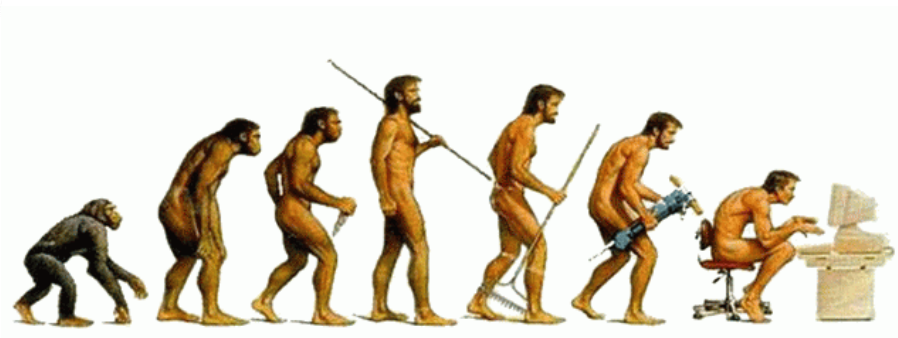


UM软件全模块功能介绍



四川同算科技有限公司

总工程师：雷 强



2020年8月20日



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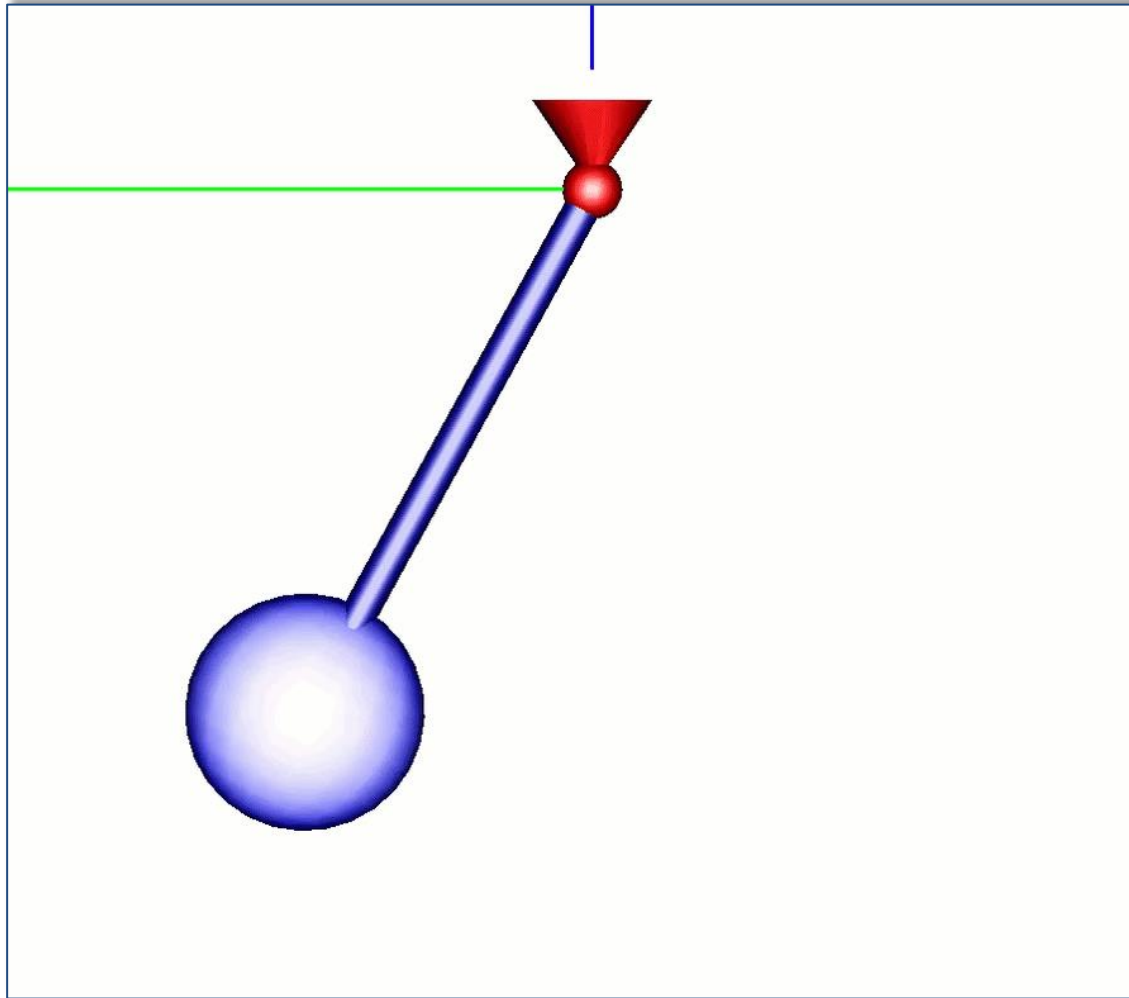
- 计算机辅助工程：Computer Aided Engineering
- 多体系统动力学：Multi-Body System Dynamics
- 动力学与控制：Dynamics and Control
- 运动学与动力学：Kinematics and Dynamics
- 虚拟样机：Virtual Prototyping
- 虚拟仿真/试验：Virtual Simulation/Experiments
- 数值积分：Numerical Integration
- 数值计算：Numerical Computation
- 计算力学：Computational Mechanics
- 车辆系统动力学：Vehicle System Dynamics
- 车桥耦合作用：Vehicle-Bridge Interaction



- 现代工程中研究的对象更复杂、更精细
- 实物试验耗资巨大：时间、人力、物力
- 实际工程中影响因素很多，无法做因素分析
- 存在很多干扰条件，不容易总结出科学规律
- 很多工况的试验根本没有条件进行
- 检测手段有限，无法获得所有试验数据



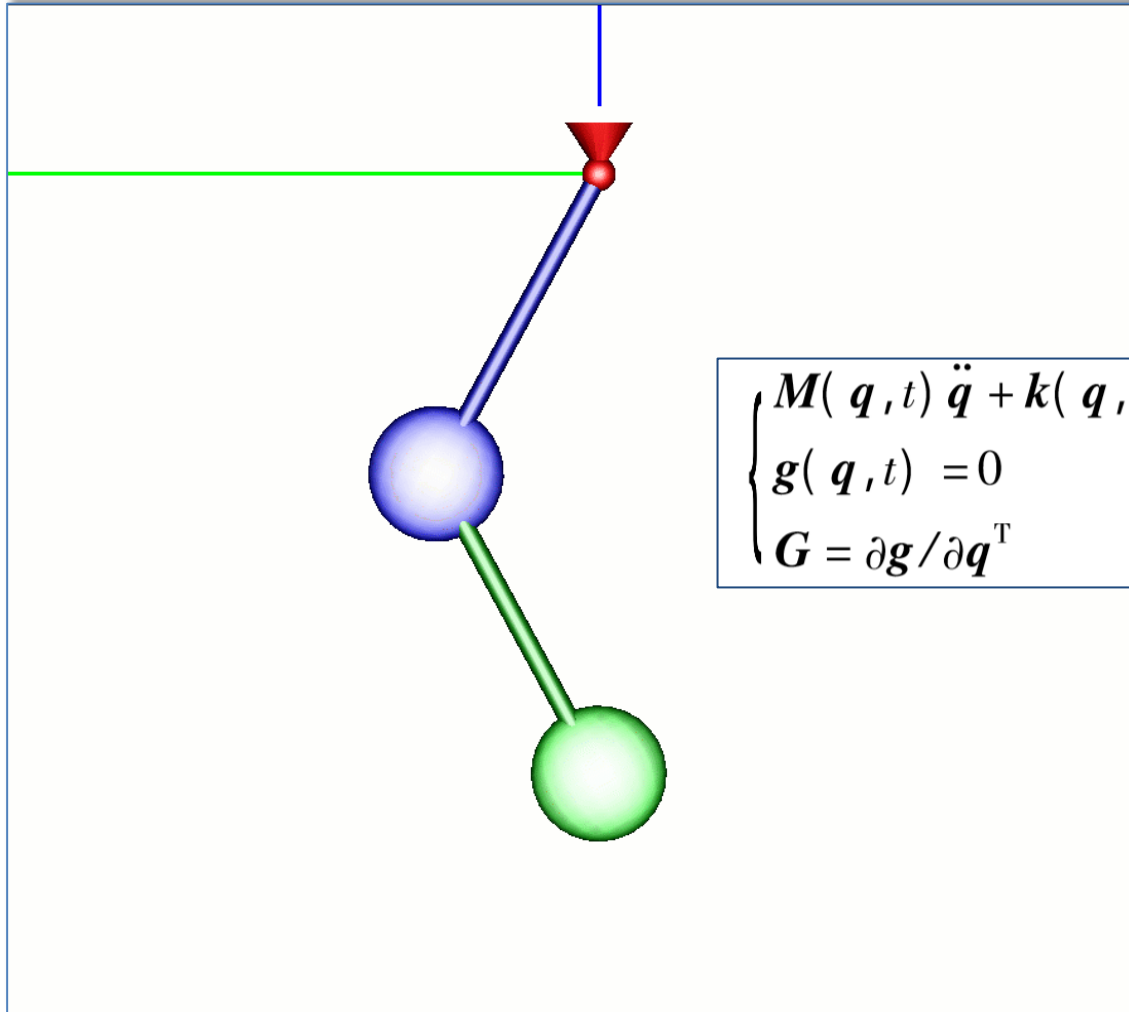
最简单的单摆



$$T = 2\pi \sqrt{\frac{l}{g}}$$



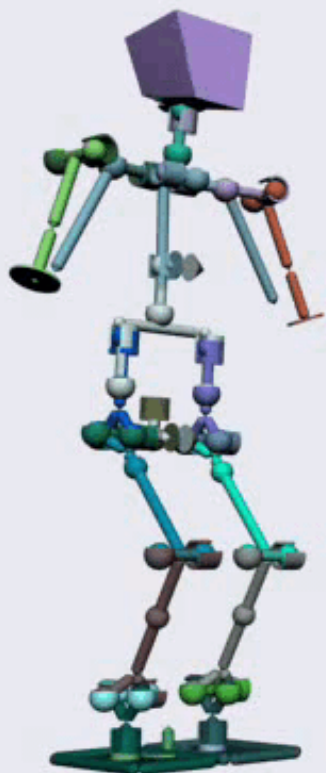
复杂一些的双摆



$$\begin{cases} M(\mathbf{q}, t) \ddot{\mathbf{q}} + \mathbf{k}(\mathbf{q}, \dot{\mathbf{q}}) = \mathbf{Q}(\mathbf{q}, \dot{\mathbf{q}}, t) + \mathbf{G}^T(\mathbf{q}) \lambda \\ \mathbf{g}(\mathbf{q}, t) = 0 \\ \mathbf{G} = \partial \mathbf{g} / \partial \mathbf{q}^T \end{cases}$$

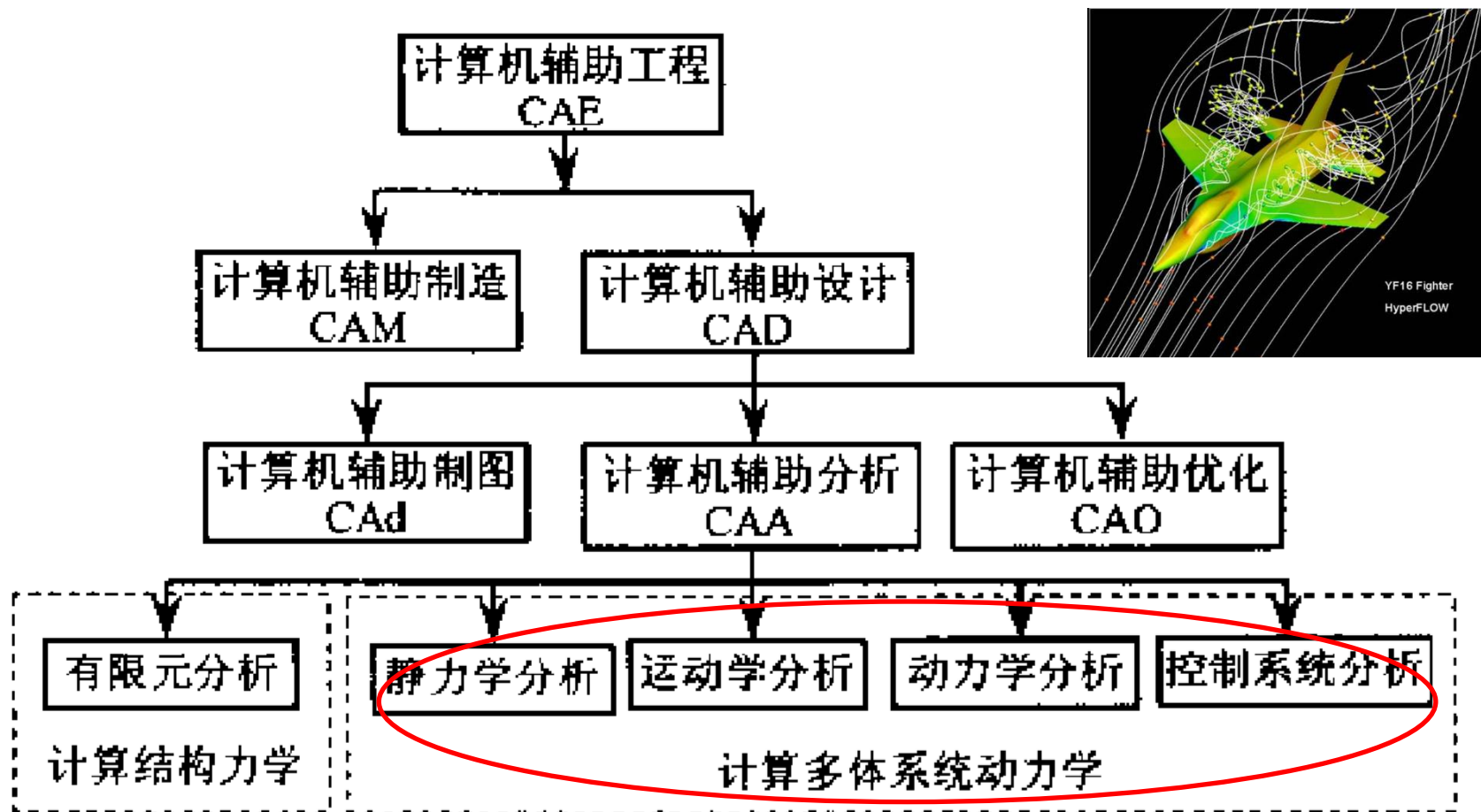


非常复杂的机器人





- 可建立复杂的力学模型，自动求解微分方程组
- 用计算机模拟来指导实物试验，减少次数，节约成本
- 在设计阶段进行多种参数的仿真计算，确定最优方案
- 排除干扰条件，探究系统规律
- 进行现实中不可能实施的试验
- 获得所有需要的仿真结果数据



《计算多体系统动力学》——洪嘉振，1999



- 基础课程：理论力学、材料力学、机械设计、机械原理、机械振动、数值分析、多体动力学、固体力学、弹性力学、流体力学
- 专业课程：车辆工程、铁道工程、桥梁工程、车辆（铁路、汽车、履带车）动力学、列车动力学、轨道动力学、车辆-轨道耦合动力学、车辆-桥梁耦合动力学、轨道交通等行业标准
- 相关课程：有限元法、自动控制原理、非线性振动

用户群体：高校在读硕士和博士研究生、CAE工程师、研究人员



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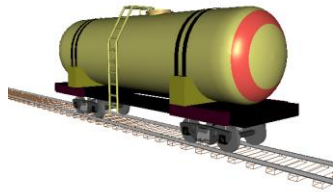
2. UM软件的架构与用户界面

3. UM软件的模块及功能展示

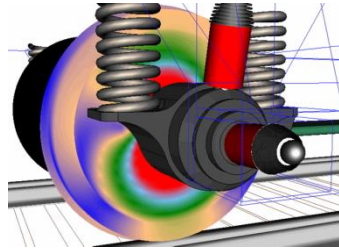




UM的软件架构:通用内核平台+行业专用模块



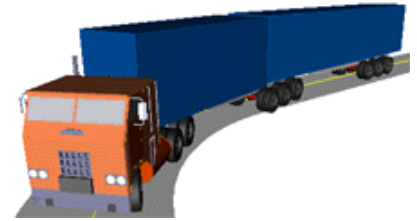
UM Loco



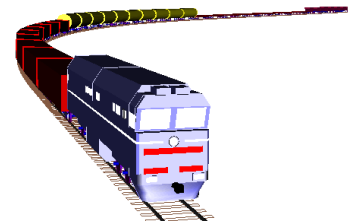
UM Flexible wheelset



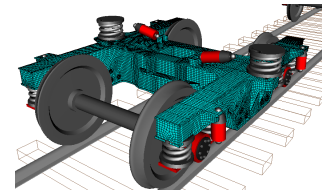
UM Tracked Vehicles



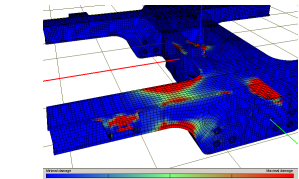
UM Automotive



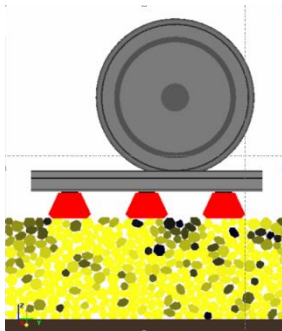
UM Train /
UM Train3D



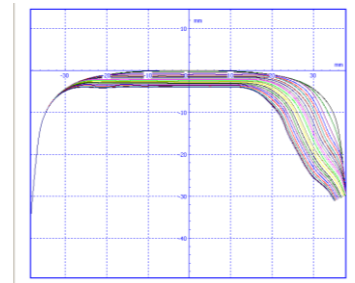
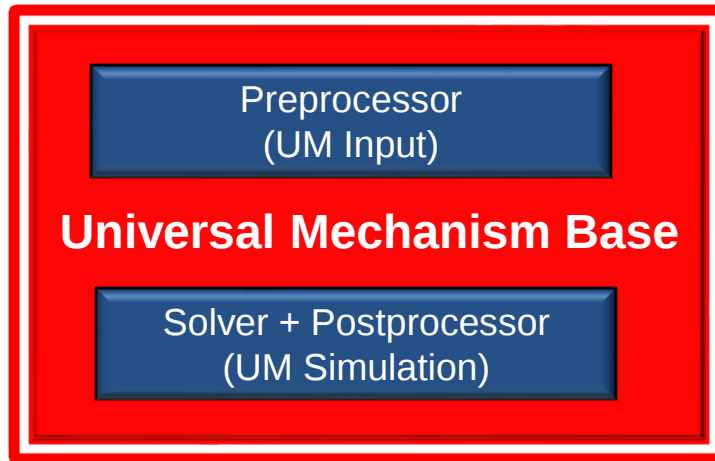
UM FEM



UM Durability



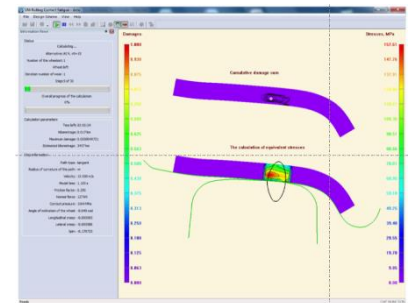
UM Ballast



UM Rail/Wheel Profile Wear



UM COM server for train simulators

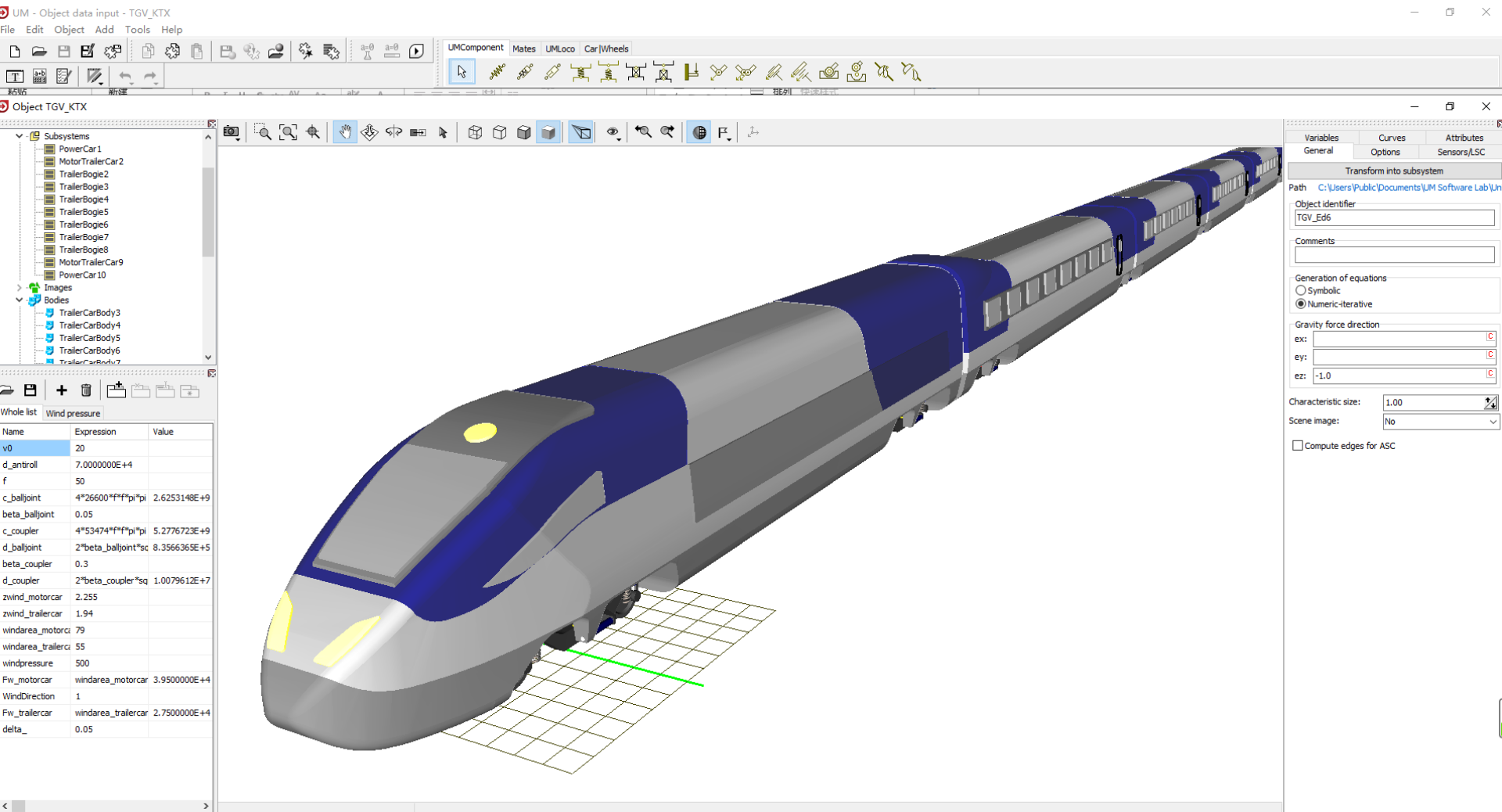


UM Rolling Contact Fatigue





UM软件的建模界面



UM Input



www.tongsuan.cn



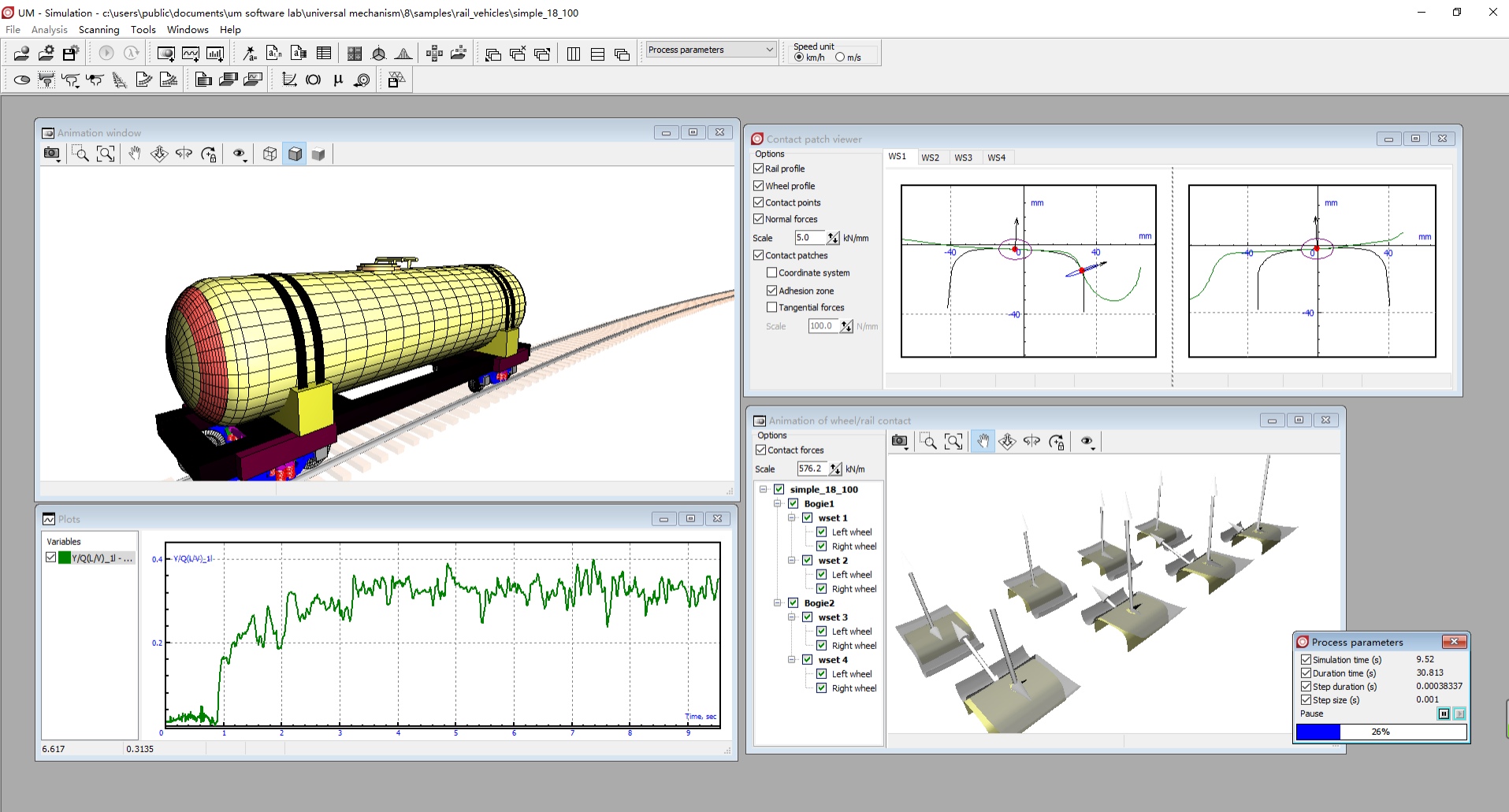
leiqliang@tongsuan.cn



187 0283 9989



UM软件的仿真界面



UM Simulation



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3. UM软件的模块及功能展示





UM软件模块列表

序号	模块名称
1	UM Base
1.1	UM Base/Control Panel
1.2	UM Base/Training Ground
1.3	UM Base/Ride Comfort
2	UM Subsystems
3	UM Loco
3.1	UM Loco/Multipoint Contact Model
3.2	UM Loco/Contact add-on Interface
3.3	UM Loco/Wheel Profile Wear Evolution
3.4	UM Loco/Rail Profile Wear Evolution
4	UM Automotive
5	UM Tracked Vehicle
6	UM Driveline
7	UM Flexible Wheelset
8	UM Monorail Train
9	UM Maglev
10	UM Experiments

序号	模块名称
11	UM Cluster
12	UM FEM
12.1	UM FEM/Vehicle-Bridge Interaction
12.2	UM FEM/Monorail Track
12.3	UM FEM/Maglev Track
13	UM Control
13.1	UM Control/User-defined Routines
13.2	UM Control/Matlab Import
13.3	UM Control/Matlab Cosimulation
13.4	UM Control/Block Editor
14	UM CAD Interfaces
15	UM Train
16	UM Train 3D
17	UM Ballast
18	UM RCF
19	UM Durability
20	UM 3D Contact

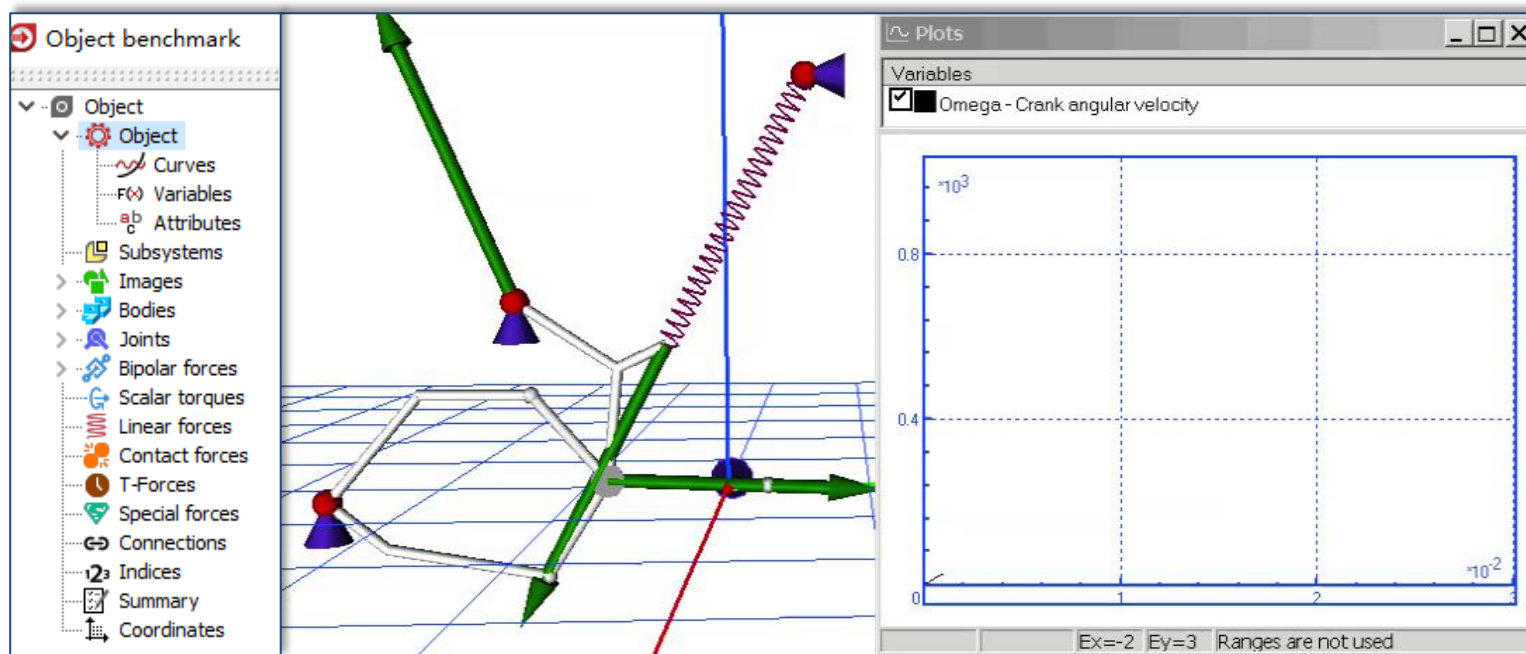
序号	模块名称
21	UM COM Server
22	UM Flexible Railway Track
23	UM Scene
24	UM Pneumatic Systems
25	UM Sensors
26	UM Video Flow





