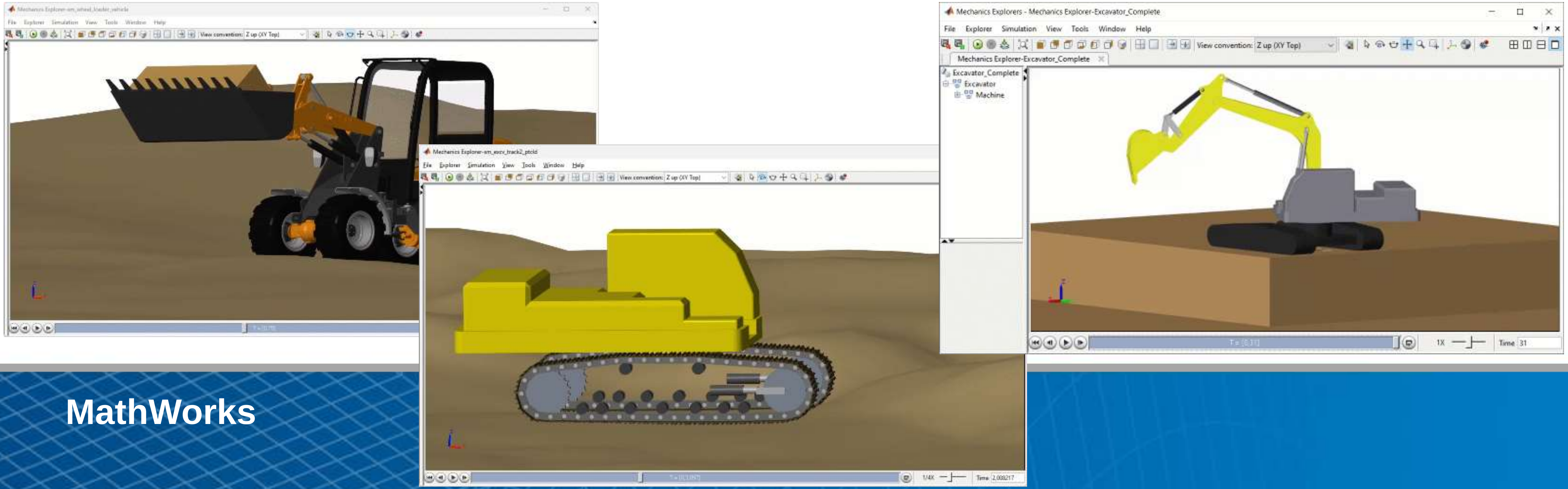
建機・農機・オフロードソリューション


Mechanics Explorers - Mechanics Explorer-Excavator_Complete
File Explorer Simulation View Tools Window Help
View convention: Z up (XY Top)
Mechanics Explorer-Excavator_Complete
Excavator_Complete
Excavator
Machine
1X
Time 31
File Explorer Simulation View Tools Window Help
View convention: Z up (XY Top)
1/4X
Time 2.008217

MathWorks

https://www.mathworks.com/matlabcentral/fileexchange/159126-wheel-loader-design-with-simscape

https://www.mathworks.com/matlabcentral/fileexchange/134861-tracked-vehicle-model-with-simscape

https://www.mathworks.com/matlabcentral/fileexchange/119268-excavator-design-with-simscape

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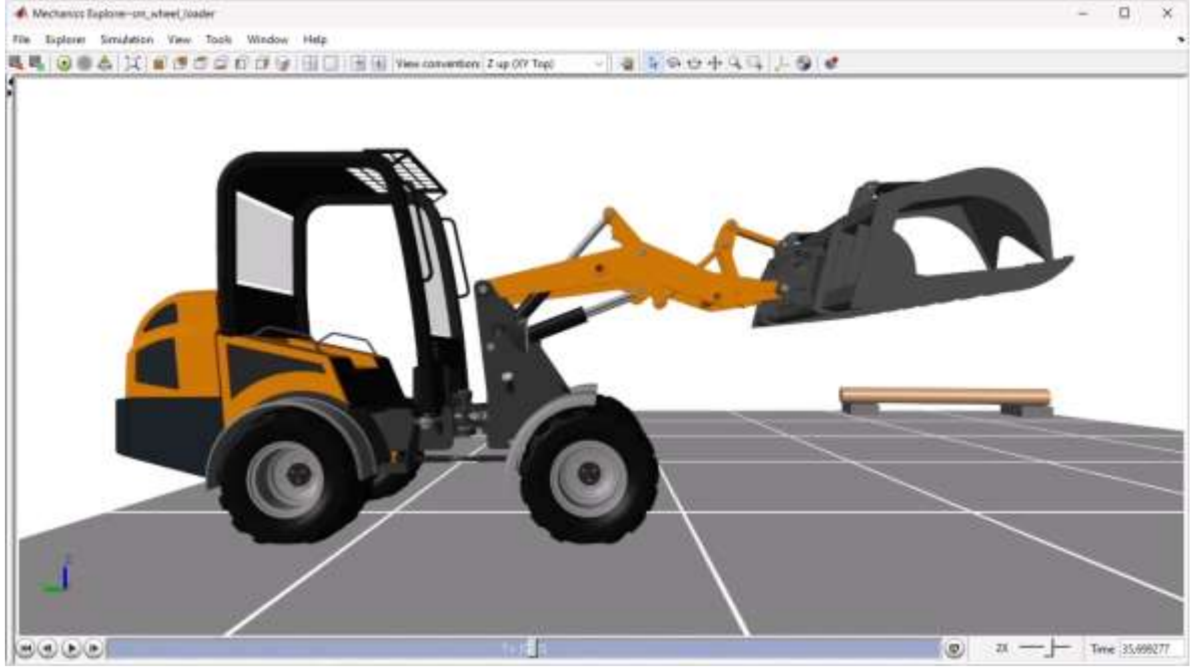
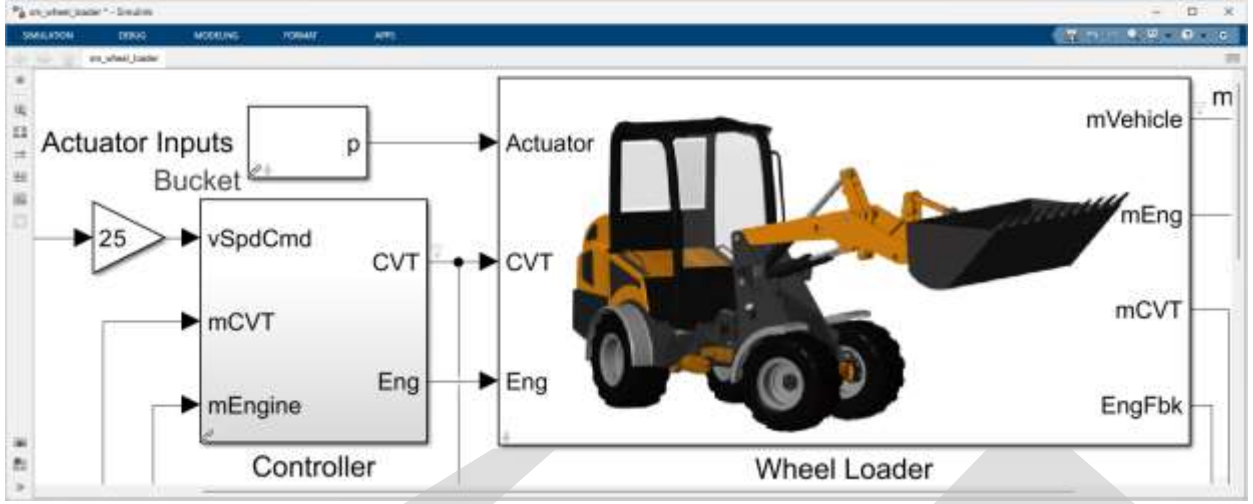
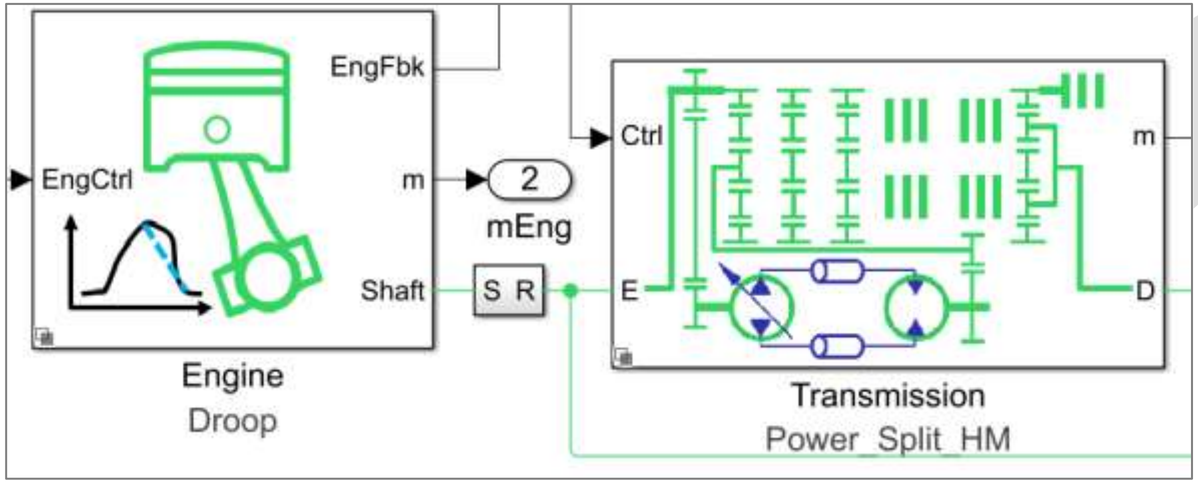
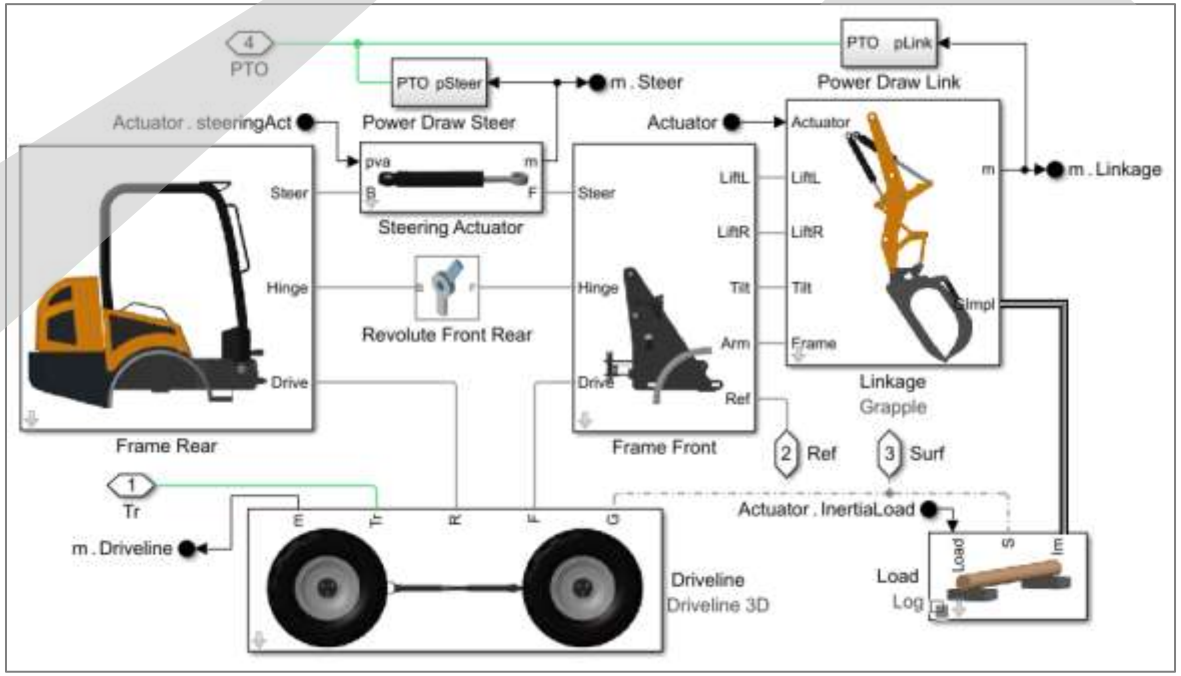
ホイールローダー with HST

