2024 MathWorks 中国汽车年会

虚拟车辆仿真的平台化应用策略

胡洪祥, MathWorks 中国

MathWorks®

CONTENTS

01. **Background / Motivation**
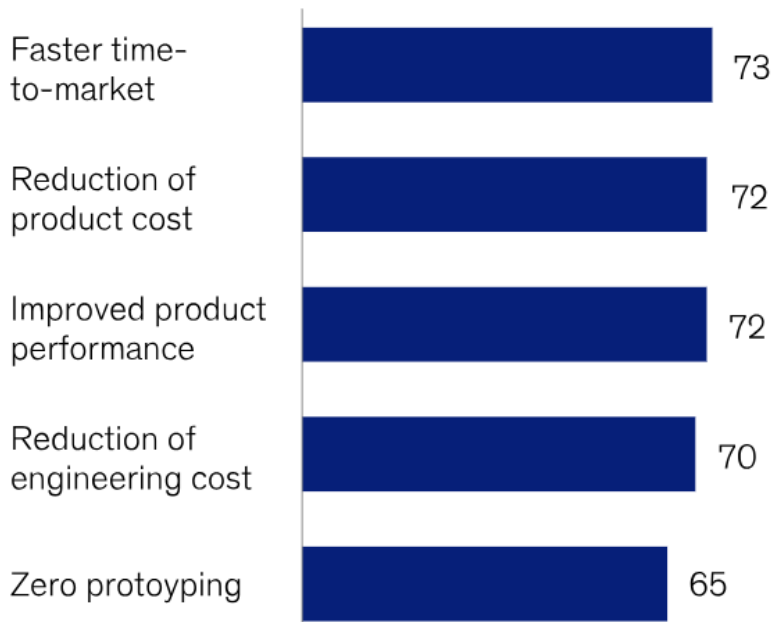
02. **Trends, Challenges, and Solutions**

03. **Summary**

McKinsey & Company

Future value drivers, %

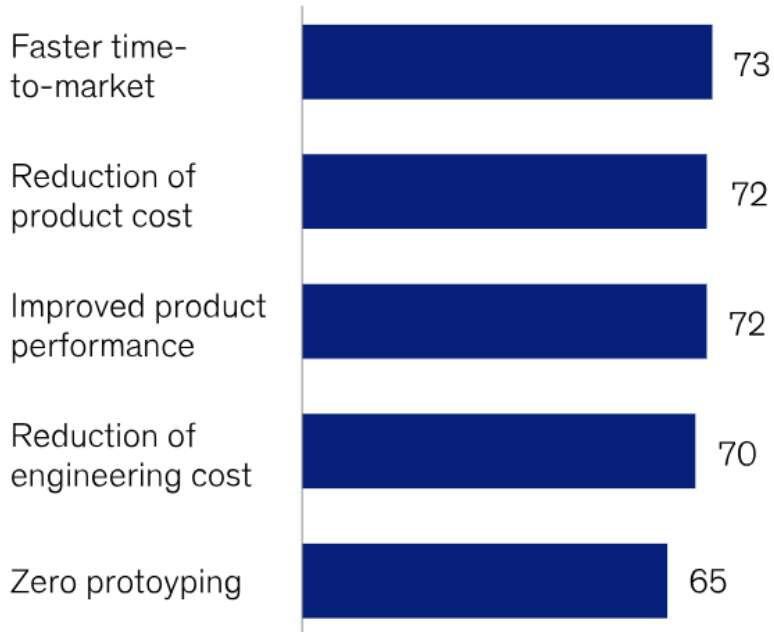|	
Faster time-to-market	73
Reduction of product cost	72
Improved product performance	72
Reduction of engineering cost	70
Zero protoyping	65

Unveiling the next frontier of **engineering simulation**
June 21,2023

Simulation drives next generation products, but are you seeing <u>McKinsey-level</u> benefits?

Industry Examples

McKinsey & Company

Future value drivers, %

Faster time-to-market	73
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Unveiling the next frontier of **engineering simulation**
June 21,2023

NA MAC,2024

"Close to 400 global users – multiple domains"

NA MAC,2023

"Simulation for everyone"
Accessibility to vehicle simulations for non-simulation users

NA MAC,2020

"500+ Members/Passive Users with 100+ Active Users"

The aim is to maximize access to simulation capabilities for as many engineers as possible

NA MAC,2024

"Close to 400 global users – multiple domains"

NA MAC,2023

"Simulation for everyone"
Accessibility to vehicle simulations for non-simulation users

NA MAC,2020

"500+ Members/Passive Users with 100+ Active Users"

