 Project Name
 Enter address here

NUMBER Project Number

DRAWING INFORMATION:
 DRAWN BY Author
 DATE 09/09/22

REVISIONS



Thank You!

Vielen Dank!

Muchas Gracias!

Grazie Mille!