Selection of Light Duty Truck Engine Air Systems Using Virtual Lab Tests

Houshun Zhang, Brian Bolton

An integrated development approach using seasoned engine technology methodologies, virtual lab parametric investigations, and selected hardware verification tests reflects today's state-of-the-art R&D trends. This presentation will outline such a strategy.

The use of this "Wired" approach results in substantial reduction in the development cycle time and hardware iterations. An example showing the virtual lab application for a viable design of the air-exhaust-turbocharger system of a light duty truck engine for personal transportation will be presented.

Design of Light Duty Truck Engine Air Systems Using Virtual Lab Tests

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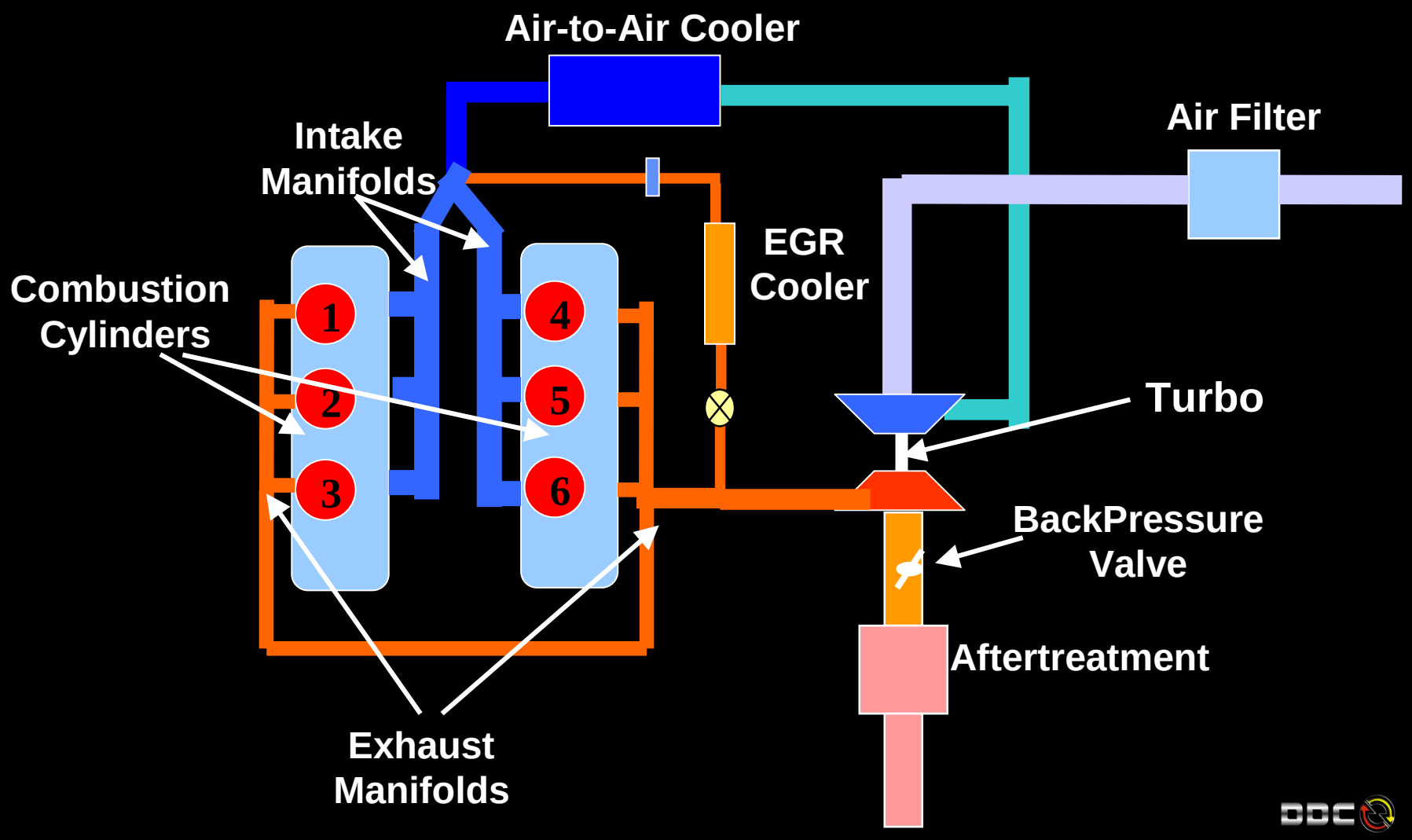
HSDI Team at DDC