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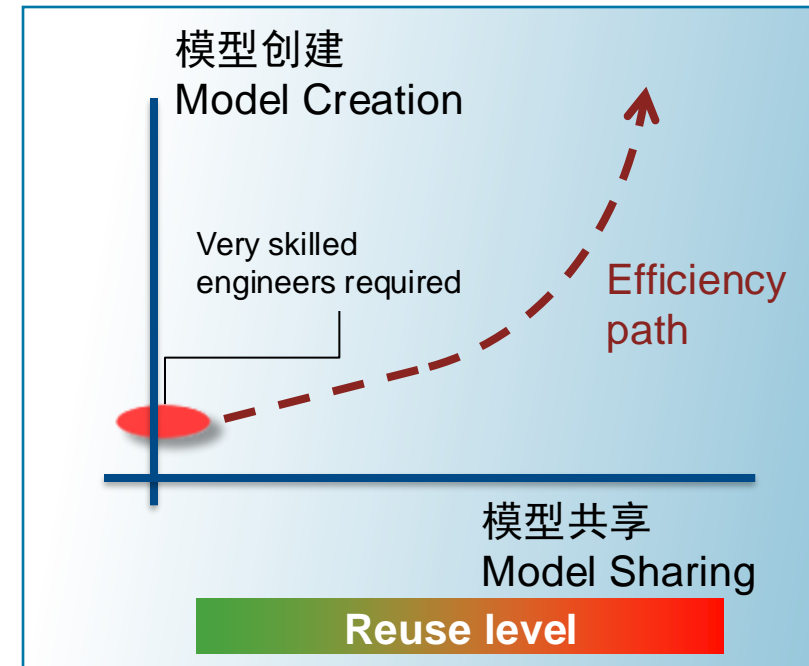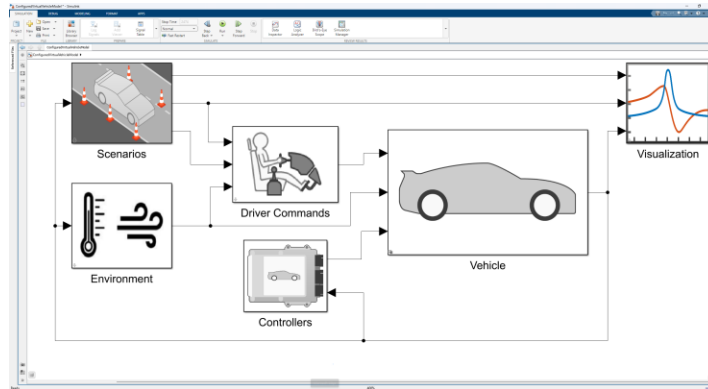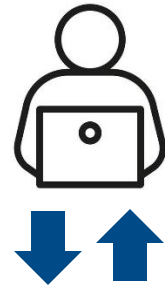# 3 Stages - Progression of Virtual Vehicle Solution
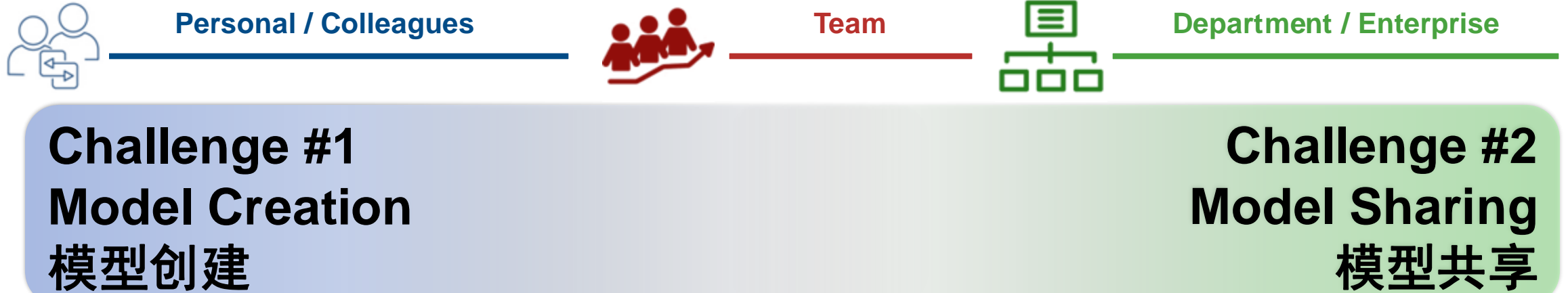
Personal / Colleagues

Team

Department / Enterprise

**Challenge #1
Model Creation
模型创建**

**Challenge #2
Model Sharing
模型共享**

Challenge #1: Model Creation

Personal / Colleagues Team Department / Enterprise

模型创建
Model Creation

Very skilled
engineers required

Efficiency
path

模型共享
Model Sharing

Reuse level

建模方法

物理原理建模 ← → **数据驱动建模**

Programming
(MATLAB, C)

Block Diagram
(Simulink)

Modeling Language
(Simscape language)

Symbolic Methods
(Symbolic Math Toolbox)

Physical Networks
(Simscape Products)

Semi-Physical
(Powertrain Blockset
Vehicle Dynamics Blockset)

Parameter Tuning
(Simulink Design Optimization)

Statistical Methods
(Model Based
Calibration Toolbox)

System Identification
(System Identification
Toolbox)

Neural Networks
(Deep Learning
Toolbox)

基于Simulink和DIL技术的智能底盘虚拟标定
13:30–14:00

随着整车开发周期的不断缩短，个别项目甚至短于24个月。面对压缩的开发周期，底盘的标定成为了关键难点。智能汽车时代，电控系统越来越多，动力、制动、悬架、转向等等都需要通过联标来确保整车性能表现，是否有一种技术能够将开发前移，确保技术验证的充分性成为行业内的热点和难题。MATLAB®和Simulink®工具包提供的集成仿真环境能解决模型化问题。通过与其他实时仿真系统的交互，可以实现虚拟标定和验证工作的前移，结合HIL和DIL技术，加上高精度车辆和轮胎模型，在虚拟环境下实现了电控系统的标定。

张伦维, 吉利汽车研究总院

整车级BEV热管理模型开发及应用
14:00–14:30

如今电动车技术不断发展和普及，热管理技术已经成为电动车设计中至关重要的一环。整车级热管理模型的搭建和仿真可以有效降低热管理系统的开发成本，并大幅提高开发效率。通过该模型，设计团队可以实现前期的架构设计预演、快速的方案迭代优化以及能耗与性能的平衡等设计目标。本演讲将深入探讨整车级电动车热管理系统的建模过程、关键技术点和项目实例。

陈博闻, 泛亚汽车技术中心
有限公司

如何在MATLAB中实现纯电动车整车能量及驾驶性的精准高效管理
15:30–16:00

在"双碳"战略指引下，新能源智能电动汽车正在加速发展，市占率也在逐渐升高。整车性能的好坏直接决定了用户对品牌的认可度，也直接影响到他们的购买决策。因此，面对当前百花齐放的激烈市场竞争，开发具有卓越性能的汽车产品（包括整车性能）显得尤为重要。在众多性能指标中，驾驶性与能耗是最为关键且直观的两项评价标准。本报告着重讨论如何应用MATLAB®来高效、精准的实现纯电动汽车（BEV）的能耗和驾驶性能管理，旨在为整车厂（OEM）的工程与技术人员在项目开发与研究过程中提供参考。