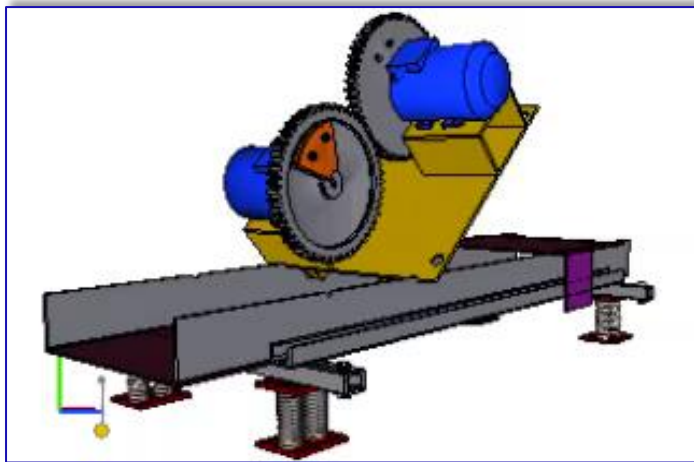
No.1 UM Base 基础模块的功能

- 必选模块，其他所有模块的基础
- 常规的运动学和动力学系统建模（几何、刚体、铰和力元）
- 运动学和动力学系统仿真计算（时域和频域）
- 后处理工具（曲线滤波、曲线运算、统计分析、FFT变换、结果输出和动画录制等）

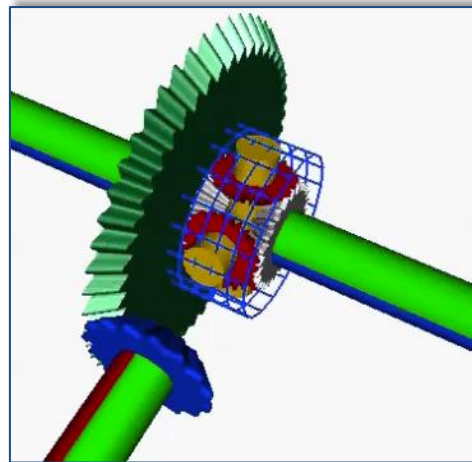




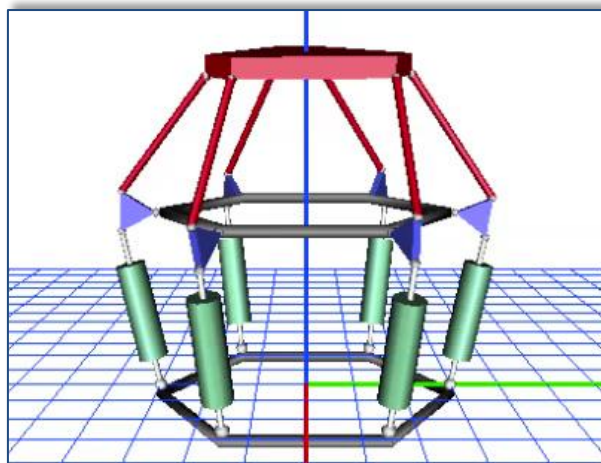
No.1 UM Base 基础模块的应用



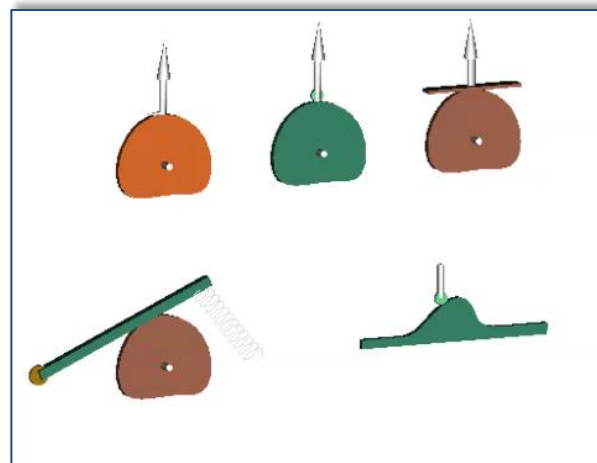
振动系统



齿轮机构



连杆机构



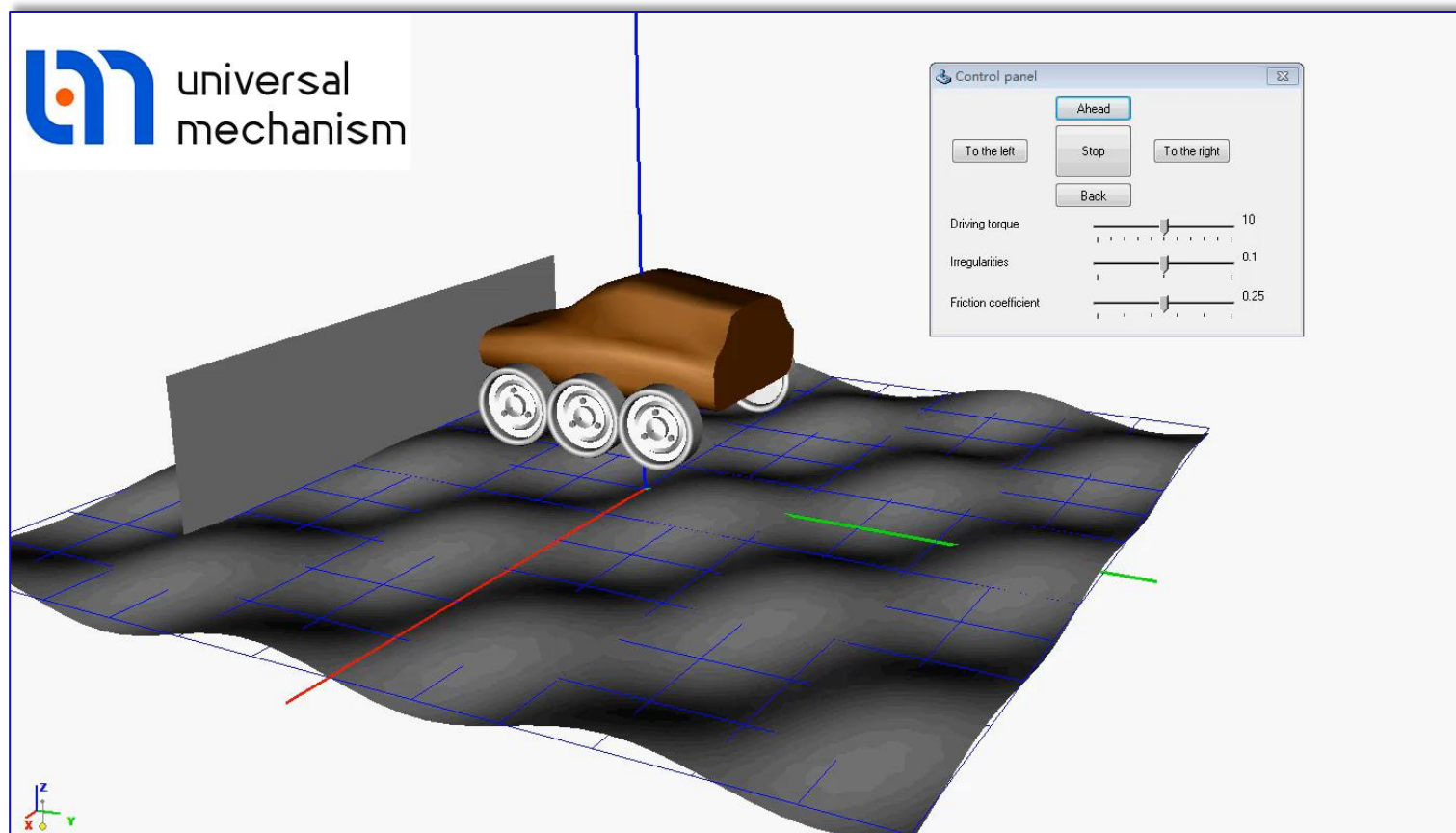
凸轮机构





No.1.1 UM Base/Control Panel 控制面板工具

- 仿真计算过程中手动控制某些参数变化
- 多用于实时交互模拟器和机器人操控仿真





No.1.2 UM Base/Training Ground 训练场地工具

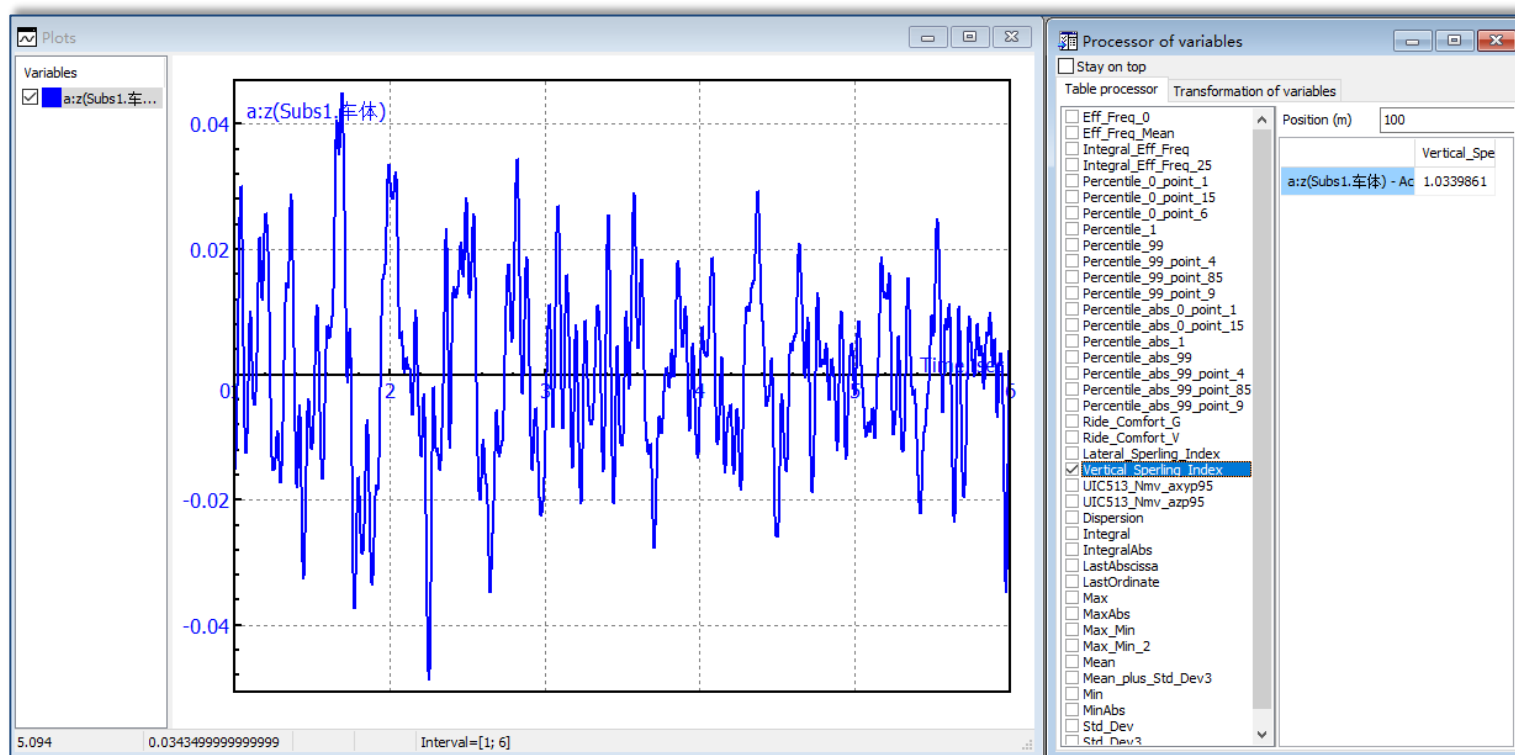
- 需要配备UM Tracked Vehicle履带车辆模块
- 支持外部CAD软件导入的三维地形，用于模拟与履带板的接触





No.1.3 UM Base/Ride Comfort 平稳性和舒适度工具

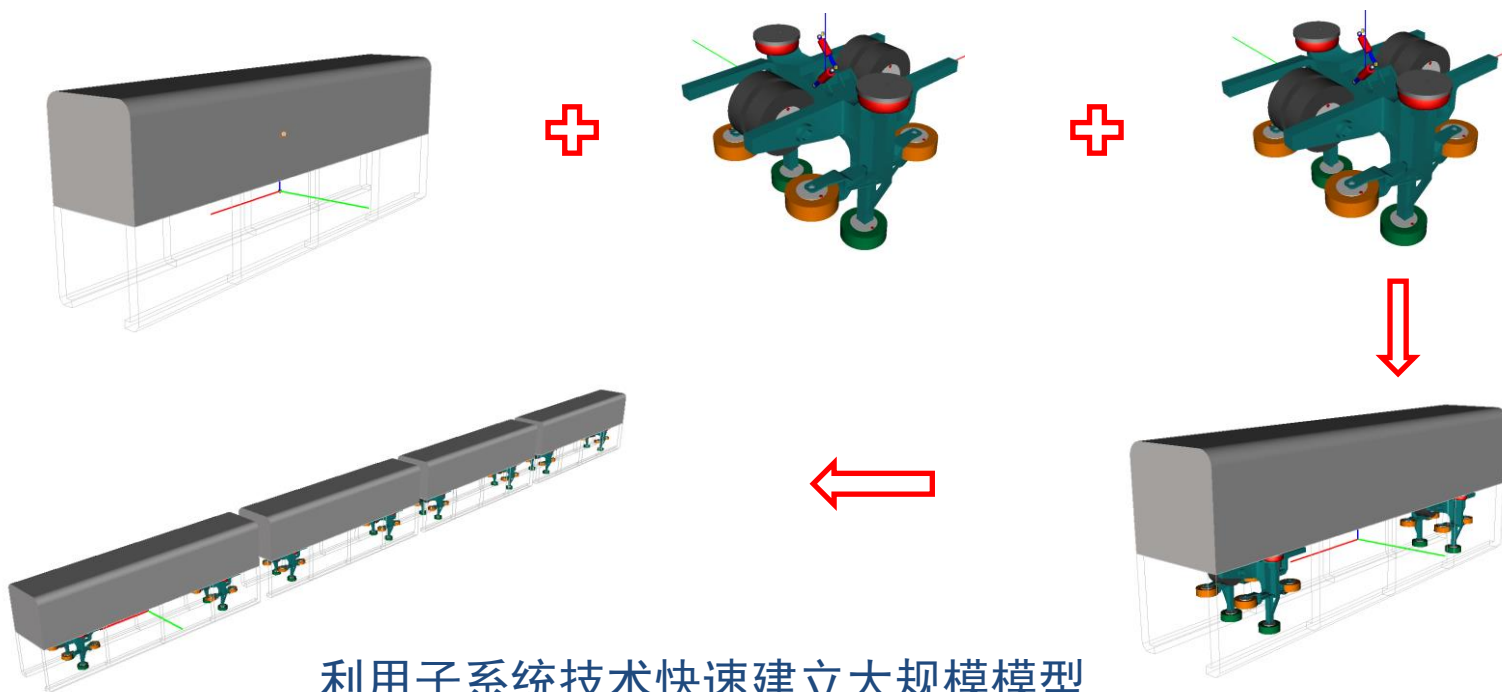
- 需要配备UM Loco、UM Monorail Train和UM Maglev 中的至少一个模块
- 根据仿真或试验获得的车辆加速度数据来评价轨道车辆平稳性（Sperling指标）和舒适度（UIC513标准）





No.2 UM Subsystems 子系统模块

- Included内嵌式子系统，可编辑修改每个子系统
- External外链式子系统，适用于多次引用同一子系统（模型）
- Standard标准子系统，如：轮对、柔性轨道、散粒体、履带等
- Linear FEM弹性体子系统（从外部有限元软件导入）





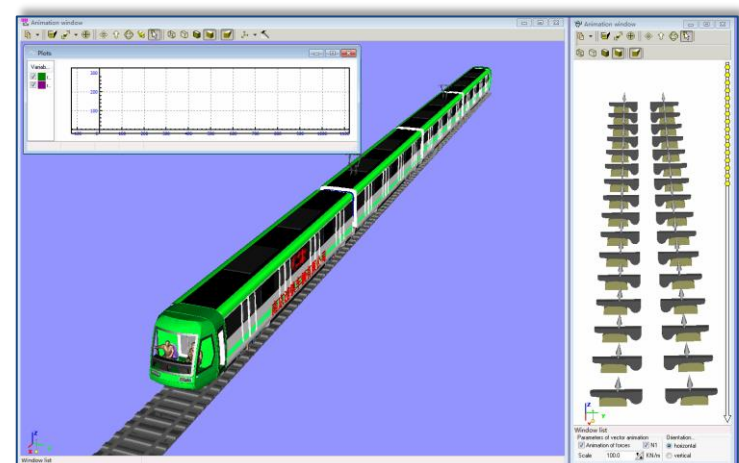
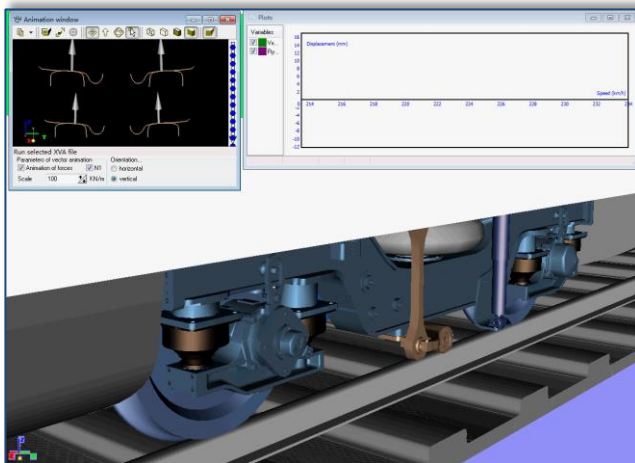
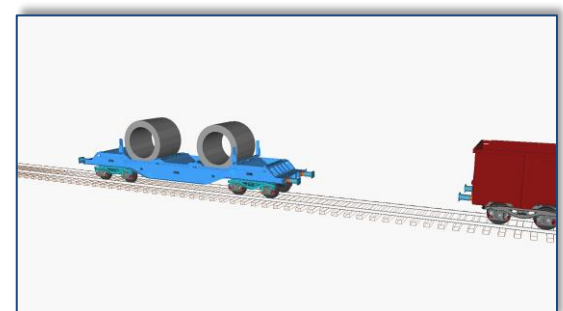
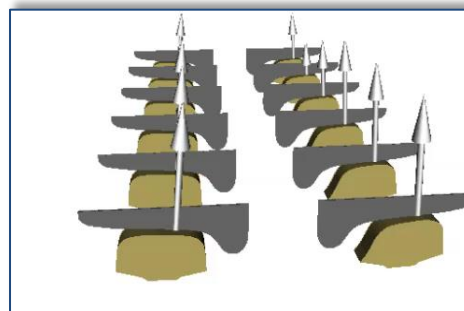
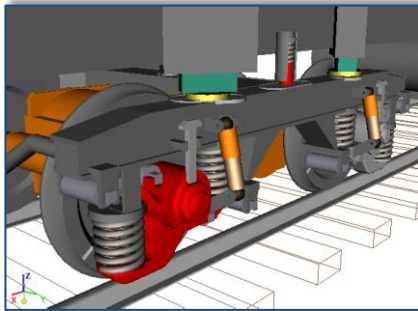
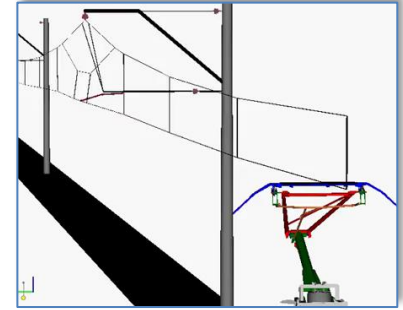
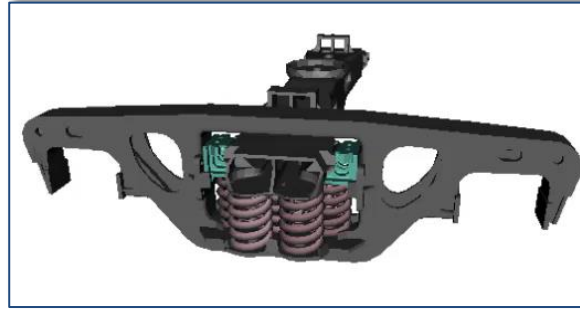
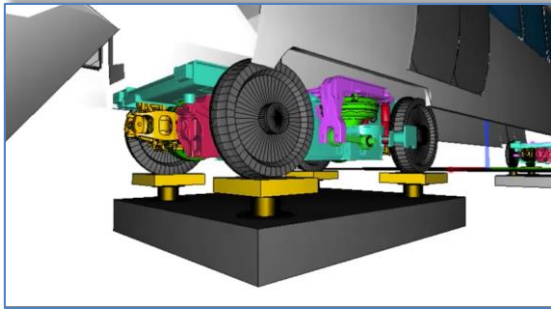
No.3 UM Loco 机车车辆模块的功能

- 提供全参数化的多种轮对子系统模板，快速创建机车、客车、货车、地铁、动车、低地板等各种铁道车辆动力学模型
- 既支持单车建模，也支持多车编组建模
- 支持变速和匀速计算，可模拟车轮圆周不圆（扁疤、椭圆、谐波和实测不圆），可设置变截面钢轨，可模拟滚动和振动台
- 提供专门的铁路平面和纵断面设计工具，支持导入实测线形
- 提供专门的轨道不平顺生成工具，内置美国谱和德国谱，支持自定义功率谱密度函数，支持导入实测数据
- 提供专门的轮轨型面制作工具，支持导入实测数据
- 可进行多种静态和动态试验，评估车辆临界速度、脱轨安全性、运行平稳性和曲线通过性能
- 可进行刚柔耦合建模和仿真分析（需配备UM FEM模块）
- 可加入完整的传动系统（需要配备UM Driveline模块）





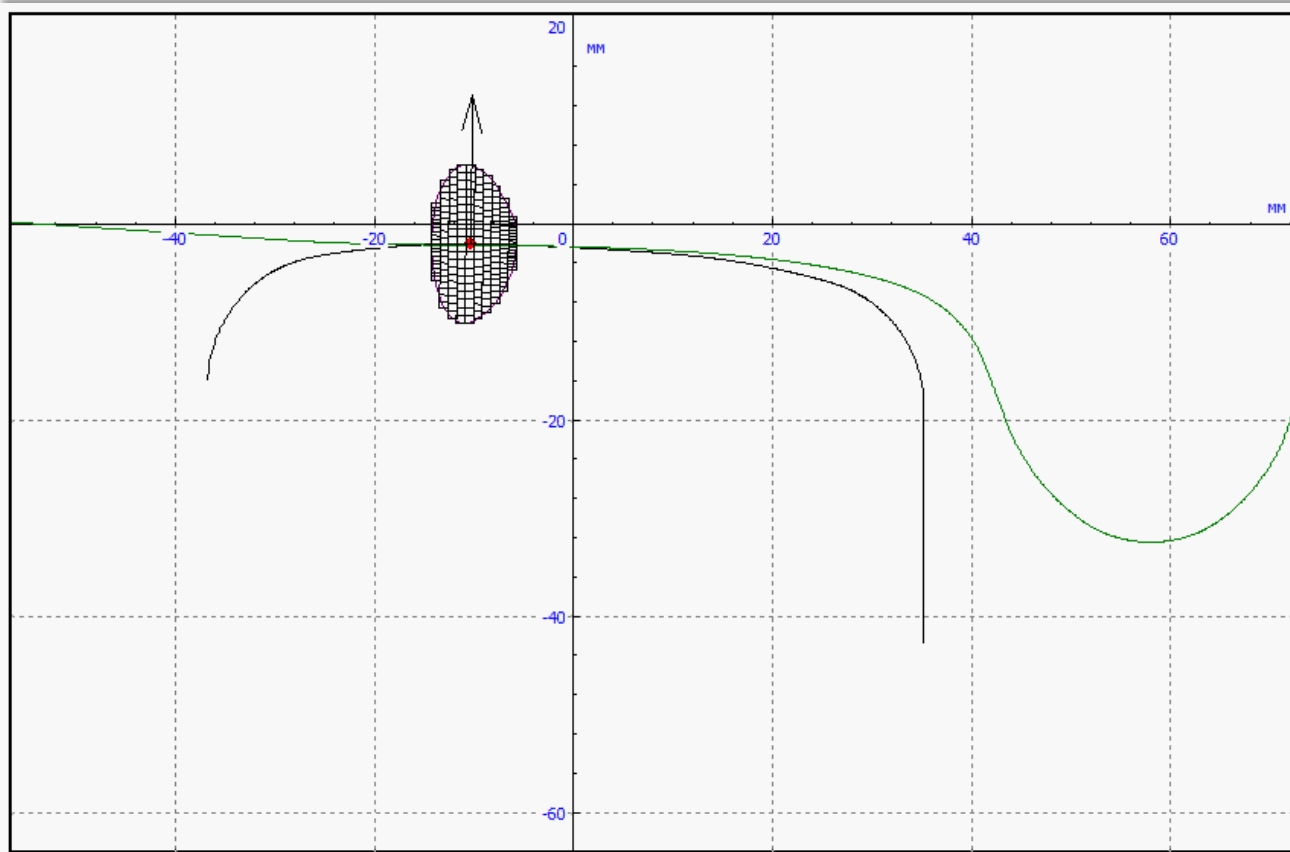
No.3 UM Loco 机车车辆模块的应用





No.3.1 UM Loco/Multi-point Contact Model 轮轨多点非赫兹接触模型

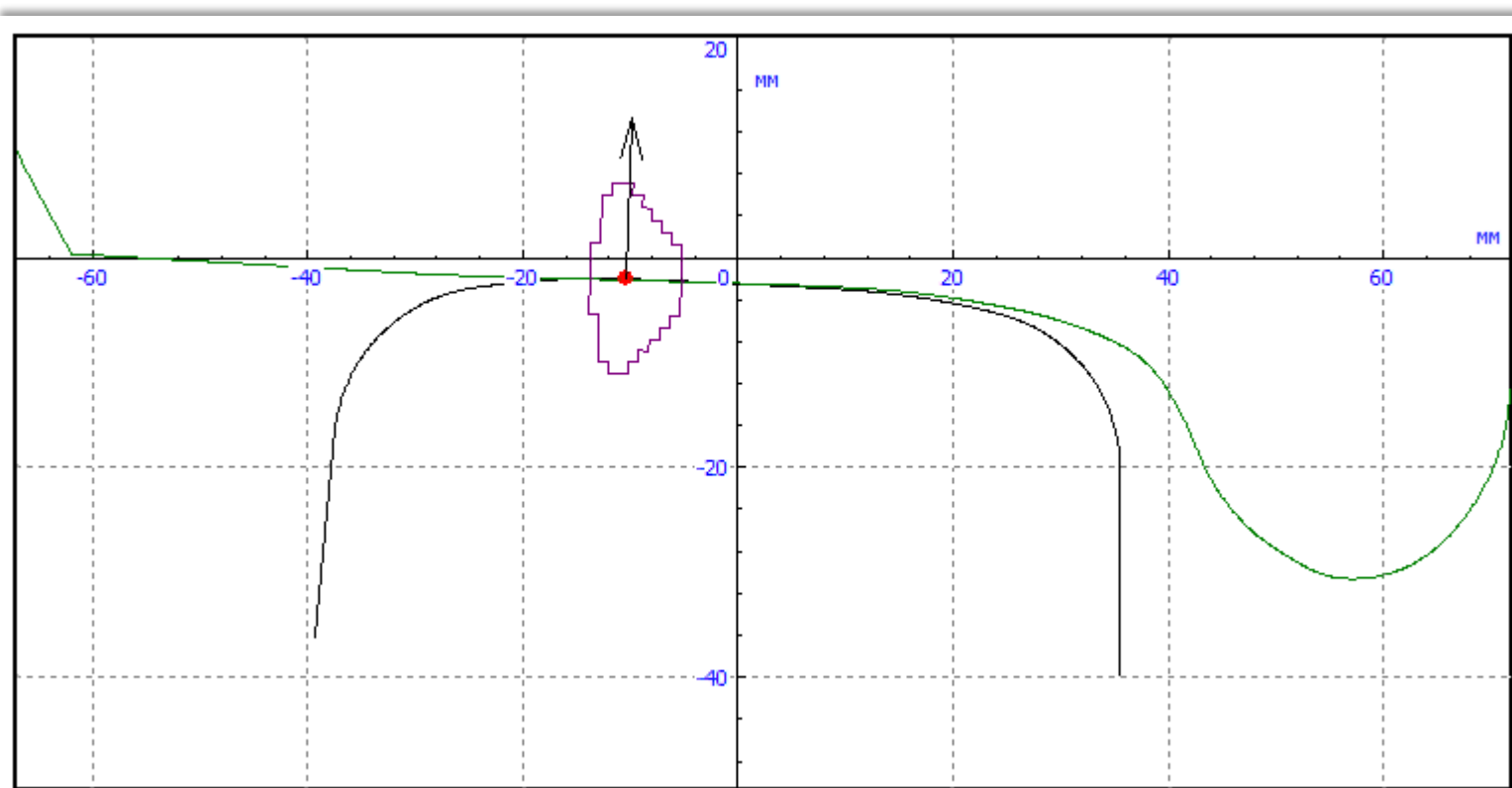
- Kik-Piotrowski轮轨多点非赫兹接触模型，与CONTACT结果接近，计算效率很高
- 用于槽型轨、道岔、轮轨磨耗、柔性轨道





