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5MW Wind Database and Wind Wizard

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Dassault Systèmes

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5MW Wind Database and Wind Wizard

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5MW Wind Database and Wind Wizard

I. 5 MW Wind Database Model

1. Introduction

2. Modeling Concepts

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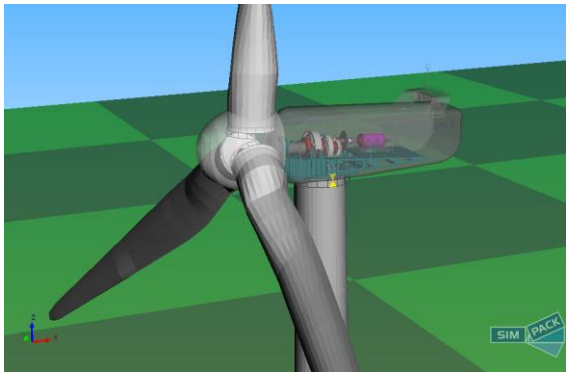
5 MW Wind Database Model

1. Introduction



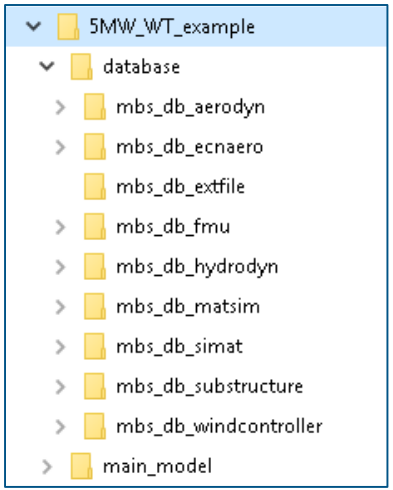
- Example model based on the NREL reference turbines (Onshore and offshore)
- Highly modularized model with easy components handling by predefined interfaces
- Suitable for different development stages:
  - Simple model for design load calculations
  - **High fidelity drivetrain model for detailed drivetrain analysis**
- Detailed drivetrain components developed in coorporation with *Institute of Machine Elements and Machine Design,TU Dresden*

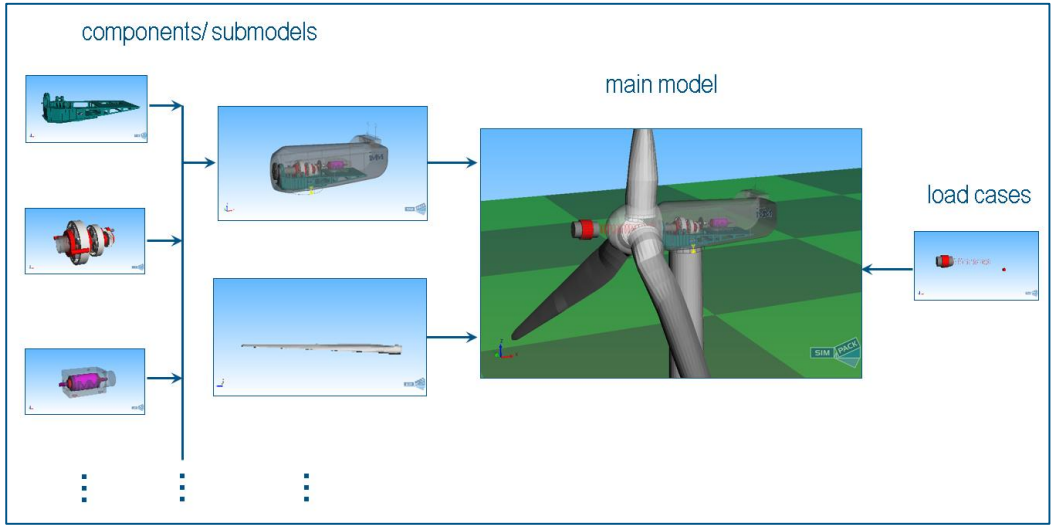
INSTITUTE OF MACHINE ELEMENTS AND MACHINE DESIGN

5 MW Wind Database Model

2. Modeling Concepts

- Folder structure and Substructures

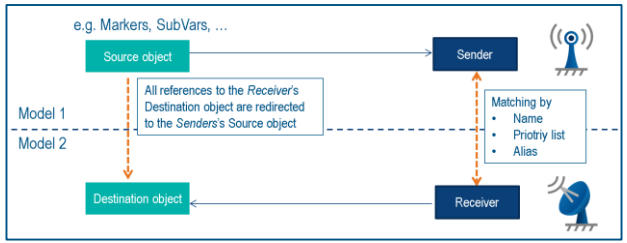


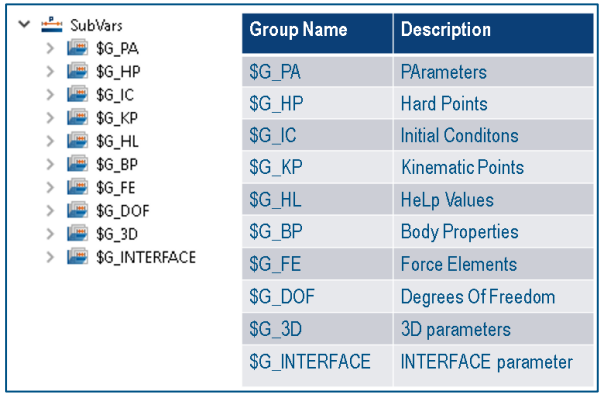


5 MW Wind Database Model

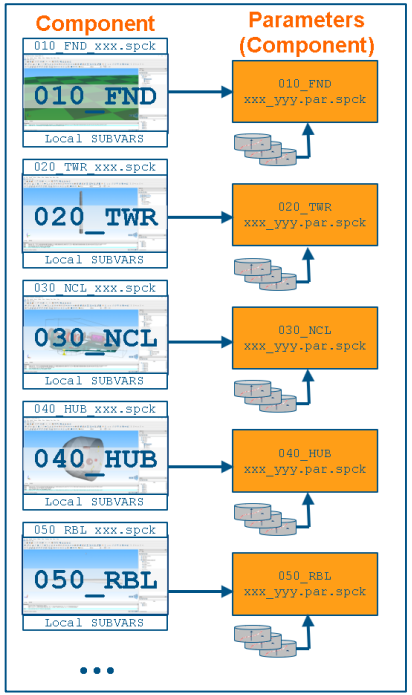
2. Modeling Concepts

- Parametrization via parameter files (par.spck) and topology files (.spck)
- SubVars with consistent naming convention
- Communicators
  → automatic assembly