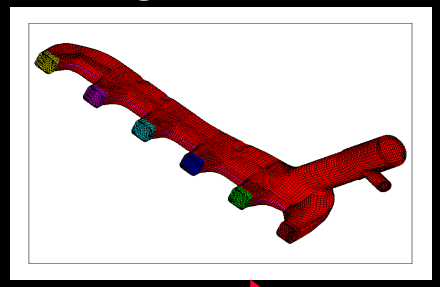
Air Handling System



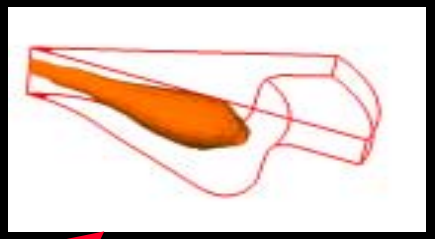
Integrated Virtual Lab

MBC - "Smart" engine

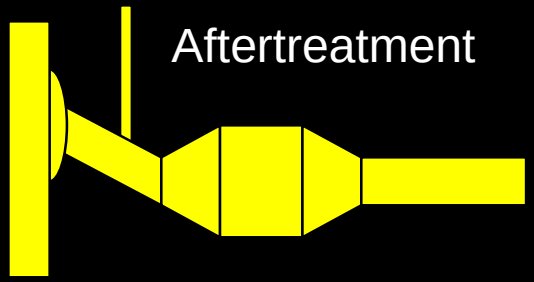
CFD



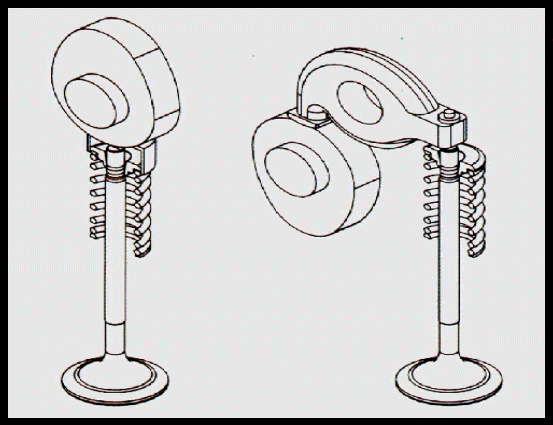
Combustion



Aftertreatment



Valve Train Dynamics