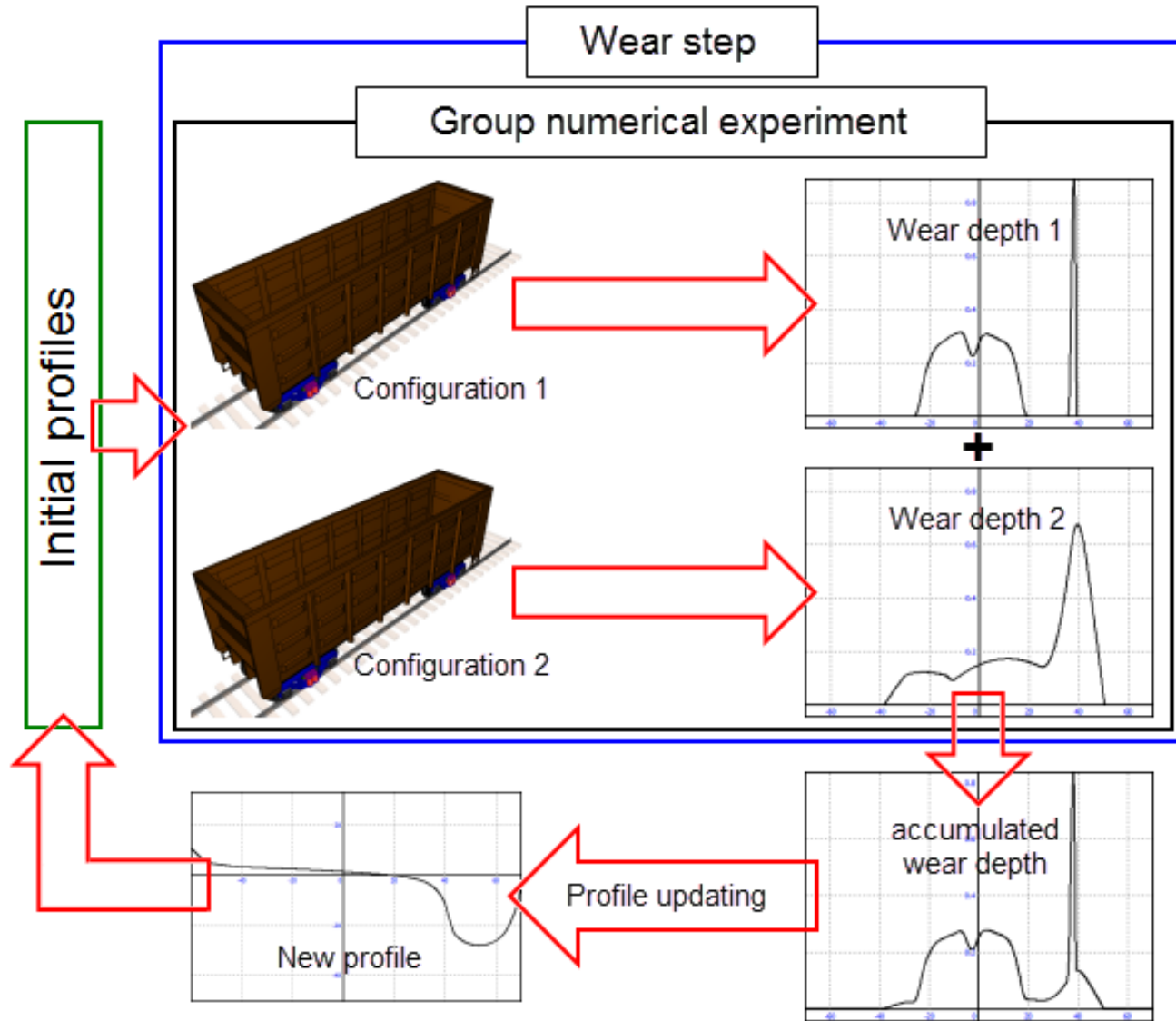
No.3.2 UM Loco/CONTACT add-on interface CONTACT程序接口

- 需要单独采购CONTACT add-on for Universal Mechanism
- 完全集成CONATCT，在每一个积分步调用DLL
- 用于槽型轨、道岔、轮轨磨耗



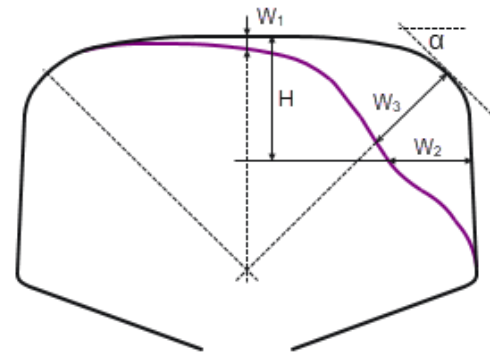
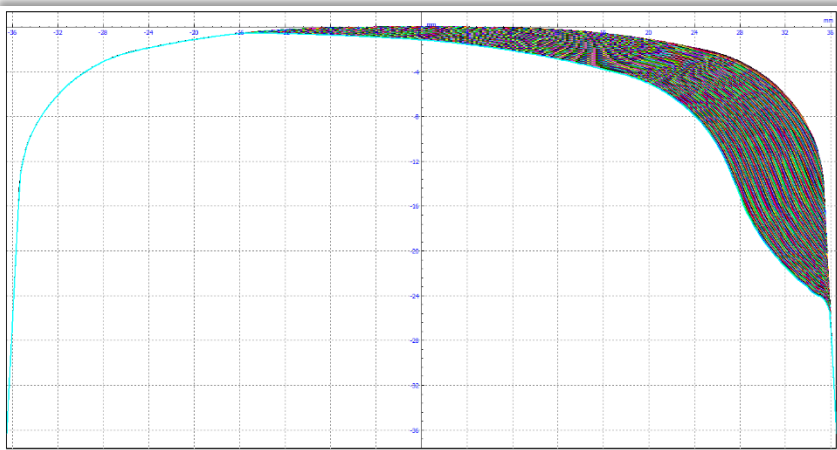


No.3.3 UM Loco/Wheel Profile Wear Evolution 车轮型面磨耗

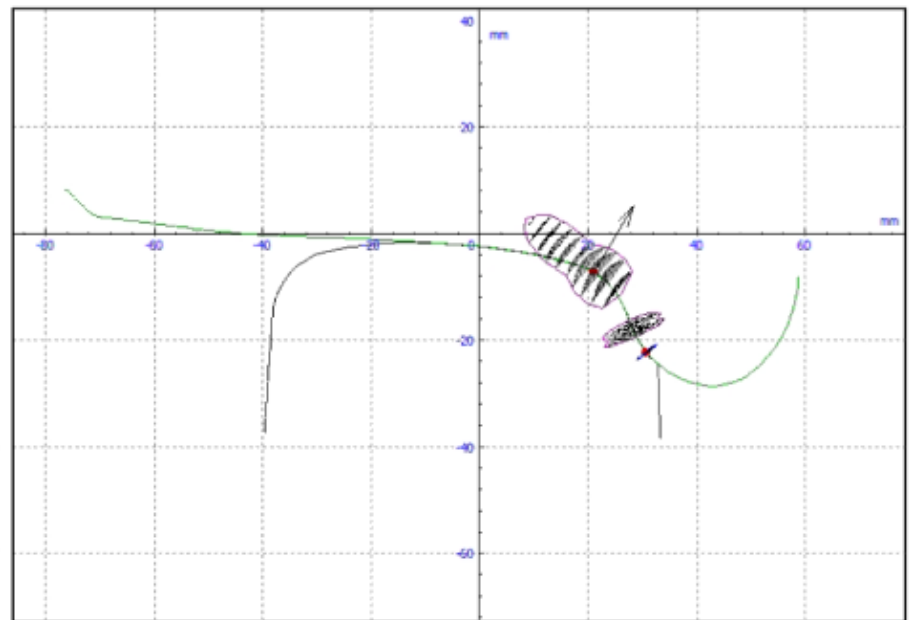
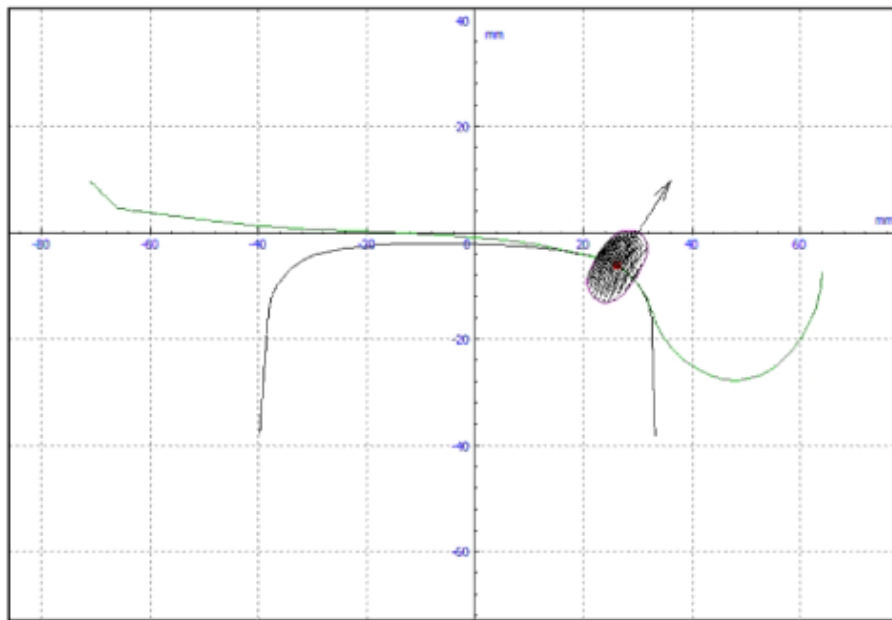




No.3.4 UM Loco/Rail Profile Wear Evolution 钢轨型面磨耗



— Initial profile
— Worn profile





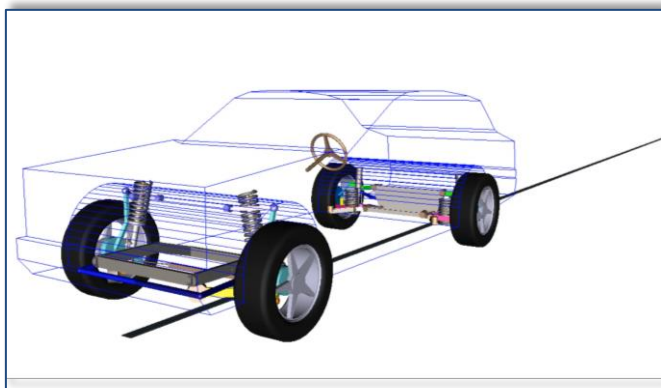
No.4 UM Automotive汽车模块的功能

- 提供Fiala、Pacejka Magic Formula、Tabular、TMEasy等多种轮胎-地面接触模型，以及Ftire软件接口，支持单点和多点接触
- 提供MacAdam、二阶预测和PID控制器等多种驾驶员模型
- 提供非独立、双叉骨、半托臂、麦弗逊、扭力梁和多连杆等多种悬架库
- 提供ISO8608、Wong、Dixon、Experiment、Track等多种路谱
- 提供专门的道路平面和纵断面设计工具
- 可进行多种静态和动态试验，评估车辆操纵稳定性和平顺性
- 可考虑气动阻力和滚动摩阻
- 可进行刚柔耦合建模和仿真分析（需配备UM FEM模块）
- 可加入完整的传动系统（需要配备UM Driveline模块）

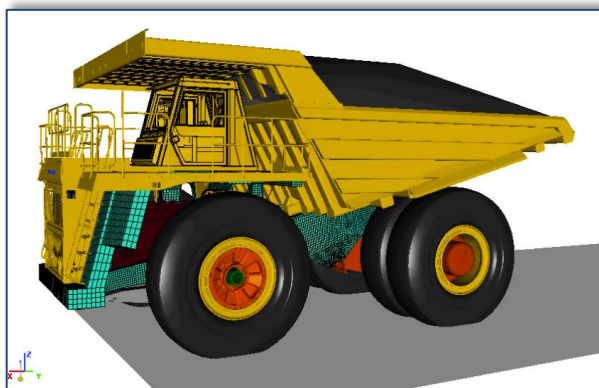




No.4 UM Automotive汽车模块的应用



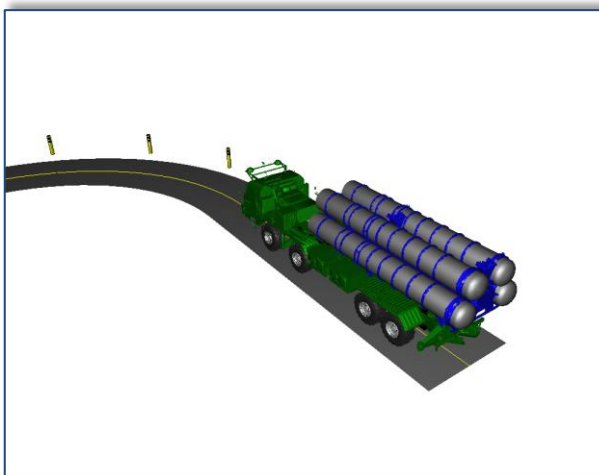
轿车



矿用自卸车



重载列车



导弹发射车



No.5 UM Tracked Vehicle 履带车辆模块的功能

- 提供全参数化的多种履带悬挂子系统模板，并支持用户自定义
- 根据参数化的负重轮、主动轮、诱导轮、托带轮和履带板，自动生成履带行动装置
- 支持单销、双销及挂胶履带的模拟
- 提供专门的道路平面设计工具，可考虑路面不平度
- 支持导入三维地形（需要配备UM Base/Training ground模块）
- 支持硬路面和软土路面
- 可进行多种静态和动态试验，评估车辆操纵稳定性、平顺性和越障性能
- 可考虑气动阻力
- 可进行刚柔耦合建模和仿真分析（需配备UM FEM模块）
- 可加入完整的传动系统（需要配备UM Driveline模块）

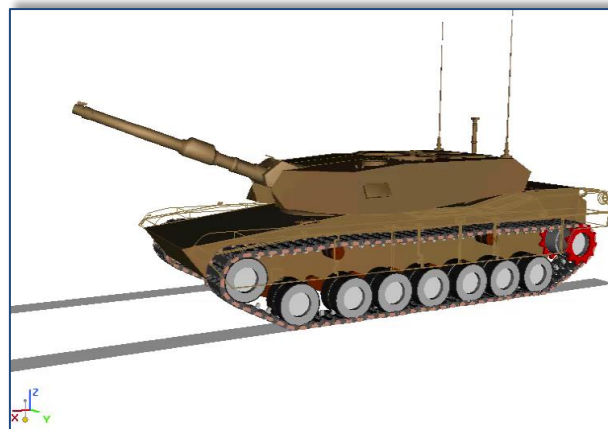




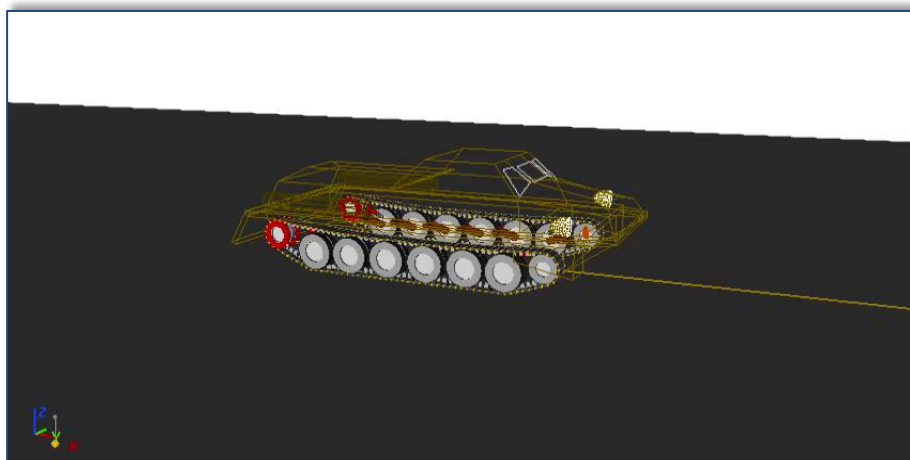
No.5 UM Tracked Vehicle 履带车辆模块的应用



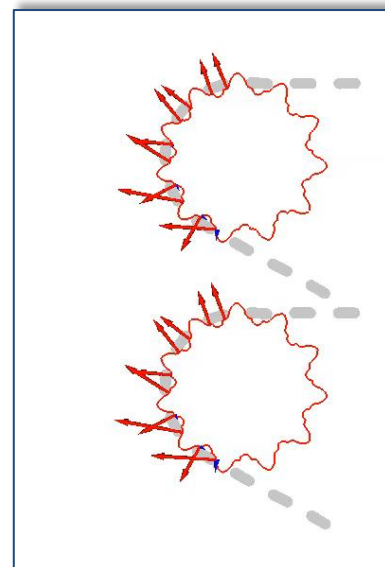
挖掘机



主战坦克



装甲运输车



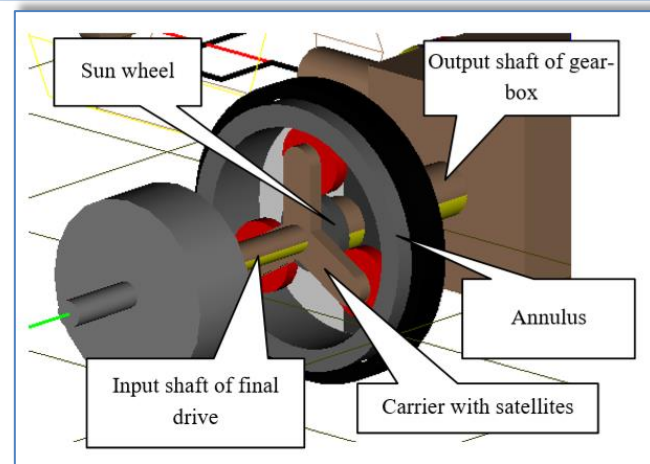
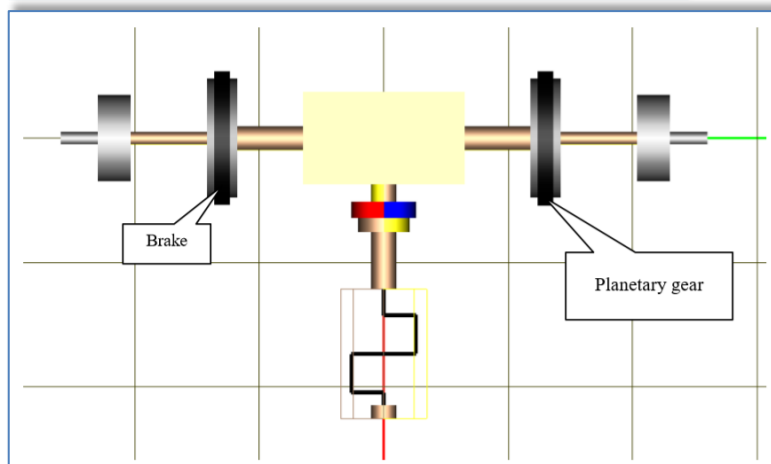
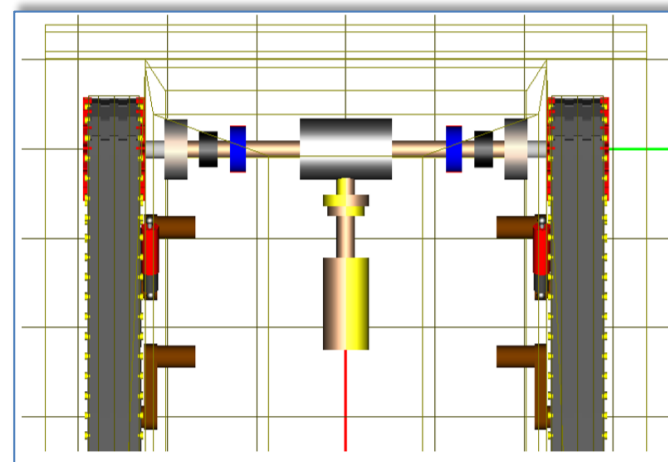
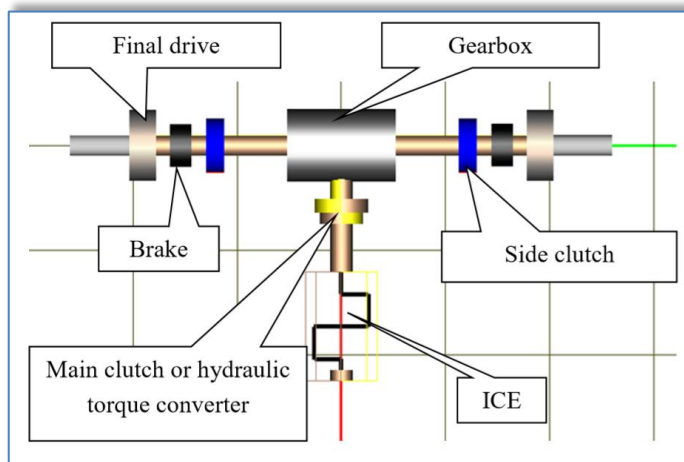
履带销-主动轮接触





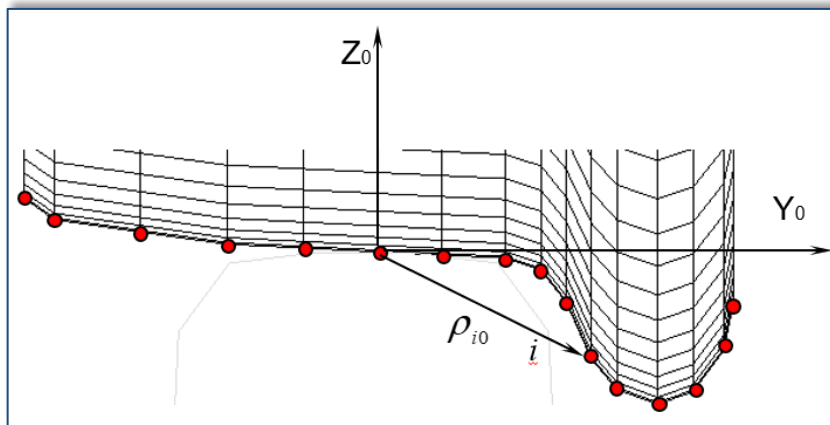
No.6 UM Driveline 传动系模块

- 提供一系列传动系专用力元（发动机、离合器、液力耦合器、液压变矩器、差动齿轮），可用于汽车、履带车辆、机车以及单轨车辆的传动系统建模

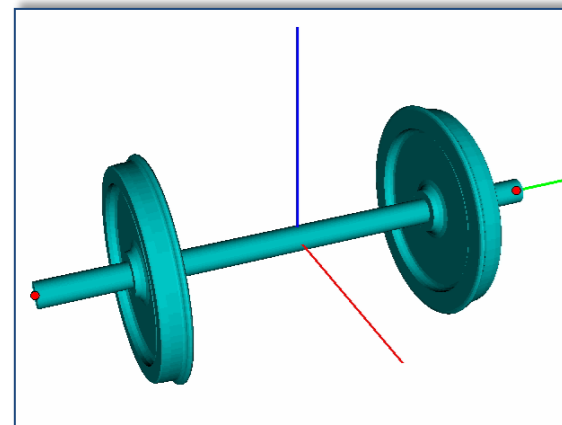




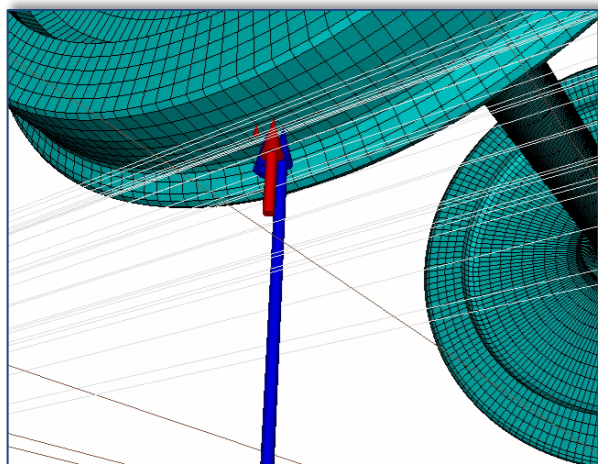
No.7 Flexible wheelset 柔性轮对子模块



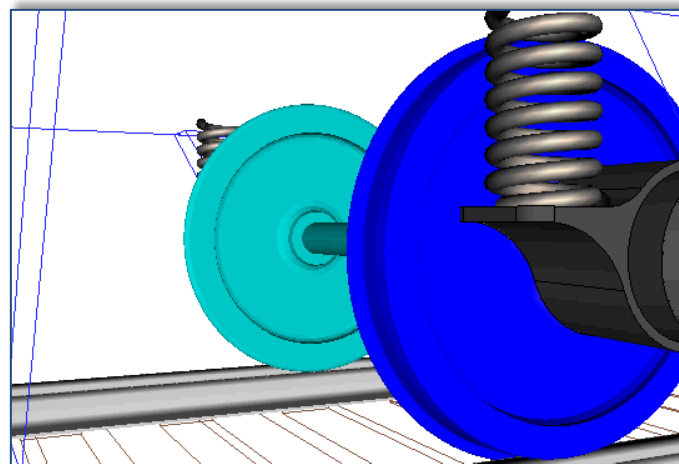
踏面匹配



高阶模态



轮轨力



应力云图



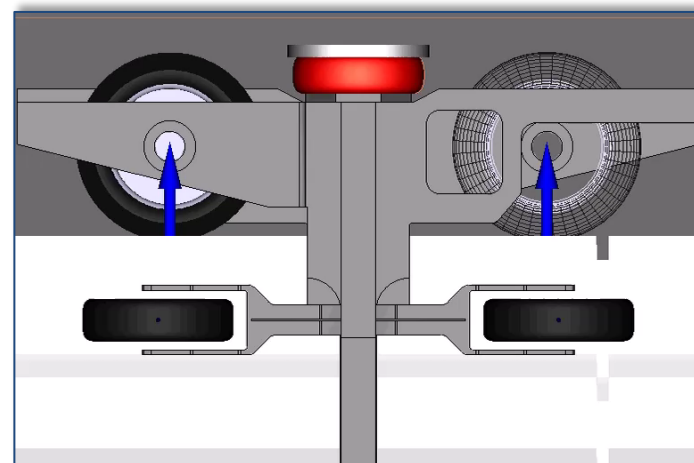
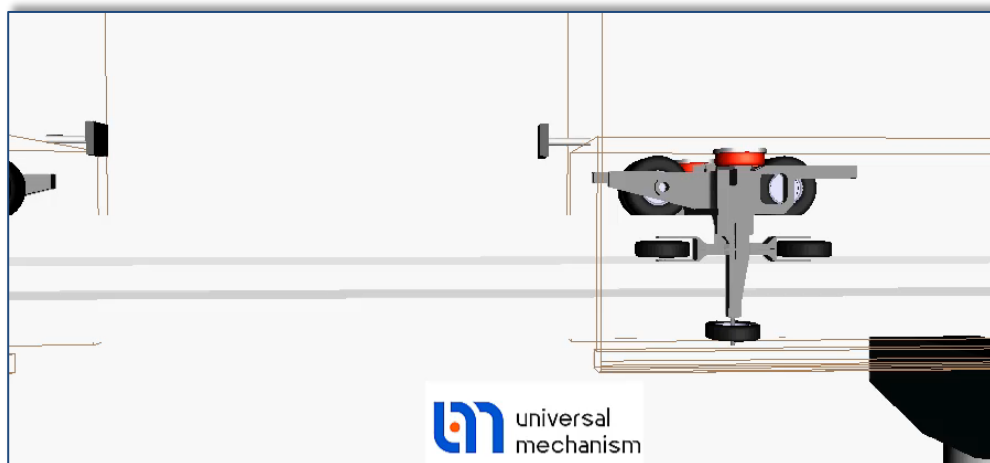
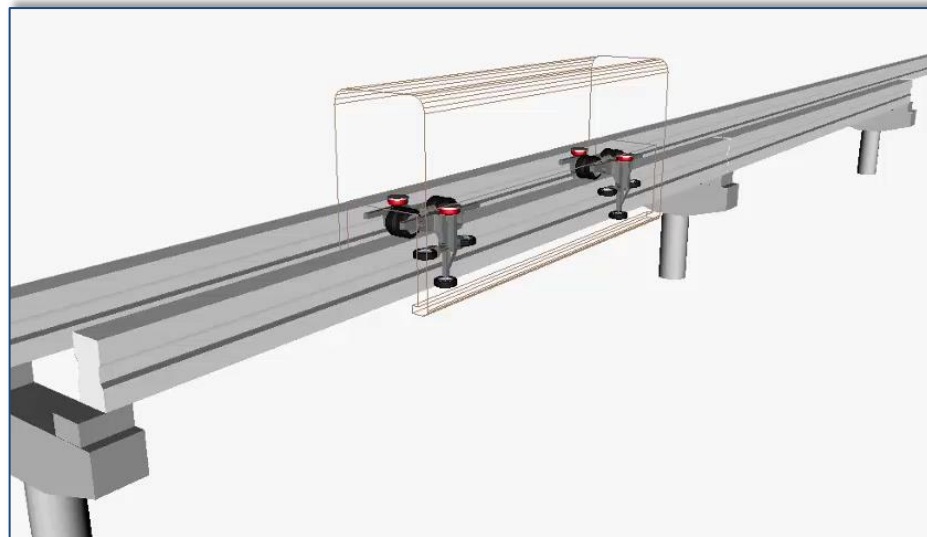
No.8 UM Monorail Train 单轨列车模块的功能