Group Name	Description
$G_PA	PArameters
$G_HP	Hard Points
$G_IC	Initial Conditons
$G_KP	Kinematic Points
$G_HL	HeLp Values
$G_BP	Body Properties
$G_FE	Force Elements
$G_DOF	Degrees Of Freedom
$G_3D	3D parameters
$G_INTERFACE	INTERFACE parameter



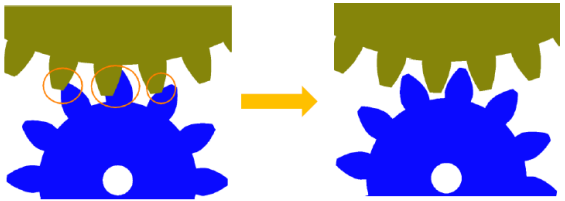
5 MW Wind Database Model

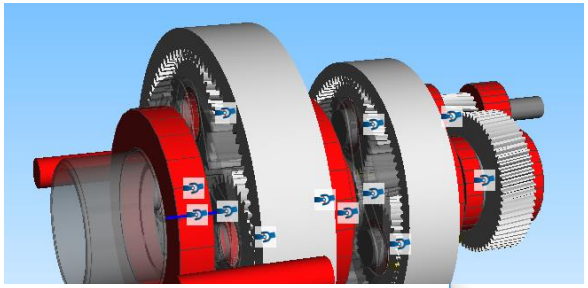
2. Modeling Concepts

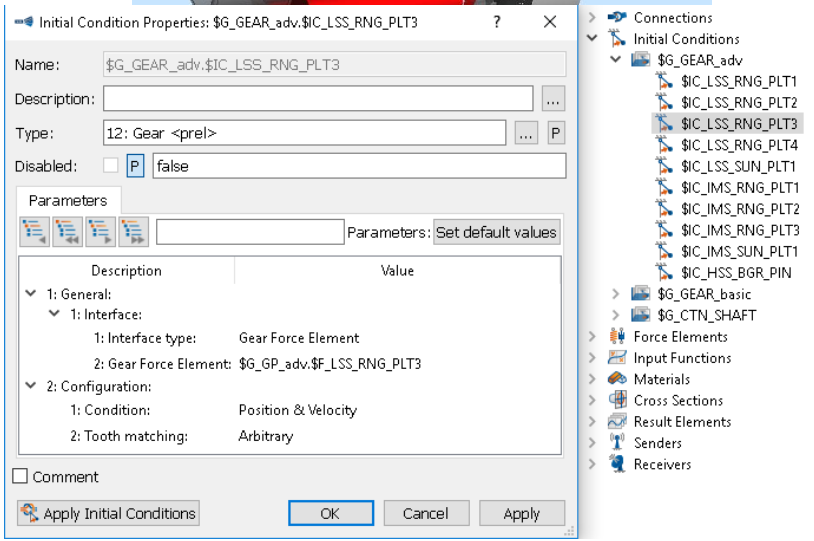
- Connections and Initial Conditions

→ Drivetrain Assembly by automatically adjusting the initial conditions such that