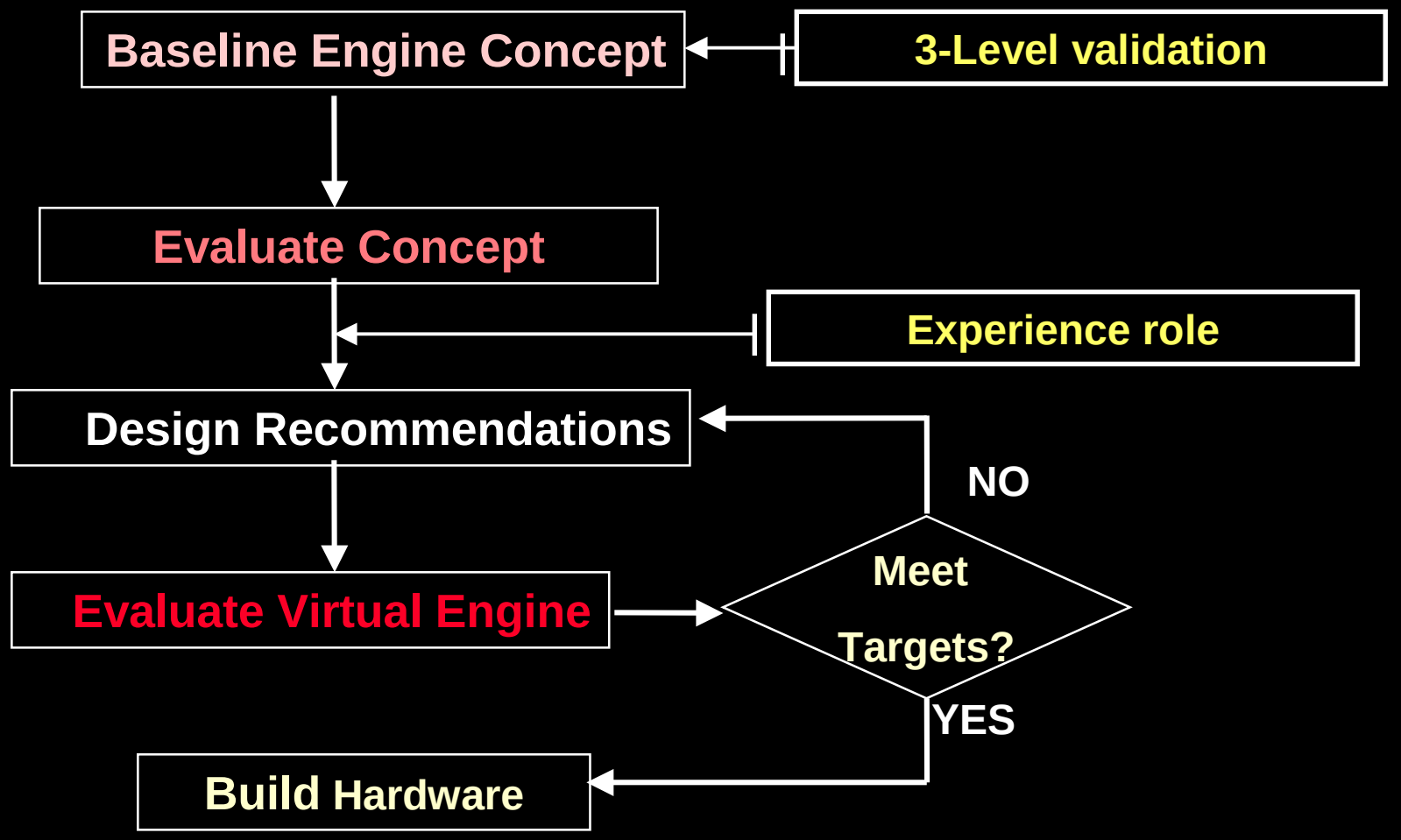
Cycle Simulation

Bearing and Crank-train

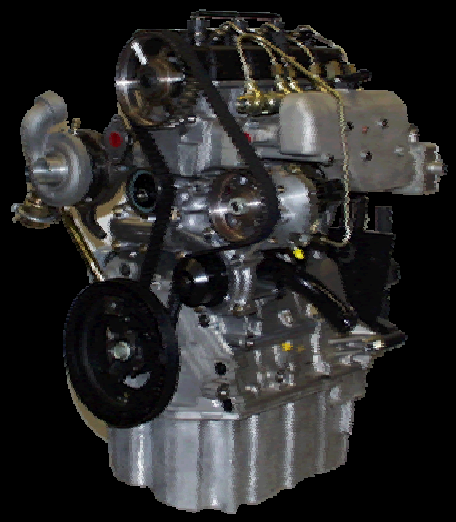
Cooling and Lubrication

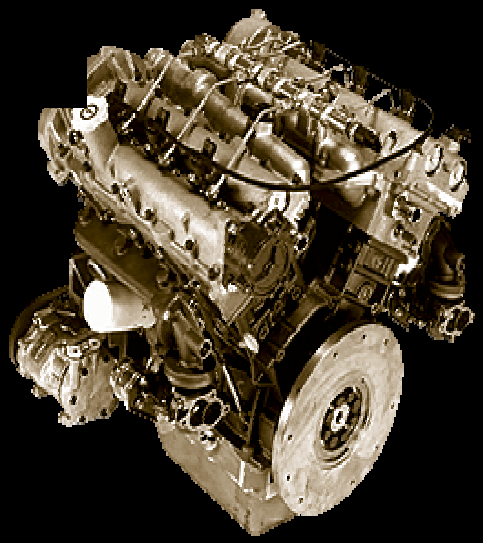
FEA

Technical Approach



Light-Duty Engines At DDC





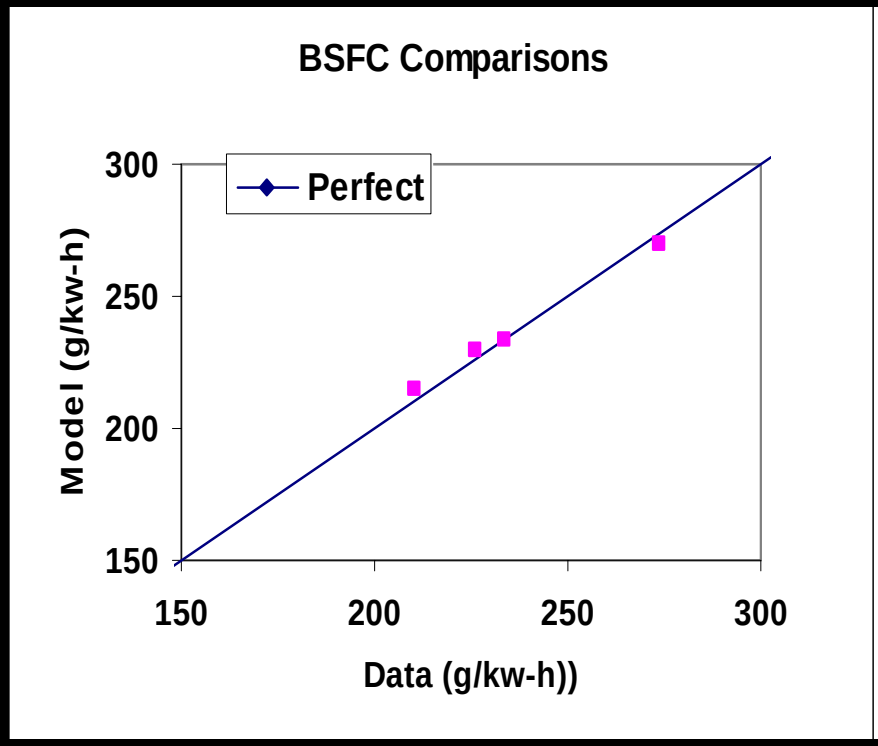
0.5 L/cylinder technology:

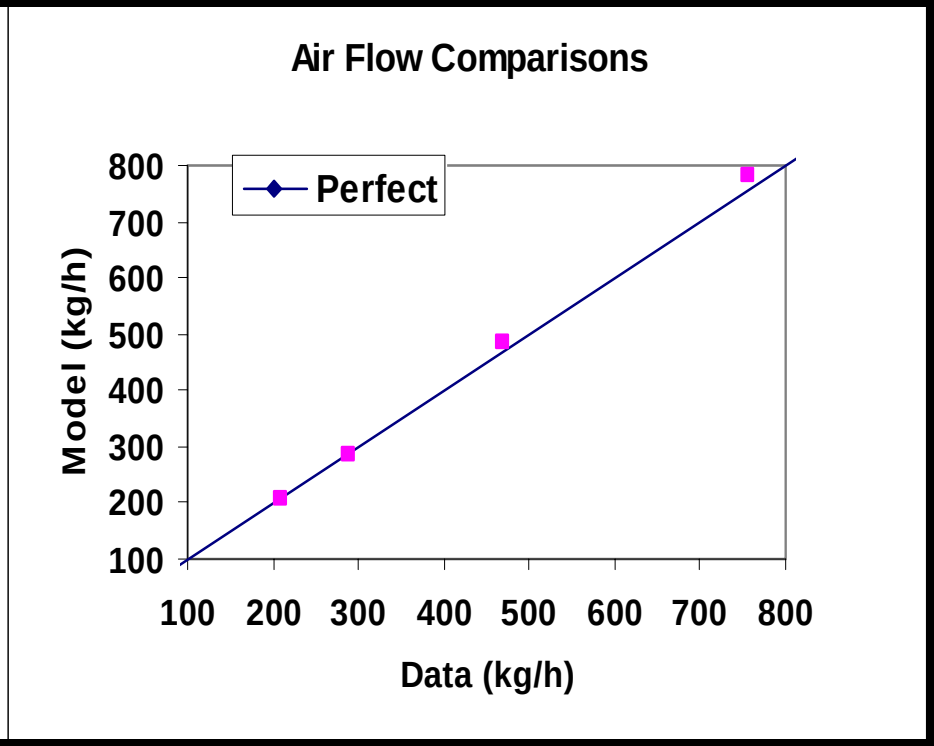
inline 3 cylinder, inline 4, V6

0.67 L/cylinder technology

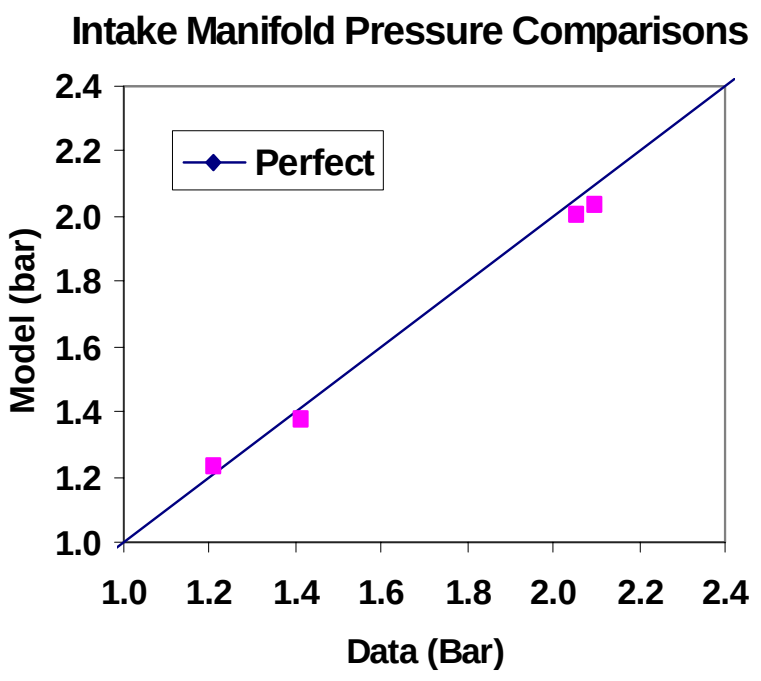
V6 configuration

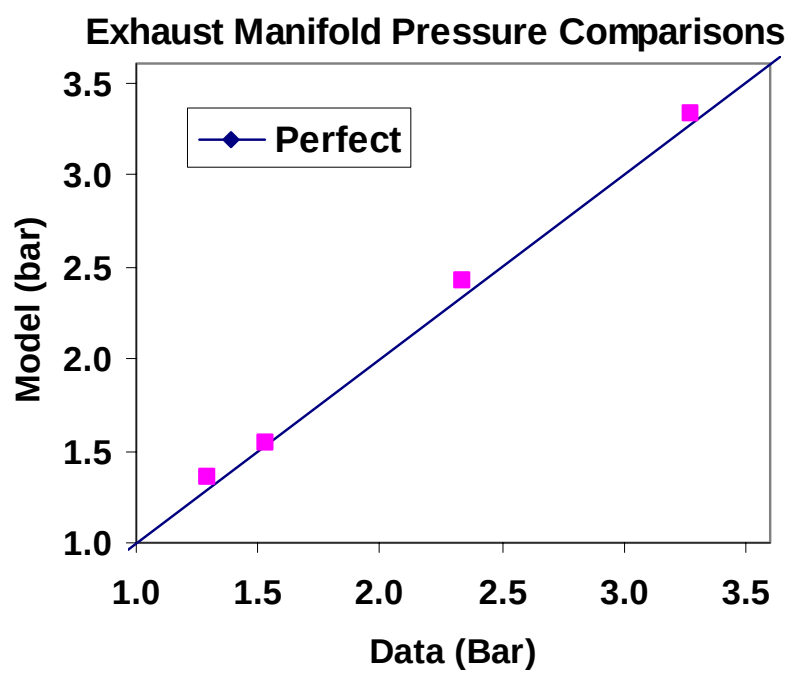
Baseline Engine
Level 1 - Performance Parameters