- 整合了铁路模块、柔性轨道模块和汽车模块的相关功能，支持跨座式单轨、悬挂式单轨以及APM车辆的动力学建模和仿真
- 走行轮、导向轮和稳定轮都采用非线性轮胎模型，提供Fiala、Pacejka Magic Formula、Tabular、TMEasy等多种轮胎-轨面接触模型，以及Ftire软件接口，支持单点和多点接触
- 提供专门的轨道梁平面和纵断面设计工具，单轨车辆与轨道线路自动匹配
- 提供专门的轨面不平度生成工具，走行面、导向面和稳定面都支持定义轨面不平度
- 可进行多种静态和动态试验，评估车辆稳定性、安全性、平稳性和曲线通过能力
- 可进行刚柔耦合建模和仿真分析（需配备UM FEM模块）
- 可加入完整的传动系统（需要配备UM Driveline模块）





No.8 UM Monorail Train 单轨列车模块的应用





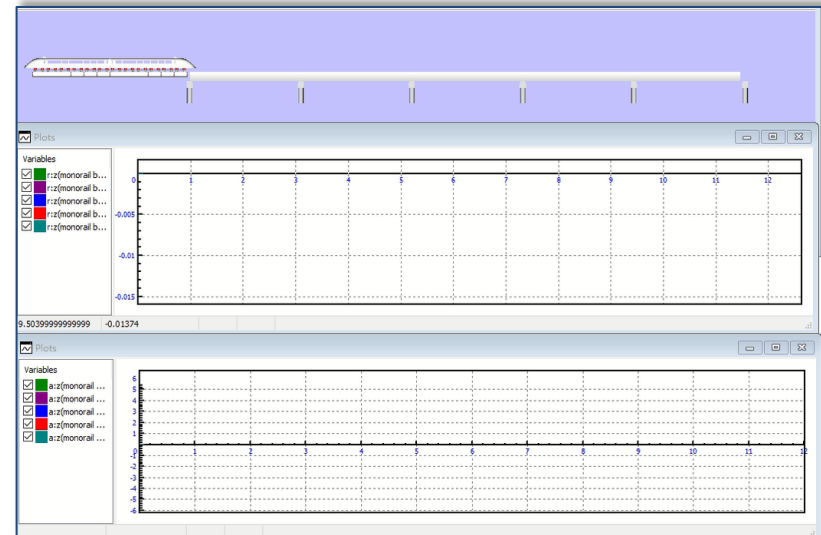
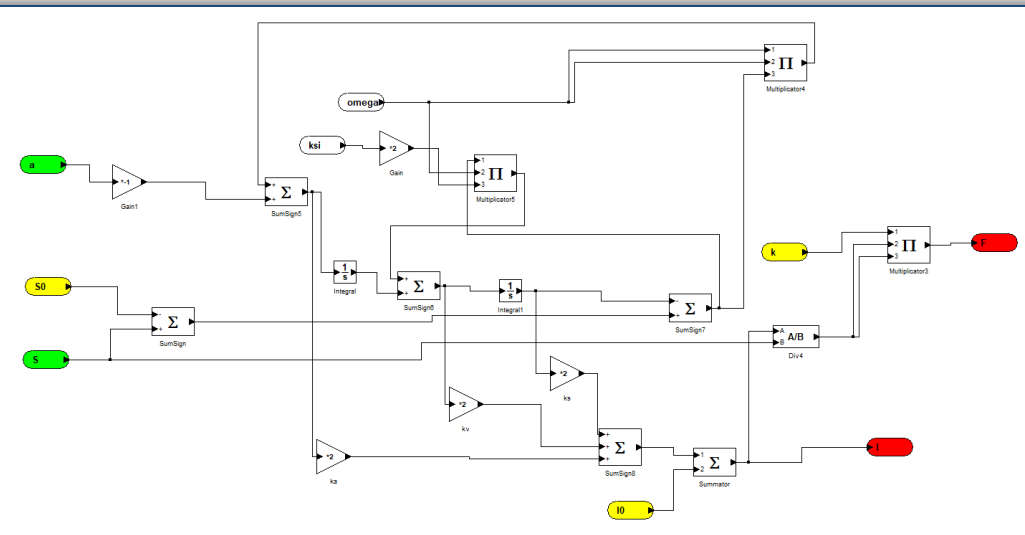
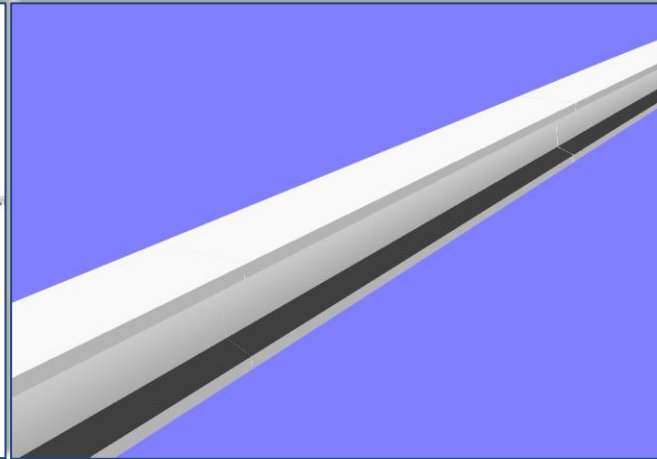
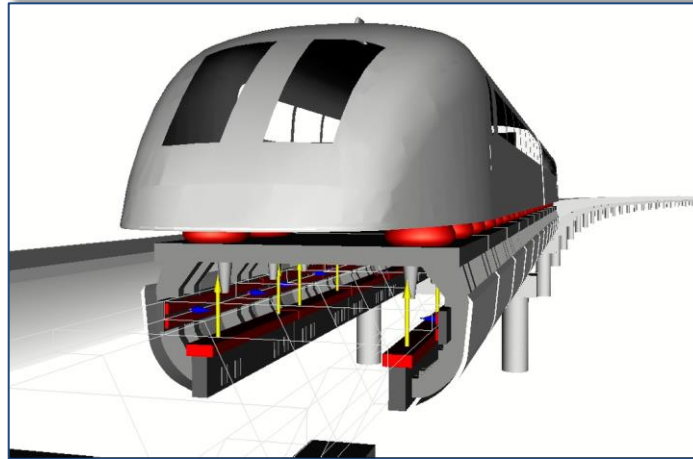
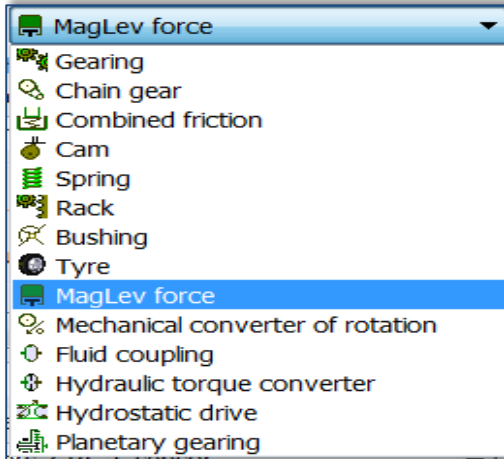
No.9 UM Maglev 磁浮列车模块的功能

- 基于单轨模块开发，整合了铁路模块、柔性轨道模块和汽车模块的相关功能，支持EMS、EDS磁浮列车的动力学建模和仿真
- 悬浮电磁铁和导向电磁铁都采用控制模型，提供刚度-阻尼、单极电磁铁和U型电磁铁等常用控制模型，支持用户自定义控制系统
- 提供专门的轨道梁平面和纵断面设计工具，磁浮车辆与轨道线路自动匹配
- 提供专门的轨面不平度生成工具，悬浮面和导向面都支持定义轨面不平度
- 可进行多种静态和动态试验，评估车辆稳定性、安全性、平稳性和曲线通过能力
- 可进行刚柔耦合建模和仿真分析（需配备UM FEM模块）





No.9 UM Maglev 磁浮列车模块的应用





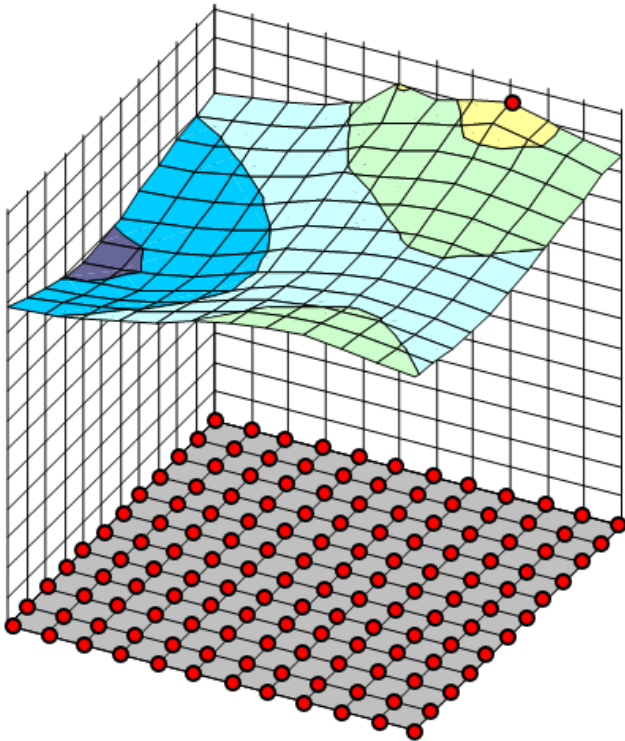
No.10 UM Experiments 多变量批处理模块

Hierarchy of parameters Tree of alternatives Identifiers Wheel-Rail Initial conditions Finish conditions Variables Integration Tools External libraries

▼ V0
 > v0 [60; 62; 64; 66; 68; 70; 68.5; 69; 69.5; 80]; - Total 9
▼ Stiffness
 > Bogie_2.c_z_2 [500000; 600000; 700000; 800000]; - Total 2
▼ Damping
 > Bogie_2.d_Spr2lv_z [60000; 70000; 80000; 90000]; - Total 2
▼ Profile
 > RWParameters._i_wheel_profile [1; 2; 3]

List of parameters

- Whole list
- Bogie_1
 - Whole list
 - Wheelset_motor_assembling_1
 - Wheelset_motor_assembling_2
 - Wheelset_motor_assembling_3
- Bogie_2
 - Whole list
 - Wheelset_motor_assembling_1
 - Wheelset_motor_assembling_2
 - Wheelset_motor_assembling_3
- RWParameters
 - Whole list
 - General
 - Profiles
 - _i_wheel_profile=1 (Number of wheel profile)
 - _i_rail_left_profile=1 (Number of left rail profile)
 - _i_rail_right_profile=1 (Number of right rail profile)
 - Track stiffness/damping
 - _z_rail_stiffness=4.4E7 (Vertical rail stiffness)
 - _y_rail_stiffness=1.8E7 (Lateral rail stiffness)
 - _z_rail_damping=400000 (Vertical rail damping)
 - _y_rail_damping=100000 (Lateral rail damping)
 - _toRsStr(rstional_rail_stiffness=1E10 (Torsional rail stiffness)
 - Wheel radii difference
 - _dr_wheel_1l=0 ((mm) Deviation of radius of wheel, wset 1, left wheel)
 - _dr_wheel_1r=0 ((mm) Deviation of radius of wheel, wset 1, right wheel)
 - _dr_wheel_2l=0 ((mm) Deviation of radius of wheel, wset 2, left wheel)
 - _dr_wheel_2r=0 ((mm) Deviation of radius of wheel, wset 2, right wheel)
 - _dr_wheel_3l=0 ((mm) Deviation of radius of wheel, wset 3, left wheel)
 - _dr_wheel_3r=0 ((mm) Deviation of radius of wheel, wset 3, right wheel)
 - _dr_wheel_4l=0 ((mm) Deviation of radius of wheel, wset 4, left wheel)
 - _dr_wheel_4r=0 ((mm) Deviation of radius of wheel, wset 4, right wheel)
 - _dr_wheel_5l=0 ((mm) Deviation of radius of wheel, wset 5, left wheel)
 - _dr_wheel_5r=0 ((mm) Deviation of radius of wheel, wset 5, right wheel)
 - _dr_wheel_6l=0 ((mm) Deviation of radius of wheel, wset 6, left wheel)





No.11 UM Cluster 分布式并行计算模块

UM Cluster server

File List of computers Service Help

List of computers

- ☐ CB15-GLAVBUH
- ☐ CB15-IVANOVA
- ☐ CB15-KARPIKOVA
- ☐ CB15-KNA01
- ☐ CB15-LEVITC
- ☐ CB15-MEYEREA
- ☐ CB15-NALOGOT
- ☐ CB15-NEP1
- ☐ CB15-NSESN
- ☐ CB15-POV
- ☐ CB15-RUTSOVA1
- ☐ CB15-SEM
- ☐ CB15-SEM1
- ☐ CB15-SNOLIS
- ☐ CB15-STEPINA1
- ☐ CB15-TER
- ☐ CB15-ZAMGLBUH
- ☐ CB15-ZEBKINA02
- ☐ CB-SURINA
- ☐ FPK7-SILAEVATV
- ☐ MSK-DC-RVC05
- ☐ MSK-DC-RVC06
- ☐ MSK-SCCM-70
- ☐ RIVC15-BOTOVSA
- ☐ RIVC15-CORP
- ☐ RIVC15-KALININAA
- ☐ RIVC15-KASPERSK
- ☐ RIVC15-LINWIN
- ☐ RIVC15-MGM
- ☐ RVC15-PLOTTER
- ☐ rvc15-shell2.msk.oao...
- ☐ RVC15-SUS
- ☐ TOCO15-BUH35
- ☐ TOCO15-BUHF

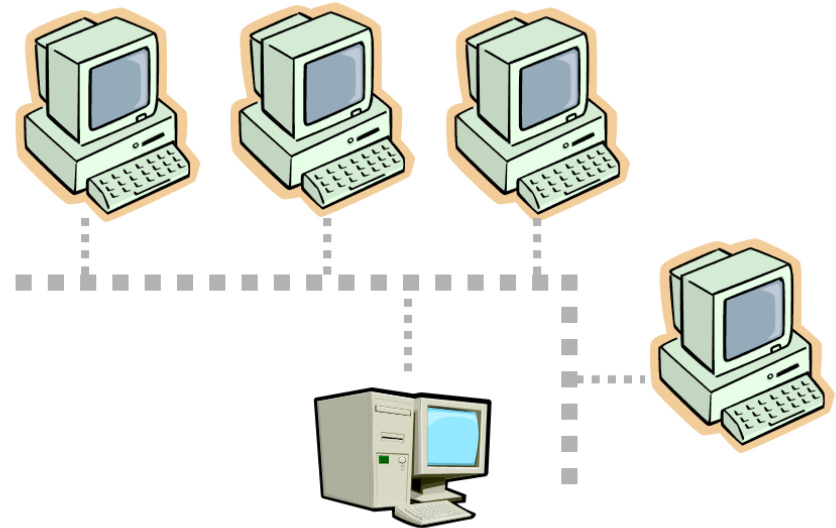
Active phase Solved projects

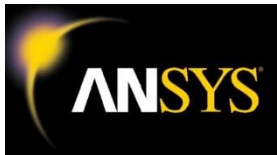
Projects

ID	Progress	%	Status	Beginning time	Project folder
0		101 from 101 (100%)	Marked for removal	02.02.2012 14:13:22	C:\Program Files\UM
1		85 from 101 (84%)	Executing	02.02.2012 14:16:58	C:\Program Files\UM

Executing experiments (grouped by computers)

ID	Progress	%	Status	Beginning time	Unique identifier
Computer [Name RIVC15-KASPERSK] [ip address 10.23.146.12]					
32		99%	Returning data... oscillator.var	02.02.2012 14:17:07	{72CC46FA-A079-4AD0-A757
29		98%	Scanning...	02.02.2012 14:17:08	{B9B6A8D7-7D66-4A8C-B136-
34		99%	Scanning...		
2		0%	Remote cleaning...		
21		97%	Returning data... oscillator		
30		0%	Remote cleaning...		
23		98%	Scanning...		
24		0%	Remote cleaning...		
Computer [Name RIVC15-CORP] [ip address 10.23.146.57]					
25		59%	Scanning...		
18		57%	Scanning...		
14		55%	Scanning...		
16		56%	Scanning...		
19		54%	Scanning...		
...		57%	Scanning...		
Computer [Name RIVC15-MGM] [ip address 10.23.146.81]					





MSC Nastran™ NX NASTRAN



ANSYS

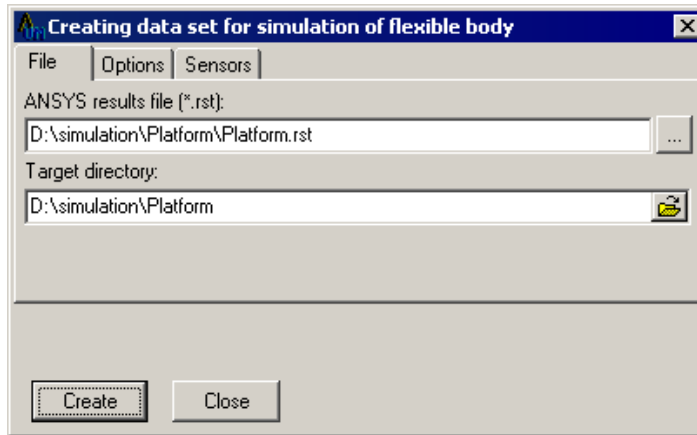
1. 建立有限元模型
2. 选择界面节点
3. 运行UM.mac宏命令

UM.mac

- 计算静模态和固有模态
- 计算自由体质量矩阵

ANSYS_UM.exe

- 转换数据格式
- 计算广义质量和刚度矩阵
- 模态正则化，剔除刚体模态



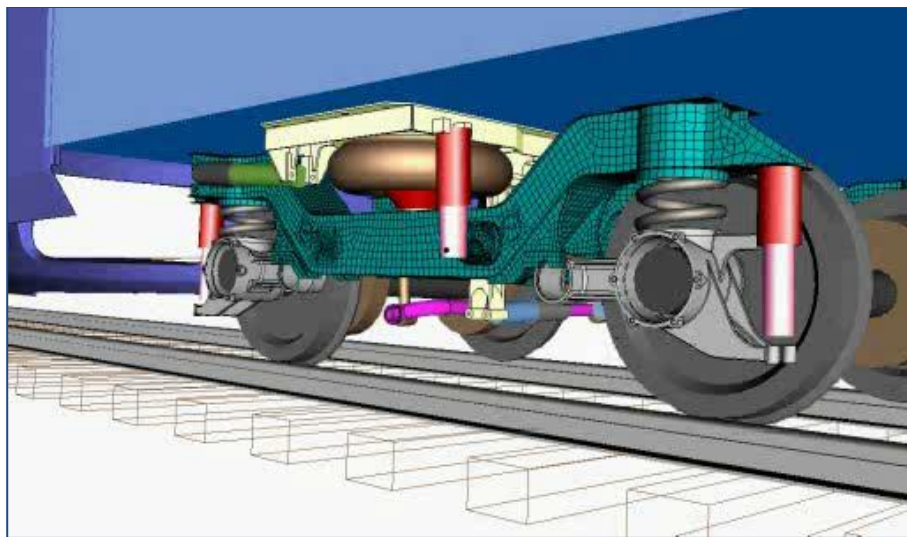
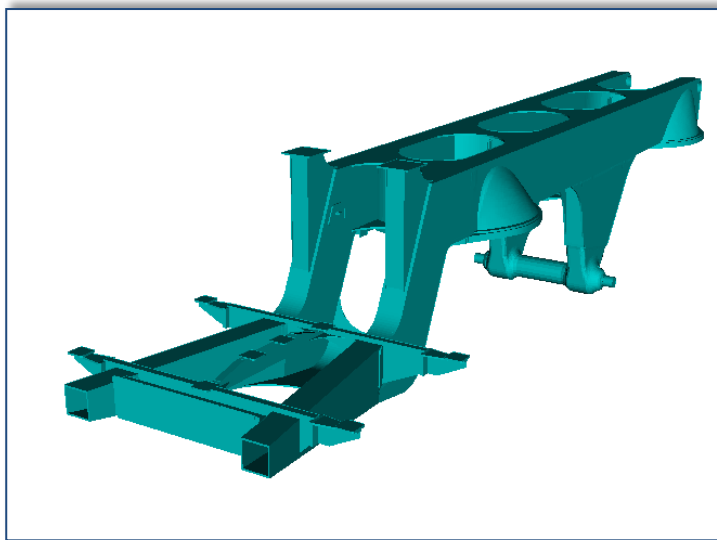
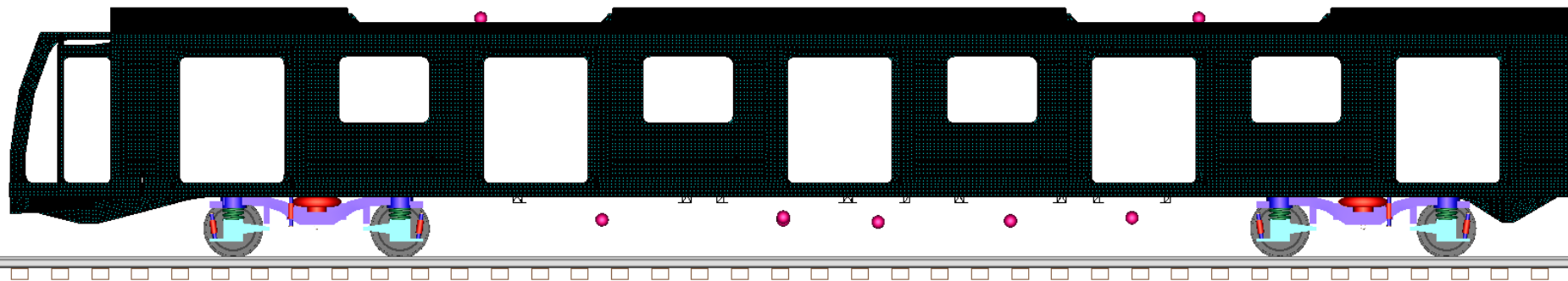
input.fum

input.fss

- *input.fum* - 中间格式文件，可观察静模态和固有模态，选择剔除部分模态
- *input.fss* - UM仿真所用的柔性子系统文件

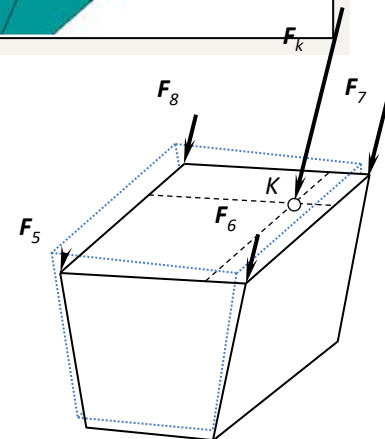
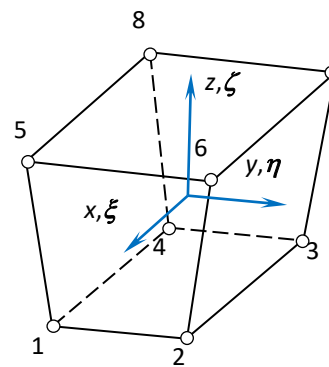
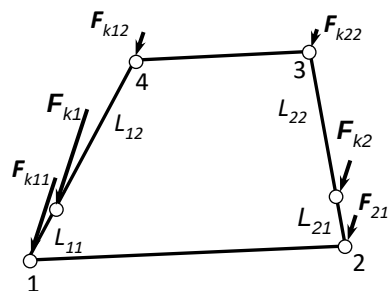
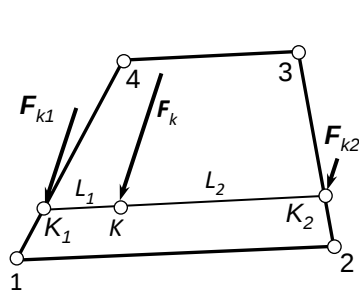
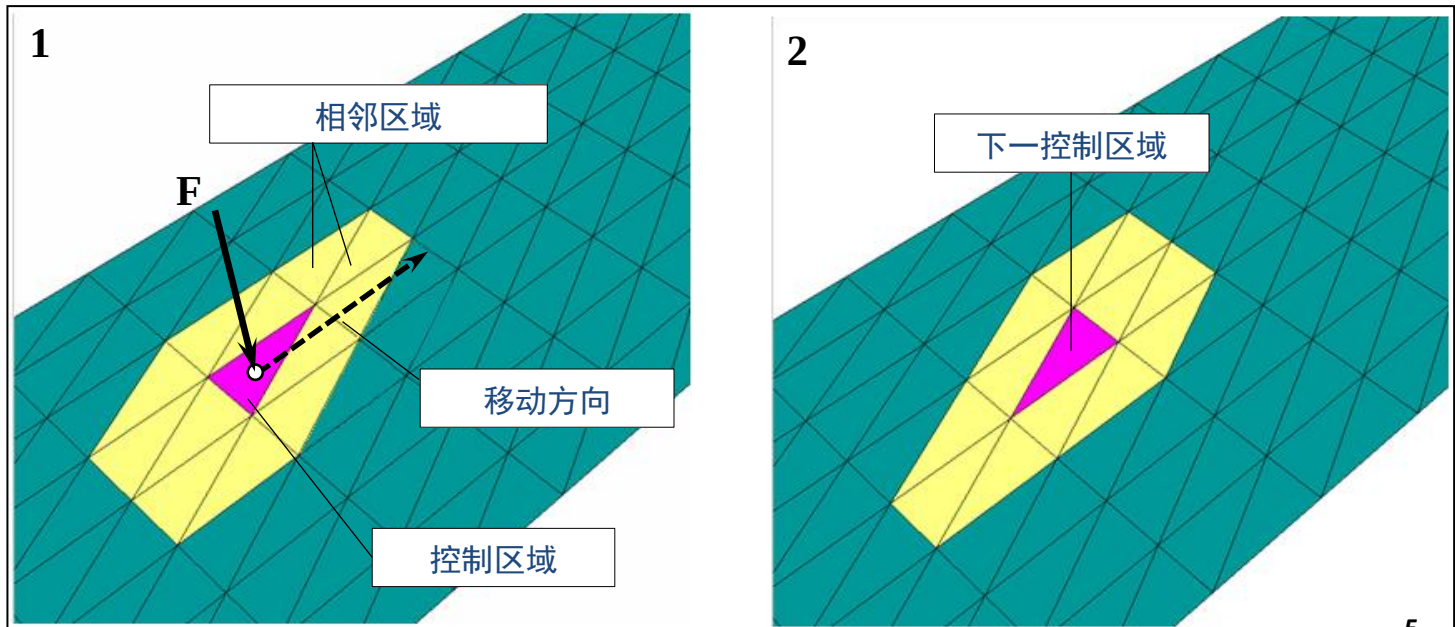


No.12 UM FEM 刚柔耦合模块



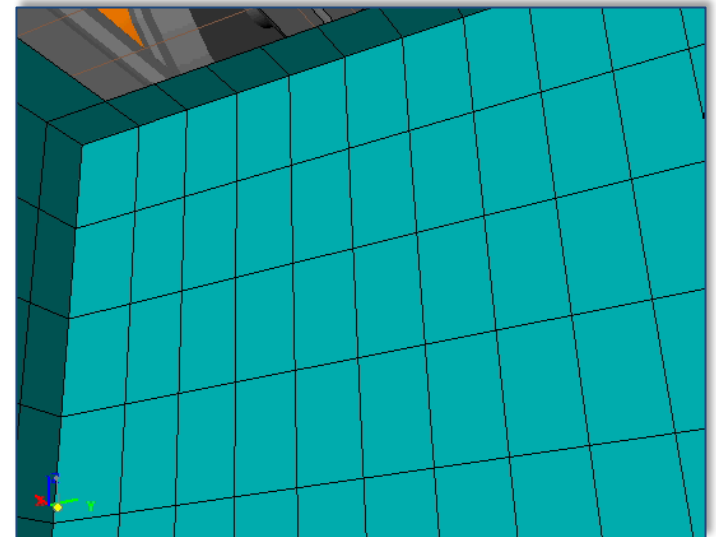
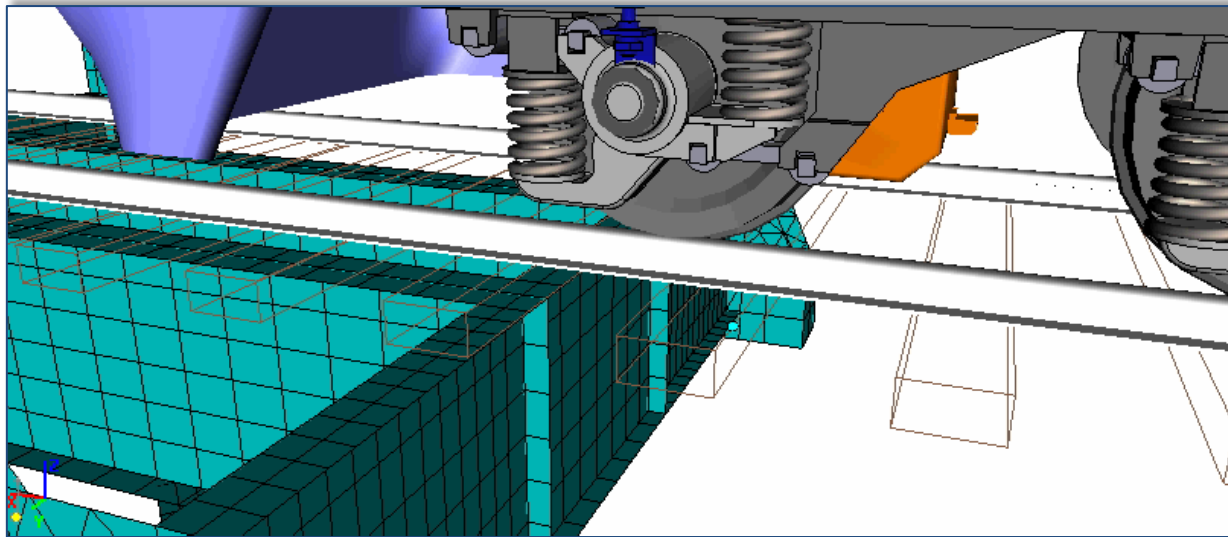