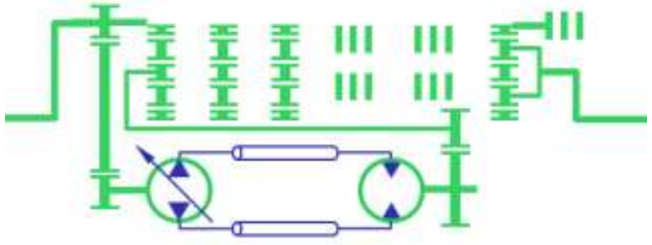
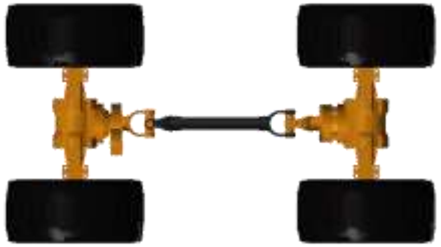
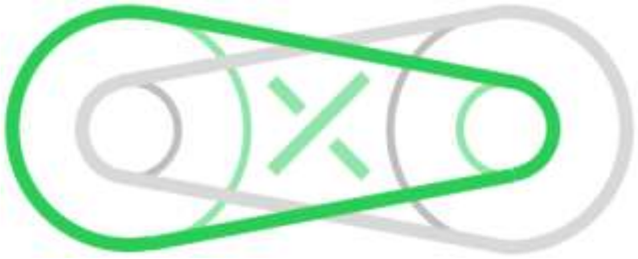
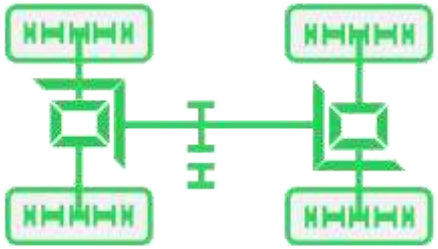
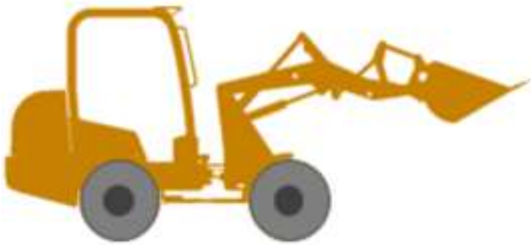

File
Explorer
Simulation
View
Tools
Window
Help
View convention: Z up (XY Top)


SIMULATION
DEBUG
MODELING
FORMAT
APPS
Actuator Inputs
Bucket
p
25
vSpdCmd
mCVT
mEngine
CVT
Eng
Controller
Actuator
CVT
Eng
mVehicle
mEng
mCVT
EngFbk
m
Wheel Loader


EngFbk
EngCtrl
m
Shaft
Engine
Droop
2
mEng
S R
Ctrl
E
m
D
Transmission
Power_Split_HM

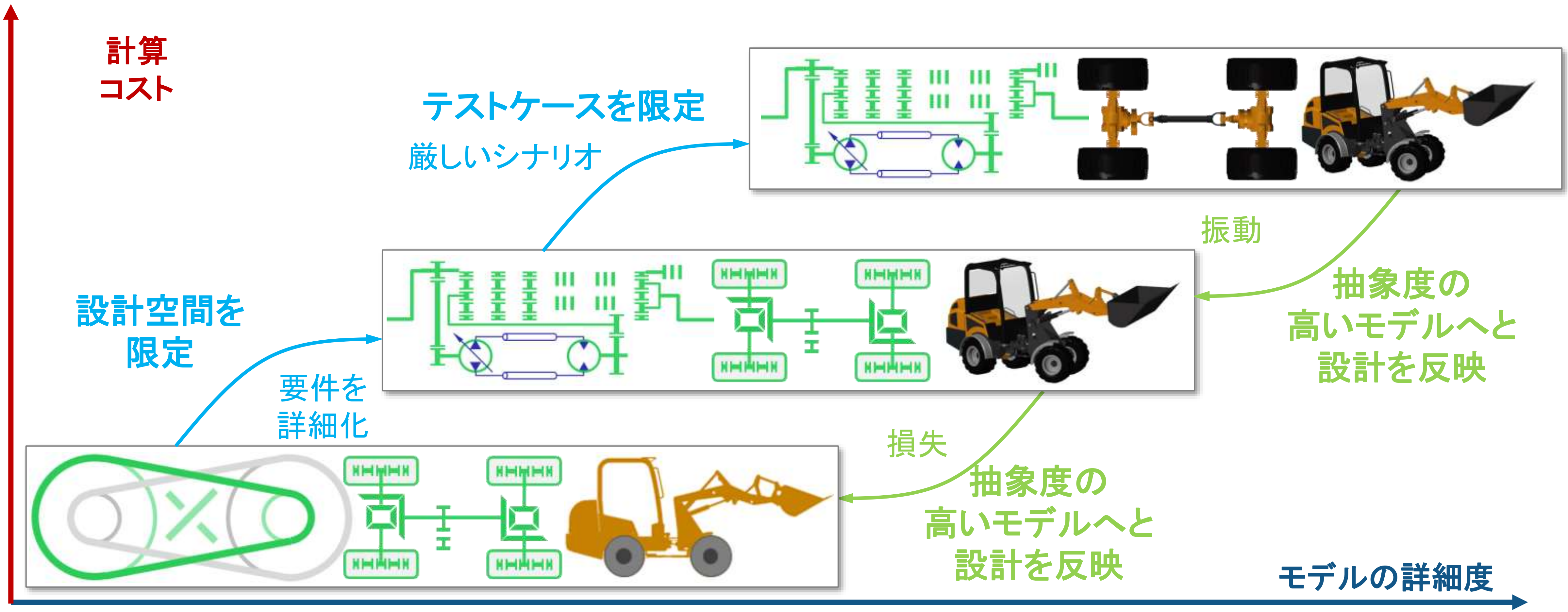

4
PTO
PTO pSteer
m . Steer
PTO pLink
Power Draw Link
Actuator . steeringAct
Power Draw Steer
Actuator
Actuator
pva
m
B
F
Steering Actuator
Steer
Hinge
Drive
Frame Rear
Revolute Front Rear
Steer
Hinge
Drive
LiftL
LiftR
Tilt
Arm
Ref
Frame Front
LiftL
LiftR
Tilt
Frame
m
Impl
m . Linkage
Linkage
Grapple
2 Ref
3 Surf
1
Tr
m . Driveline
E
Tr
R
F
G
Driveline
Driveline 3D
Actuator . InertiaLoad
Load
Log
Load
S
m