舒绍文, ONVO 乐道汽车

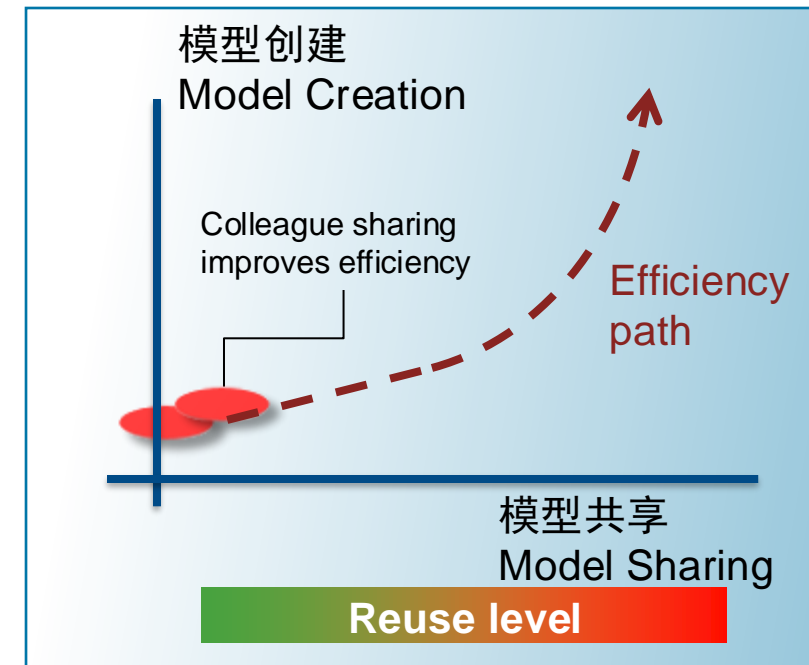# Challenge #1: Model Creation

Personal / Colleagues   Team   Department / Enterprise
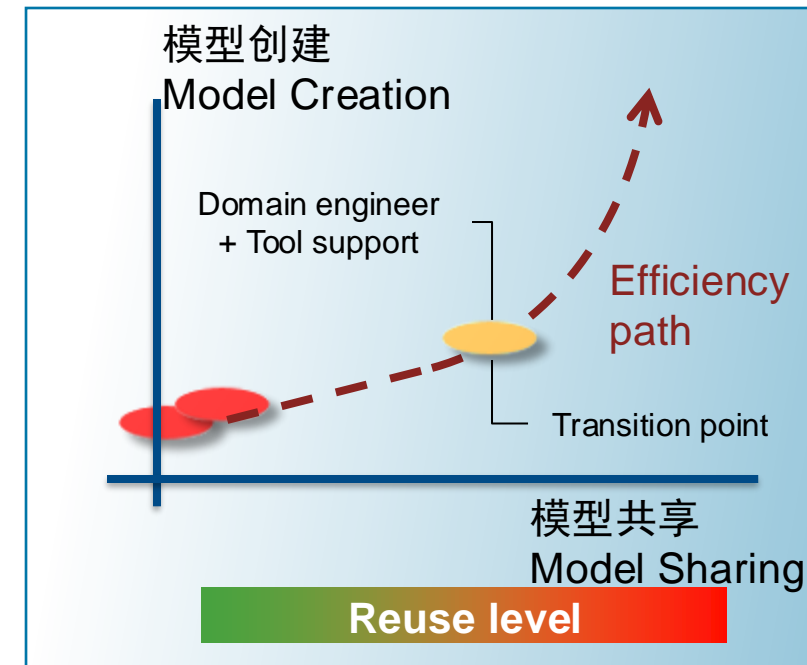
- Peer to Peer sharing improves efficiency incrementally.

模型创建
Model Creation

Colleague sharing
improves efficiency

Efficiency
path

模型共享
Model Sharing

Reuse level
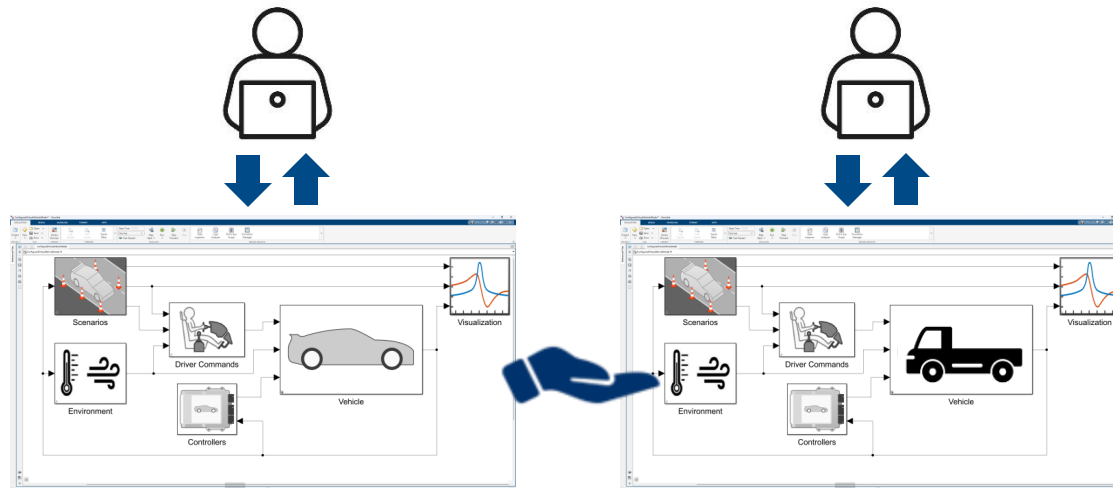
Pivotal / Transition Point: Tooling Support Introduced

Personal / Colleagues   **Team**   Department / Enterprise

- To scale effectively with increasing users, the implementation of dedicated tools is crucial to streamline processes.