No.12.1 UM FEM/Vehicle-Bridge Interaction 铁路车桥耦合模块



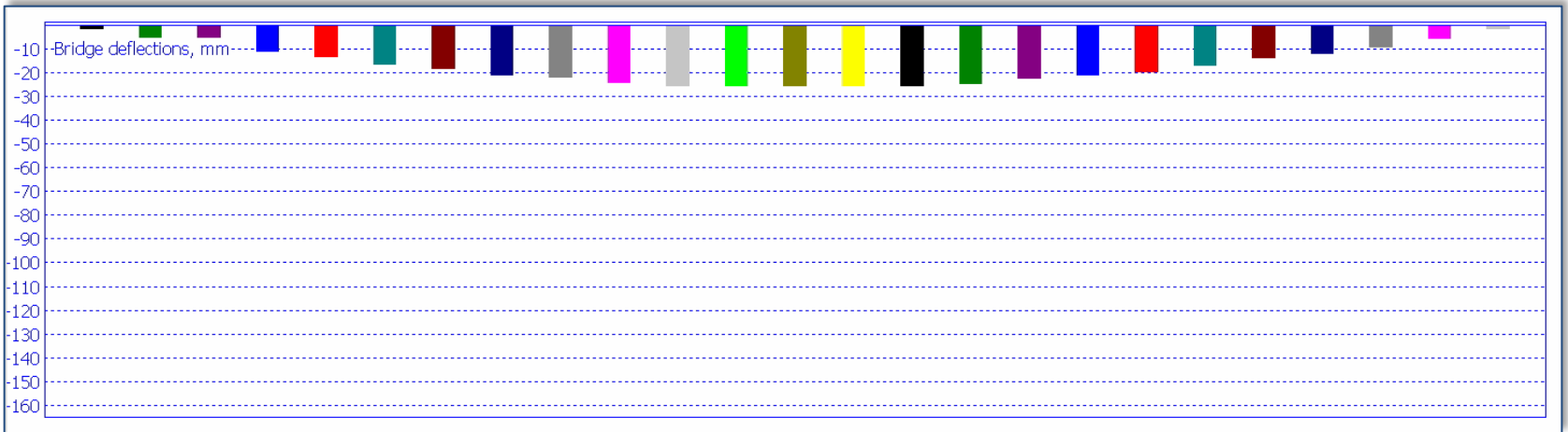
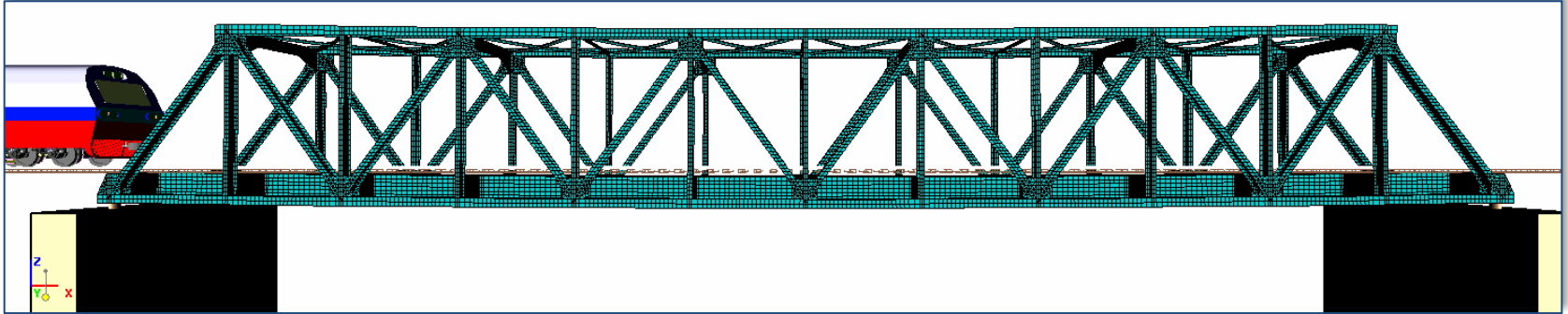


No.12.1 UM FEM/Vehicle-Bridge Interaction 铁路车桥耦合模块



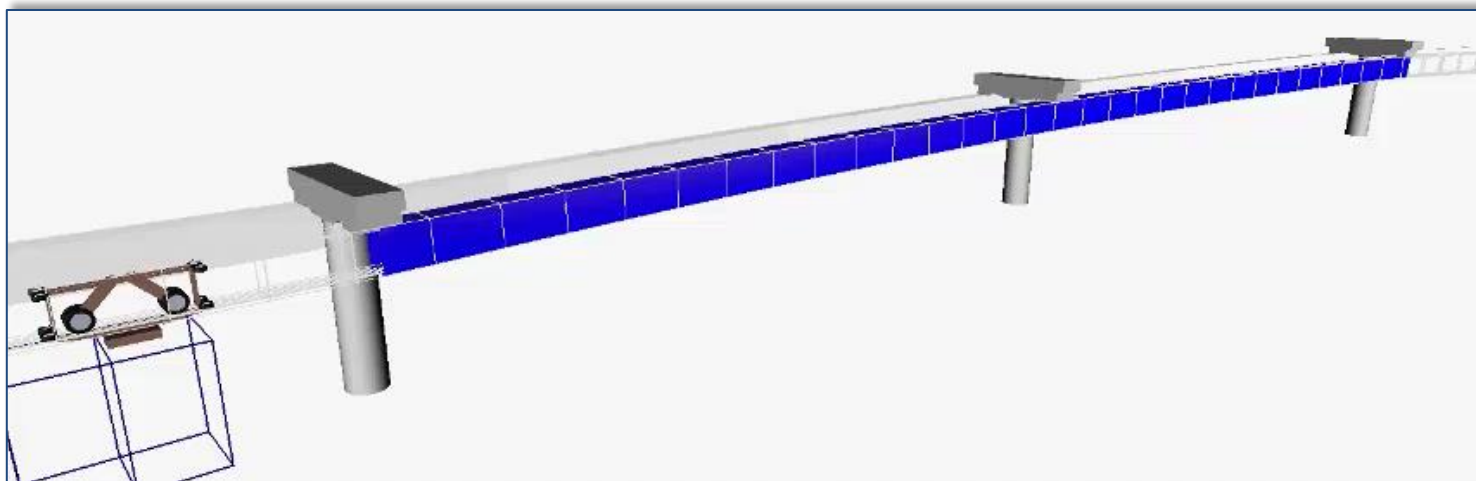
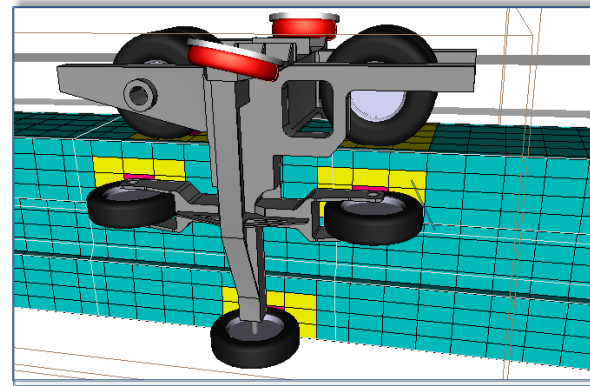
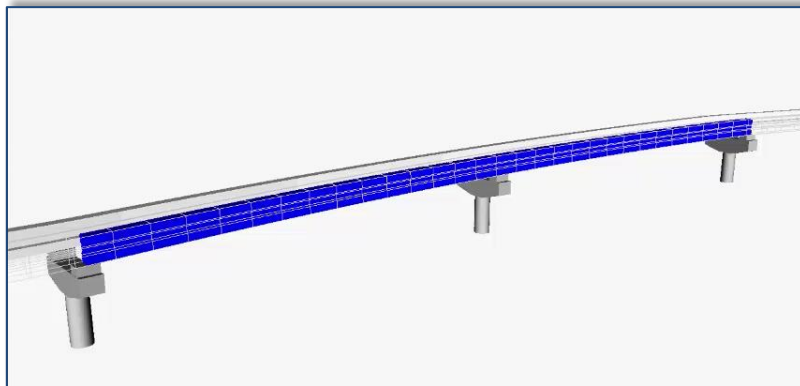


No.12.1 UM FEM/Vehicle-Bridge Interaction 铁路车桥耦合模块



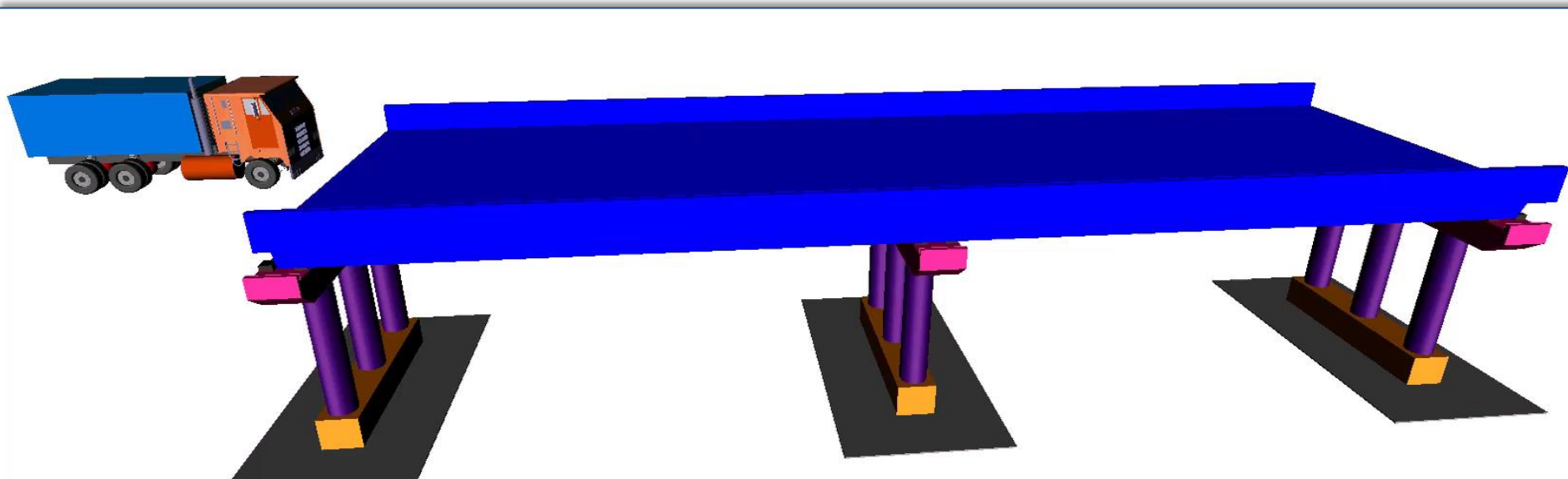


No.12.2 UM FEM/Monorail Track 单轨车桥耦合模块





No.12.2 UM FEM/Monorail Track 单轨车桥耦合模块

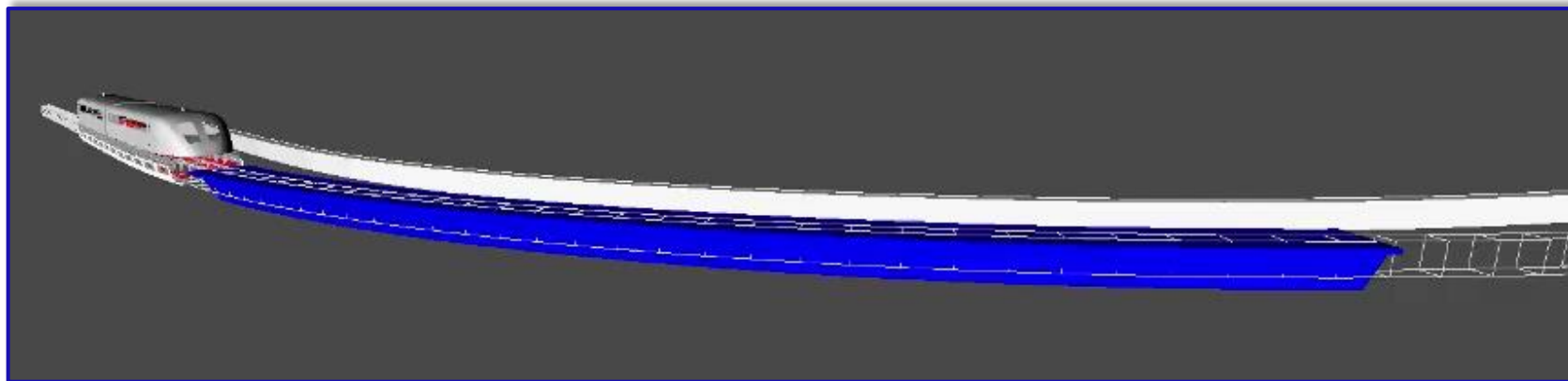
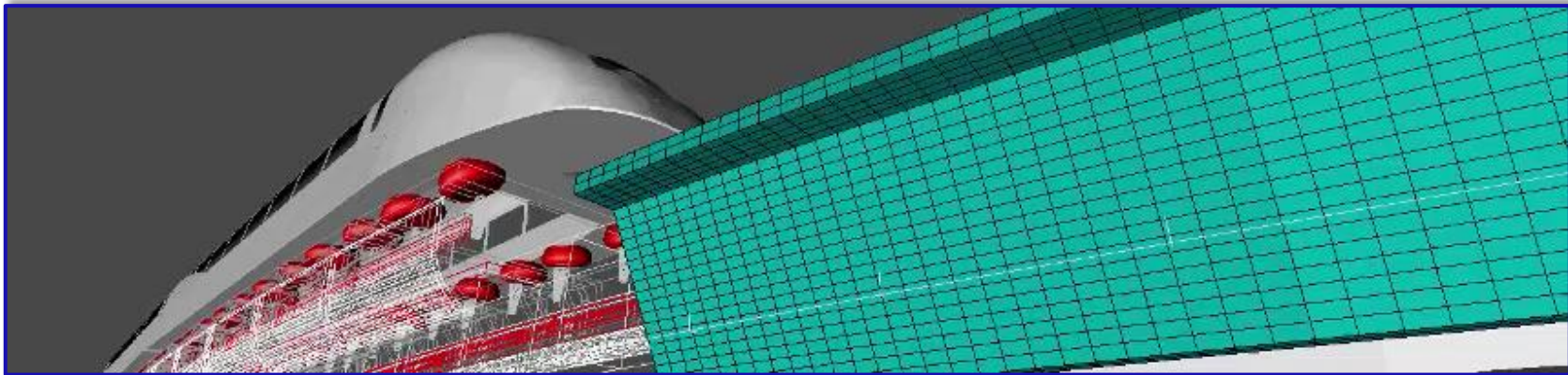


拓展应用：公路车桥耦合



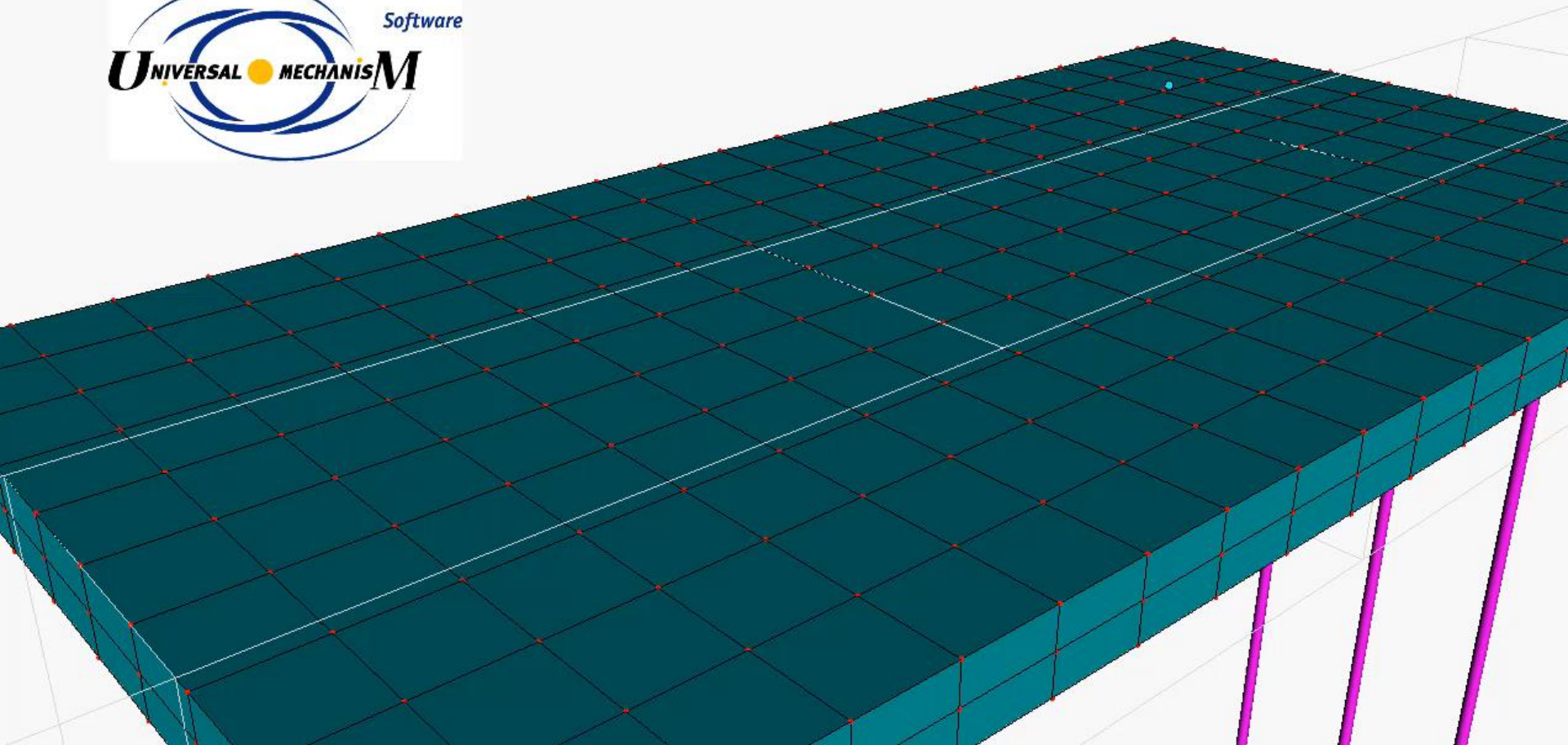


No.12.3 UM FEM/Maglev Track 磁浮车桥耦合模块





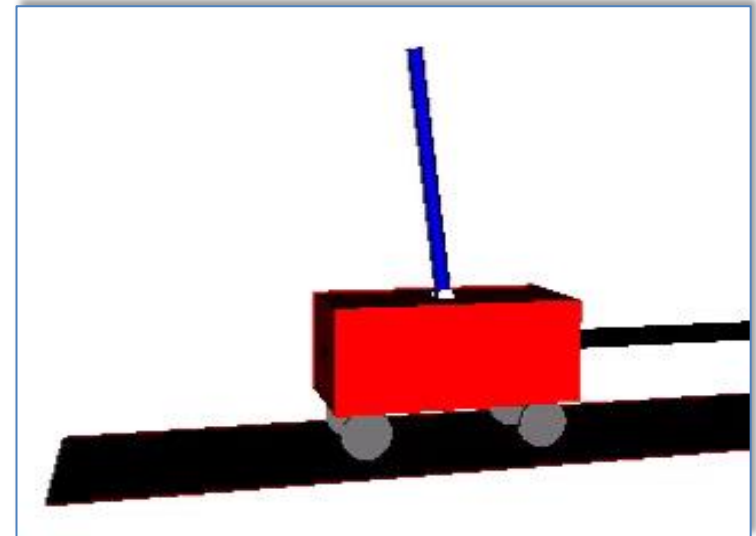
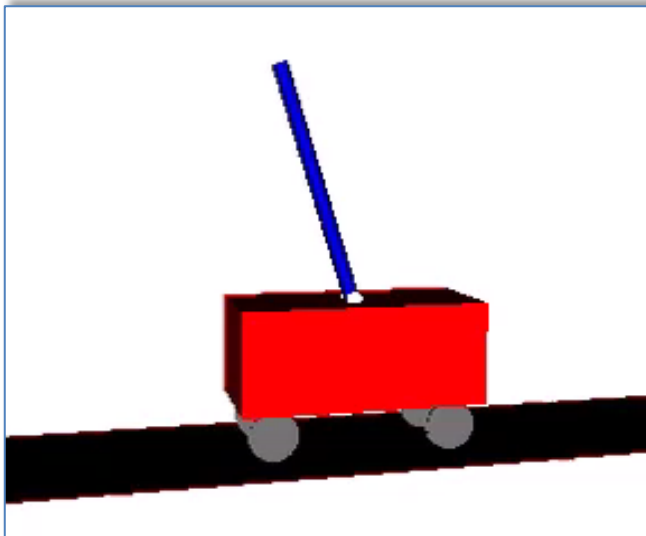
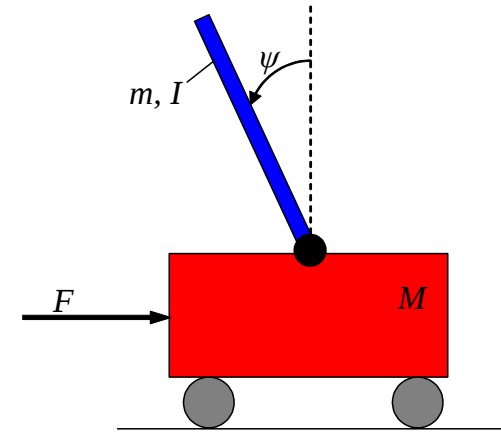
No.12.3 UM FEM/Maglev Track 磁浮车桥耦合模块

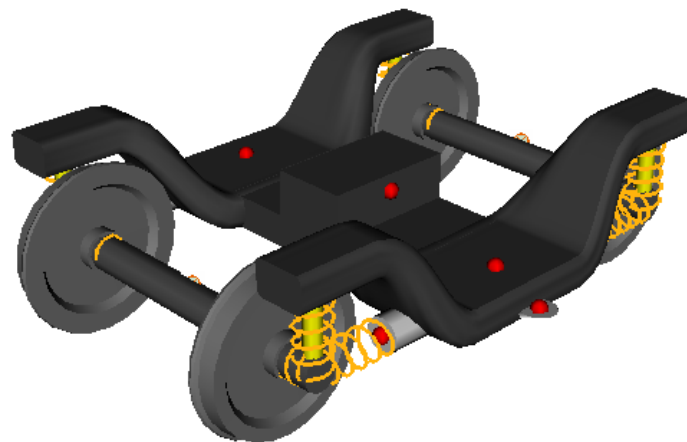
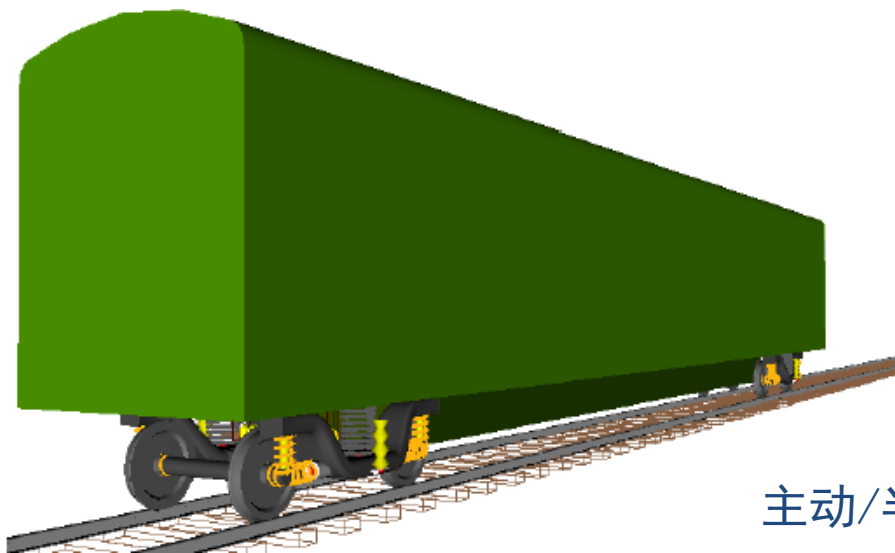




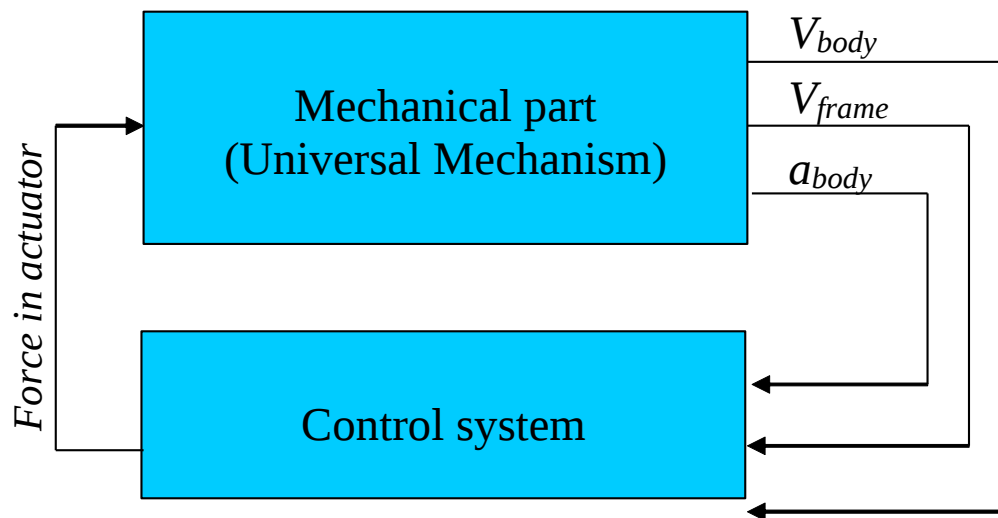
No.13 UM Control 控制系统模块

- UM Control/User-defined Routines
- UM Control/ Matlab Import
- UM Control/ Matlab Cosimulation
- UM Control/ Block Editor