目的に応じた適切な詳細度の選定

	Transmission	Driveline	Chassis
Detailed	 Power Split	 Multibody	 Multibody
Abstract	 Abstract	 Longitudinal	 Longitudinal

目的に応じた適切な詳細度の選定

Same environment streamlines model refinement



計算コスト

テストケースを限定

厳しいシナリオ

振動

抽象度の高いモデルへと設計を反映

設計空間を限定

要件を詳細化

損失

抽象度の高いモデルへと設計を反映

モデルの詳細度

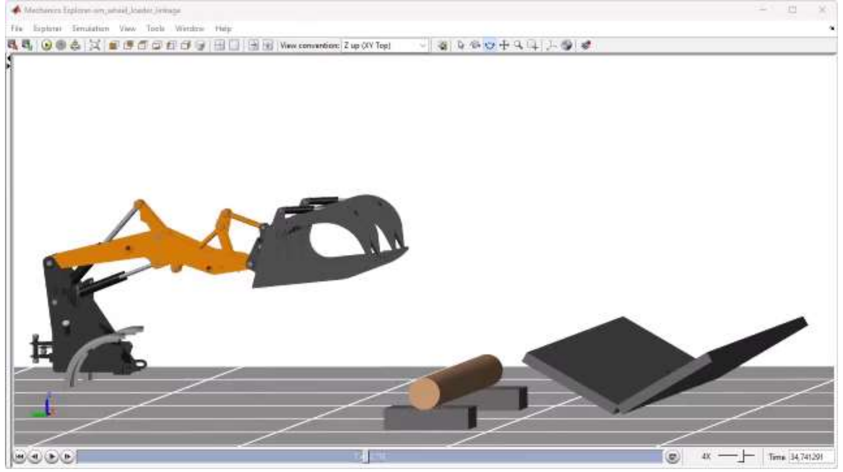
トルク及び、伝達効率の要件設計

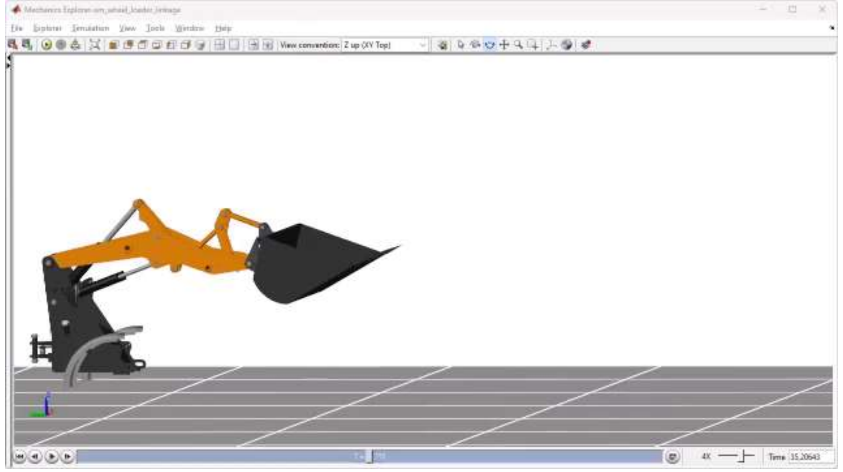
パワートレーンのギヤ比の要件設計

ドライブラインの機械的な負荷の設計

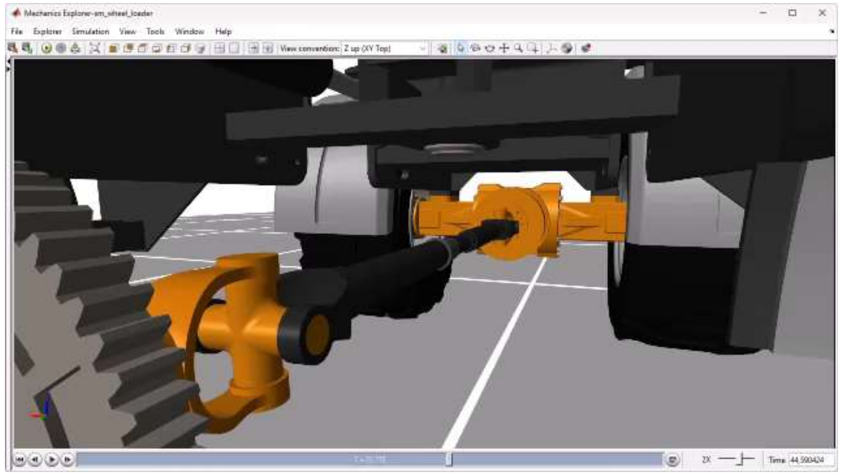
設計の目的に応じた活用

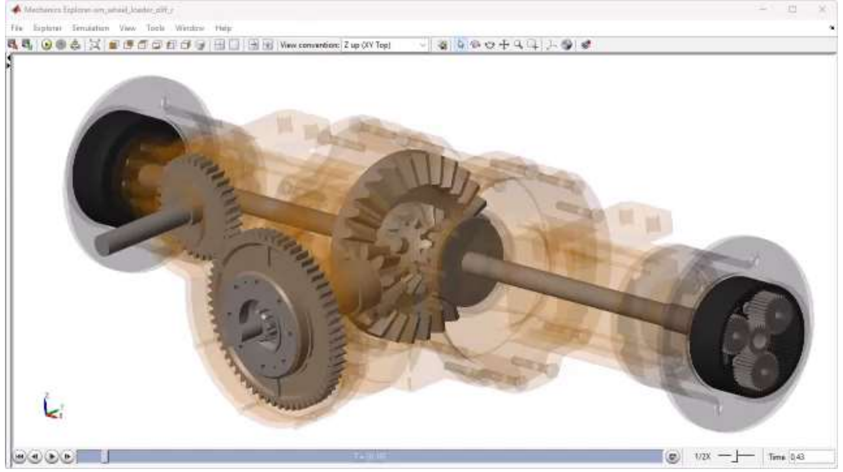
Implement



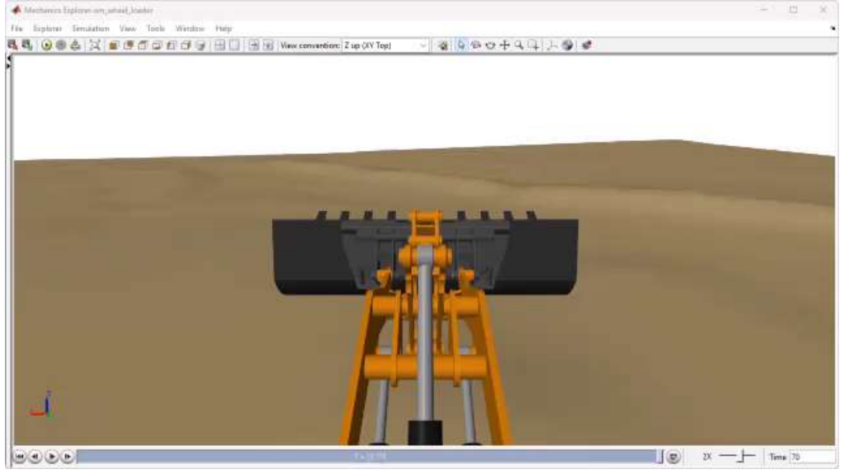


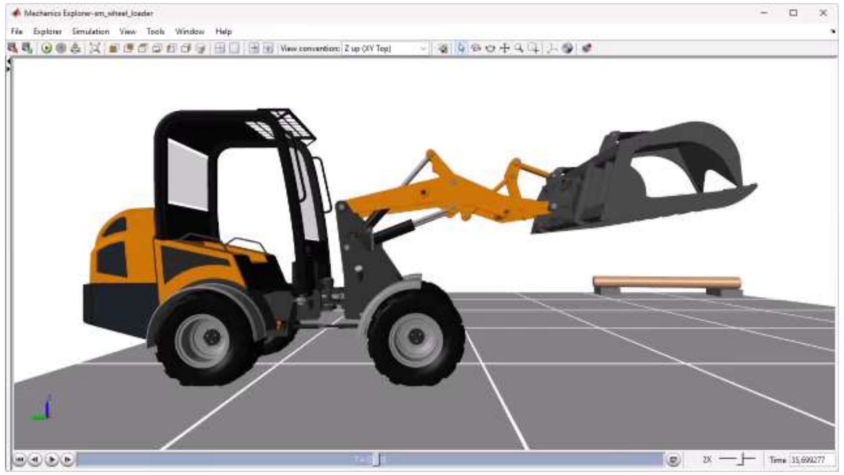
Powertrain