- all shafts rotate with right rpm
- all gears are properly meshing

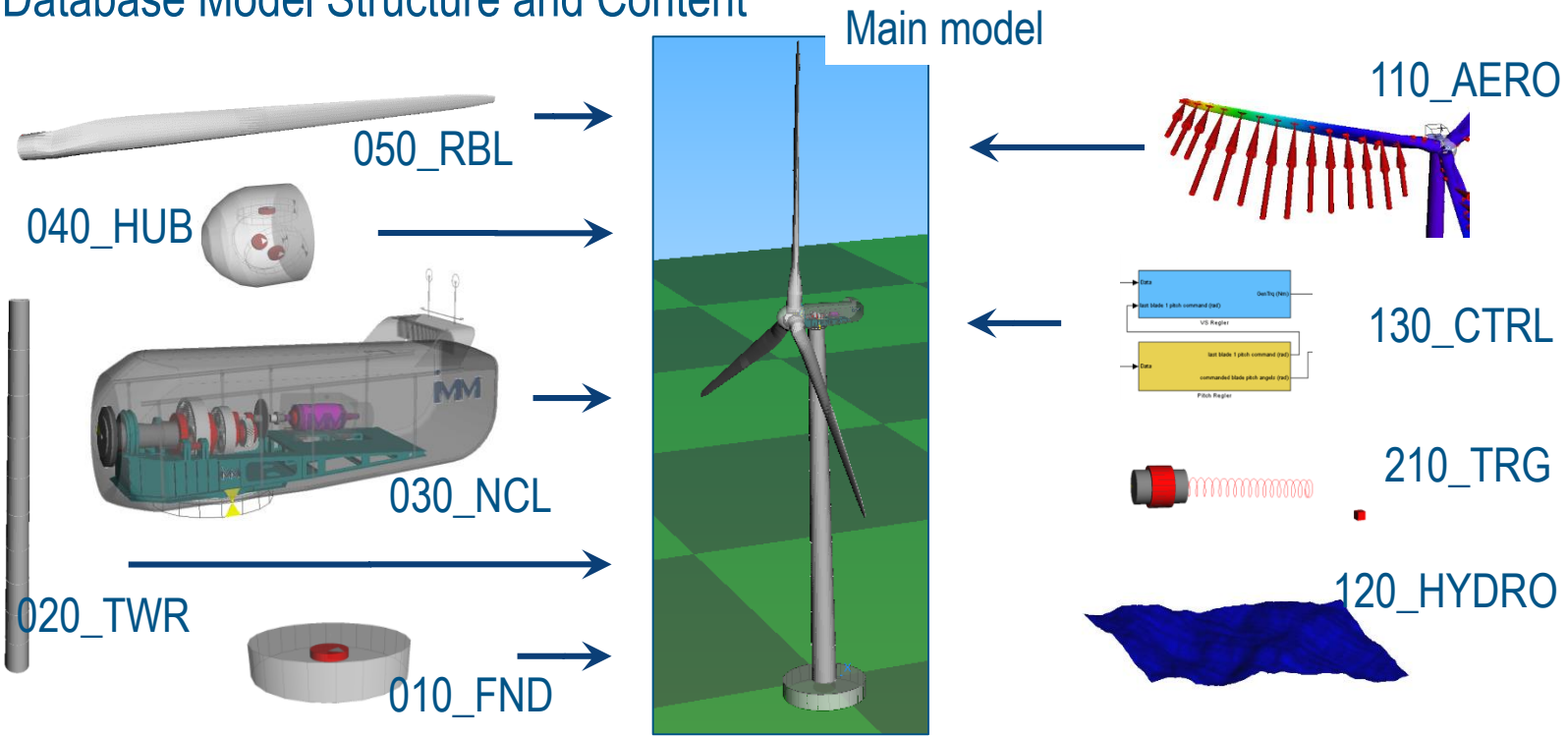






5 MW Wind Database Model

3. Database Model Structure and Content



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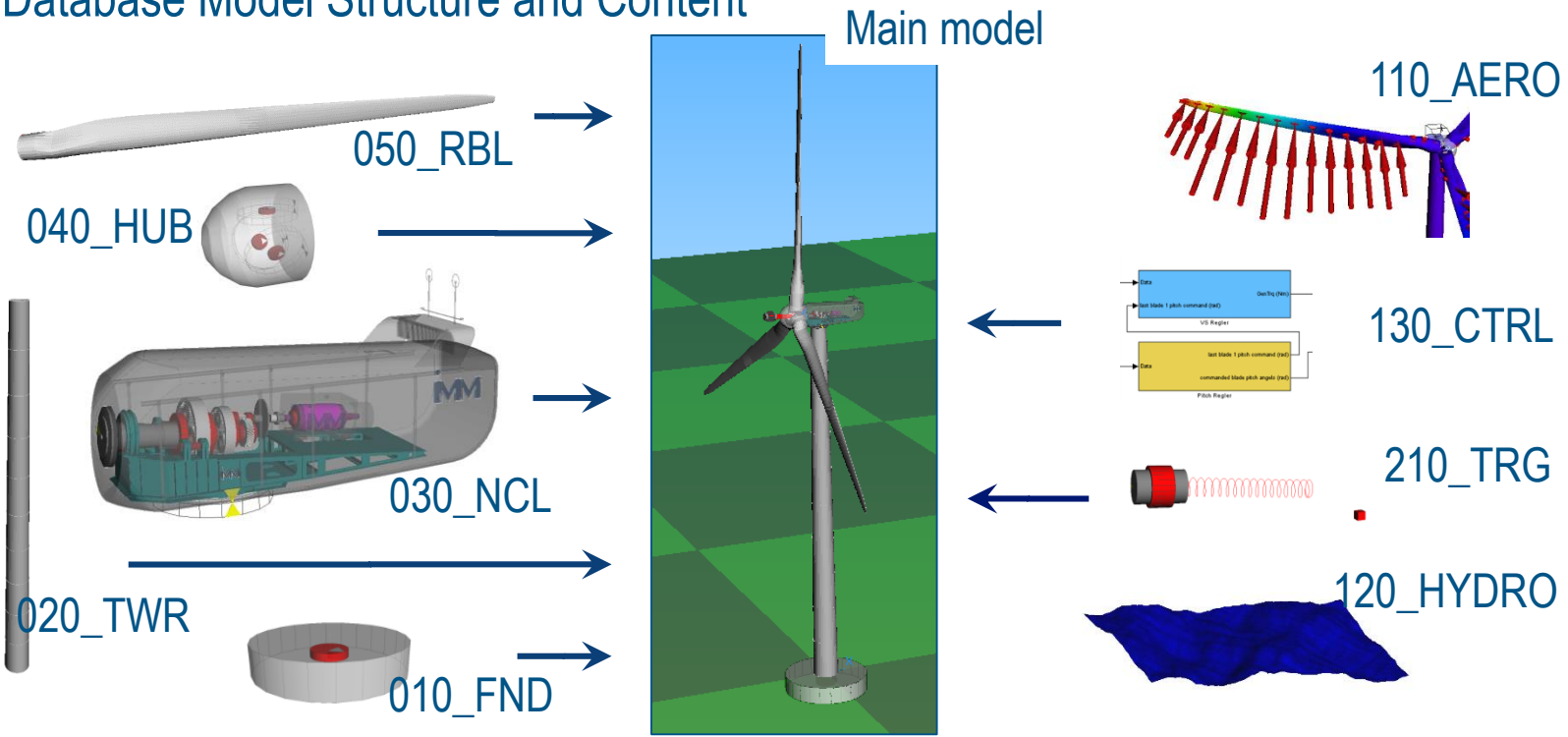

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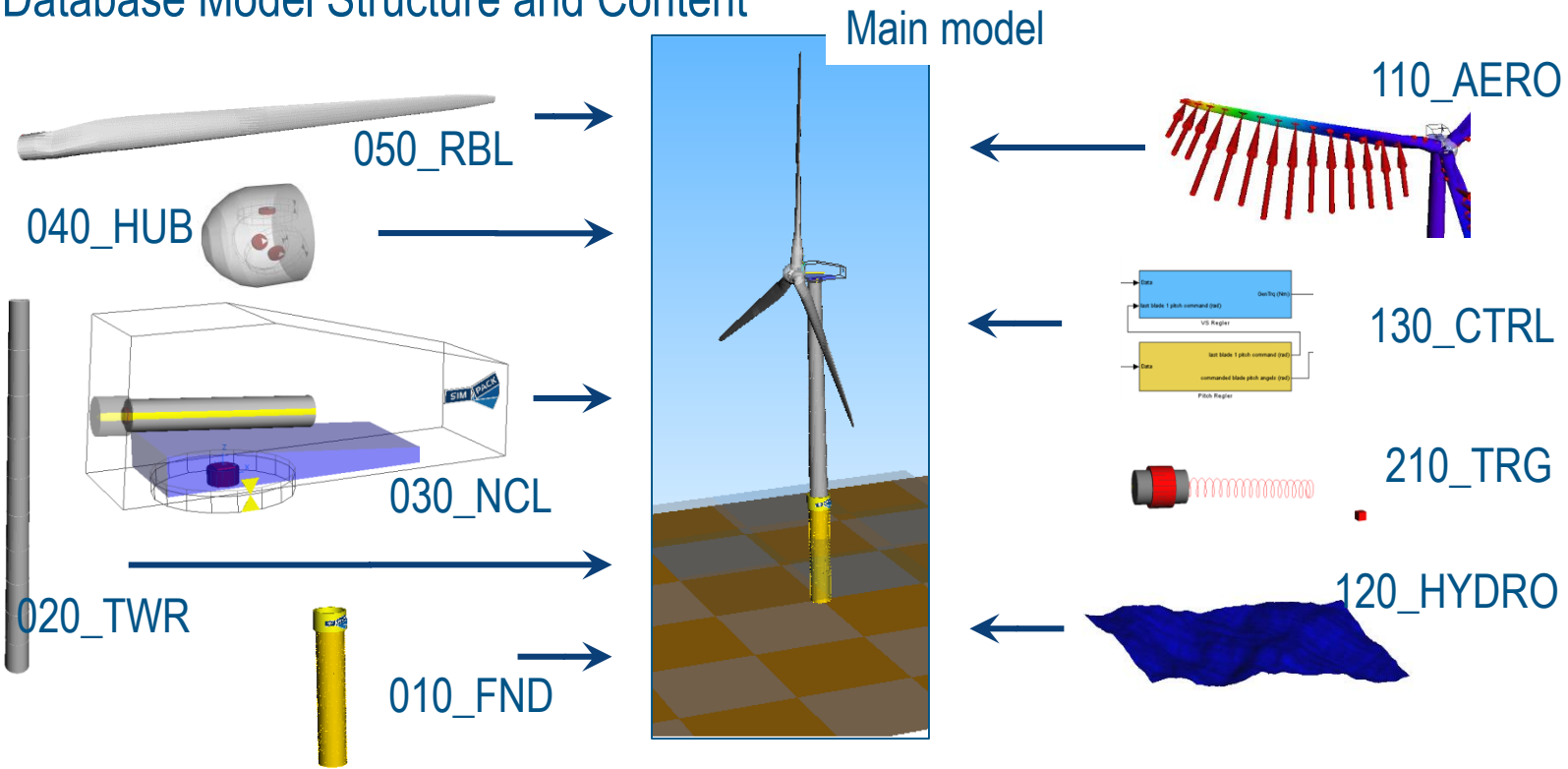

