

Contents

1	Introduction	1
2	The Combustion Engine at the Turn of Industrialization	3
2.1	The Prehistory	3
2.2	The Technological Revolution	5
3	Revolution through Simulation for the Development of Powertrains	9
3.1	Flow Calculation	9
3.1.1	3D-CFD	10
3.1.2	1D-CFD	13
3.1.3	0D-CFD	15
3.2	Elastohydrodynamics (EHD) and Tribology	18
3.3	Combustion Chamber (Combustion and Thermodynamics)	22
3.4	Material Strength and Structure	32
3.4.1	Theory of Elasticity	35
3.4.2	Alternative Methods	41
3.5	Acoustics	44
4	Big Data for Powertrains	47
4.1	The Future of Powertrain Concepts	47
4.2	The History of Simulation	52
4.3	Development Processes and Scenarios of Simulation with Big Data	58
5	Powertrain Development with Artificial Intelligence	75
5.1	Models of Artificial Intelligence	76
5.2	Overview: Levels of AI	82
5.3	Search Tree	84
5.4	Machine Learning	90
5.4.1	Supervised Learning	92
5.4.2	Unsupervised Learning	97
5.4.3	Reinforcement Learning	102

5.5	Artificial Neural Networks (ANN)	107
5.5.1	Activation Function	109
5.5.2	Feedforward Networks (ANN) and Recurrent Networks (RNN)	111
5.5.3	Training Procedure.	118
5.5.4	Network Architecture and Performance.	127
5.5.5	Fuzzy Logik	133
5.6	Deep Learning	137
5.6.1	Convolutional Neural Network (CNN)	137
5.6.2	Generative Adversarial Network (GAN)	154
5.7	Software	158
	Bibliography	161