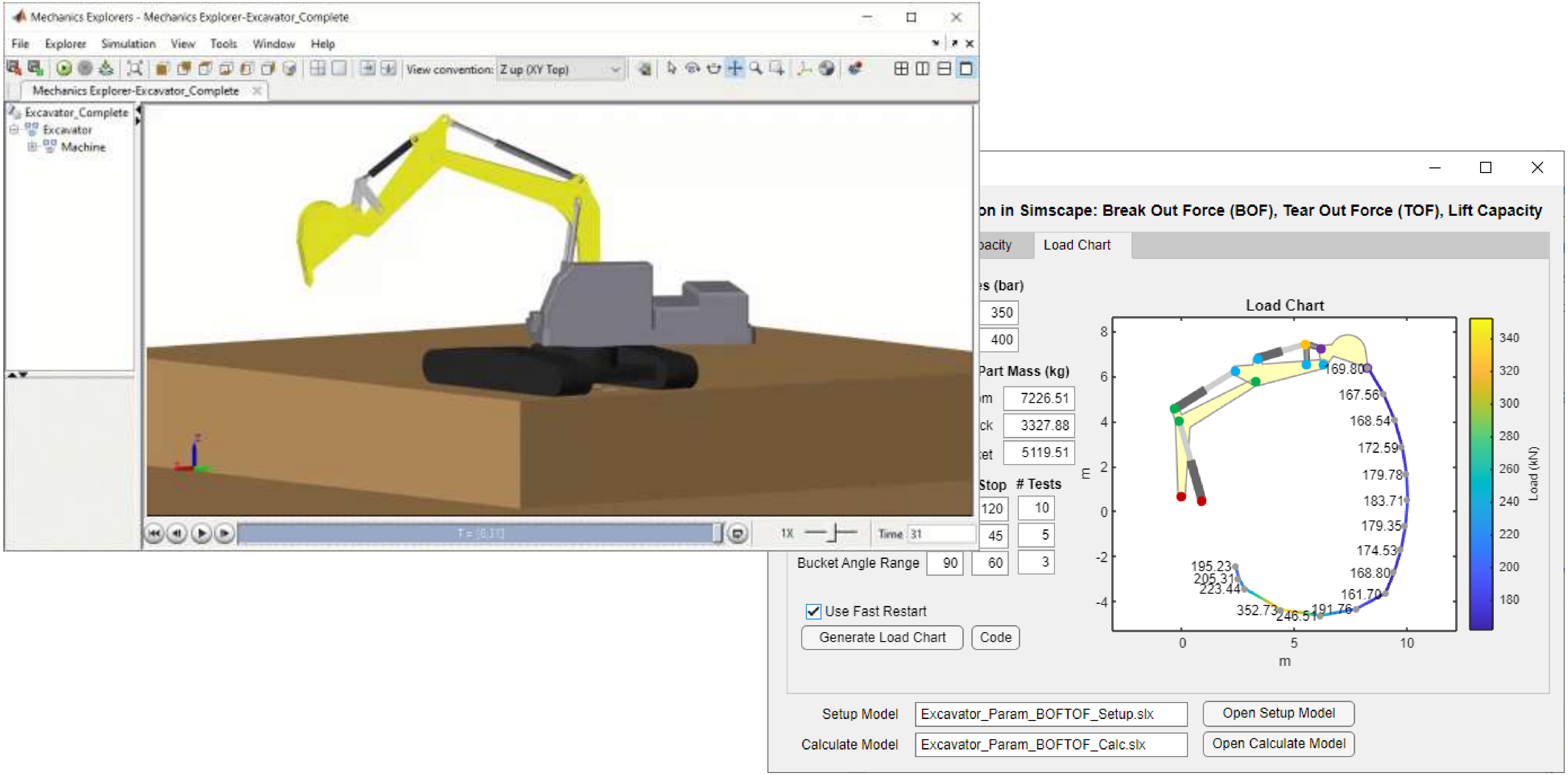


Driving





パワーショベルの最適設計



Mechanics Explorers - Mechanics Explorer-Excavator_Complete
File
Explorer
Simulation
View
Tools
Window
Help
Mechanics Explorer-Excavator_Complete
Excavator_Complete
Excavator
Machine
1X
Load Chart
8
6
4
2
0
-2
-4
0
5
10
m
m
169.80
167.56
168.54
172.59
179.78
183.71
179.35
174.53
168.80
161.70
191.76
246.51
352.73
223.44
205.31
195.23
340
320
300
280
260
240
220
200
180
Load (kN)
pacity
Load Chart
Generate Load Chart
Code
Open Setup Model
Open Calculate Model

View convention: Z up (XY Top)

Time 31

on in Simscape: Break Out Force (BOF), Tear Out Force (TOF), Lift Capacity

es (bar)

350
400

Part Mass (kg)