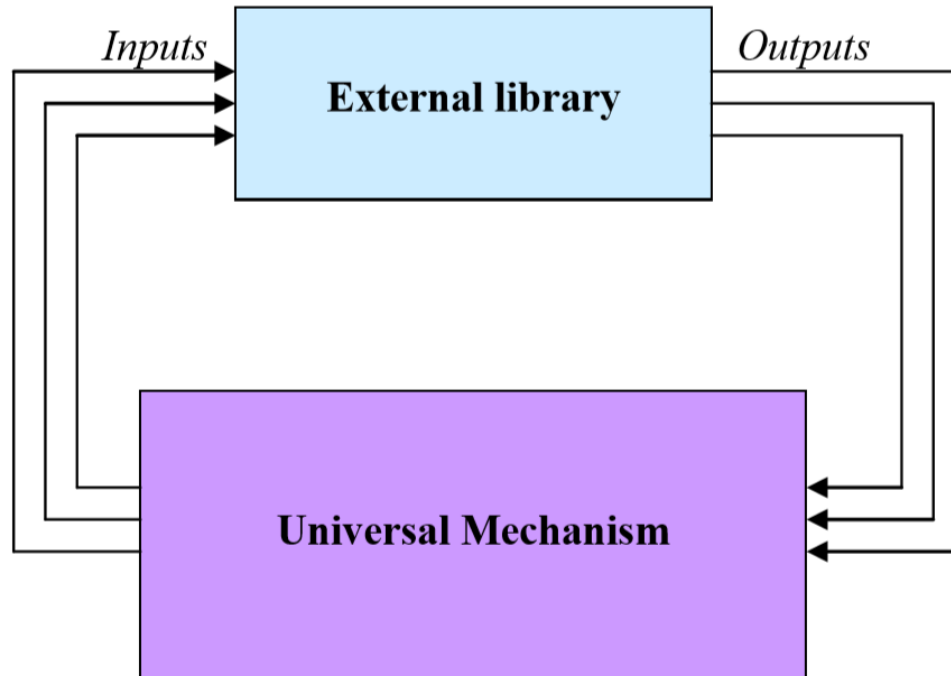


主动/半主动悬挂





No.13.1 UM Control/User-defined Routines 用户自定义模块



支持任何可以编译动态链接库的程序语言
如Delphi, C++等

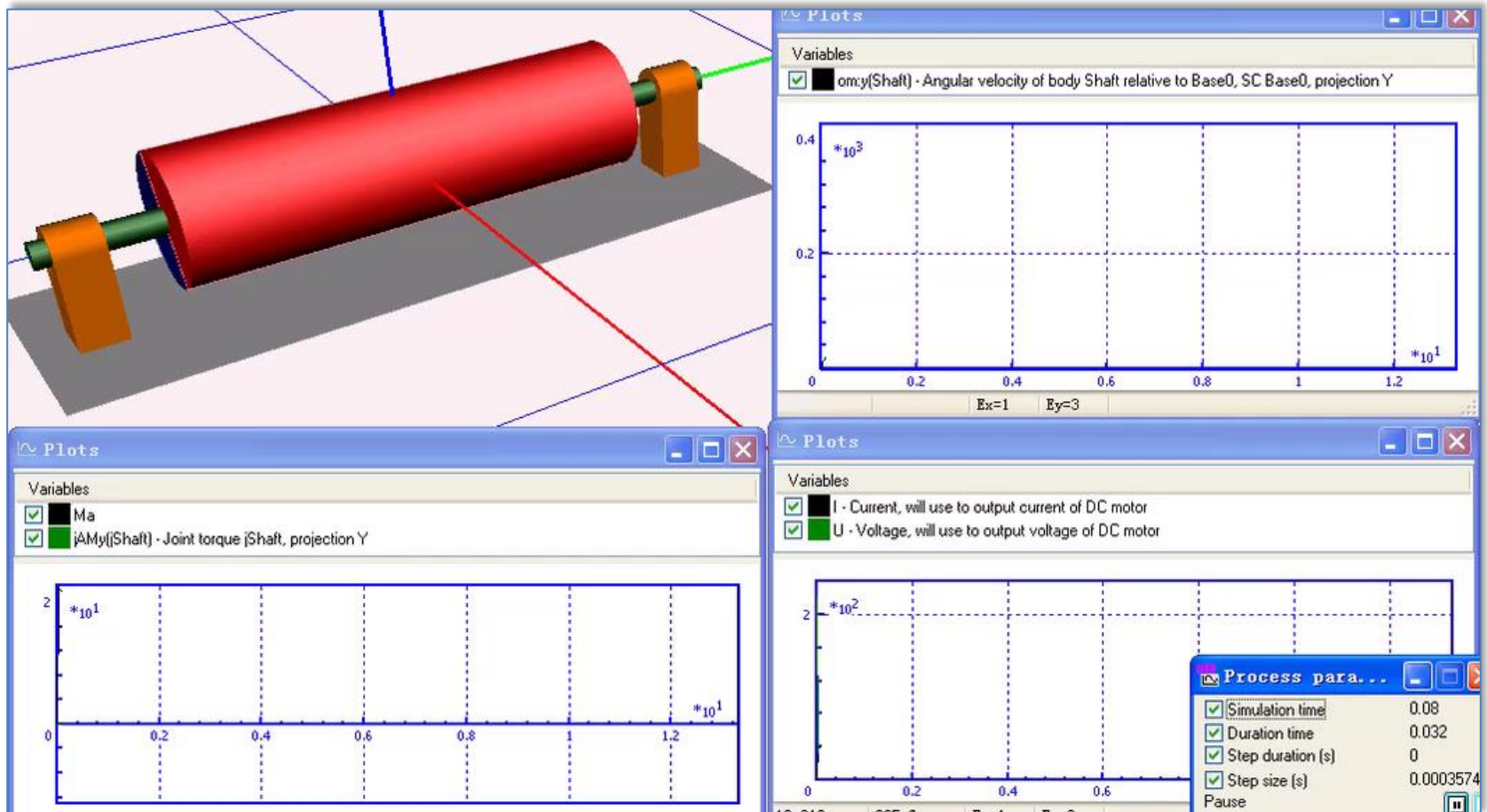


No.13.2 UM Control/Matlab Import 导出Simulink控制系统至UM

Universal Mechanism

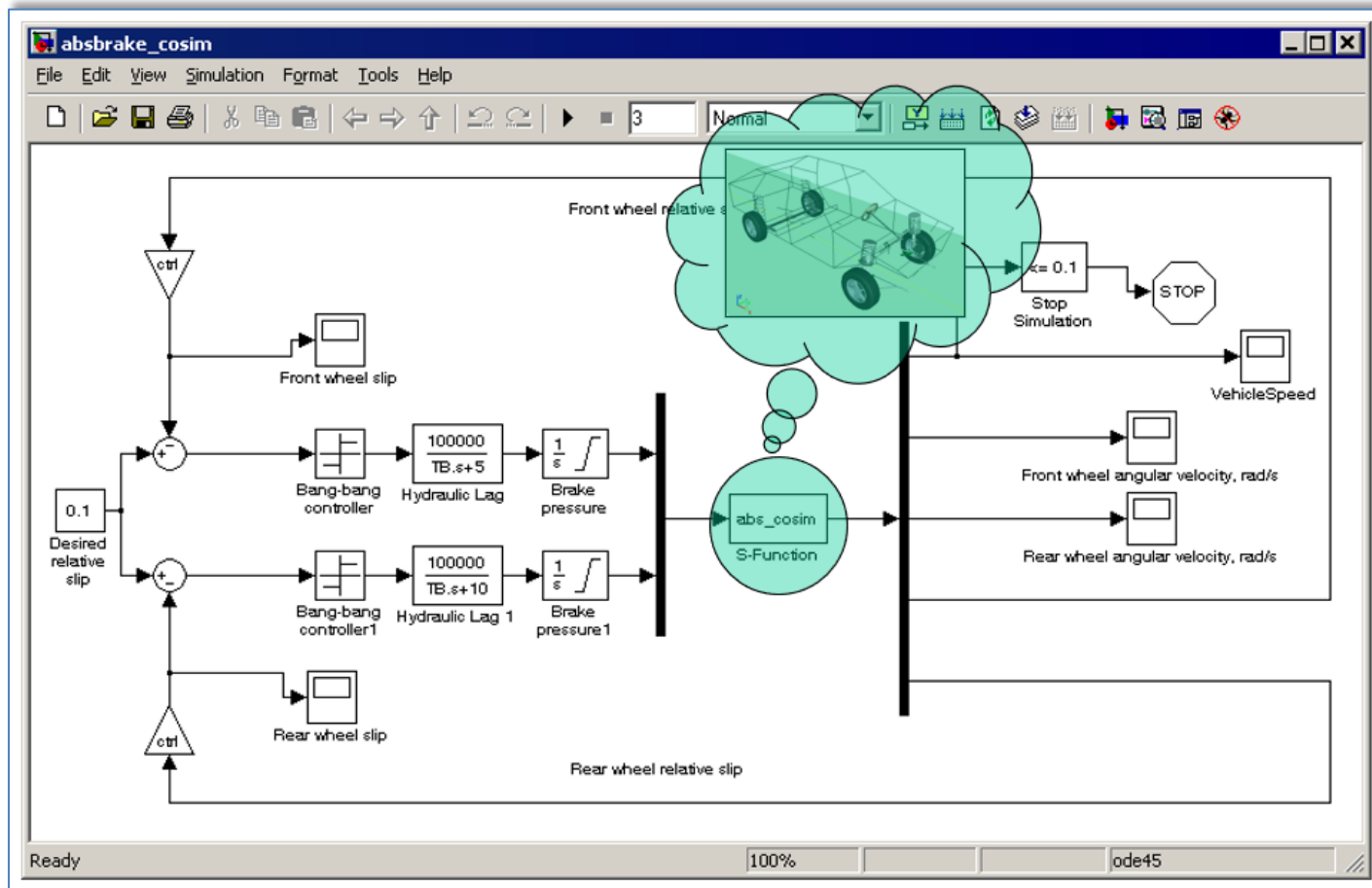
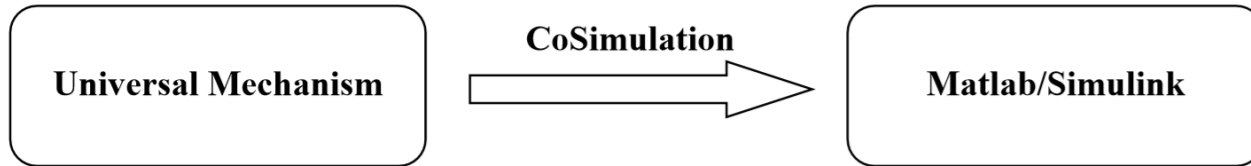
Matlab Import

Matlab/Simulink



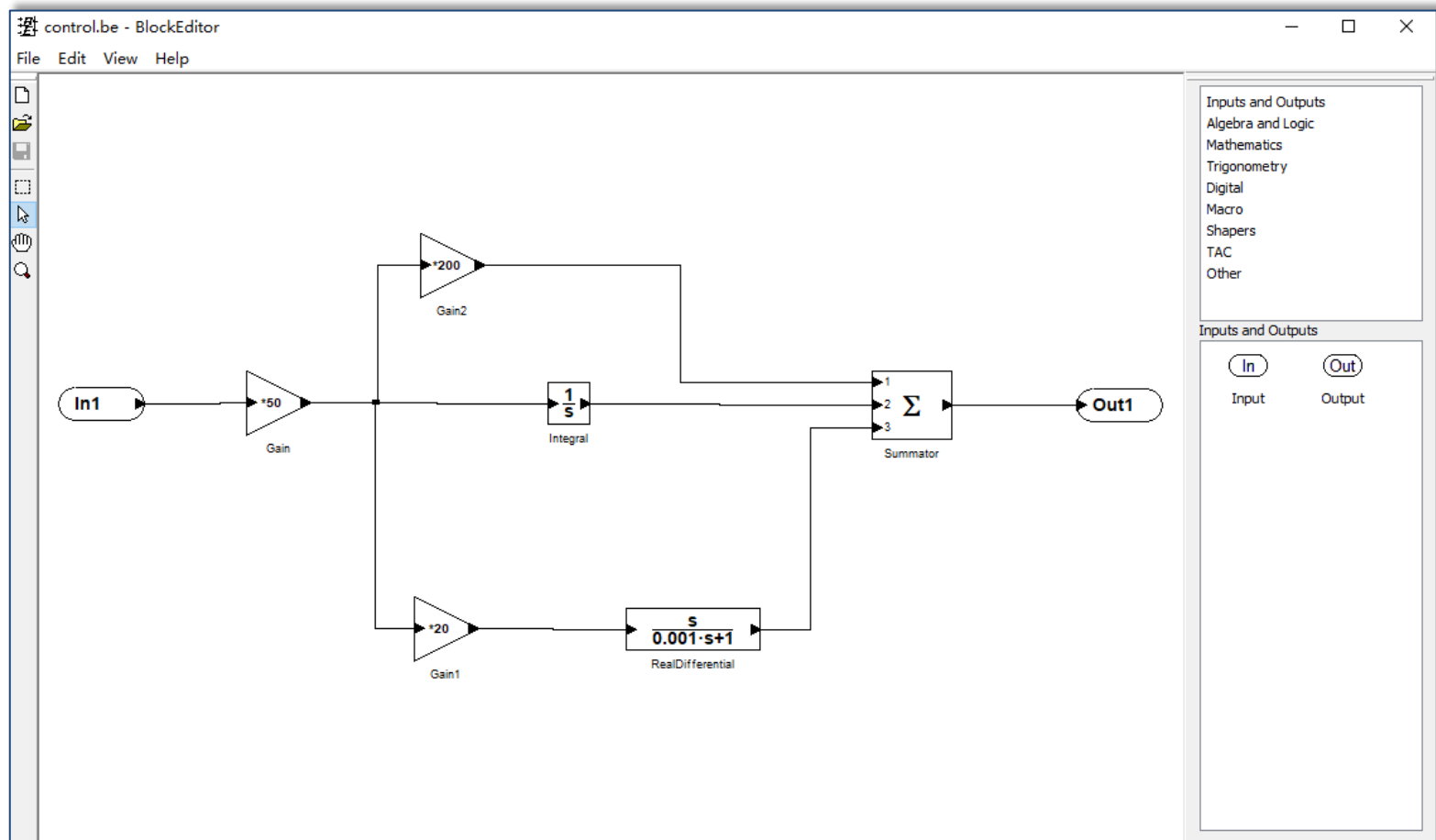


No.13.3 UM Control/Matlab Cosimulation 导出UM模型至Simulink





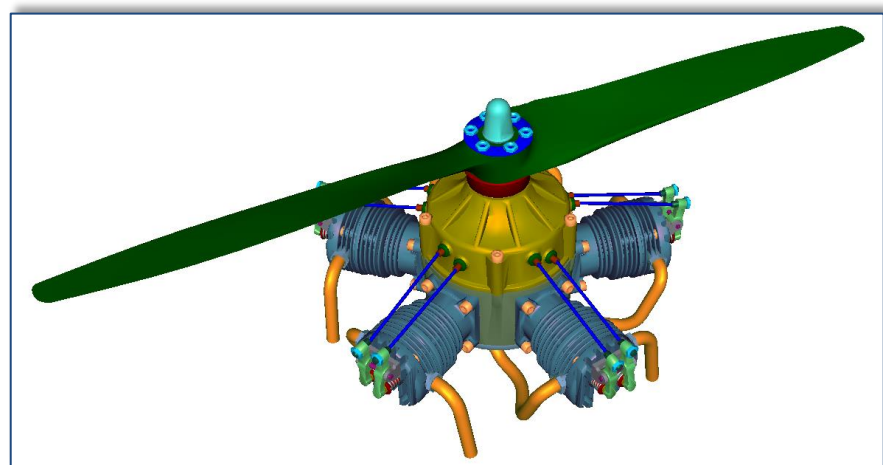
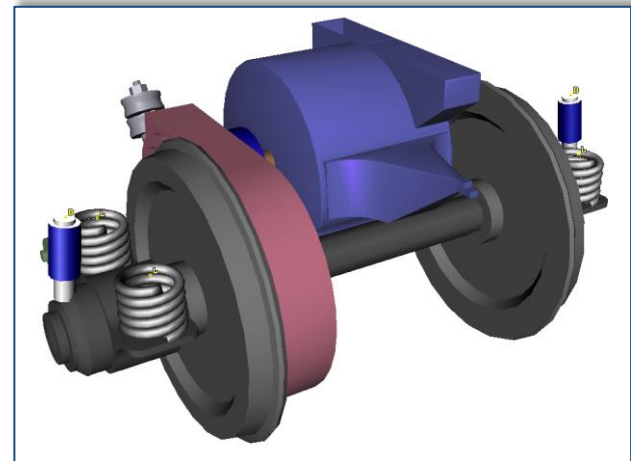
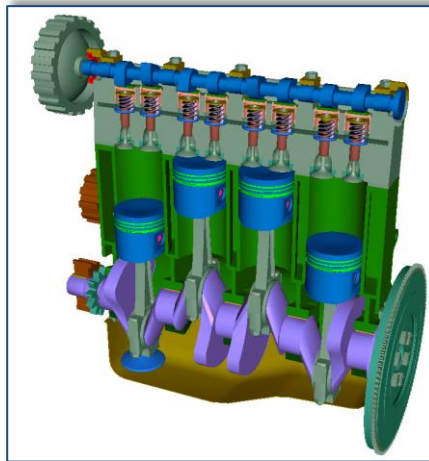
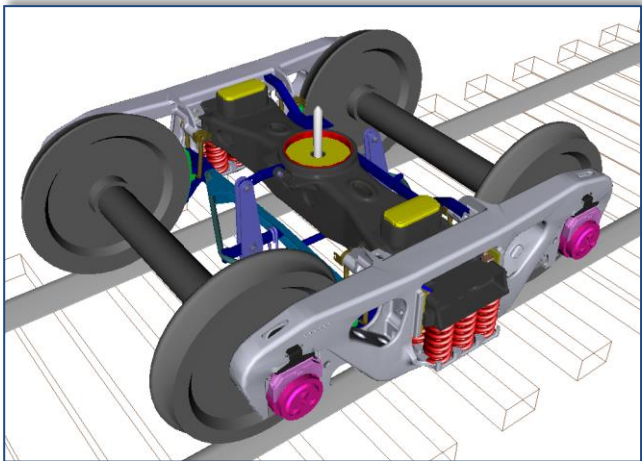
No.13.4 UM Control/Block Editor 自带的控制系统建模工具



无需编译DLL，操作简便



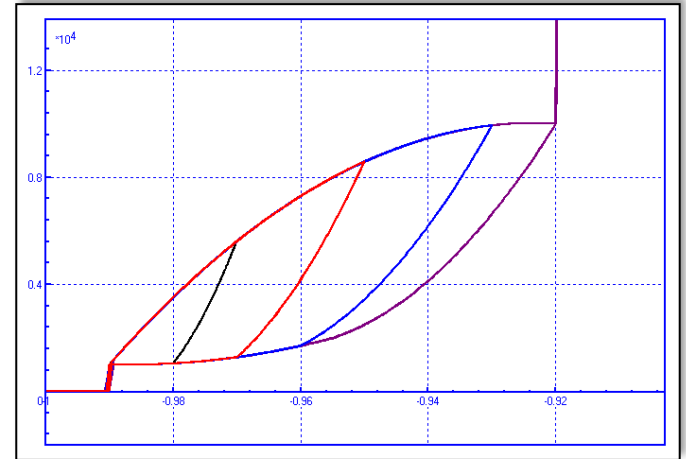
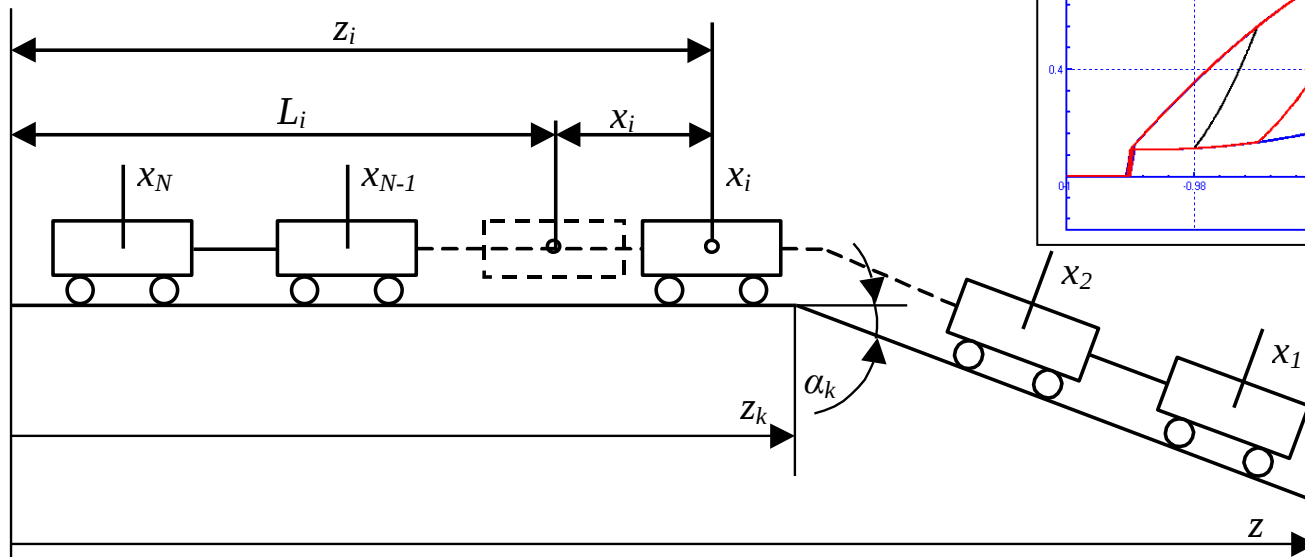
No.14 UM CAD Interfaces 三维软件接口





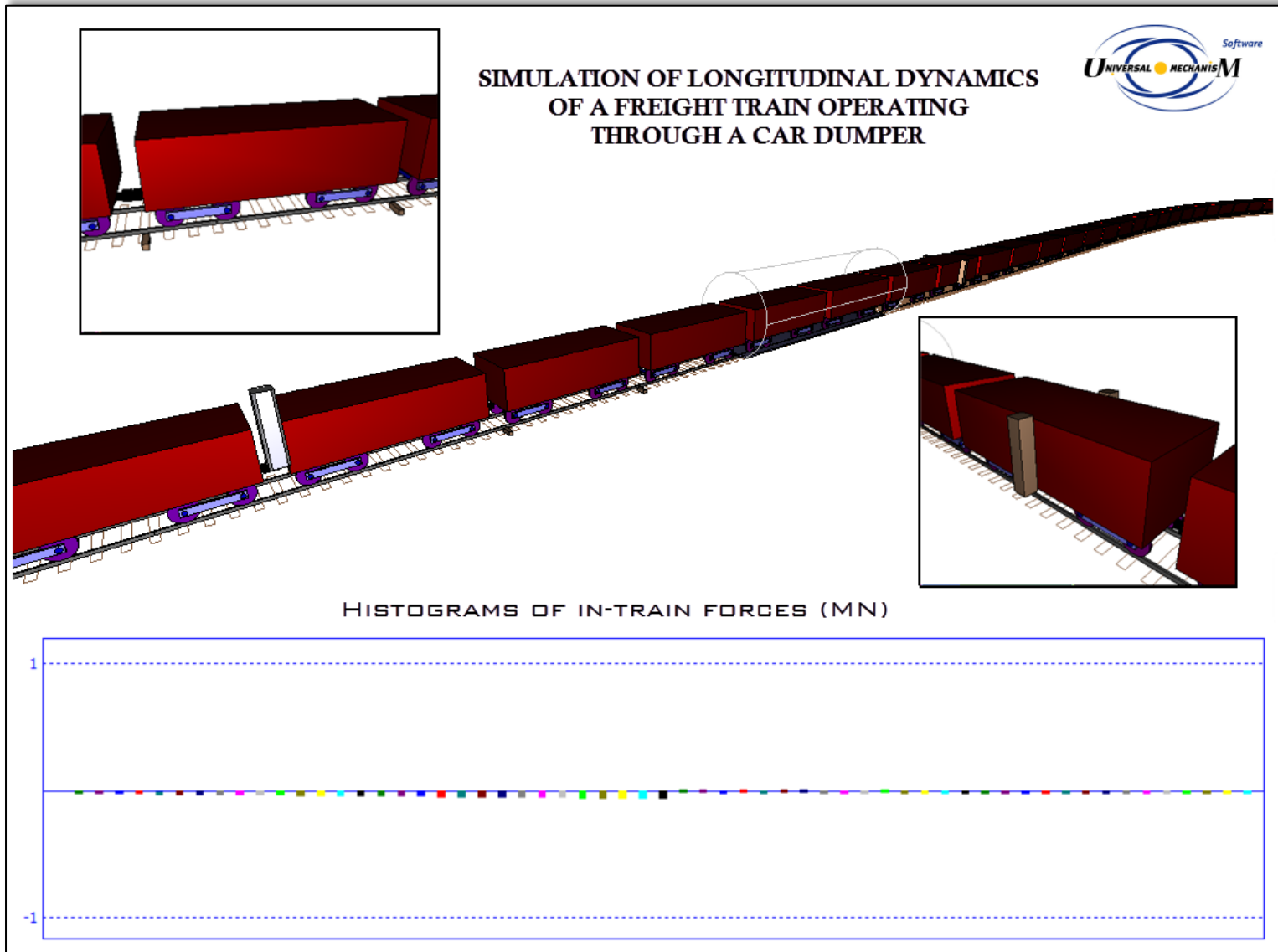
No.15 UM Train 列车纵向动力学模块

$$m_i \ddot{x}_i = -S_{i-1}(x_{i-1} - x_i) + S_{a_{i-1}}(\dot{x}_{i-1} - \dot{x}_i) - S_i(x_i - x_{i+1}) + S_{a_i}(\dot{x}_i - \dot{x}_{i+1}) + B_i[\dot{x}_i, (t - t_i)] - Q_i(z_i) + W_i[\dot{x}_i, R(z_i)]$$



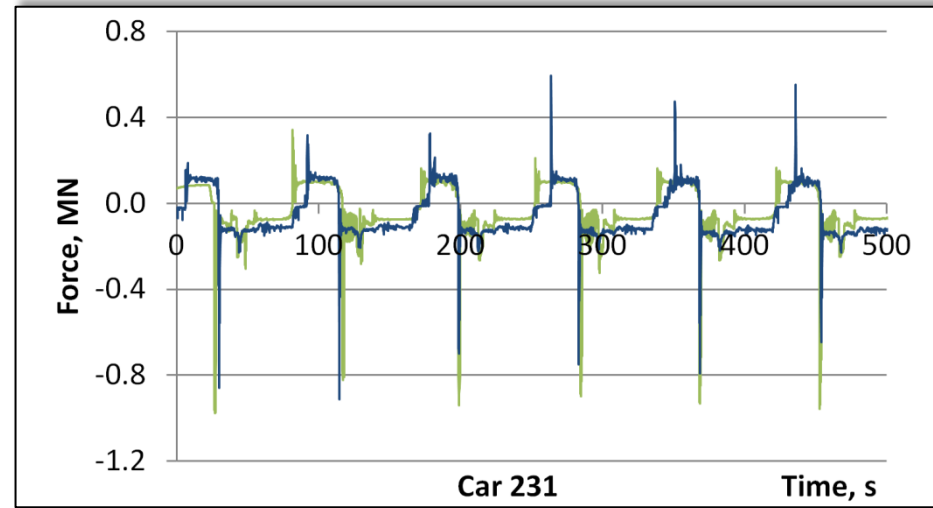
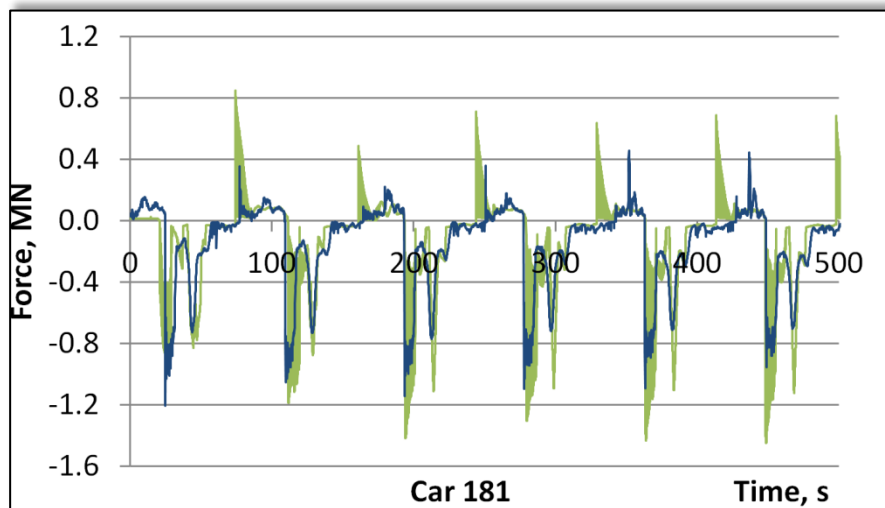
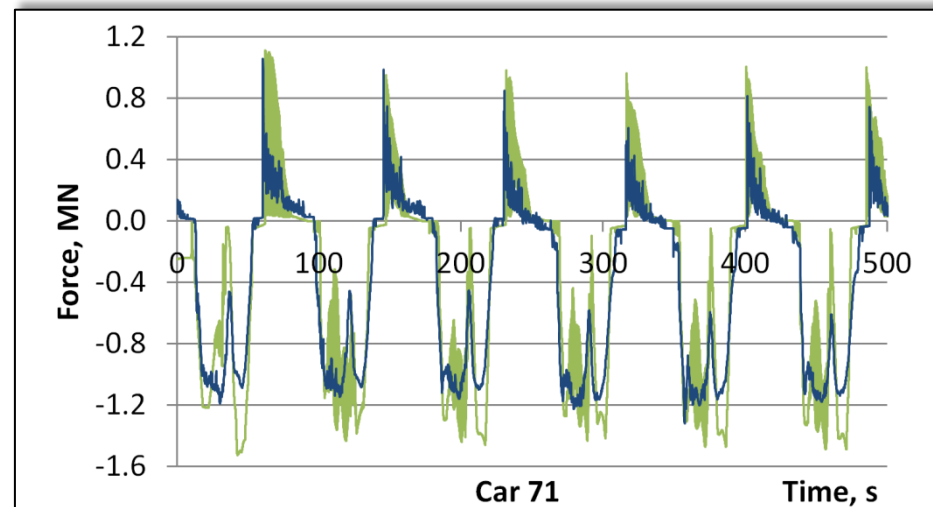
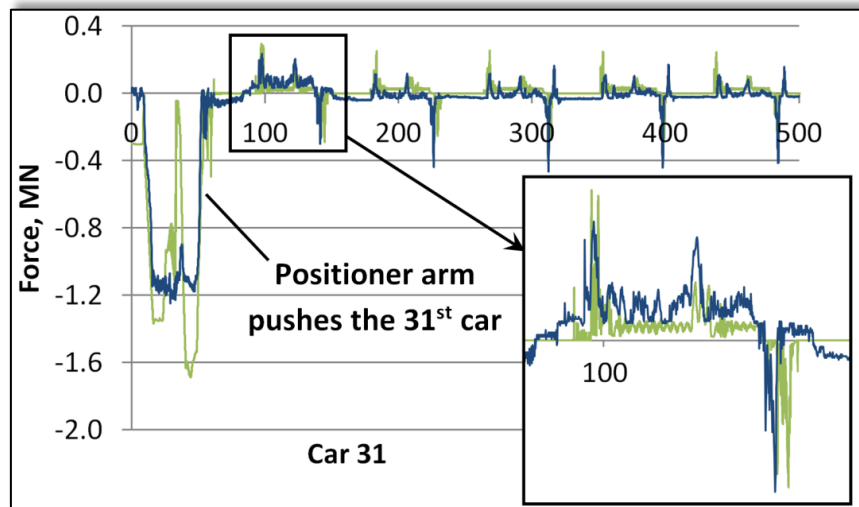