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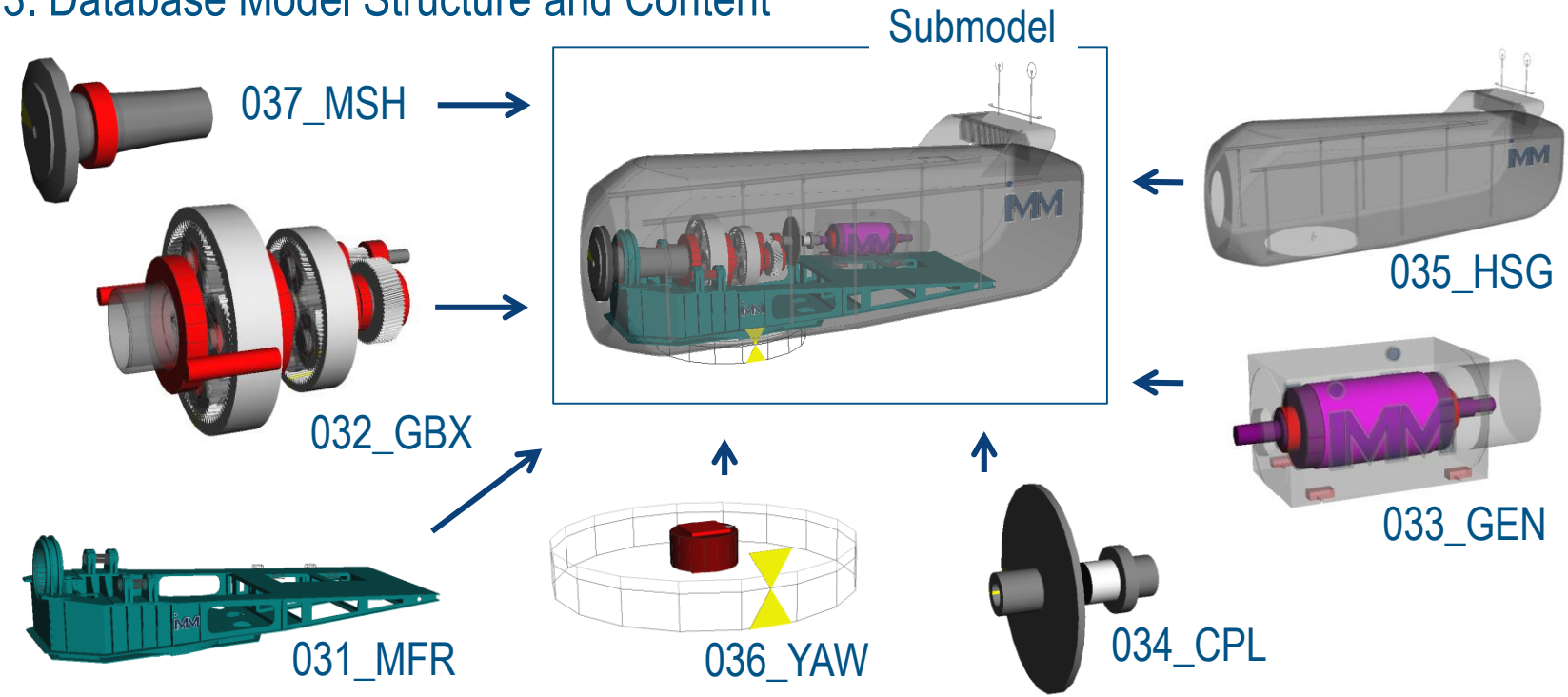