- Vehicle templates
- Existing components
- Pre-defined parameters
- Targeting internal use
- UI development
- Pre and post processing
- Workflow driven
- Automation

Tool support

Model created through UI and existing templates supporting more users

模型创建
Model Creation

Domain engineer
+ Tool support

Efficiency path

Transition point

模型共享
Model Sharing

Reuse level
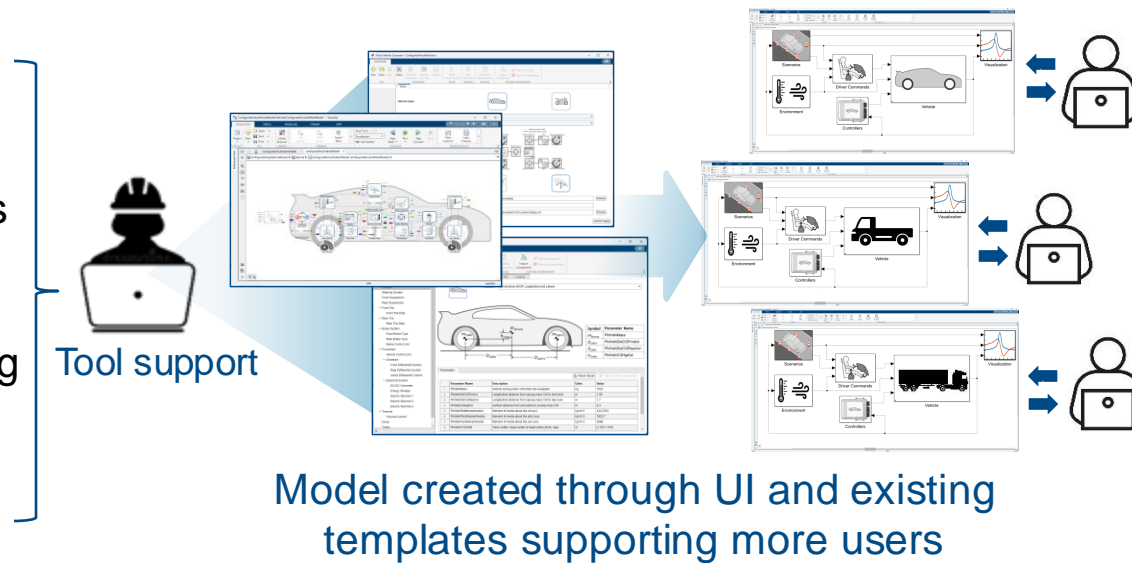
Challenge #2: Model Sharing

Challenge #2: Model Sharing
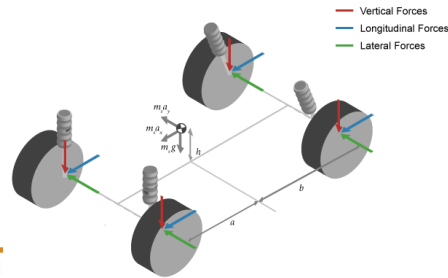
Personal / Colleagues — **Team** — **Department / Enterprise**

Powertrain Analysis

- **Longitudinal vehicle model**
- Low fidelity suspension
- Detail motor model
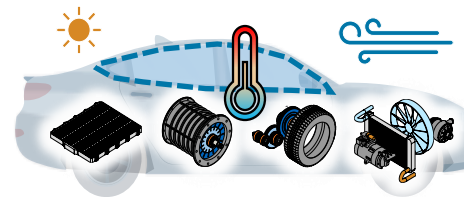- No thermal capability
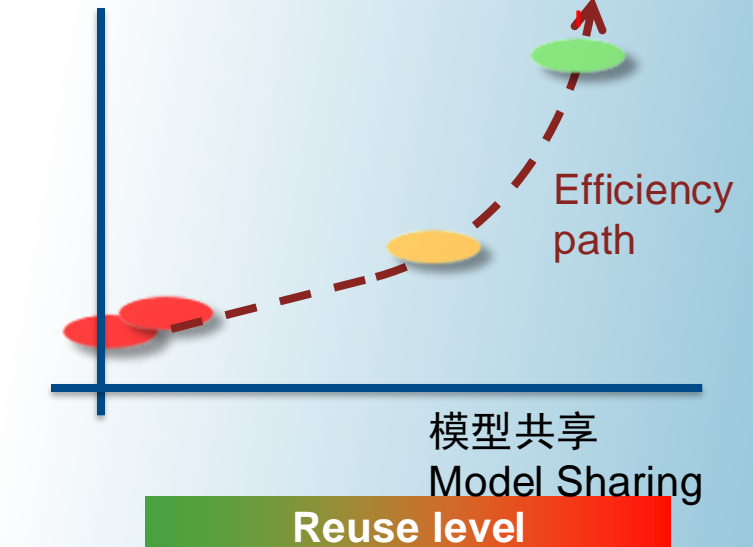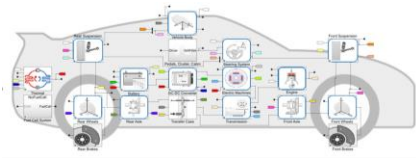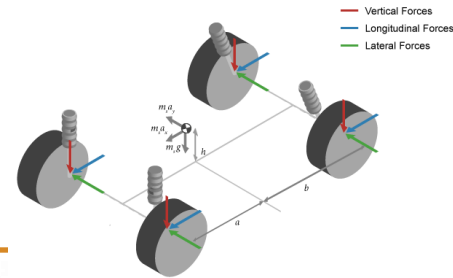- Pack level battery model

Vehicle Dynamic Analysis

- Complex vehicle model
- 3DOF vehicle body
- Medium fidelity suspension model
- Pack level battery model

Vertical Forces
Longitudinal Forces
Lateral Forces

Thermal Analysis

- **Longitudinal vehicle model**
- Mid-fidelity powertrain components
- Cell level battery model
- Environment

模型创建
Model Creation

Efficiency path

模型共享
Model Sharing

Reuse level

Challenge #2: Model Sharing

**Personal / Colleagues**   **Team**   **Department / Enterprise**

Powertrain Analysis

- **Longitudinal vehicle model**
- Low fidelity suspension
- Detail motor model
- No thermal capability
- Pack level battery model

Thermal Analysis

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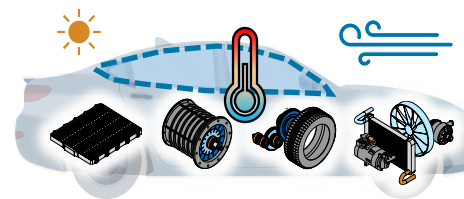
Vehicle Dynamic Analysis

- Complex vehicle model
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模型创建
Model Creation