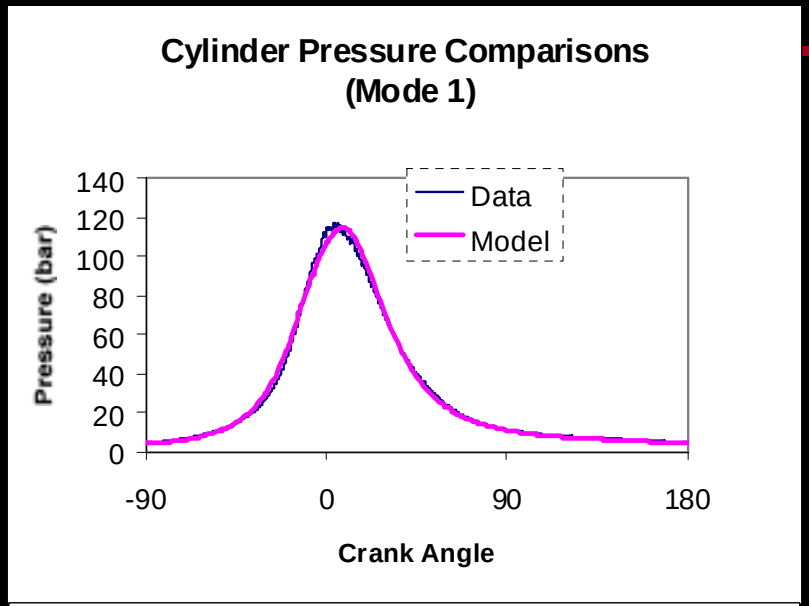
Baseline Engine
Level 2 - Cycle Averaged Parameters