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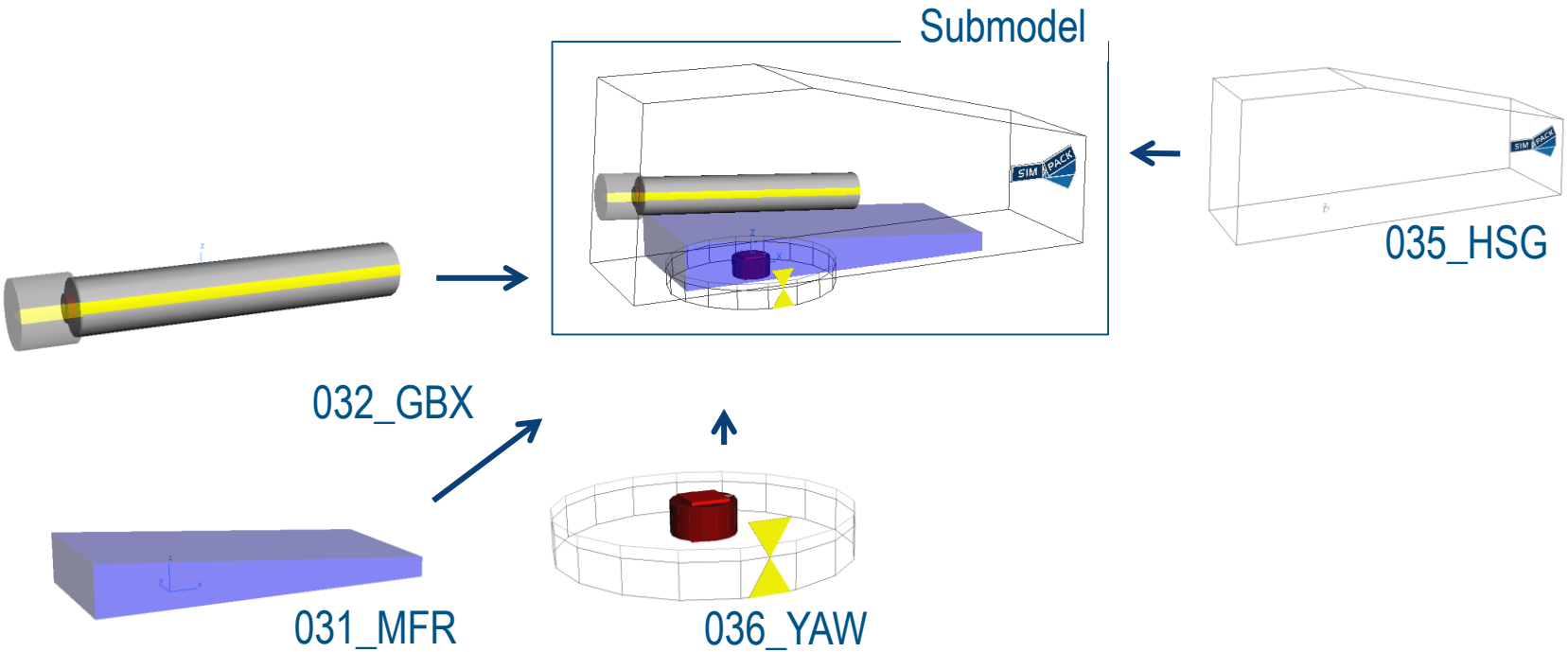
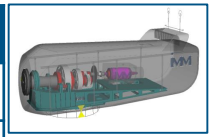


5 MW Wind Database Model

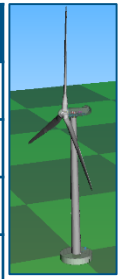
3. Database Model Structure and Content

- Components / Submodels / Main models

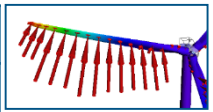
Nacelle	
031_MFR	Mainframe (detailed, simple)
032_GBX	Gearbox (detailed, simple)
033_GEN	Generator
034_CPL	Coupling
035_HSG	Housing (detailed, simple)
036_YAW	Yaw
037_MSH	Main shaft



Wind turbine	
010_FND	Foundation
020_TWR	Tower
030_NCL	Nacelle
040_HUB	Hub
050_RBL	Rotorblade



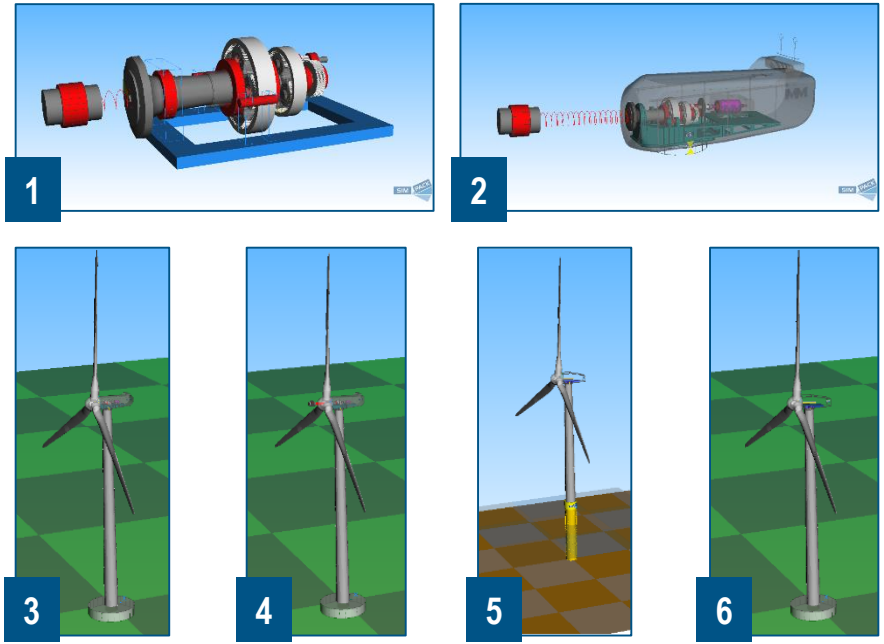
Load cases	
110_AERO	Aerodynamics
120_HYDRO	Hydrodynamics
130_CTRL	Controller
210_TRG	Testrigs



5 MW Wind Database Model

3. Database Model Structure and Content

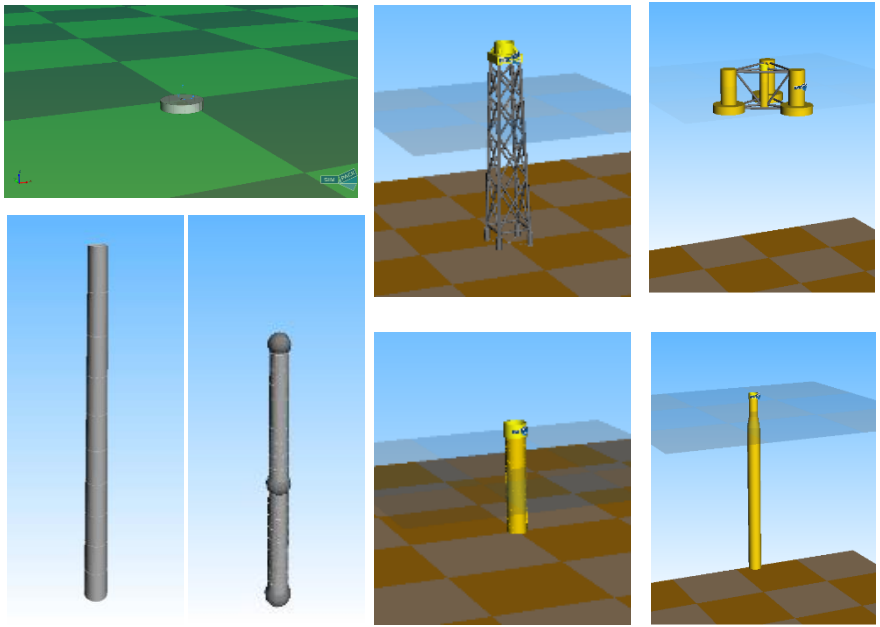
- Main models:
  1. 5MW_GBX_TRG
  2. 5MW_NCL_DRT_TRG
  3. 5MW_WT_DRT_onshore
  4. 5MW_WT_DRT_TRG
  5. 5MW_WT_DLC_onshore
  6. 5MW_WT_DLC_offshore