m	7226.51
ck	3327.88
et	5119.51

		Stop	# Tests
		120	10
		45	5
Bucket Angle Range	90	60	3

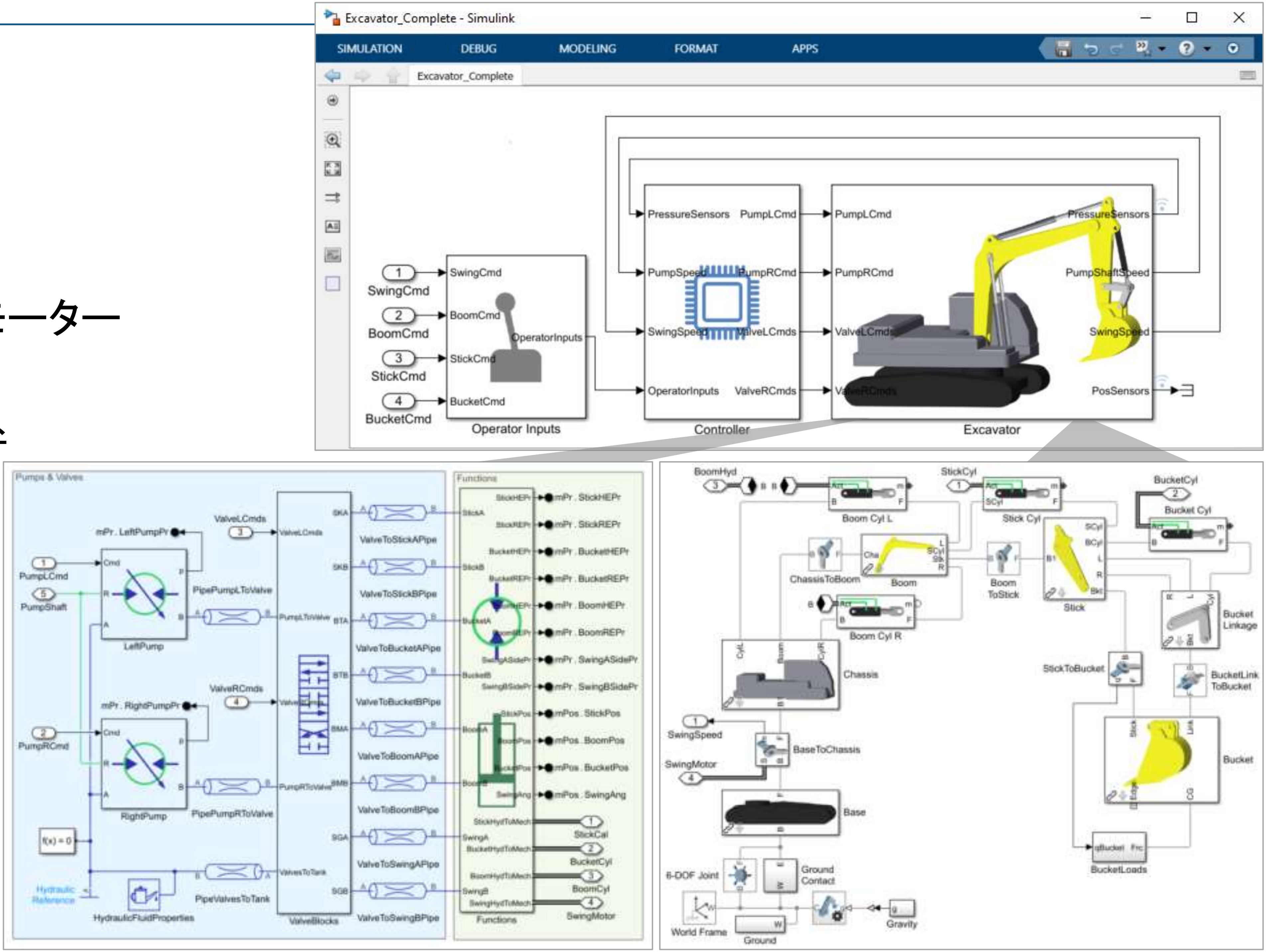
☑ Use Fast Restart

Setup Model: Excavator_Param_BOFTOF_Setup.slx

Calculate Model: Excavator_Param_BOFTOF_Calc.slx

モデル概要

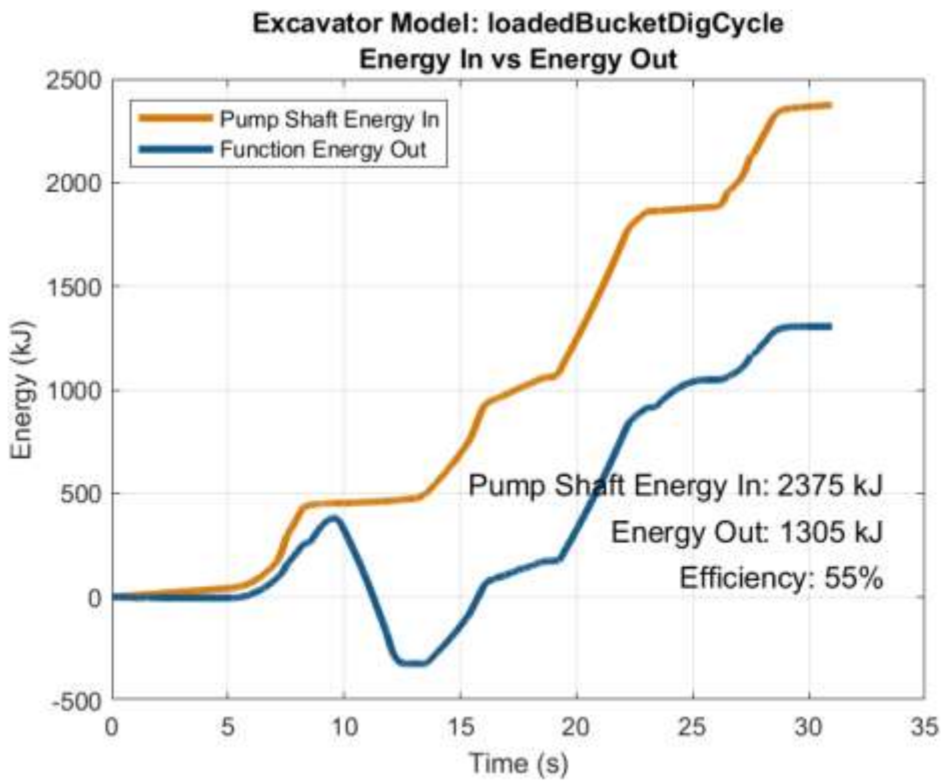
- 2ポンプ
- 4シリンダー, 1モーター
- 6方向切換え弁
- 各種圧力調整弁

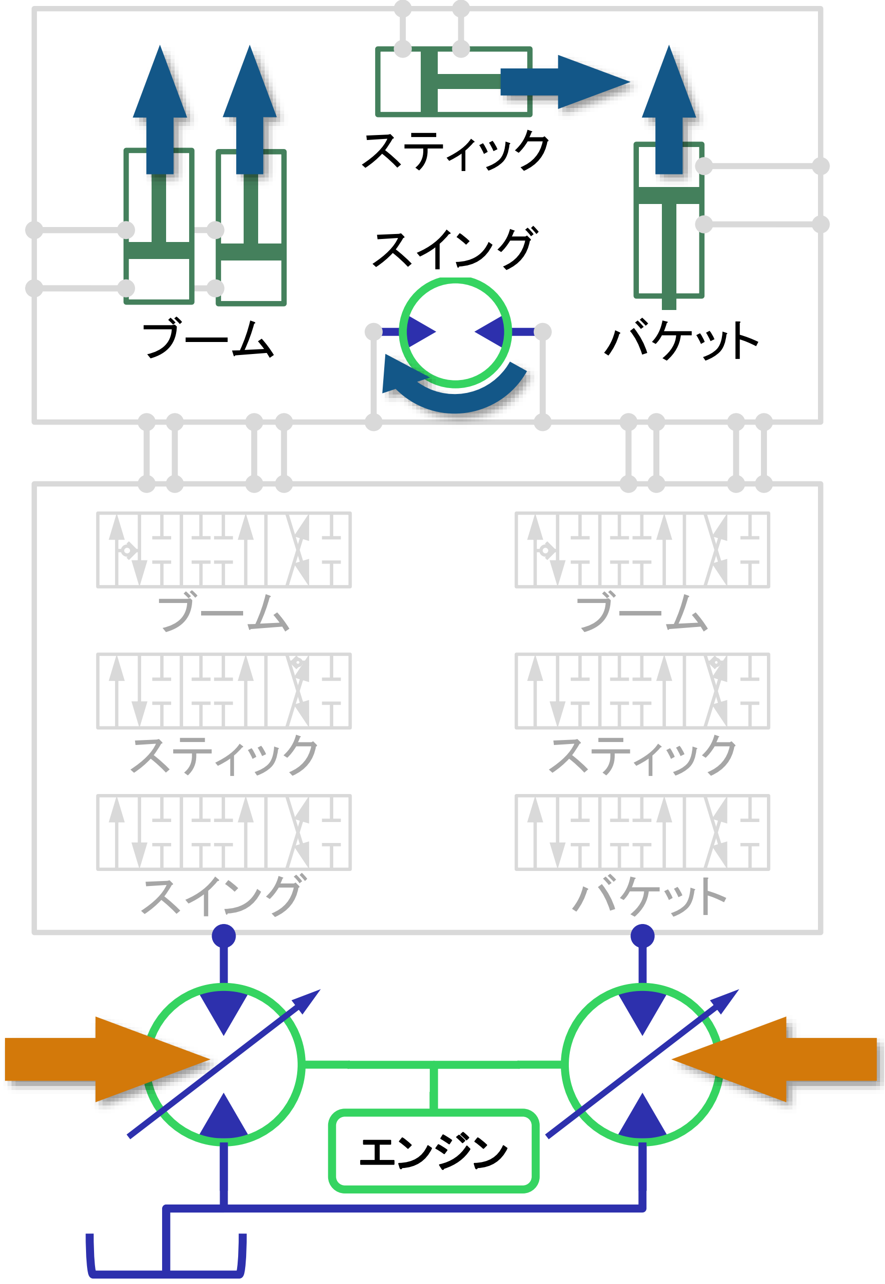


Excavator_Complete - Simulink
SIMULATION
DEBUG
MODELING
FORMAT
APPS
Excavator_Complete
1 SwingCmd
2 BoomCmd
3 StickCmd
4 BucketCmd
SwingCmd
BoomCmd
StickCmd
BucketCmd
OperatorInputs
Operator Inputs
PressureSensors
PumpSpeed
SwingSpeed
OperatorInputs
PumpLCmd
PumpRCmd
ValveLCmds
ValveRCmds
Controller
PumpLCmd
PumpRCmd
ValveLCmds
ValveRCmds
PressureSensors
PumpShaftSpeed
SwingSpeed
PosSensors
Excavator
Pumps & Valves
Functions
ValveLCmds
mPr. LeftPumpPr
PumpLCmd
PumpShaft
Cmd
LeftPump
PipePumpLToValve
ValveRCmds
mPr. RightPumpPr
PumpRCmd
RightPump
PipePumpRToValve
f(x) = 0
Hydraulic Reference
HydraulicFluidProperties
PipeValvesToTank
ValveBlocks
ValveToStickAPipe
ValveToStickBPipe
ValveToBucketAPipe
ValveToBucketBPipe
ValveToBoomAPipe
ValveToBoomBPipe
ValveToSwingAPipe
ValveToSwingBPipe
mPr. StickHEPr
mPr. StickREPr
mPr. BucketHEPr
mPr. BucketREPr
mPr. BoomHEPr
mPr. BoomREPr
mPr. SwingASidePr
mPr. SwingBSidePr
mPos. StickPos
mPos. BoomPos
mPos. BucketPos
mPos. SwingAng
1 StickCyl
2 BucketCyl
3 BoomCyl
4 SwingMotor
Functions
BoomHyd
Boom Cyl L
StickCyl
Stick Cyl
BucketCyl
Bucket Cyl
ChassisToBoom
Boom
Boom ToStick
Stick
Bucket Linkage
Boom Cyl R
Chassis
StickToBucket
BucketLink ToBucket
SwingSpeed
SwingMotor
BaseToChassis
Bucket
Base
BucketLoads
6-DOF Joint
Ground Contact
World Frame
Ground
Gravity