Efficiency path

模型共享
Model Sharing

Reuse level

Challenge #2: Model Sharing

**Personal / Colleagues**   **Team**   **Department / Enterprise**

- At this level, the following becomes increasing important
  - Cross-team contributions and reuse of <u>assets</u> (models)
  - Discoverability of existing content
  - Ownership and feedback
  - Collaboration and learning
  - Management and maintenance of <u>assets</u> (models)

模型创建
Model Creation

Efficiency path

模型共享
Model Sharing

Reuse level
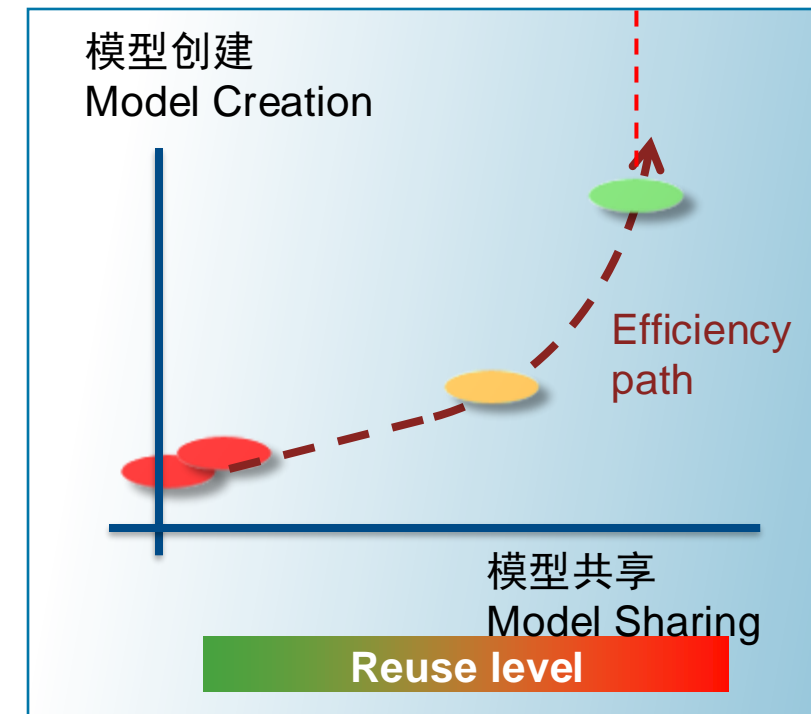
Challenge #2 - Proposed Solution

Imagine MATLAB File Exchange…
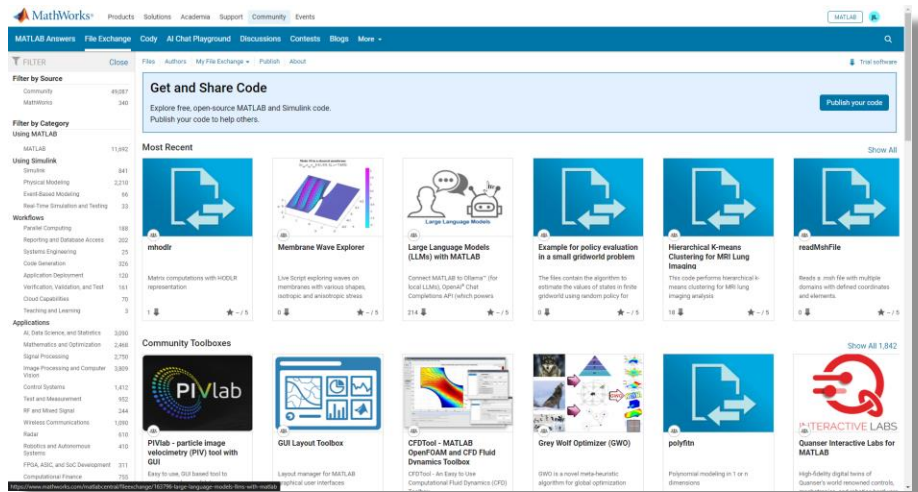
01 | **Access**

02 | **Collaboration and Sharing**
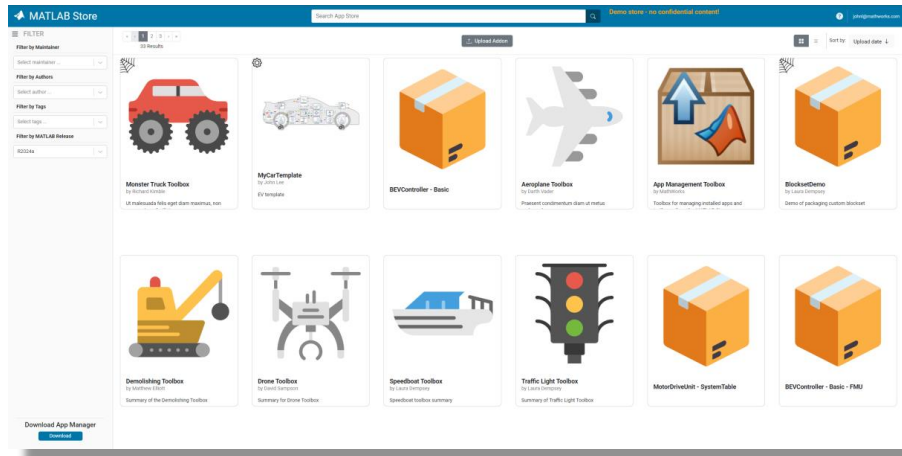
03 | **Learning and Development**