No.15 UM Train 列车纵向动力学模块





No.15 UM Train 列车纵向动力学模块



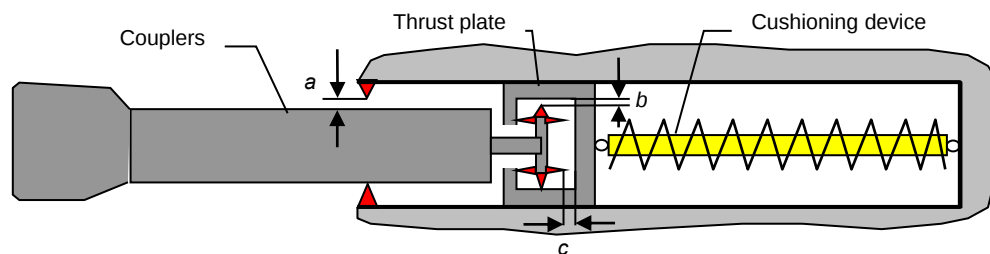
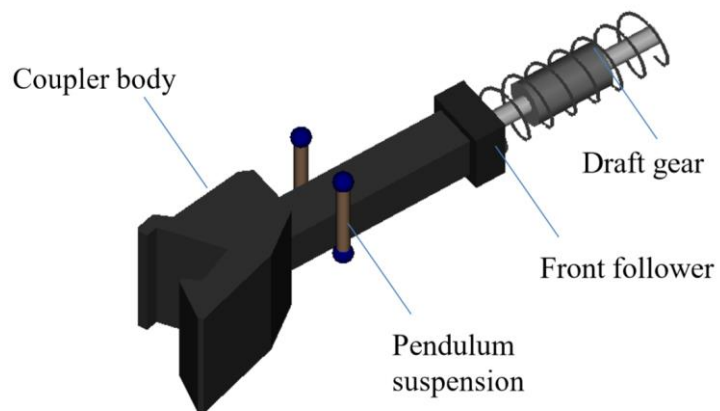
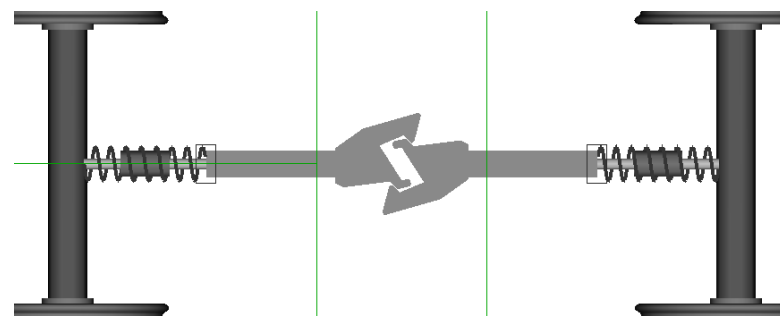
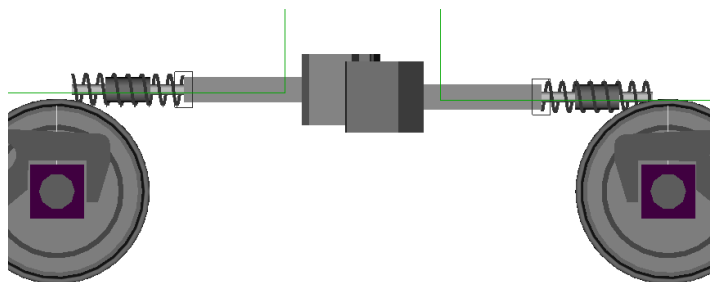
—— 试验数据

—— 仿真结果





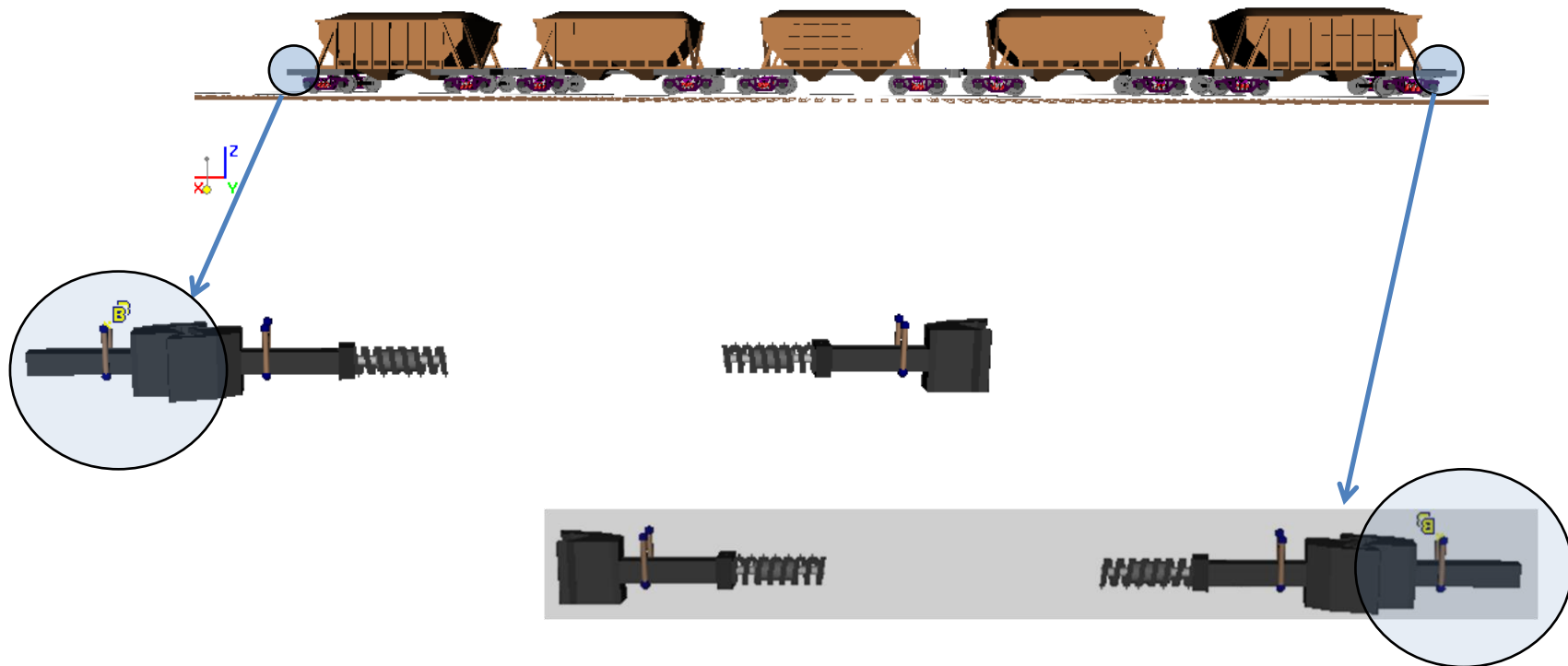
No.16 UM Train 3D 三维列车动力学模块



自动车钩3D模型



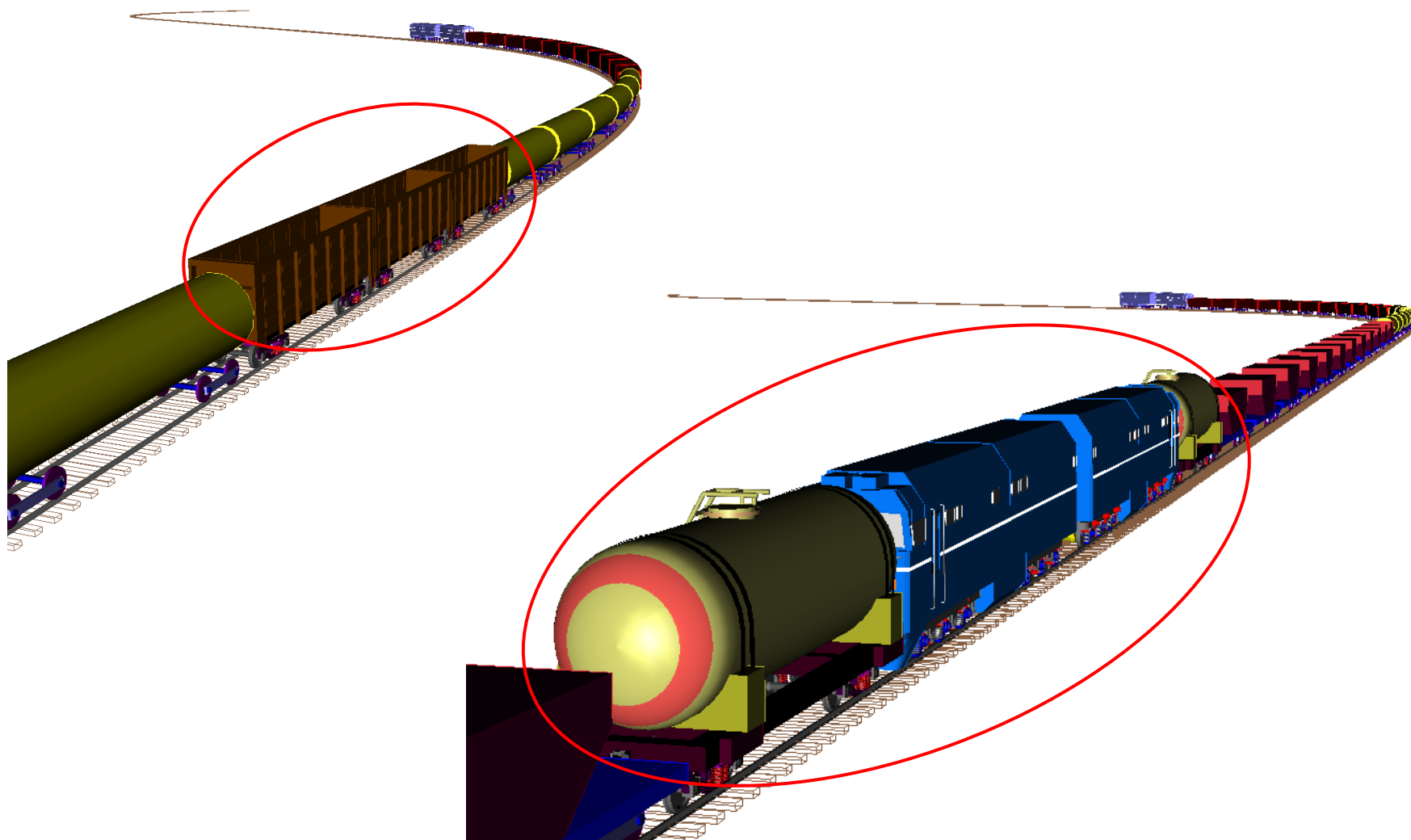
No.16 UM Train 3D 三维列车动力学模块



支持三维车辆和一维车辆的耦合

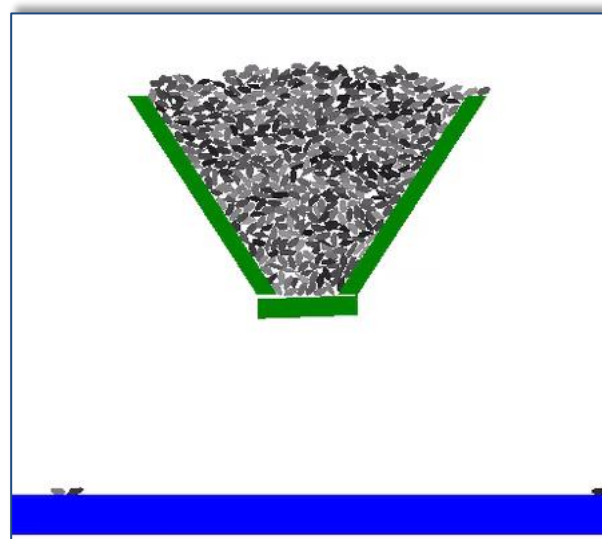
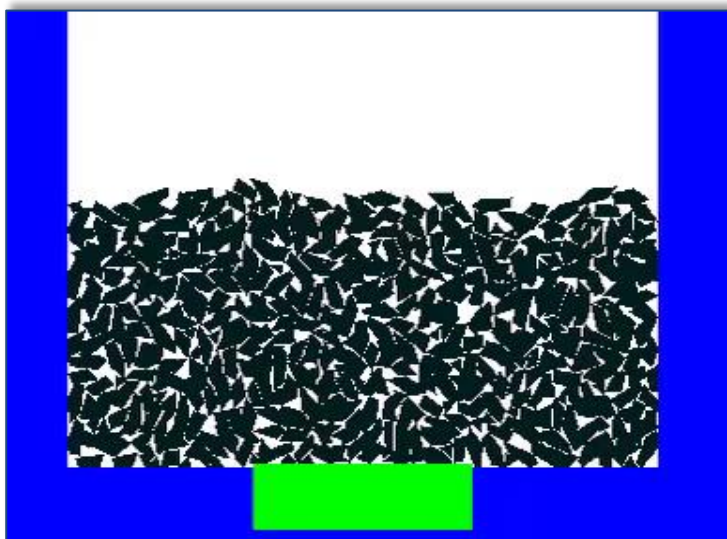
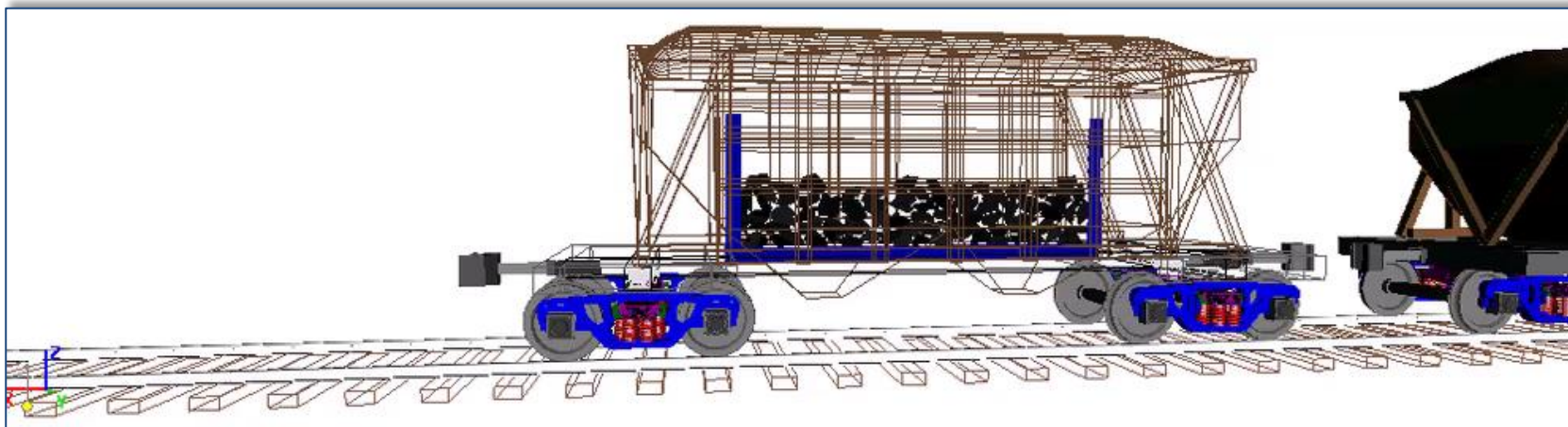


No.16 UM Train 3D 三维列车动力学模块



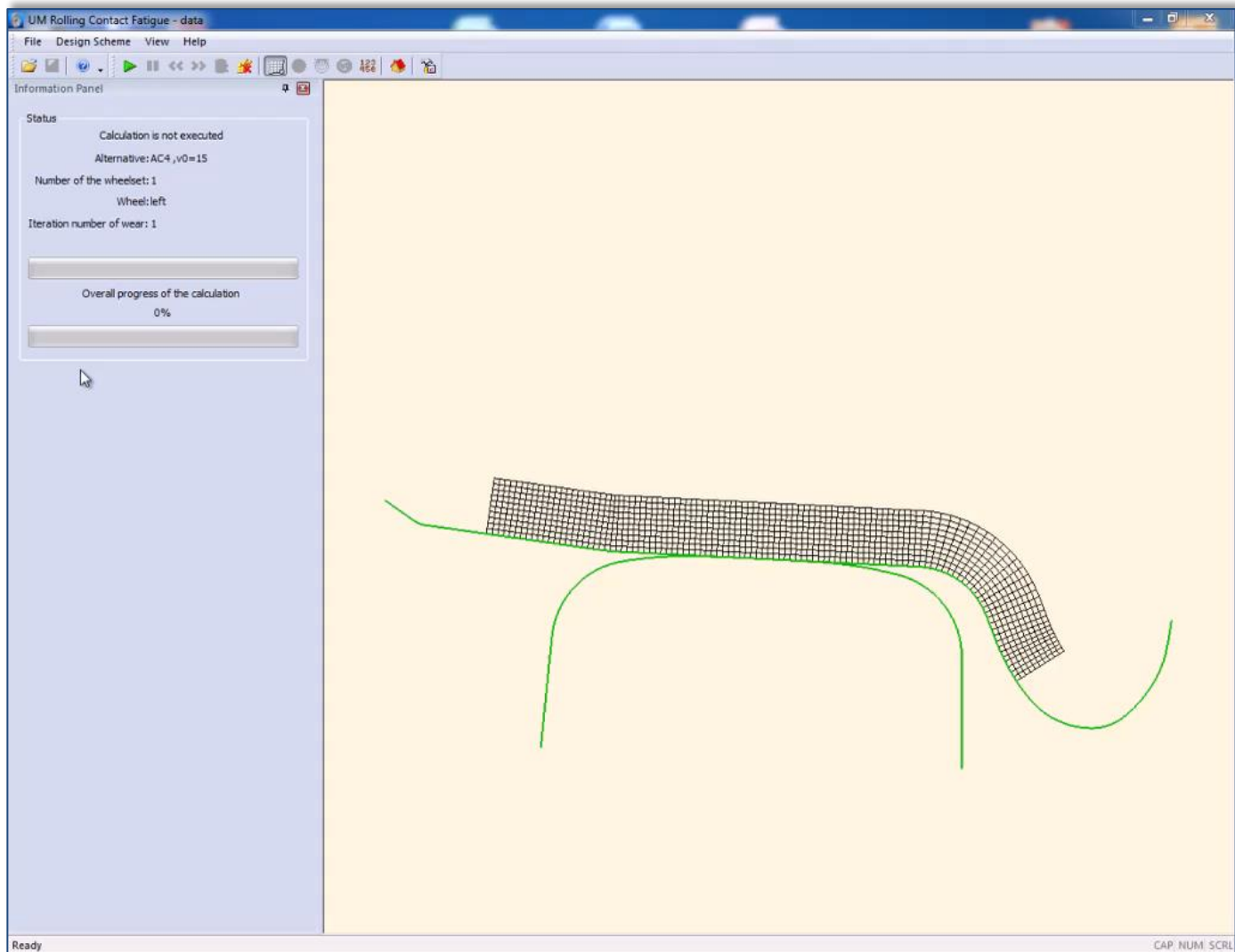


No.17 UM Ballast 平面散体模块





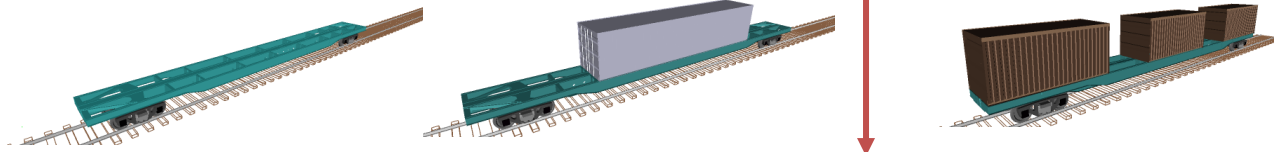
No.18 UM RCF 轮轨滚动接触疲劳模块





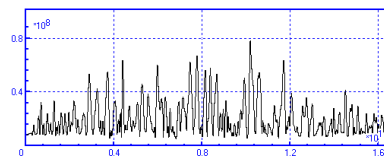
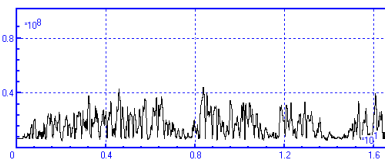
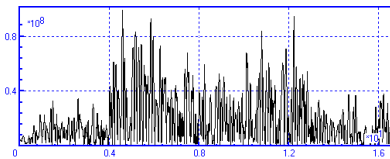
No.19 UM Durability 疲劳耐久性模块

划分不同的载荷工况



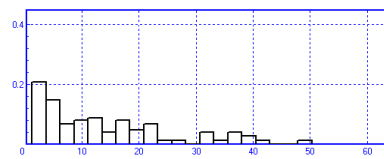
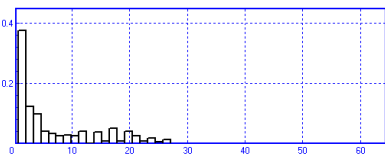
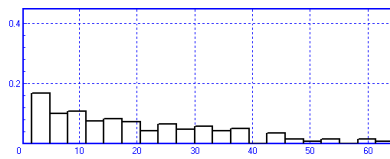
载荷工况

刚柔耦合动力学建模和仿真



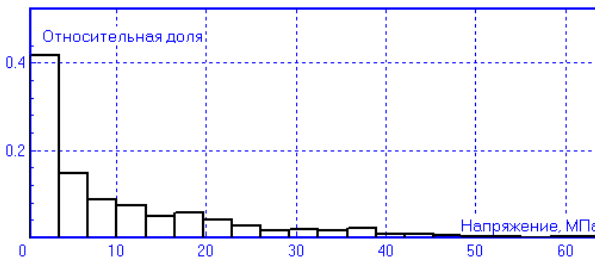
应力时程

应力载荷分析



工况载荷直方图

工作应力载荷参数分析

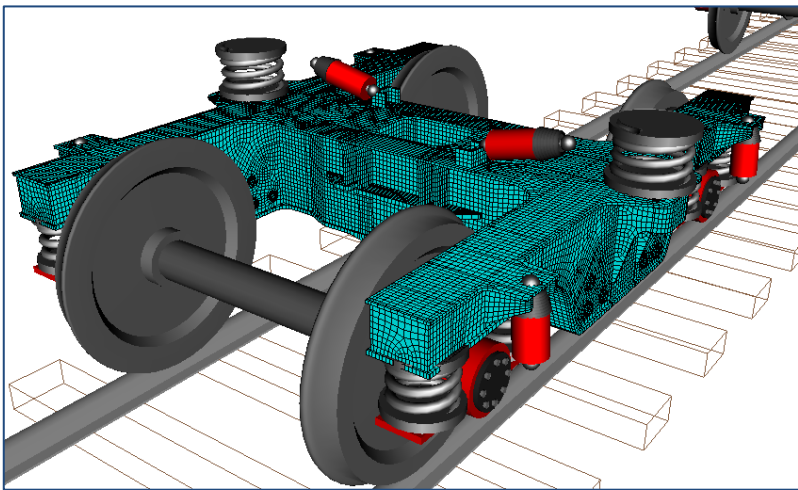


工作载荷直方图

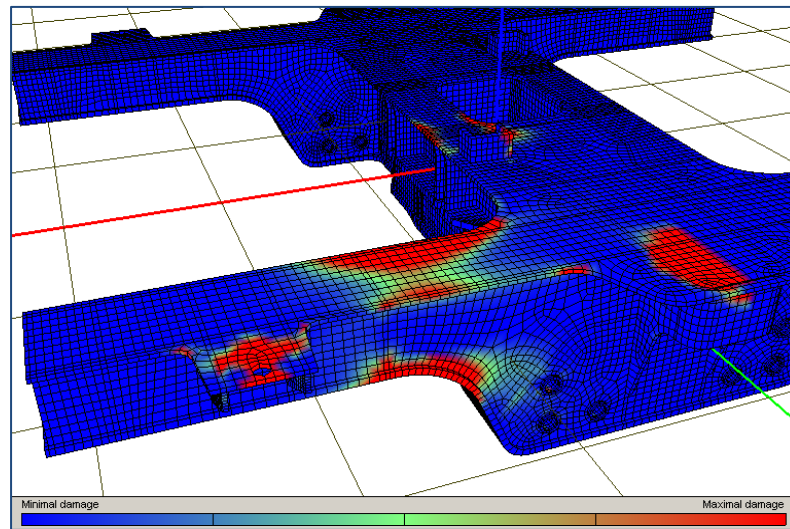
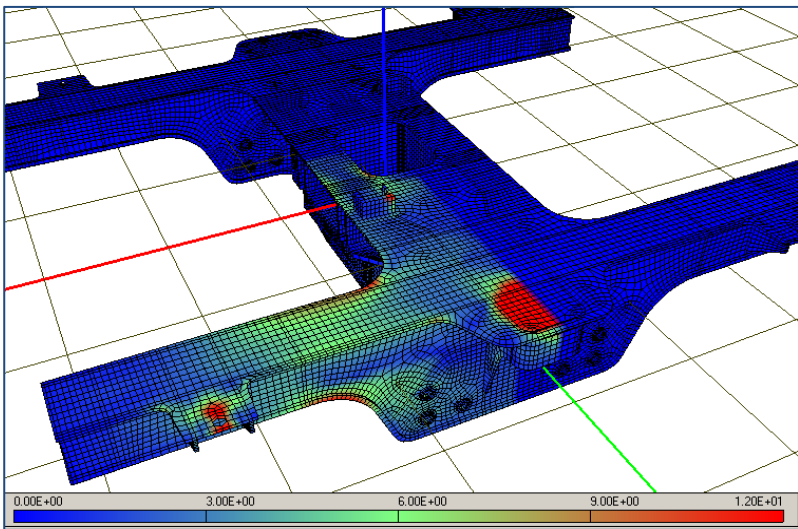


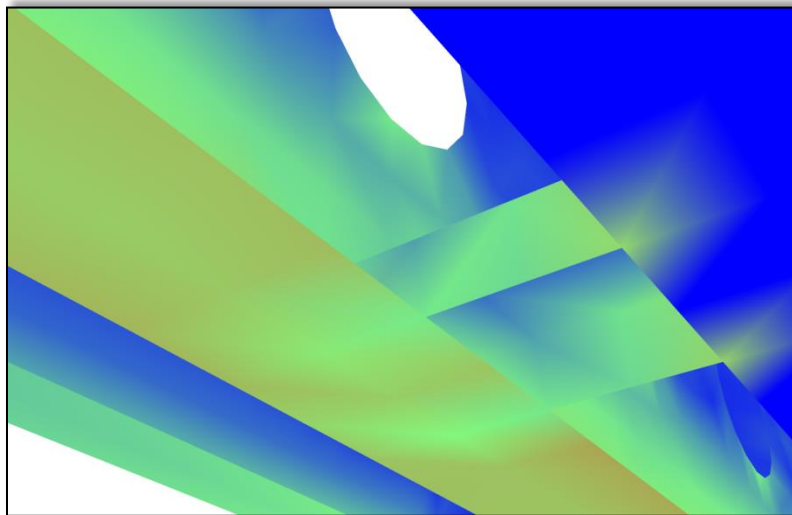


No.19 UM Durability 疲劳耐久性模块

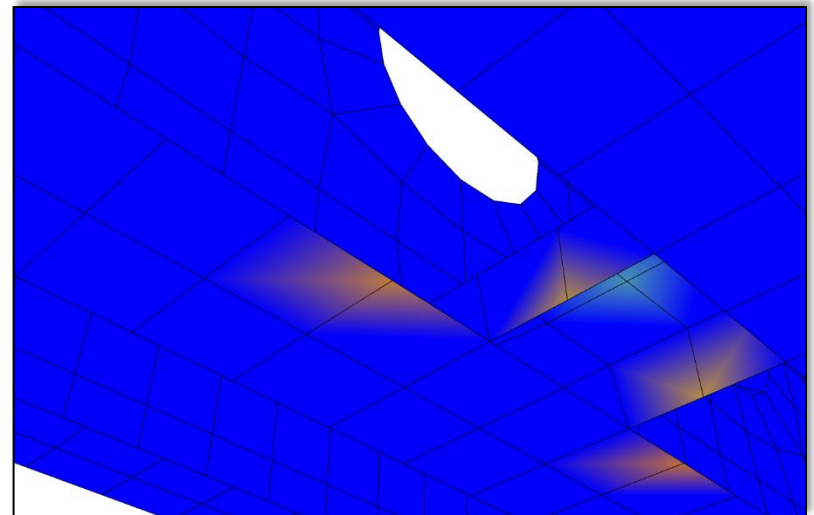


俄罗斯某机车构架应力
载荷和疲劳耐久性分析





最大应力幅分布



等效应力幅分布

安全系数

$$n = 1.28 \square [n] = 1.8$$

疲劳寿命 (年)