効率・燃費（消費エネルギー）の評価

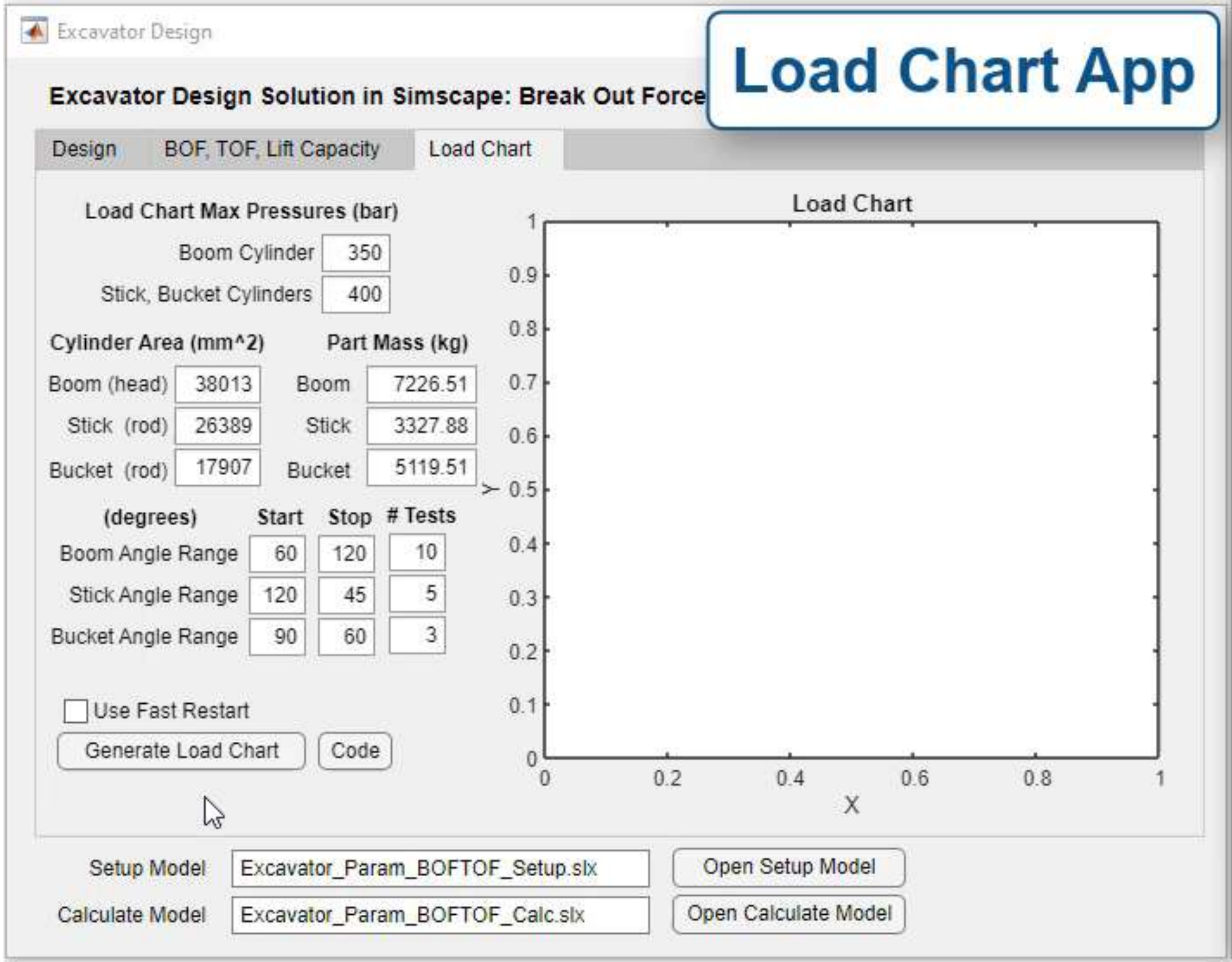
- シミュレーション結果からエネルギーを算出
  - 入力エネルギー ⬅
  - 出力エネルギー ⬅




スティック
ブーム
スイング
バケット
ブーム
ブーム
スティック
スティック
スイング
バケット
エンジン

設計空間の探索: 負荷チャート

- パラメータスイープ
  - マルチコア実行にも対応



Load Chart App

Excavator Design

Excavator Design Solution in Simscape: Break Out Force

Design
BOF, TOF, Lift Capacity
Load Chart

Load Chart Max Pressures (bar)

Boom Cylinder: 350

Stick, Bucket Cylinders: 400

Cylinder Area (mm^2)		Part Mass (kg)	
Boom (head)	38013	Boom	7226.51
Stick (rod)	26389	Stick	3327.88
Bucket (rod)	17907	Bucket	5119.51

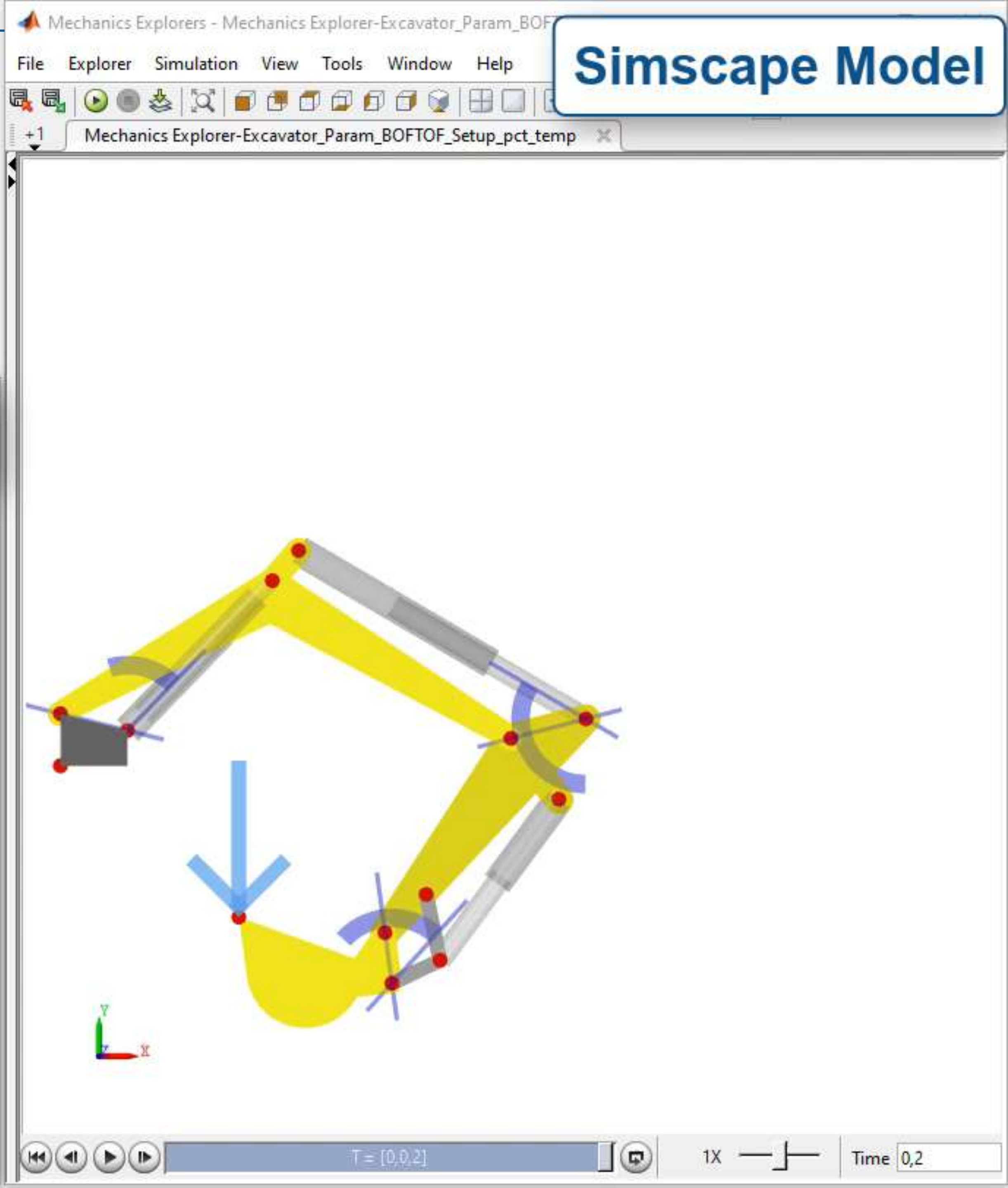
(degrees)	Start	Stop	# Tests
Boom Angle Range	60	120	10
Stick Angle Range	120	45	5
Bucket Angle Range	90	60	3

☐ Use Fast Restart

Generate Load Chart
Code
Load Chart
Y
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
X
0
0.2
0.4
0.6
0.8
1
Open Setup Model
Open Calculate Model