04 | **Time and Effort Savings**

05 | **Quality and Reliability**

Challenge #2 - Proposed Solution

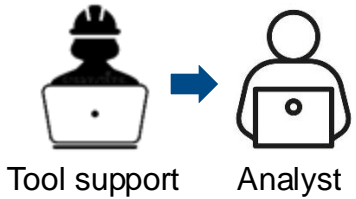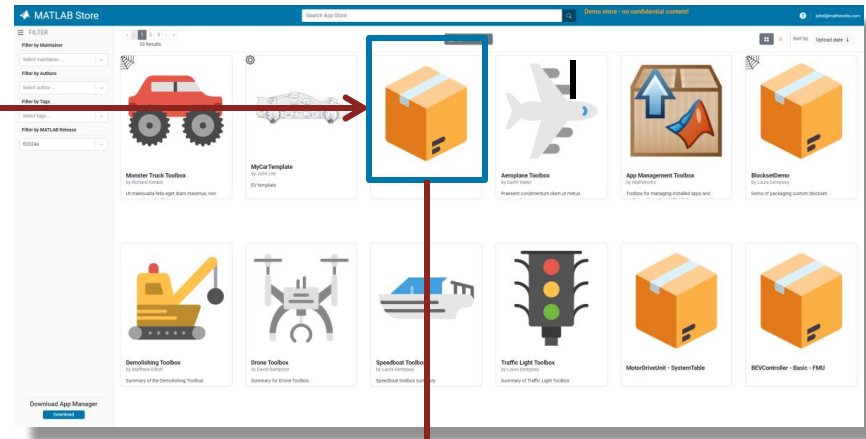**Imagine MATLAB File Exchange…as an internal "Vehicle Component Garage"**

01 | **Access**

04 | **Time and Effort Savings**

02 | **Collaboration and Sharing**

05 | **Quality and Reliability**

03 | **Learning and Development**

Example Use Cases 1: Analyst Workflow

Tool support → Analyst

Clearly defined analysis package
Ex: performance variation with change in motor curve

Analysis Type

- Test Scenarios
- Vehicle Template
- Output Monitor
- Analysis
- Reporting
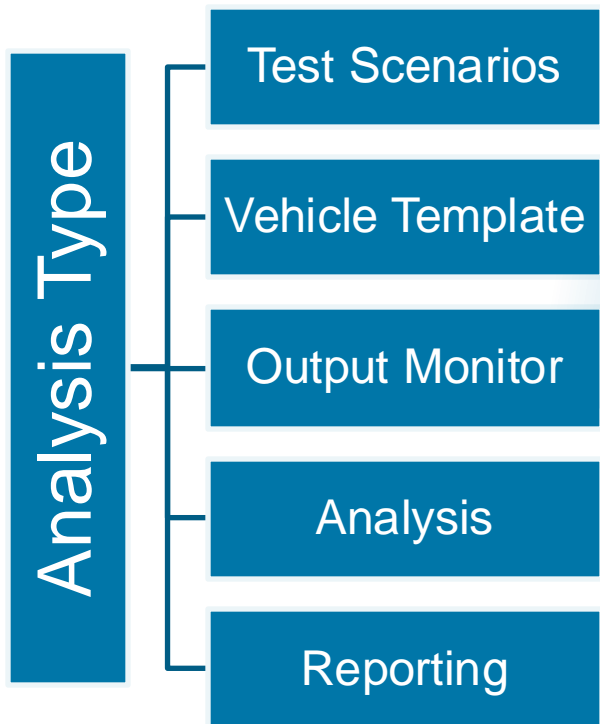
Content is packaged and released

MBD Toolkit
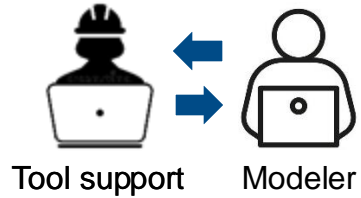by Matt Elliott

Version: 1.1.0

Requires

Aeroplane Toolbox @ 3.3
Demolishing Toolbox @ 2.0

MATLAB Release Compatibility

Packaged with R2023b
No MATLAB compatibility specified

Platform Compatibility

✔ Windows   ✔ Linux   ✔ Mac   ✔ MATLAB Online

User can work on an abstracted level

Final Report

Example Use Cases 2: Advanced Users

Tool support **Modeler**

- Modelers may need to self-study to create new models.
- New components are developed without checking for similar content.
- No direct way to share content with others.
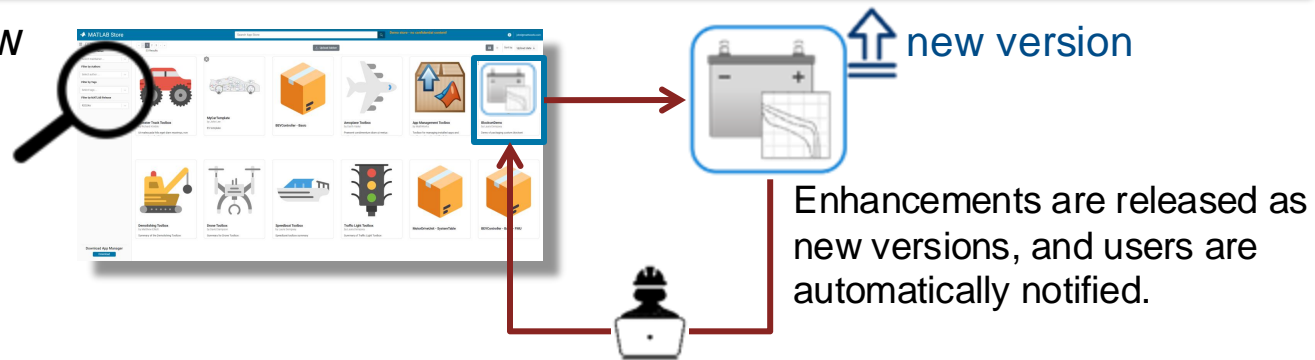- Time and resources might be wasted

New component requirements

NEW new creation
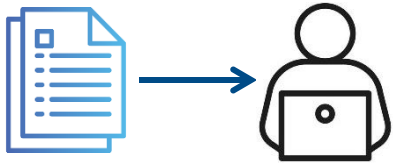
Old workflow

New workflow

new version

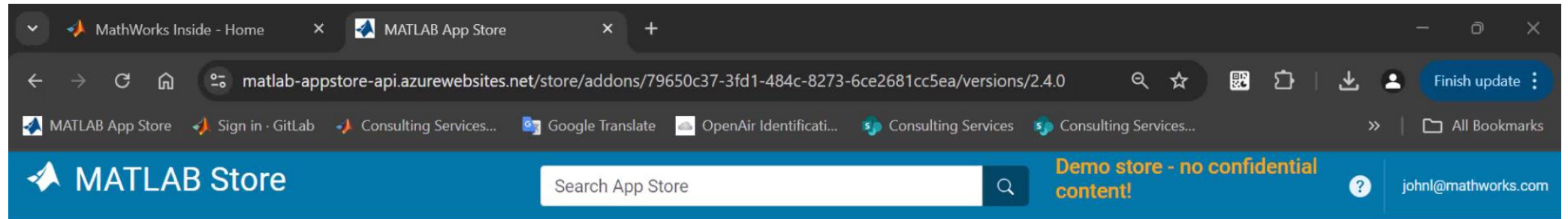Enhancements are released as new versions, and users are automatically notified.