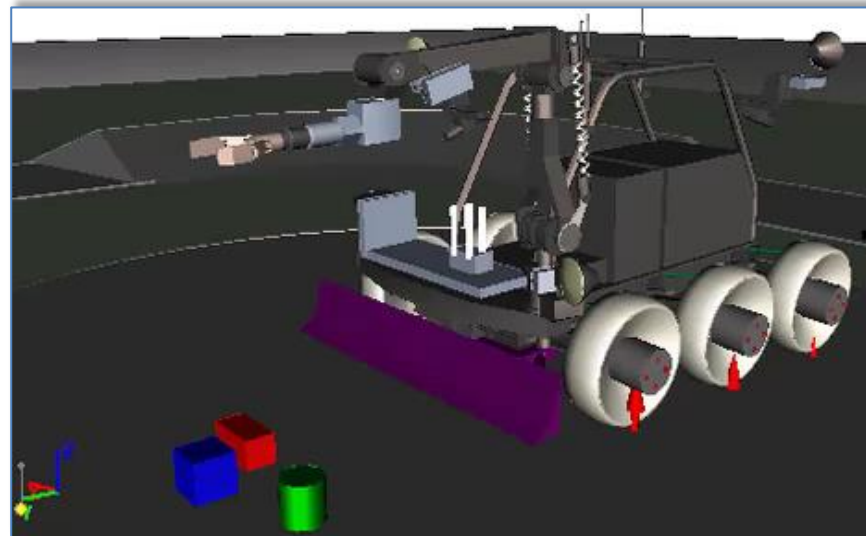
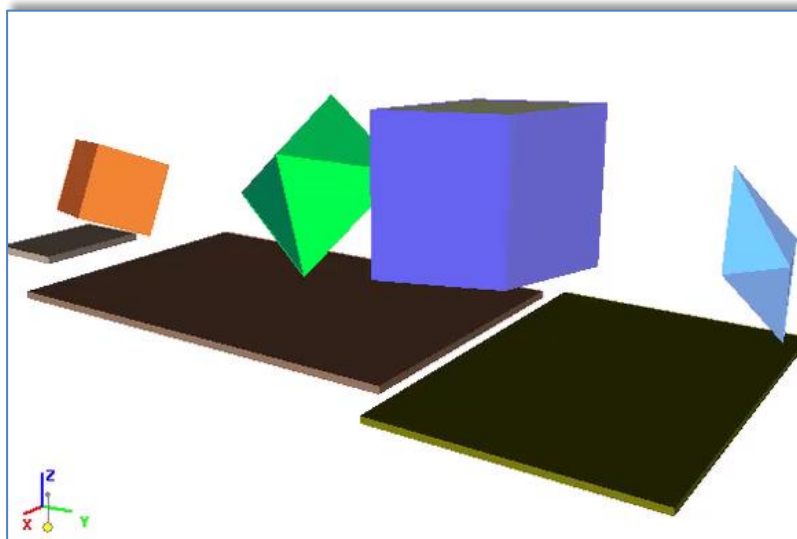
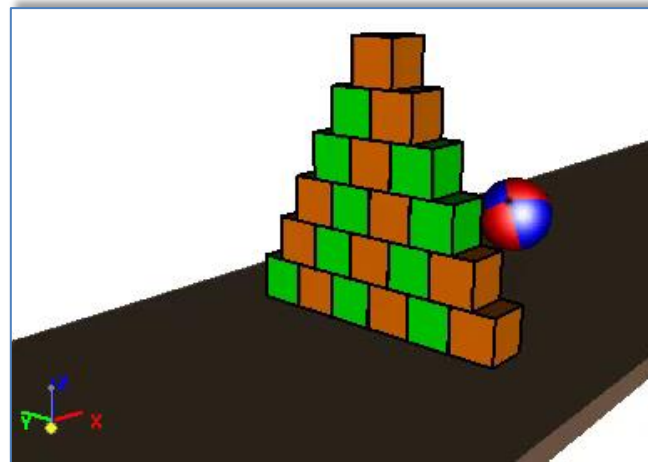
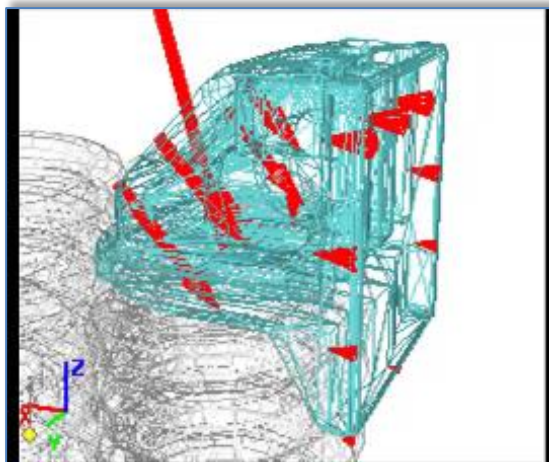
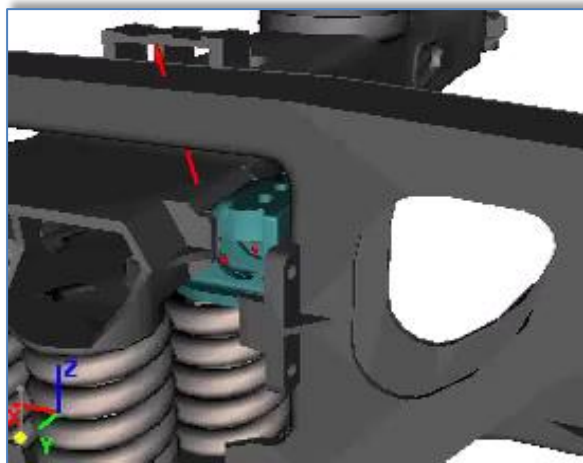
$$T_K = 7.35 \square [T_K] = 32$$



试验验证

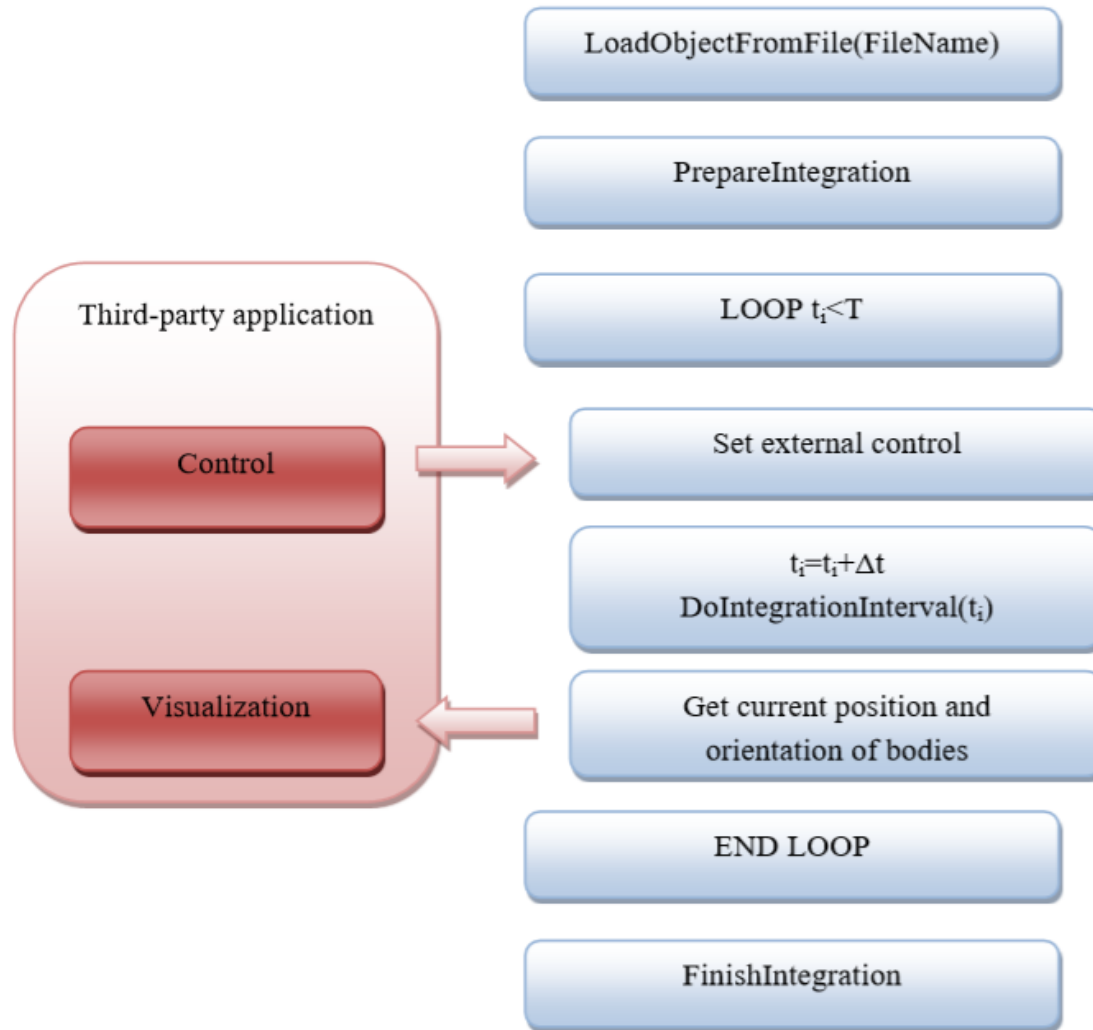


No.20 UM 3D Contact 自动三维接触模块



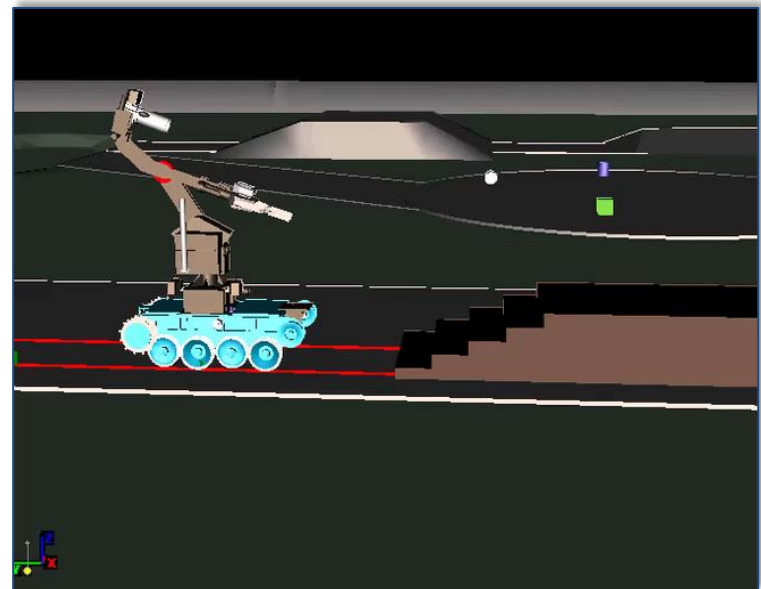
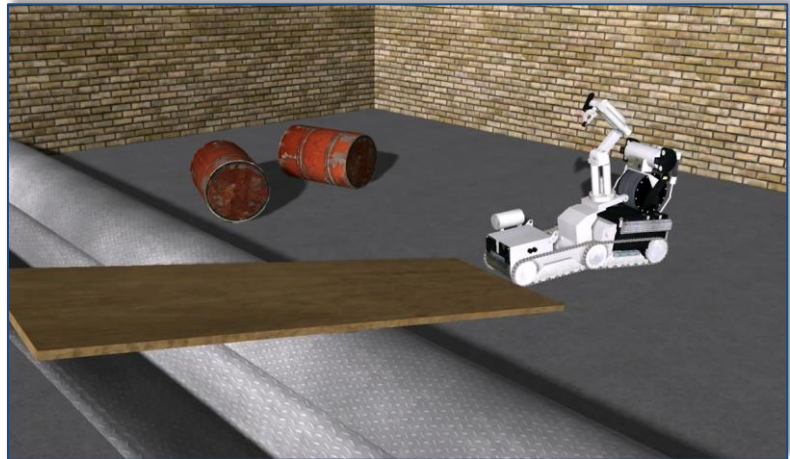


No.21 UM COM Server COM服务器模块





No.21 UM COM Server COM服务器模块





No.21 UM COM Server COM服务器模块



Tsim
TREN SIMULATÖRÜ



a)



b)



c)



d)

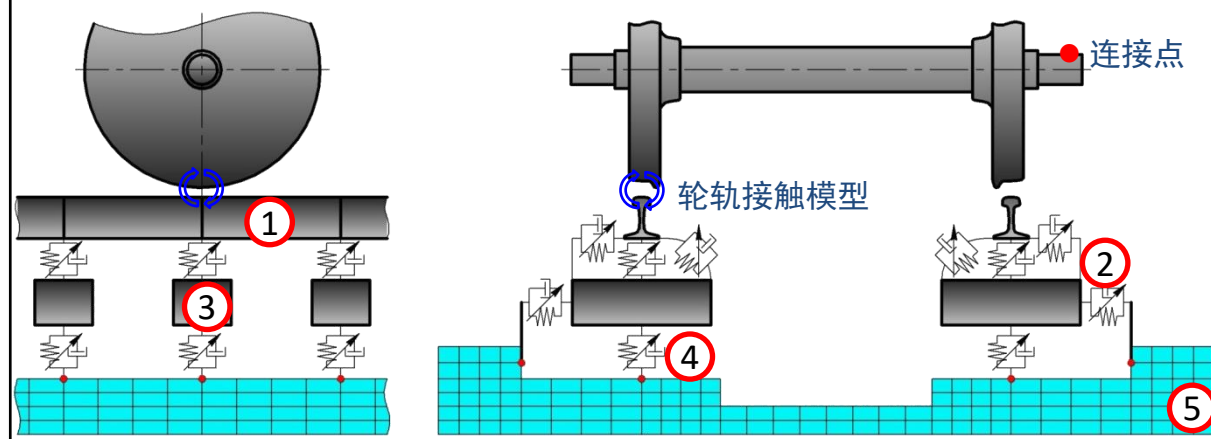




No.22 UM Flexible Railway Track 铁路柔性轨道模块

精细的三维柔性轨道模型

有效频率范围：0-5000 Hz



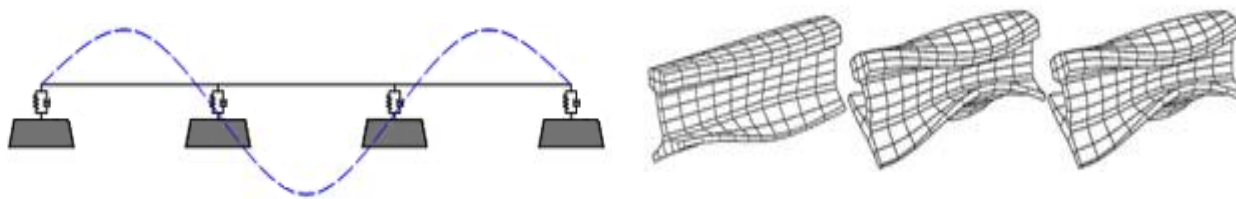
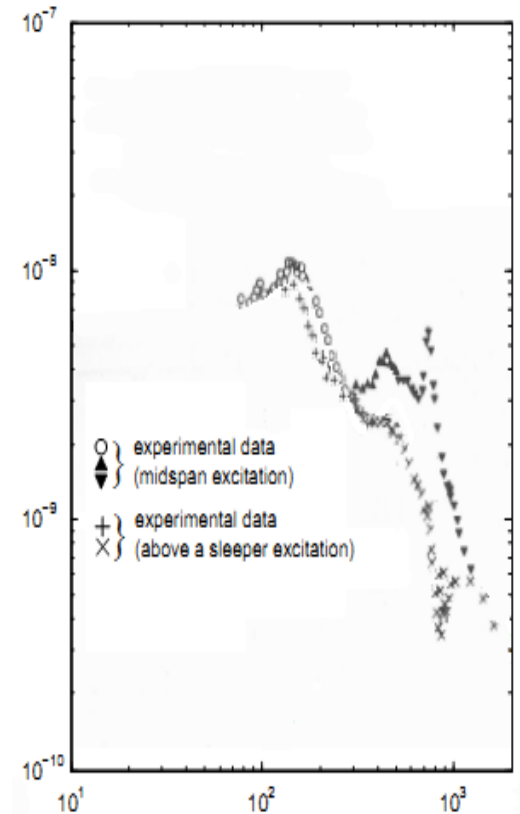
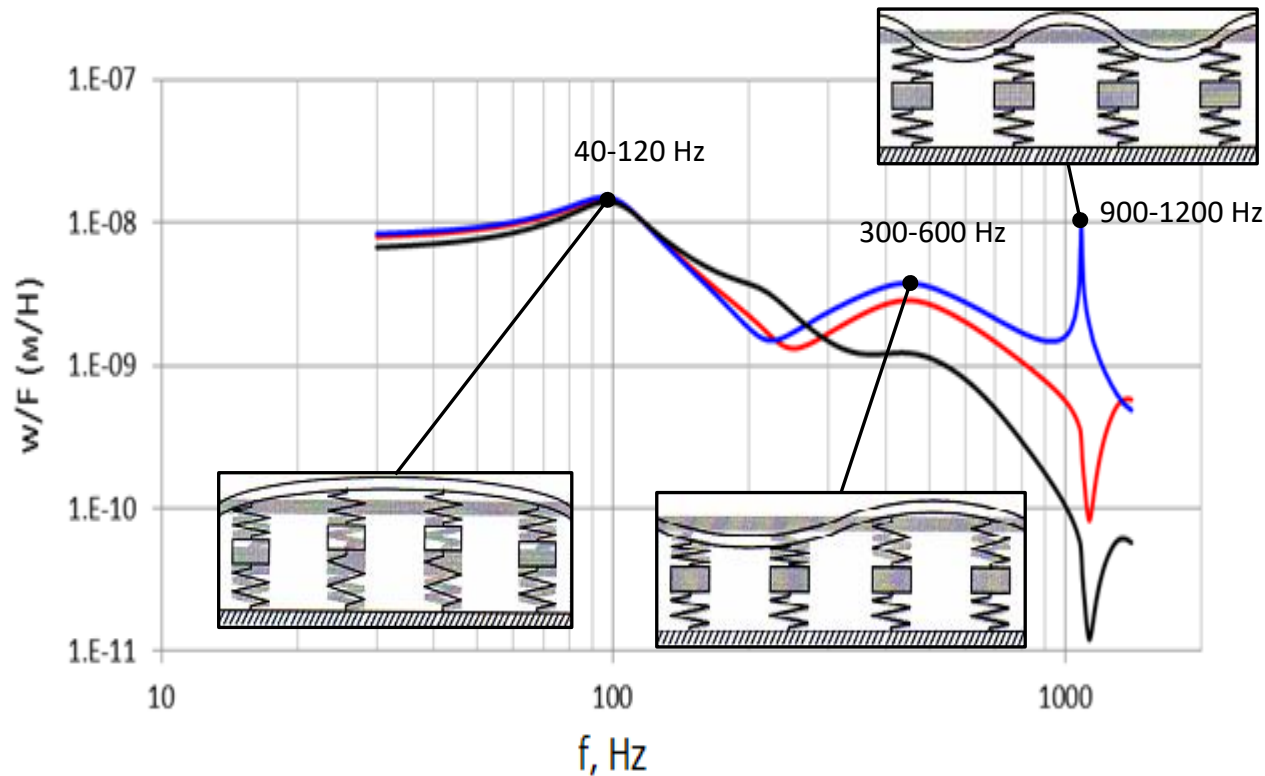
序号	轨道系统元件	力学模型
1	钢轨	3D 铁木辛柯梁
2	扣件	线性/非线性Bushing力元
3	轨枕（半枕）	三自由度刚体
4	轨枕垫板	线性/非线性Bushing力元
5	下部基础	刚性基础/ 外部导入弹性基础

适用范围

轨道结构振动、轮轨噪声、钢轨波磨、车轨耦合、车线桥耦合



No.22 UM Flexible Railway Track 铁路柔性轨道模块

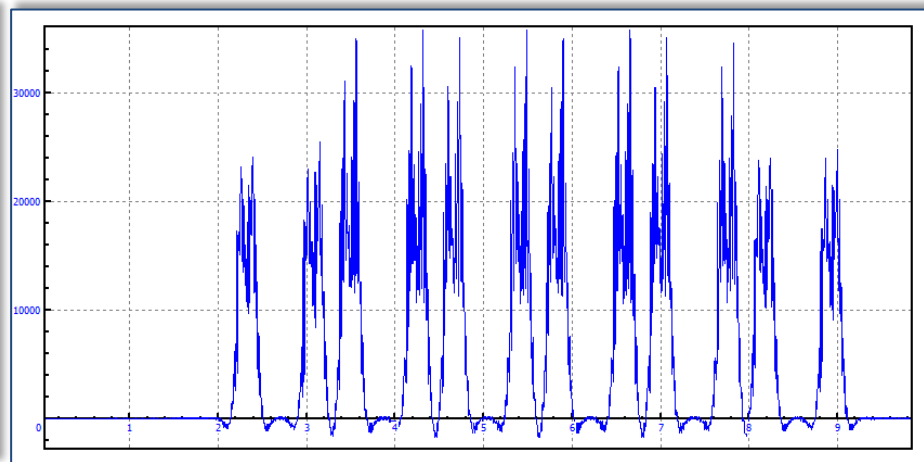
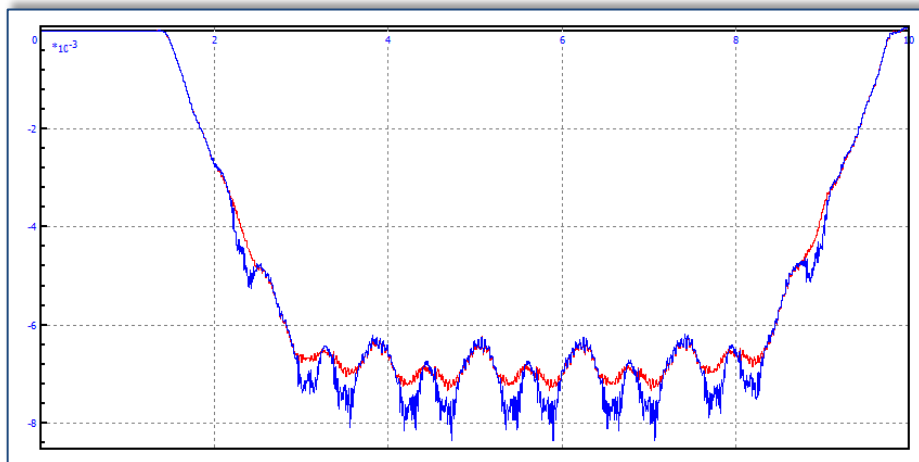
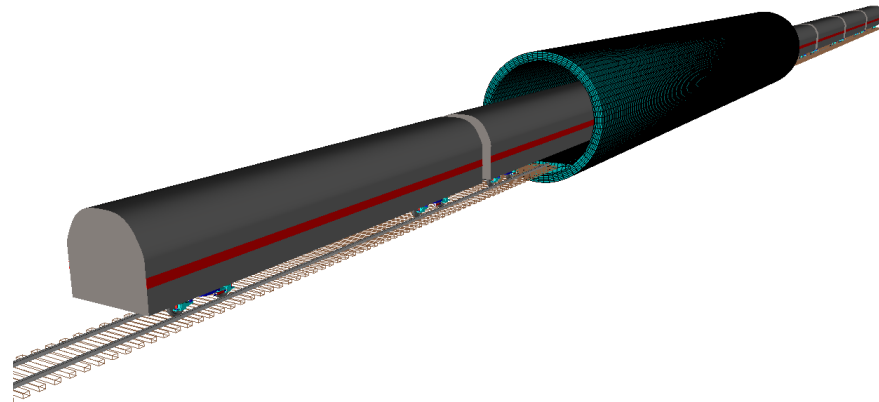
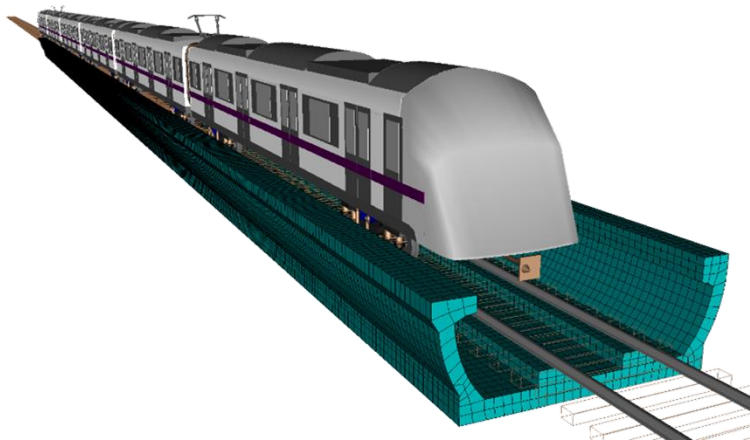


[K. KNOTHE, S.L. GRASSIE. Modelling of Railway Track and Vehicle/Track Interaction at High Frequencies. Vehicle System Dynamics: International Journal of Vehicle Mechanics and Mobility, Volume 22, Issue 3-4, 1993]





No.22 UM Flexible Railway Track 铁路柔性轨道模块





No.23 UM Scene 场景模块



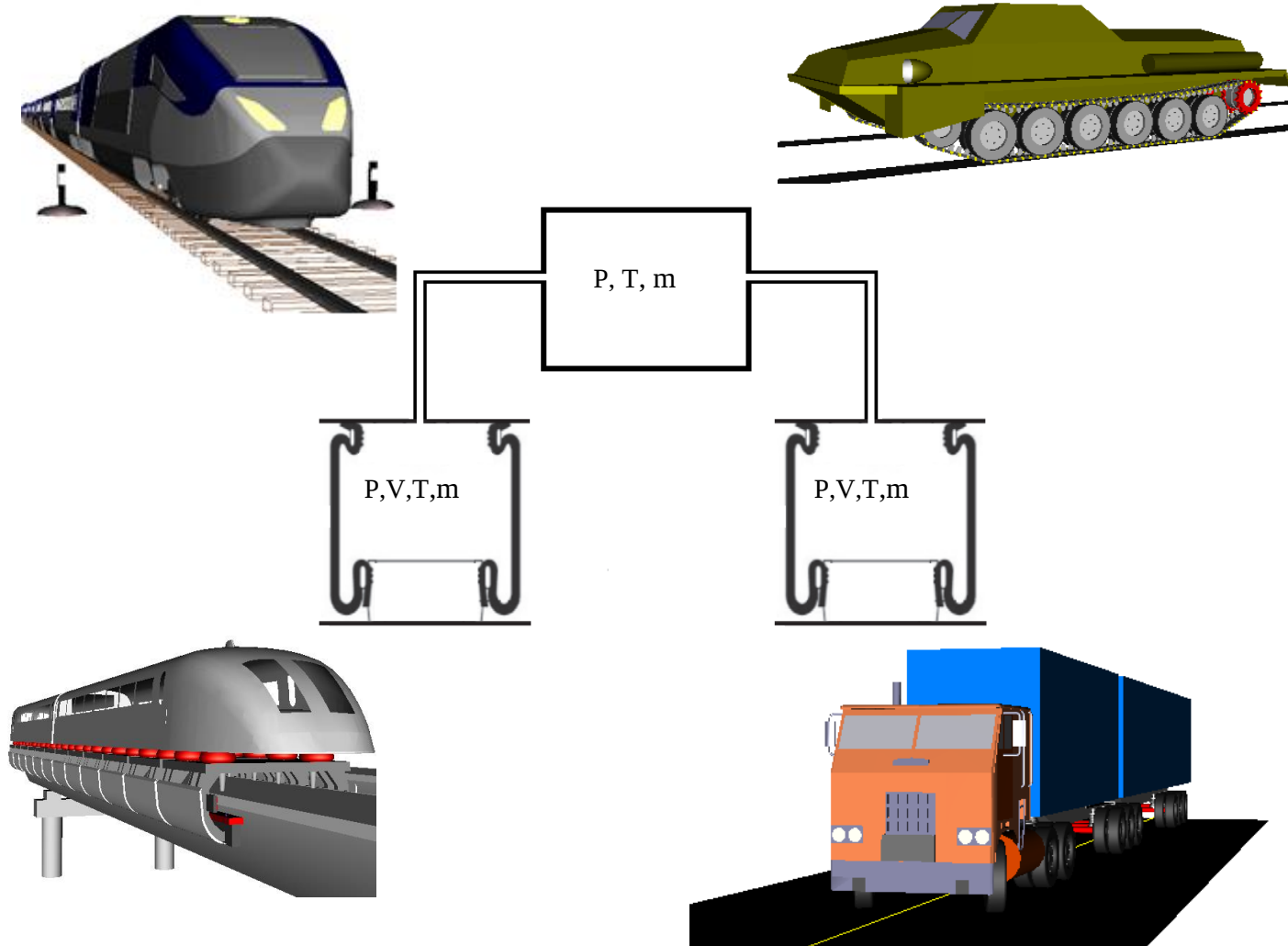


No.23 UM Scene 场景模块





No.24 UM Pneumatic Systems 气动模块





No.24 UM Pneumatic Systems 气动模块

UM - Simulation - c:\users\public\documents\um software lab\universal mechanism\9\samples\pneumatics\test 6as

File Analysis Scanning Tools Windows Help

Object simulation inspector

Speed unit
km/h m/s

Object simulation inspector

Solver Identifiers Initial conditions Object variables XVA Information Tools Pneumatics

Simulation process parameters Solver options Type of coordinates for bodies

Solver
☐ BDF
☐ ABM
☒ Park
☐ Gear 2
☐ Park Parallel

Type of solution
☐ Null space method (NSM)
☒ Range space method (RSM)

Time

Step size for animation and data storage

Error tolerance

☐ Delay to real time simulation
☐ Keep system matrix decomposition
☒ Computation of Jacobian
☐ Block-diagonal Jacobian

Integration Message Close

灭圆柏? left=16

Variables
☒ P, AS 1L - Pressu...
☒ P, AS 2L - Pressu...
☒ P, AS 3L - Pressu...
☒ P, AS 1R - Pressu...
☒ P, AS 2R - Pressu...
☒ P, AS 3R - Pressu...

Field name missing

Variables
☒ M(PS 2) - Mass (kg), Cha...
☒ M(PS 2) - Mass (kg), Cha...
☒ M(PS 2) - Mass (kg), Cha...
☒ M, AS 1L - Mass (kg), AS...
☒ M, AS 2L - Mass (kg), AS...
☒ M, AS 3L - Mass (kg), AS...
☒ M, AS 1R - Mass (kg), A...
☒ M, AS 2R - Mass (kg), A...
☒ M, AS 3R - Mass (kg), A...





UM软件模块列表

序号	模块名称
1	UM Base
1.1	UM Base/Control Panel
1.2	UM Base/Training Ground
1.3	UM Base/Ride Comfort
2	UM Subsystems
3	UM Loco
3.1	UM Loco/Multipoint Contact Model
3.2	UM Loco/Contact add-on Interface
3.3	UM Loco/Wheel Profile Wear Evolution
3.4	UM Loco/Rail Profile Wear Evolution
4	UM Automotive
5	UM Tracked Vehicle
6	UM Driveline
7	UM Flexible Wheelset
8	UM Monorail Train
9	UM Maglev
10	UM Experiments

序号	模块名称
11	UM Cluster
12	UM FEM
12.1	UM FEM/Vehicle-Bridge Interaction
12.2	UM FEM/Monorail Track
12.3	UM FEM/Maglev Track
13	UM Control
13.1	UM Control/User-defined Routines
13.2	UM Control/Matlab Import
13.3	UM Control/Matlab Cosimulation
13.4	UM Control/Block Editor
14	UM CAD Interfaces
15	UM Train
16	UM Train 3D
17	UM Ballast
18	UM RCF
19	UM Durability
20	UM 3D Contact

序号	模块名称
21	UM COM Server
22	UM Flexible Railway Track
23	UM Scene
24	UM Pneumatic Systems
25	UM Sensors
26	UM Video Flow



Thanks for your kind attention!



微信公众号



QQ交流群



技术中心：成都市金牛区交大路2号智业·加州印象6楼22号

商务中心：眉山市彭山区蔡山西路2号伟业广场19楼11号