5 MW Wind Database Model

3. Database Model Structure and Content

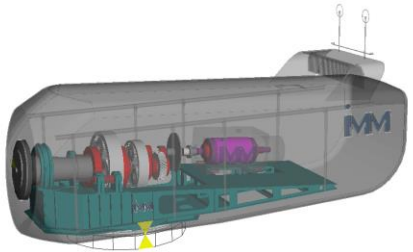
- 010_FND (Foundation)
  - Onshore foundation
  - Offshore foundations (OC4 Jacket, Monopile, Semisubmersible, Spar buoy)
- 020_TWR (Tower)
  - NREL onshore tower
  - NREL OC4 offshore tower (with or wihtout point masses)



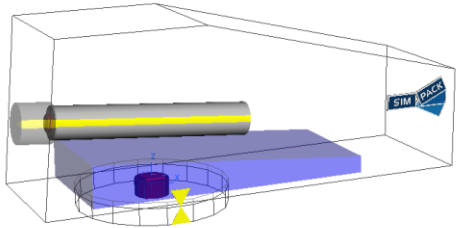
5 MW Wind Database Model

3. Database Model Structure and Content

- 030_NCL_A_DRT (detailed)
  - Advanced gear pair modeling (including flexible gear teeth)
  - Flexible bodies for nearly all drivetrain entities
  - Automatic drivetrain assembly



- 030_NCL_B_DLC (simple)
  - Two-mass oscillator
  - Automatic drivetrain assembly



5 MW Wind Database Model

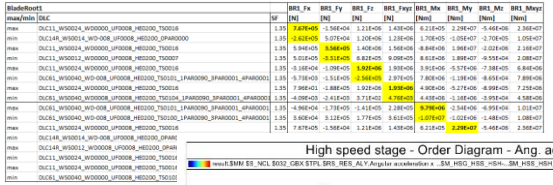
3. Database Model Structure and Content

- 040_HUB
  - Pitch control system
- 050_RBL (Rotorblade)
  - Created with Simpack Rotorblade Generator
  - Simple and advanced model
- 210_TRG (Testrig)
  - Resonance Analysis testrig applicable to Nacelle or Windturbine model
  - Gearbox testrig
- 110_AERO
  - AeroDyn v13 Force element
- 120_HYDRO
  - HydroDyn Force element
- 130_CTRL
  - Windcontroller Interface
  - MatSIM
  - FMU
  - Cosimulation

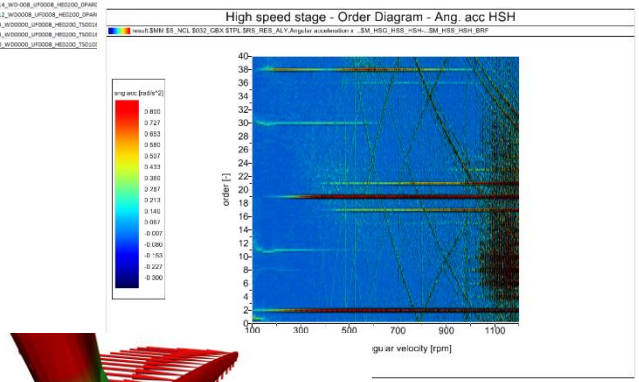
5 MW Wind Database Model

4. Use Cases

- Load Calculation Tool with simple windturbine model (see example in Documentation I.6.1.3.)
- Drivetrain resonance analysis with detailed wind turbine / nacelle model (tutorial for drivetrain resonance analysis via Simpack scripting)
- Durability analysis with detailed wind turbine model (prepared FE input decks in the database; workflow using SIMULIA Abaqus, fe-safe, Simpack and Isight)



BladeRoot1			BR1_Fx	BR1_Fy	BR1_Fz	BR1_Fxyz	BR1_Mx	BR1_My	BR1_Mz	BR1_Mxyz
max/min	DLC	SF	[N]	[N]	[N]	[N]	[Nm]	[Nm]	[Nm]	[Nm]
max	DLC11_WS0024_WD0000_UF0008_HE0200_TS0016	1.35	7.67E+05	-1.56E+04	1.21E+06	1.43E+06	6.21E+05	2.29E+07	-5.46E+06	2.36E+07
min	DLC14R_WS0014_WD-008_UF0008_HE0200_OPAR0000	1.35	-2.62E+05	5.07E+04	1.20E+06	1.23E+06	1.70E+05	-1.05E+07	-2.70E+05	1.05E+07
max	DLC11_WS0024_WD0000_UF0008_HE0200_TS0016	1.35	5.94E+05	3.56E+05	1.40E+06	1.56E+06	6.84E+06	1.96E+07	-2.02E+06	2.16E+07
min	DLC11_WS0012_WD0000_UF0008_HE0200_TS0007	1.35	5.01E+05	-3.51E+05	6.82E+05	9.09E+05	8.61E+06	1.88E+07	-9.55E+04	2.08E+07
max	DLC11_WS0024_WD0000_UF0008_HE0200_TS0016	1.35	-3.16E+04	-1.09E+05	1.92E+06	1.93E+06	3.91E+06	-5.57E+06	-7.38E+05	6.84E+06
min	DLC61_WS0040_WD-008_UF0008_HE0200_TS0101_1PAR0090_3PAR0001_4PAR0001	1.35	-5.73E+03	-1.51E+05	-2.56E+05	2.97E+05	7.80E+06	-1.19E+06	-8.65E+04	7.89E+06
max	DLC11_WS0024_WD0000_UF0008_HE0200_TS0016	1.35	7.96E+01	-1.88E+05	1.92E+06	1.93E+06	4.90E+06	-5.27E+06	-6.99E+05	7.25E+06
min	DLC61_WS0040_WD-008_UF0008_HE0200_TS0104_1PAR0090_3PAR0001_4PAR0001	1.35	-4.09E+03	-2.41E+03	5.71E+02	-4.76E+03	4.43E+06	-1.16E+06	-3.95E+04	4.58E+06
max	DLC61_WS0040_WD-008_UF0008_HE0200_TS0101_1PAR0090_3PAR0001_4PAR0001	1.35	-4.96E+04	-1.73E+05	-1.41E+05	2.28E+05	9.79E+06	-2.56E+06	-6.95E+04	1.01E+07
min	DLC61_WS0040_WD-008_UF0008_HE0200_TS0100_1PAR0090_3PAR0001_4PAR0001	1.35	5.60E+04	3.12E+05	1.77E+05	3.61E+05	-1.07E+07	-1.02E+06	-1.48E+05	1.08E+07
max	DLC11_WS0024_WD0000_UF0008_HE0200_TS0016	1.35	7.67E+05	-1.56E+04	1.21E+06	1.43E+06	6.21E+05	2.29E+07	-5.46E+06	2.36E+07
min	DLC14R_WS0014_WD-008_UF0008_HE0200_OPAR0									
max	DLC14R_WS0012_WD0008_UF0008_HE0200_SPAR0									
min	DLC11_WS0024_WD0000_UF0008_HE0200_TS0016									
max	DLC11_WS0024_WD0000_UF0008_HE0200_TS0016									
min	DLC61_WS0040_WD0000_UF0008_HE0200_TS0100									