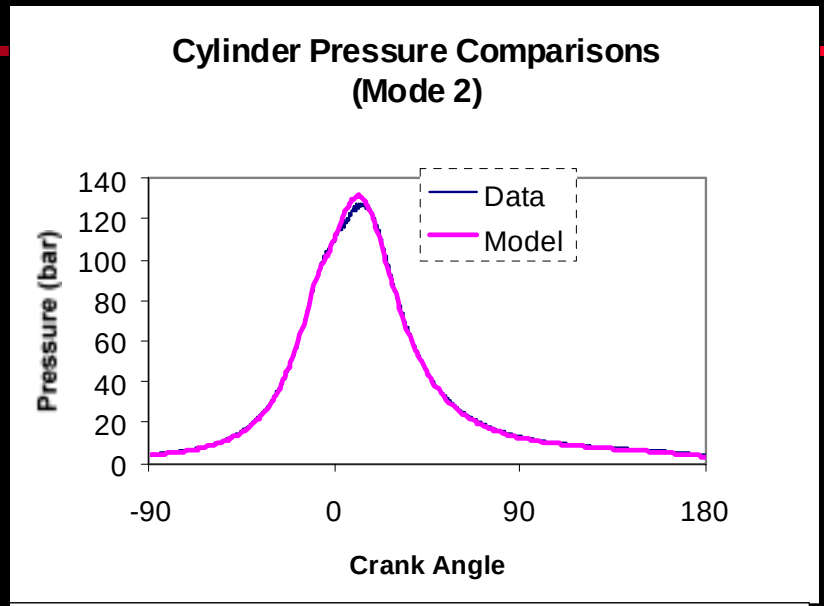


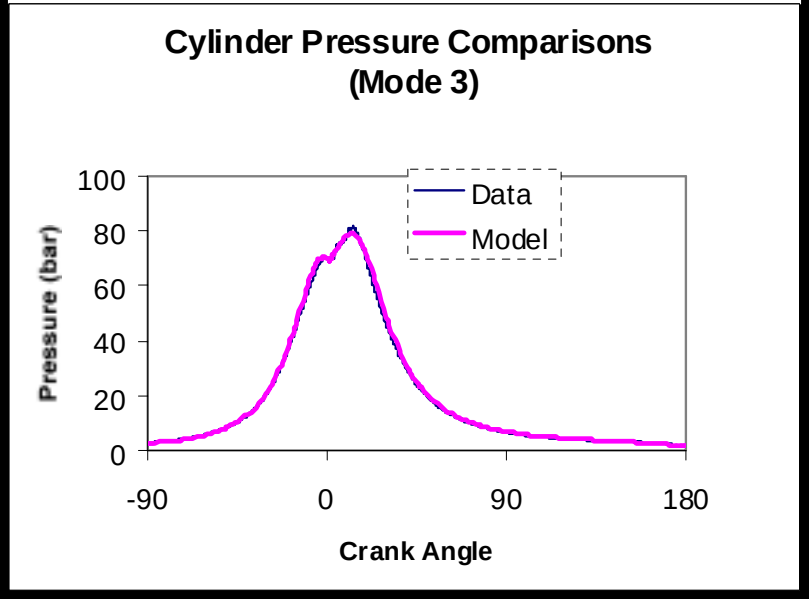


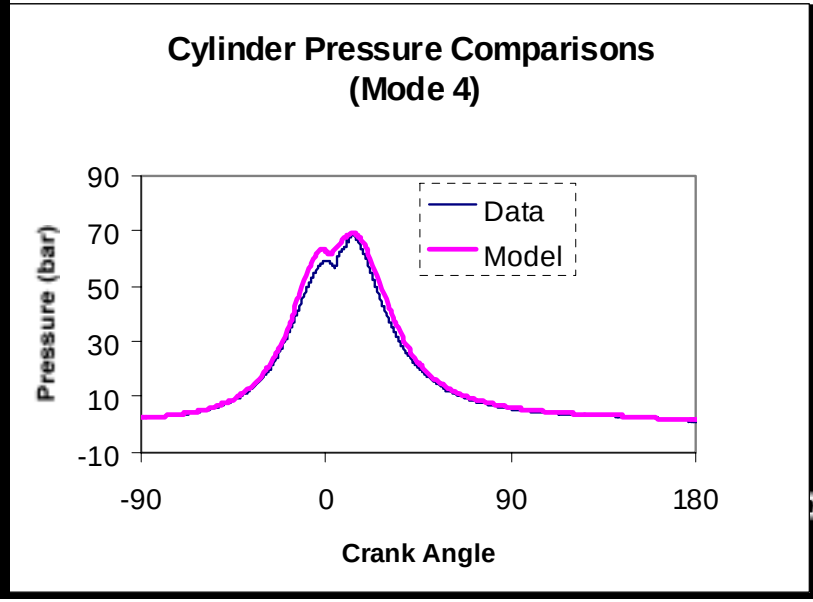
Baseline Engine

Level 3 - Detailed Cylinder Parameters



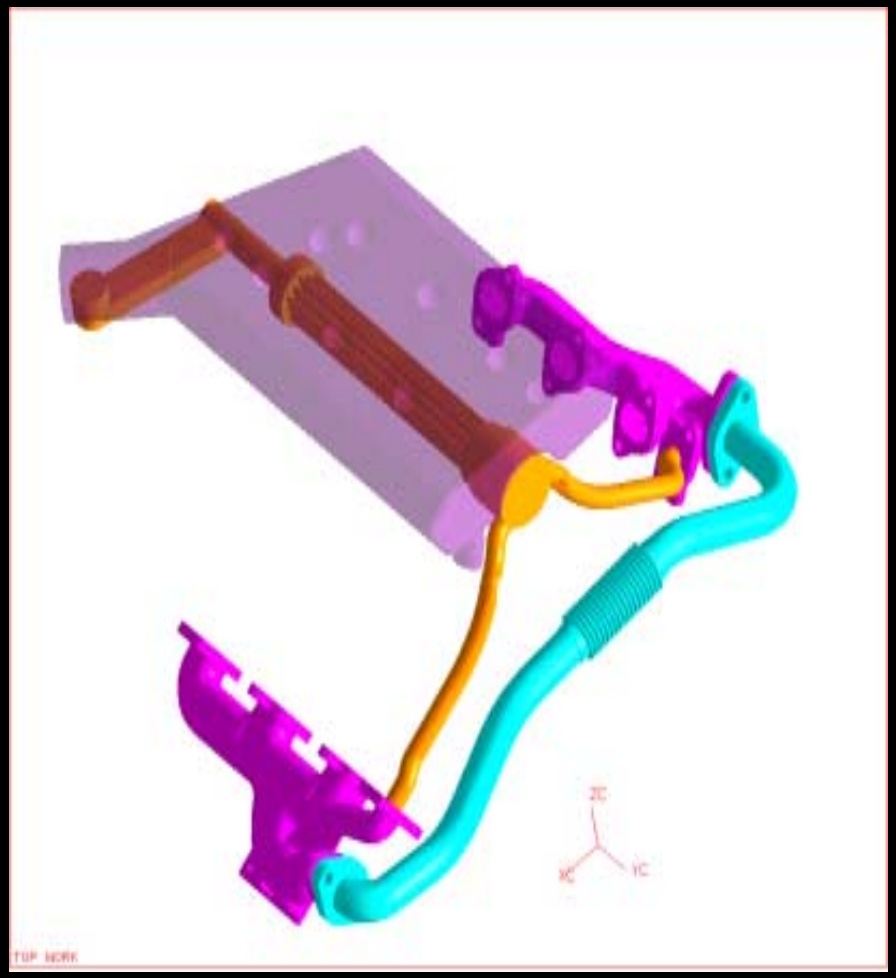




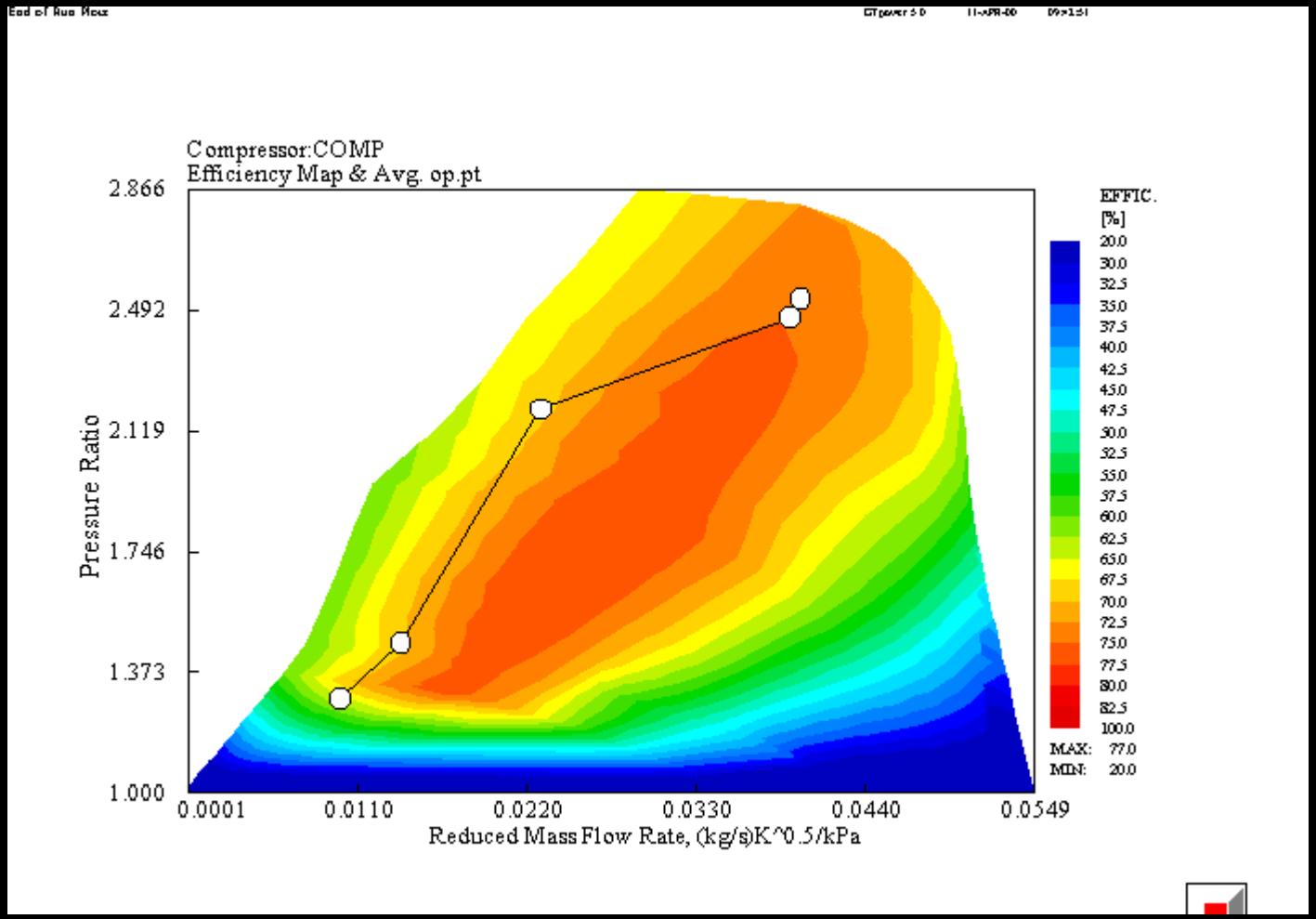


Intake and Exhaust System Evaluation

- **Air Handling System**
  - **Turbocharger**
  - **Intake Manifold**
  - **Exhaust Manifold**
  - **EGR System**
  - **Cam Profiles and Timings**
- **Engine System Package**
- **Combustion System with KIVA**
- **Engine Thermal Loading**