- Existing contents are available to facilitate:
  - Collaboration – build on existing component.
  - Continuous improvements – release added contents as new versions
  - Faster learning – review similar contents.

Demo Steps

- MATLAB Store walkthrough

- Search for existing thermal related contents

- Download and install the desired content as MATLAB Toolbox

- Integrate with exiting vehicle template

Demo Video

Architecture Design

App Store front end

App Manager (GUI)

Package Manager

Test runners

App Store back end

Version Control +

App Store storage

Artifactory
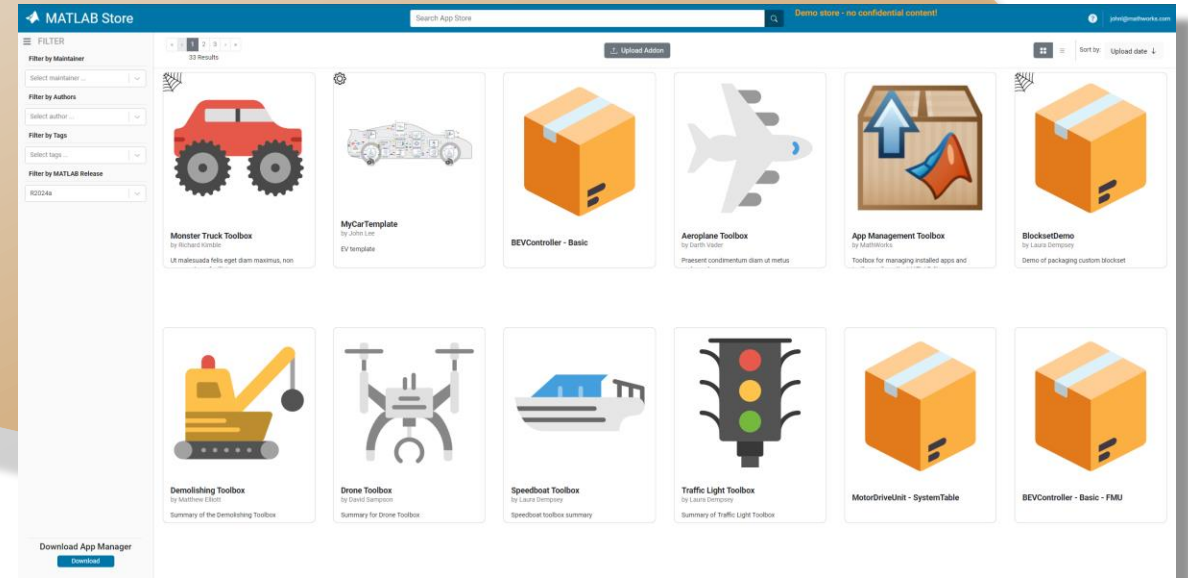
Flexible platform

Integrated with MATLAB Add-On

Integrated with version release tools

捷豹路虎
Jaguar Land Rover Standardizes on MATLAB for Developing, Packaging, and Sharing Engineering Tools

挑战Challenge

Minimize the use of disparate tools and manual processes for data analysis to reduce duplication of effort and increase productivity

解决方案Solution

Standardize on MATLAB for developing engineering data analysis tools and work with MathWorks consultants to develop an app store for sharing and distributing those tools

结果Results

- Tool quality improved and tool development time reduced
- Collaboration and engineering productivity increased
- Reliance on third-party software tools reduced
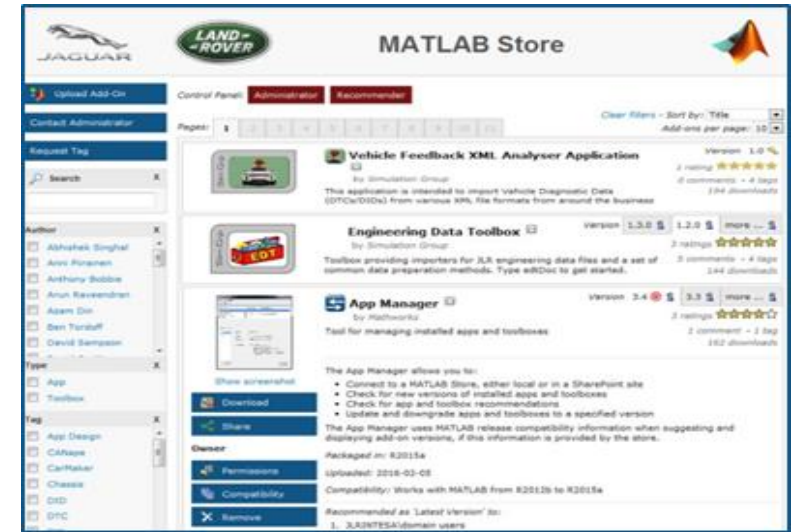
Jaguar Land Rover's MATLAB App Store, which provides one-click download and install of ready-to-use engineering tools, authored by their engineers for their engineers

In addition to avoiding duplication of effort, the MATLAB App Store enables engineers to become productive more quickly. New engineers can get the tools they need to do their jobs within minutes.