5MW Wind Database and Wind Wizard

II. 5 MW Wind Wizard Model

1. Simpack Wizard Introduction

2. 5MW Wind Wizard model

3. Demo Video

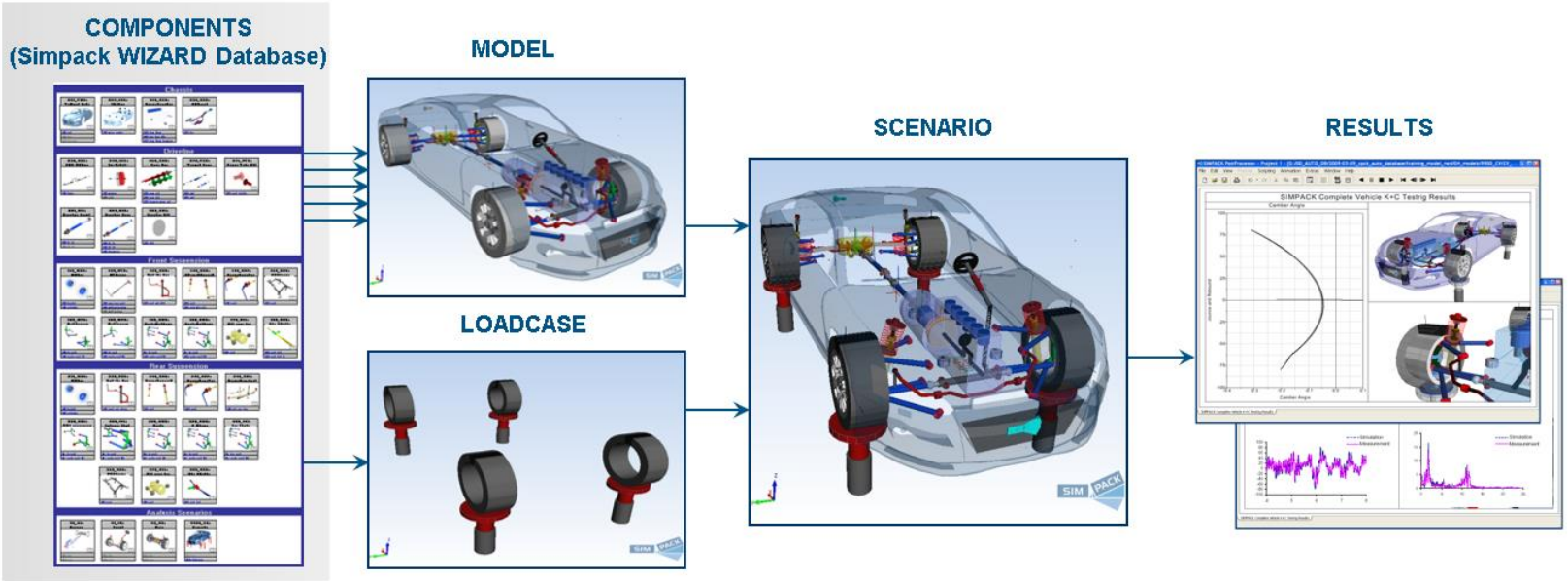
5MW Wind Wizard Model

1. Simpack Wizard Introduction

- Simpack module which allows simple usage of databases
- An extra GUI mode option **designed for non-Multibody Simulation (MBS) specialists** to perform customer-specific standardized MBS tasks
- When working with Simpack Wizard, **a complete MBS Model** with Loadcase can be set up **in less than a minute**, the Model and Loadcase can be easily parameterized and variants can be created
- Applicable to all kinds of Simpack application areas (Automotive, Engine, Wind, etc.)

5MW Wind Wizard Model

1. Simpack Wizard Introduction



5MW Wind Wizard Model

1. Simpack Wizard Introduction

- Very fast set up of complete models and scenarios
- Easy exchange of submodels/components to modify the topology
- All project engineers work with the same database
  - ➢ no risk of overwriting important values or changing topology
  - ➢ reduces maintenance time and ensures everyone is up to date
- Easy update to the latest database version
- Easy exchange of models and/or parametrization
- Easy integration of user-defined submodels, loadcases, etc.