Setup Model: Excavator_Param_BOFTOF_Setup.slx

Calculate Model: Excavator_Param_BOFTOF_Calc.slx



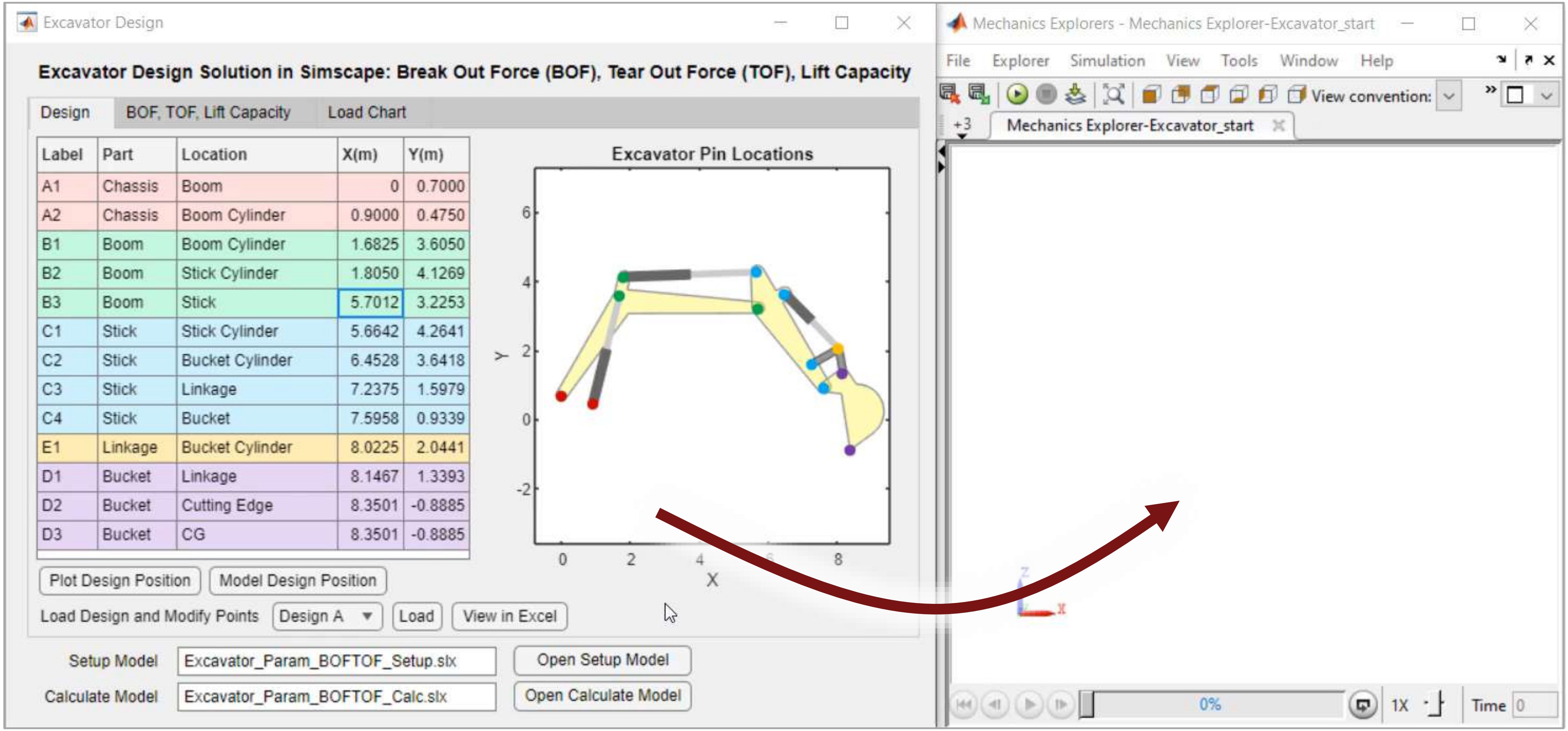
Simscape Model

Mechanics Explorers - Mechanics Explorer-Excavator_Param_BOF

File
Explorer
Simulation
View
Tools
Window
Help
+1
Mechanics Explorer-Excavator_Param_BOFTOF_Setup_pct_temp
Y
X
T = [0,0.2]
1X
Time

Time: 0.2

機構解析結果の機構設計への反映


Excavator Design
Design
BOF, TOF, Lift Capacity
Load Chart
Excavator Pin Locations
Y
X
6
4
2
0
-2
0
2
4
6
8
Plot Design Position
Model Design Position
Load Design and Modify Points
Design A
Load
View in Excel
Open Setup Model
Open Calculate Model
Mechanics Explorers - Mechanics Explorer-Excavator_start
File
Explorer
Simulation
View
Tools
Window
Help
View convention:
Mechanics Explorer-Excavator_start
Z
X
0%
1X
Time
0

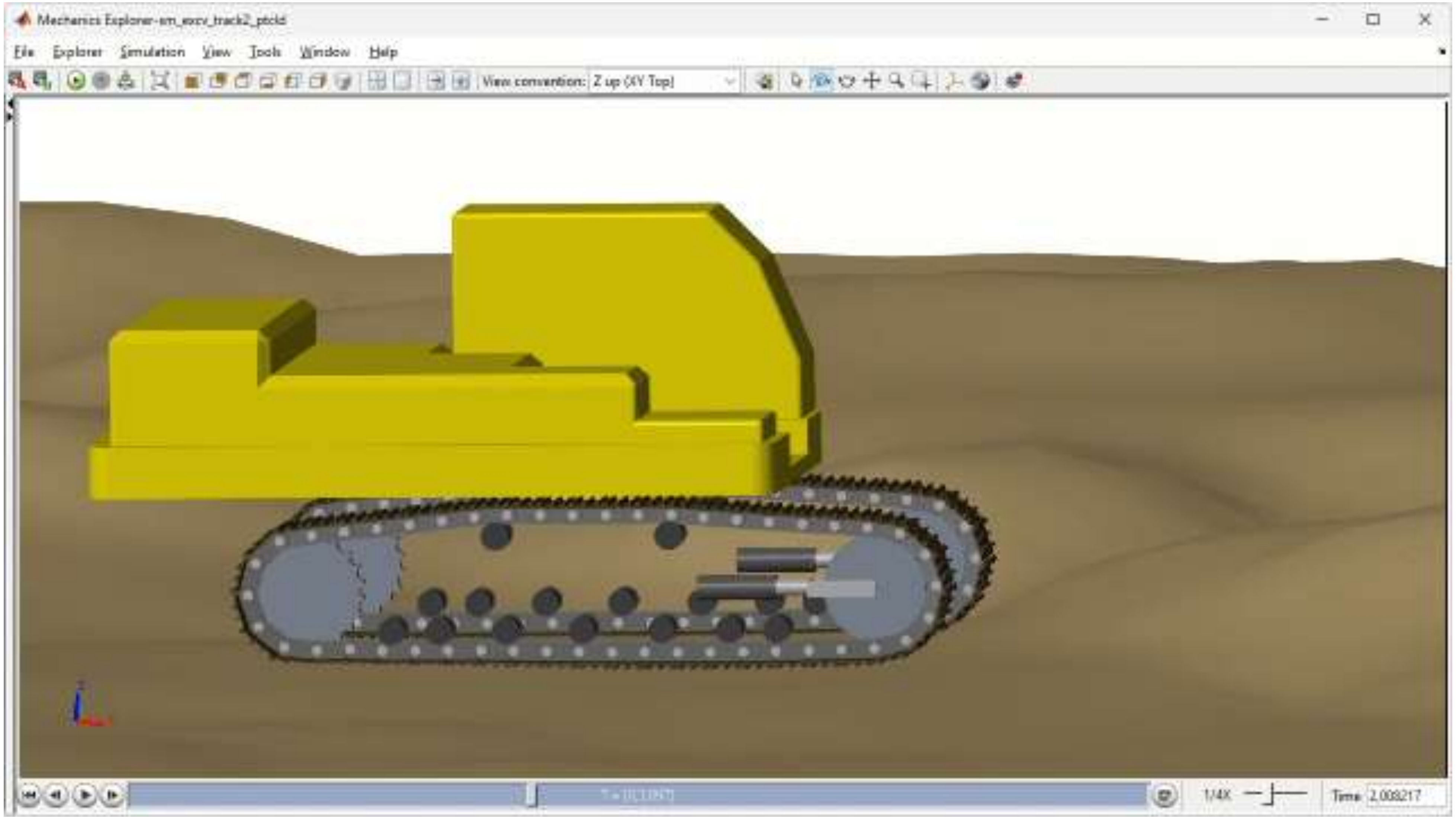
Excavator Design Solution in Simscape: Break Out Force (BOF), Tear Out Force (TOF), Lift Capacity

Label	Part	Location	X(m)	Y(m)
A1	Chassis	Boom	0	0.7000
A2	Chassis	Boom Cylinder	0.9000	0.4750
B1	Boom	Boom Cylinder	1.6825	3.6050
B2	Boom	Stick Cylinder	1.8050	4.1269
B3	Boom	Stick	5.7012	3.2253
C1	Stick	Stick Cylinder	5.6642	4.2641
C2	Stick	Bucket Cylinder	6.4528	3.6418
C3	Stick	Linkage	7.2375	1.5979
C4	Stick	Bucket	7.5958	0.9339
E1	Linkage	Bucket Cylinder	8.0225	2.0441
D1	Bucket	Linkage	8.1467	1.3393
D2	Bucket	Cutting Edge	8.3501	-0.8885
D3	Bucket	CG	8.3501	-0.8885

Setup Model: Excavator_Param_BOFTOF_Setup.slx

Calculate Model: Excavator_Param_BOFTOF_Calc.slx

クローラー with 不整地走行


Mechanics Explorer-sm_excv_track2_ptcld
File
Explorer
Simulation
View
Tools
Window
Help
1/4X
Time

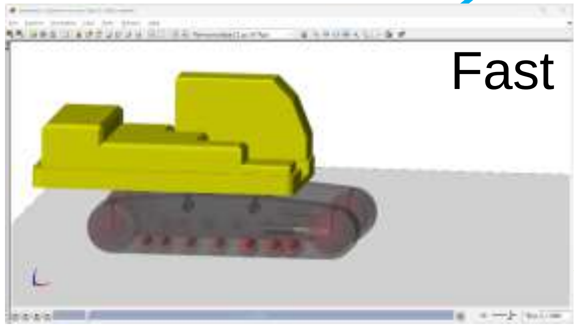
View convention: Z up (XY Top)

Time 2.008217

目的に応じた適切な詳細度の選定

同一のパラメータ、シーン、コードを活用することで、
モデルの精度改善の取り組みをシームレスに

計算時間

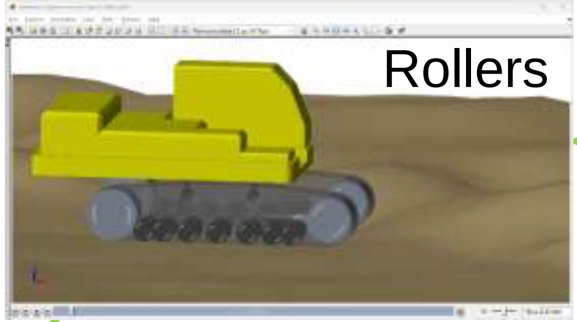


設計パラメータを限定

概算設計を活用

効率 etc.