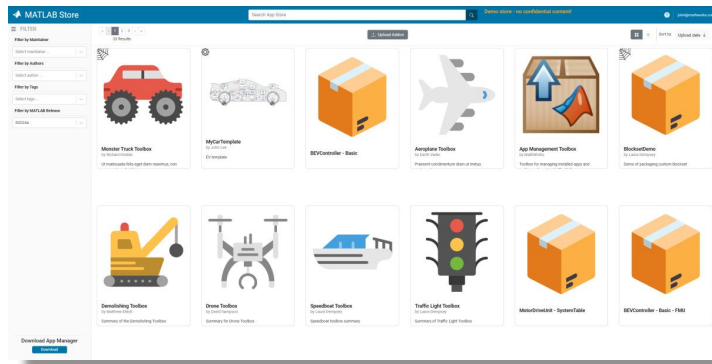# Key to Success – Methodology and Guidelines

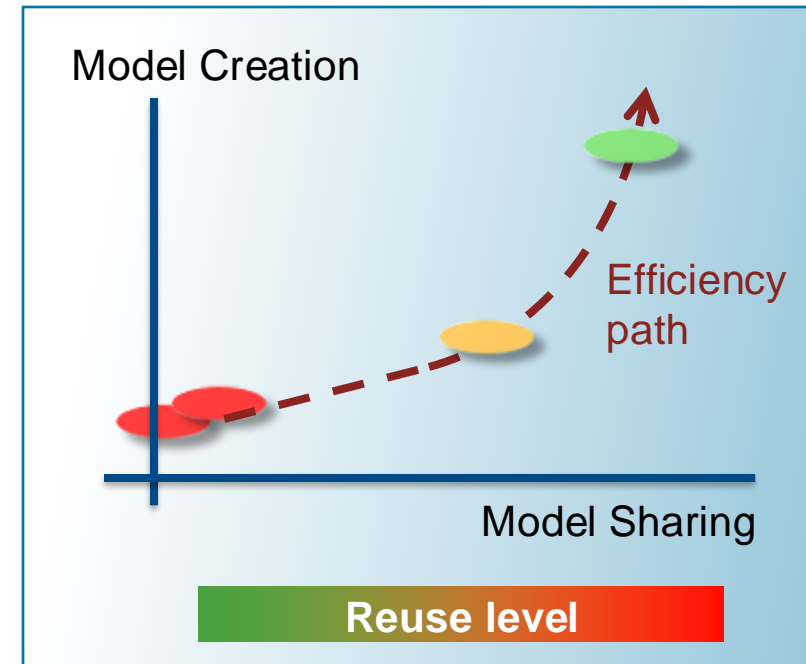**Personal / Colleagues**   **Team**   **Department / Enterprise**

MATLAB Store is a Tool
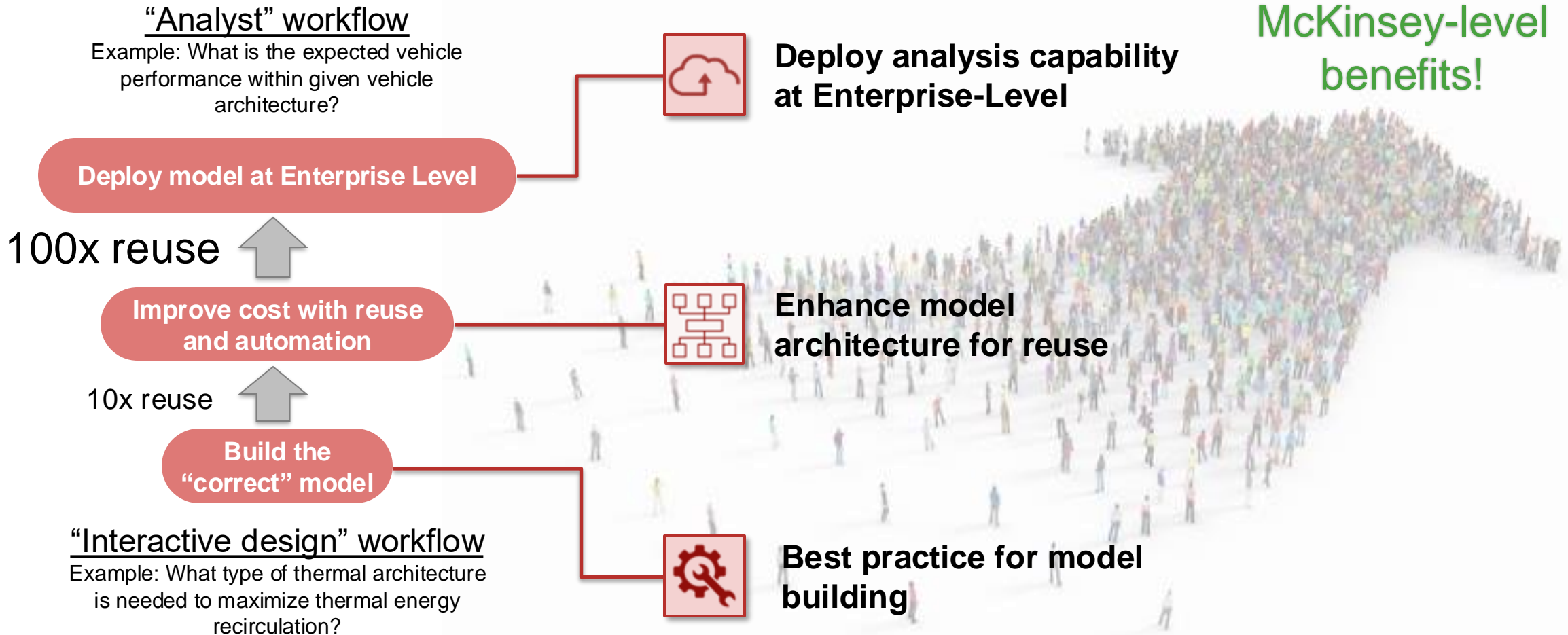
Without Guidelines

With Guidelines

Model Creation

Efficiency path

Model Sharing

Reuse level

CONTENTS

Establishing and Scaling Up Virtual Vehicle Workflow

"Analyst" workflow
Example: What is the expected vehicle performance within given vehicle architecture?

Deploy model at Enterprise Level

Deploy analysis capability at Enterprise-Level

McKinsey-level benefits!

100x reuse ⬆

Improve cost with reuse and automation

Enhance model architecture for reuse

10x reuse ⬆

Build the "correct" model

"Interactive design" workflow
Example: What type of thermal architecture is needed to maximize thermal energy recirculation?

Best practice for model building

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中国汽车年会

Thank you

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