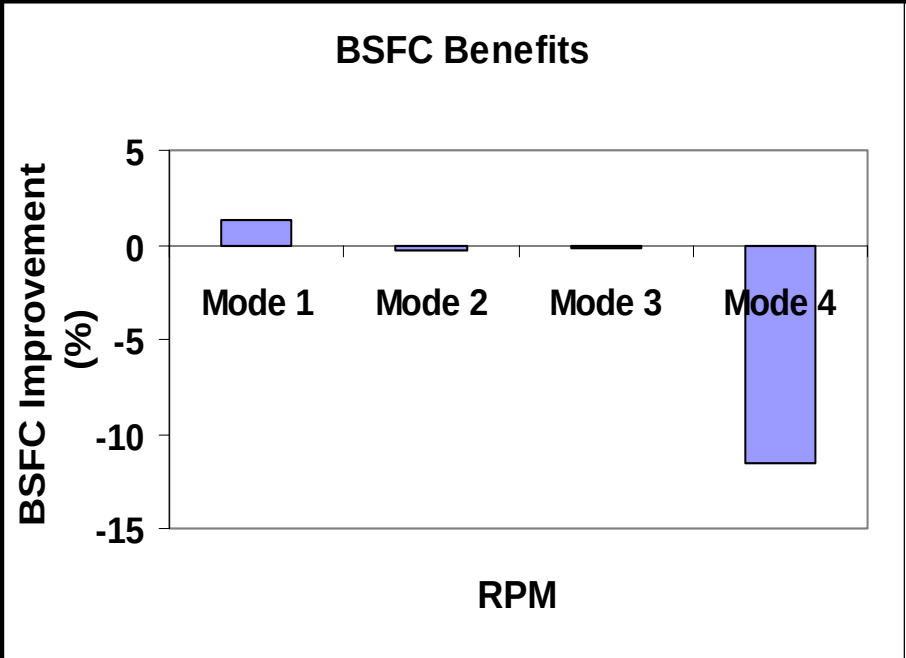
Turbocharger Evaluation

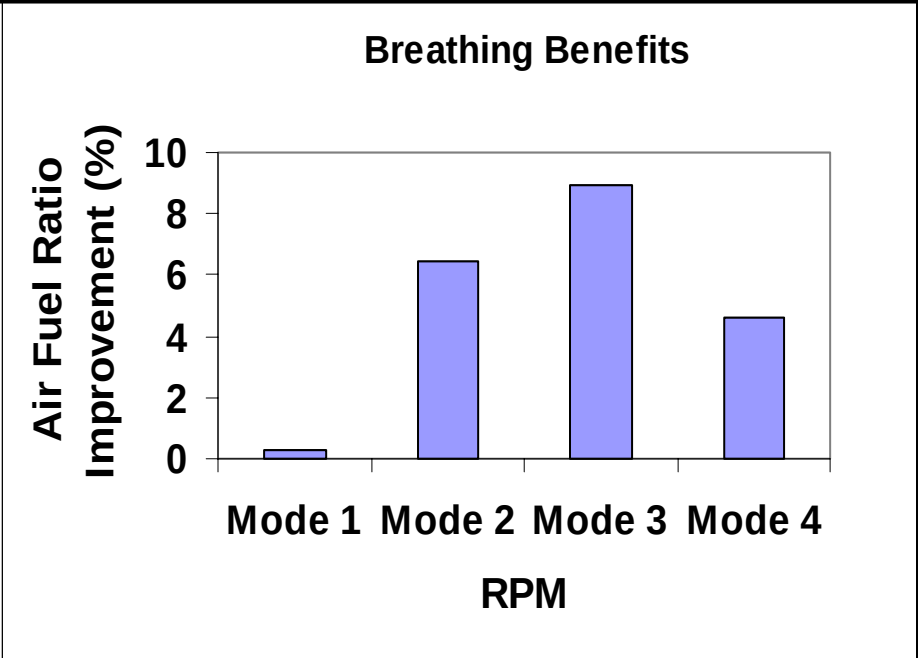


Benefits of Advanced Air System Virtual Simulations

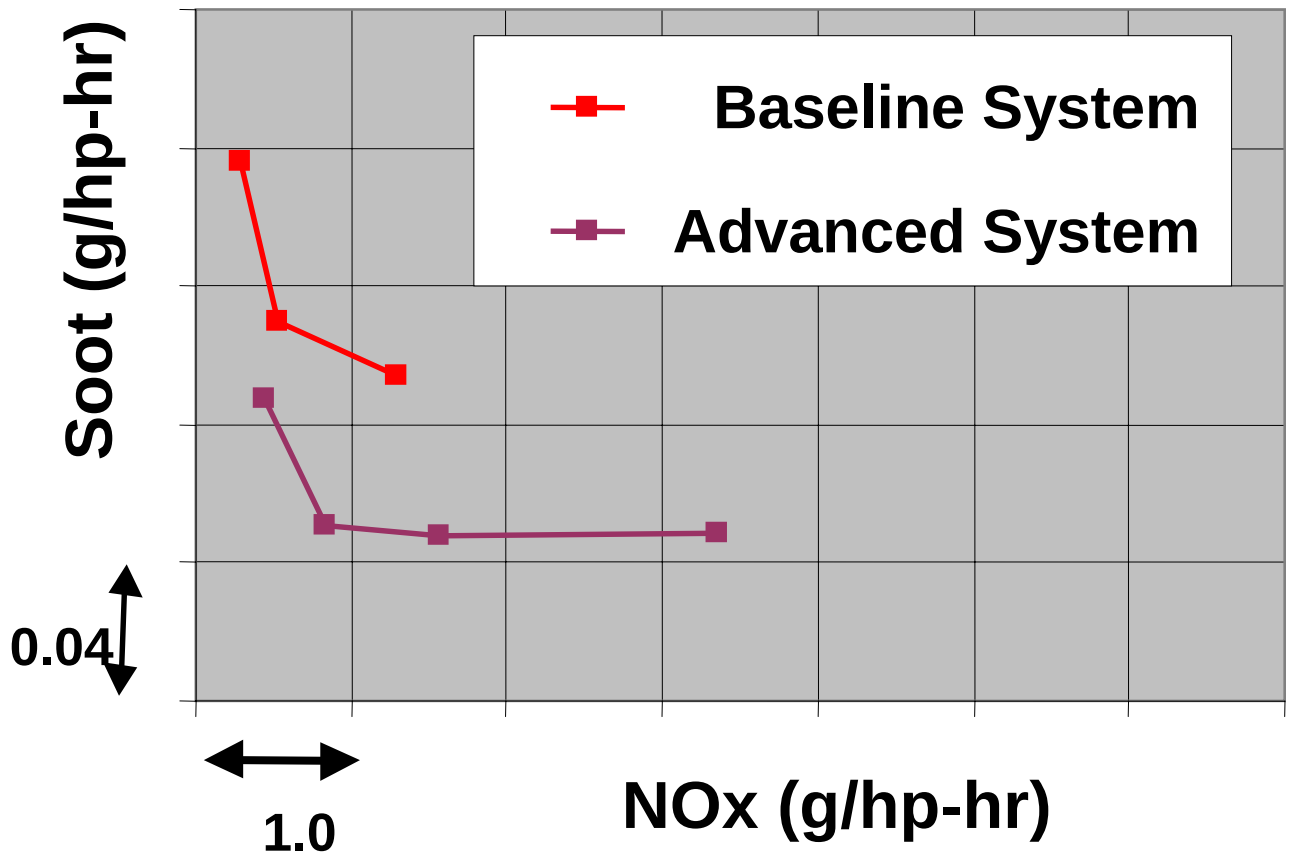
Performance Improvement Example

- **Offers Substantial Benefits in BSFC and Breathing in Overall Engine Cycle**





Emissions Improvement



Final Remarks

- **An Integrated Approach Using Engine Technology Experience and Advanced Virtual Lab has been Developed to Design Advanced Air Systems and Turbochargers.**

- **Engine Design Issues Associated with Performance and Emissions can be Effectively Addressed When Cycle Simulation Is Used Properly.**