抽象モデルを精度up

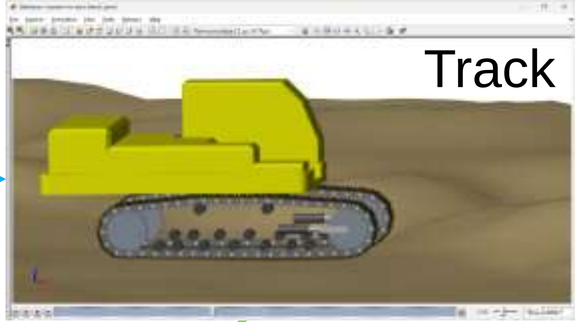


テストシーンを限定

概算では設計
難しい条件

振動 etc.

抽象モデルの精度up



高詳細度

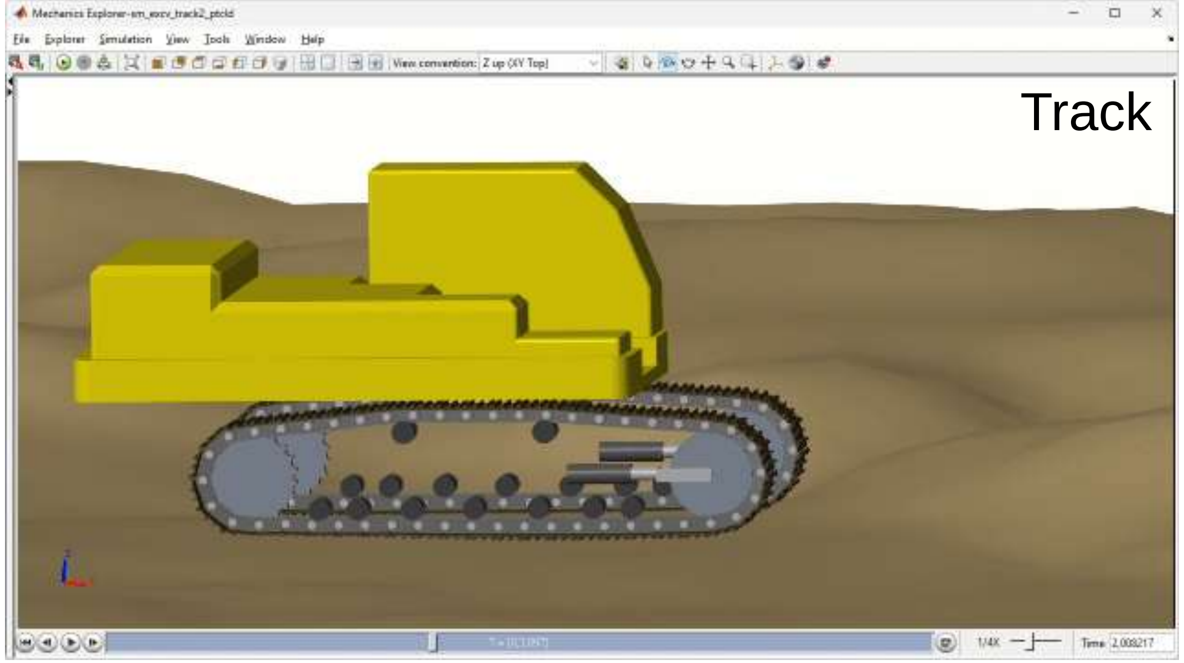
自動運転の設計のための
負荷トルクの模擬

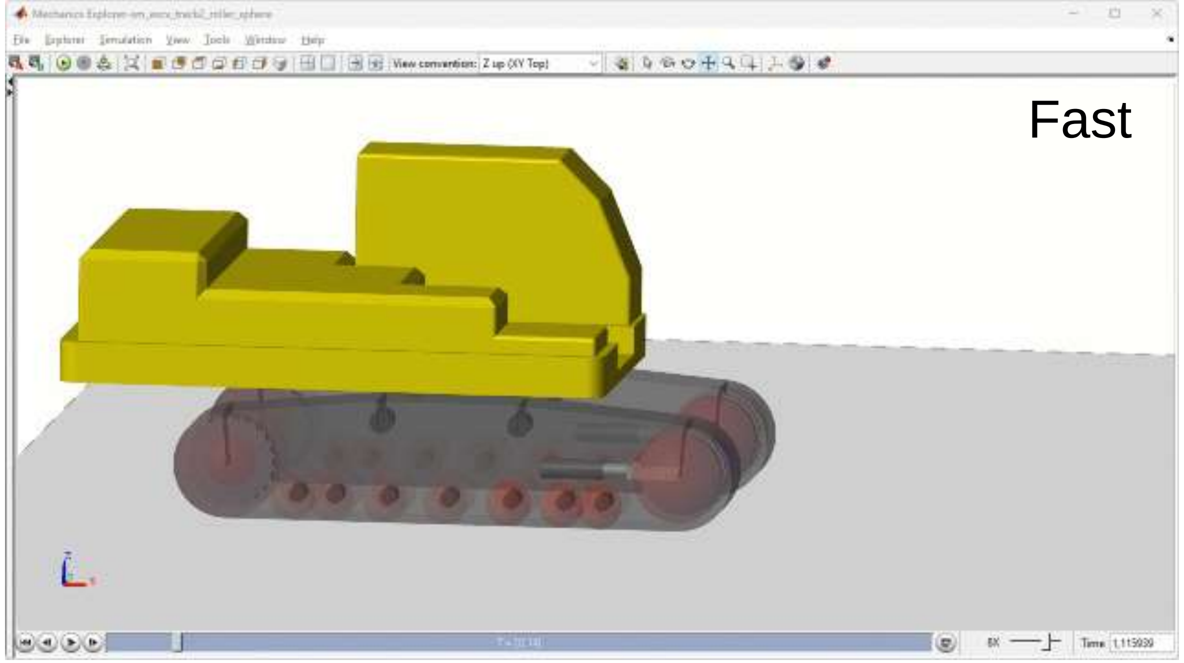
パワートレーンの設計のための
負荷トルクの模擬

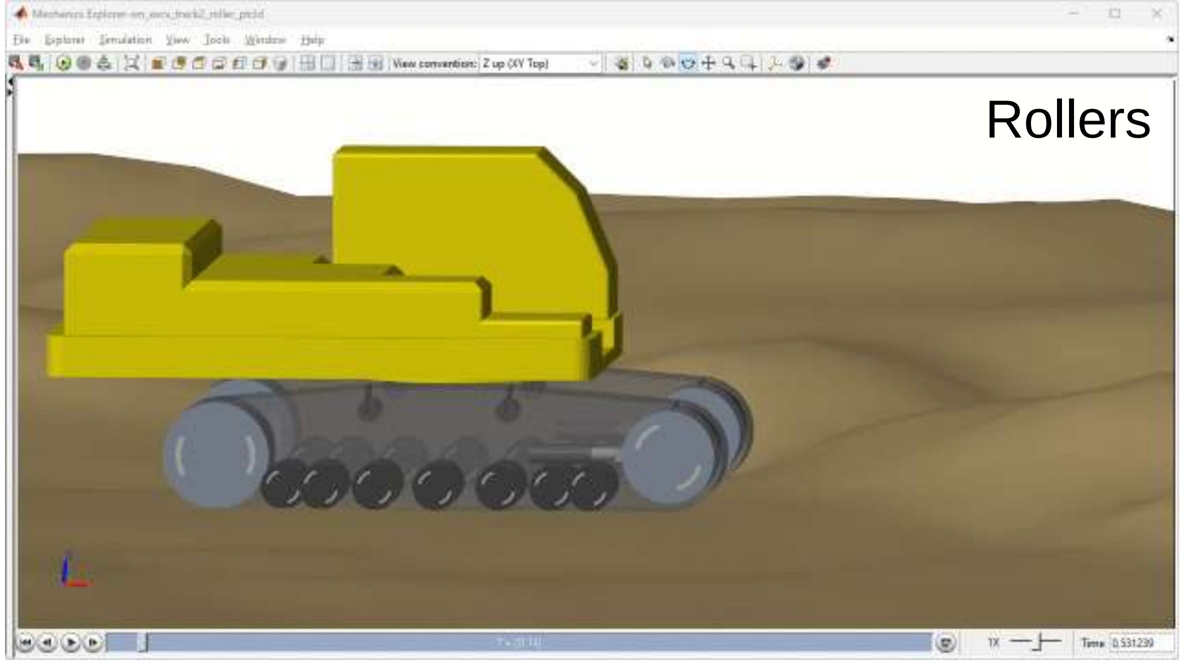
クローラにかかる
機械的な負荷の設計

目的に応じた適切な詳細度の選定

- 適切な詳細度を設定するために
  - モデル作成の労力とリターン
  - 同一モデルの再利用







Accelerating the pace of engineering and science

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