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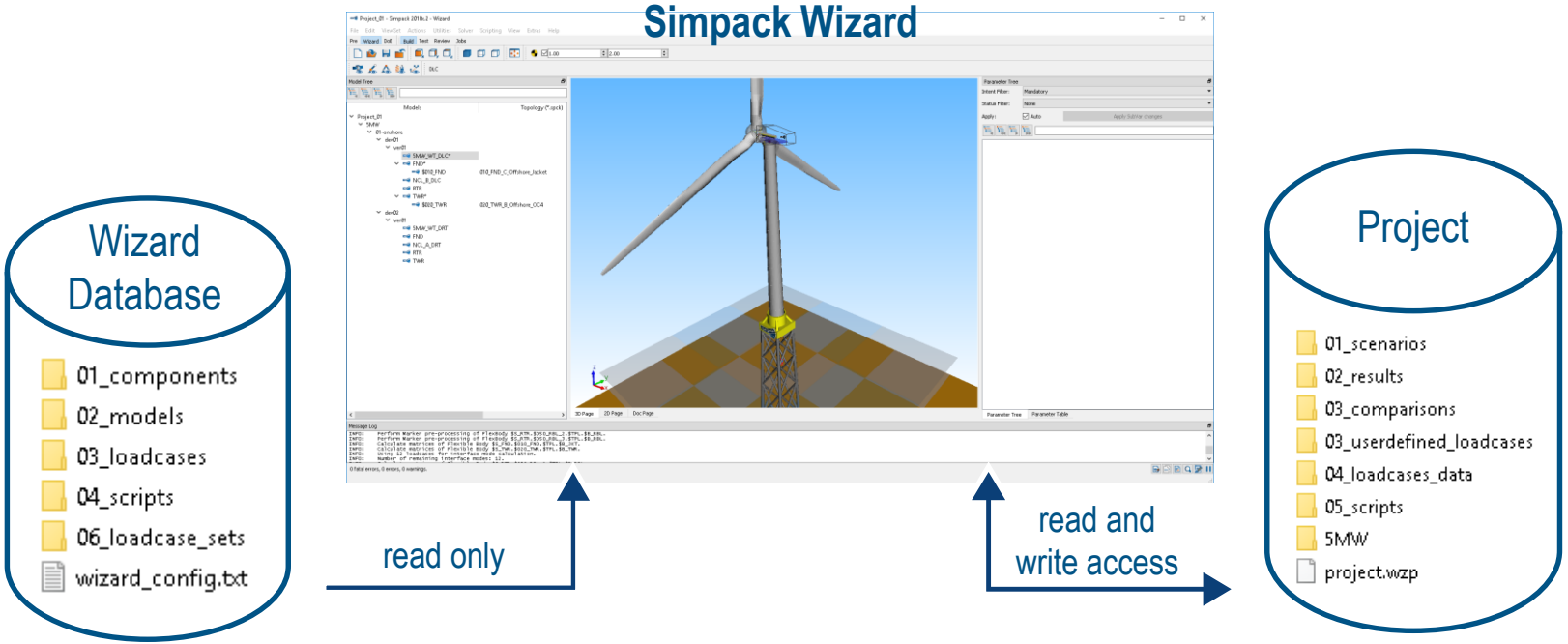
Simpack **3D**EXPERIENCE Integration - Power'By

5MW Wind Wizard Model

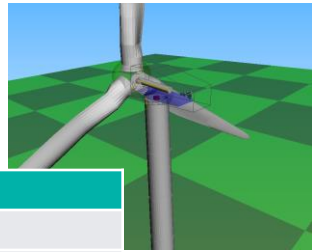
1. Simpack Wizard Introduction

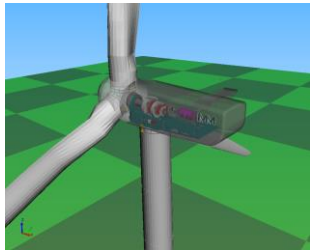


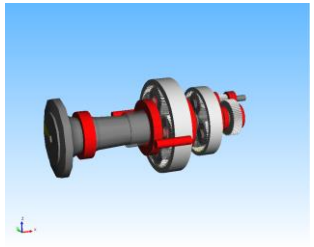
5MW Wind Wizard Model

2. 5MW Wind Wizard Model

- Database components are used
- Rearranged Main models, Submodels and Loadcases



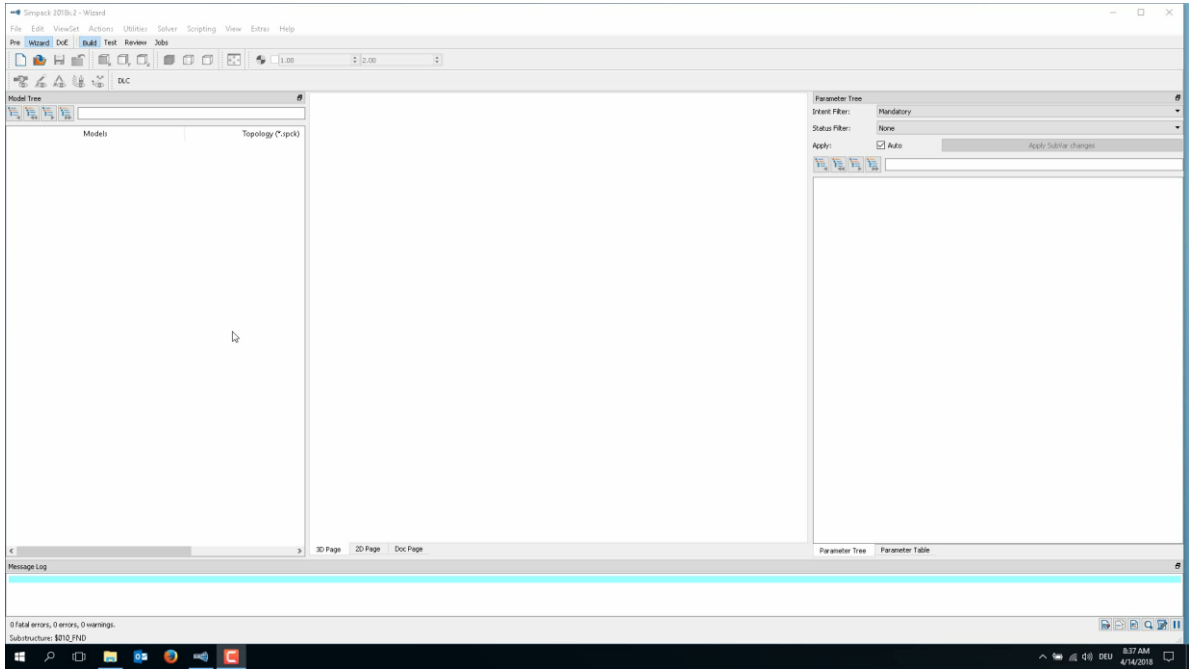




Models	Loadcases	Description
5MW_WT_DLC	AERO_CTRL	Windforces + Controller
	AERO_CTRL_HYDRO	Windforces + Controller + Hydroforces
	HYDRO	Hydroforces
	PWR_CRV	Power curve
5MW_WT_DRT	RES_ALY	Resonance Analysis with Run-up
GBX_A_DRT	TRG	Testrig with Run-up, Static Torque, No Torque, HSS Brake
NCL_A_DRT	RES_ALY	Resonance Analysis with Run-up

5 MW Wind Wizard Model

3. Demo Video



5MW Wind Database and Wind Wizard

III. Summary and Conclusion

5MW Wind Database and Wind Wizard

Summary and Conclusion

Database Model

- Modularized example model for Multibody Simulation engineers
- From low to high fidelty applications

Wizard Model

- Database example model prepared for Simpack Wizard
- Model maintanance by Multibody Simulation specialists
- Designed for non-specialist users

Both models are available!

Feel free to contacts us via Andreas.KRINNER@3ds.com or Steve.MULSKI@3ds.com