SEMA SHOW EDUCATION
SEMA
SHOW

Digital Testing and Design as it Relates to Product Development

Dan Agnew, Principal Engineer
EngSim Corporation
November 4, 2021

SEMA SHOW PRESENTATION DISCLAIMER

The views and opinions presented in this session are those of the speaker and do not necessarily represent the views and opinions of SEMA. Speakers are not SEMA representatives and their presence does not represent SEMA's endorsement or sponsorship of the speaker or the speaker's views, company, products or services. Unless otherwise stated, SEMA does not exercise any editorial control over the views, opinions and specific content.

All material presented is for informational purposes only and nothing presented in this session should be construed as legal advice. Legal issues raised by the subject matter of this presentation, including applicable federal, state and local laws are not fully addressed. The purpose of the session is to provide information to help attendees improve the effectiveness of their business practices. The information presented is not intended to urge or suggest that attendees adopt any specific practices or policies for their business, nor is it intended to encourage concerted action among competitors or any other action on the part of businesses that would in any manner fix or stabilize the price, or any element of price, of any good advice.

Each attendee must conduct their own due diligence and make an individual decision, based on your unique facts and circumstances, on whether to adopt or implement specific practices, policies, techniques or methods of doing business. Consult your attorney regarding the legality of any policies or procedures that your business plans to adopt and any legal or regulatory obligations those policies or procedures may raise.

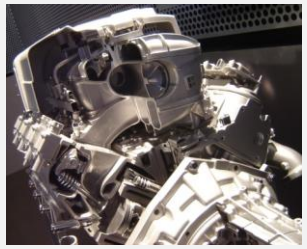
Session content is protected by U.S. copyright law and may not be used without the prior written permission of SEMA or, in the case of third party materials, the owner of that content.

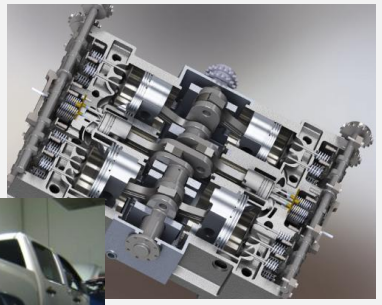
With regard to any information presented, SEMA makes no warranty, express or implied, including the warranties of merchantability and fitness for a particular purpose, and specifically disclaims any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, product, service or process presented and makes no representation that its use would not infringe upon privately owned or intellectual property rights such as copyright, trademark, patent, trade dress, etc.

Seminars may not be audio- or video-recorded without written permission from SEMA.

About EngSim

- EngSim is an engineering service company specializing in engine and vehicle computer simulation.
  - Typical Projects
    - IC Engine
    - Battery Electric Powertrain
    - Valvetrain
    - Cooling, Lube/Oil
    - Vehicle Systems – Traditional Automotive or Racing, HD Truck, Locomotive, Battery/Hybrid Electric Vehicle



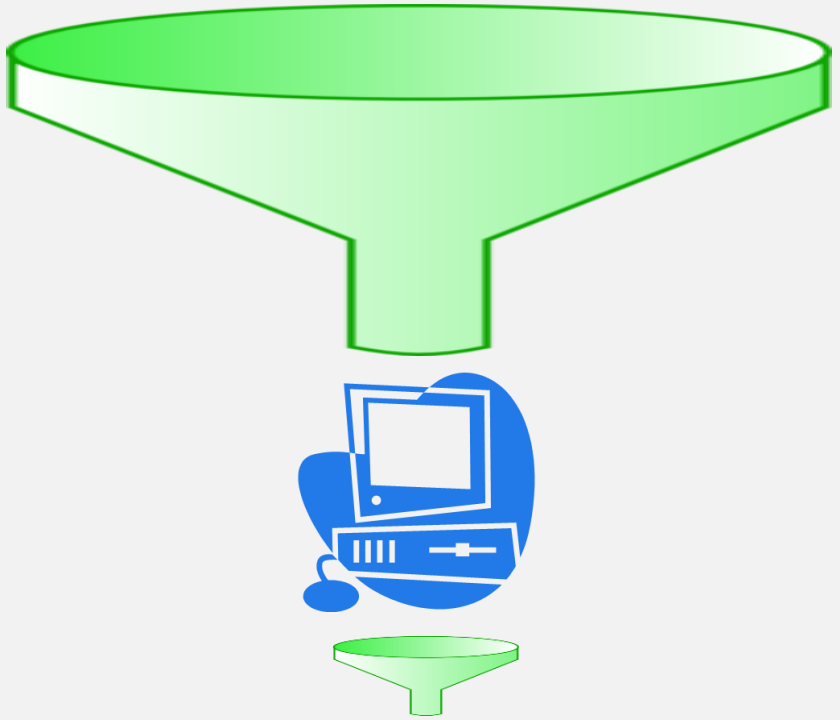


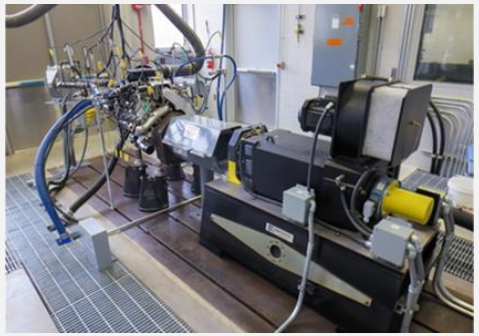
  - For many clients, EngSim is their “virtual” engineering department for “virtual” engineering/testing.

EngSim

Why “Digital” or Virtual Testing

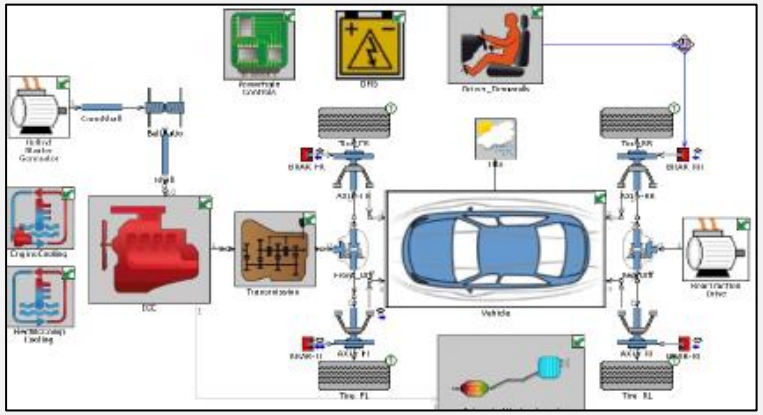
- Computer based engine simulations are not meant to replace good testing, just supplement and make that testing more efficient (time and cost), and improve understanding.
- Take those thousands of crazy ideas, filter them into just a few reasonable ones to verify with physical testing.
- There are lots of computer based tools and resources to pick from to help you.



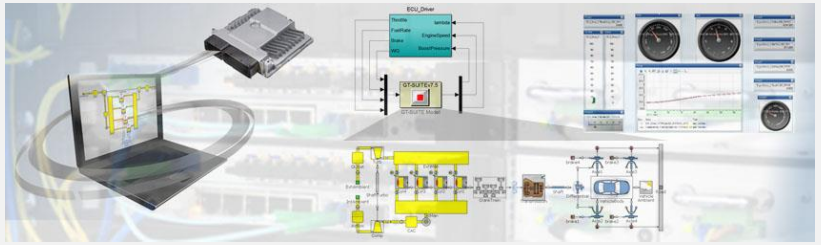


EngSim's Digital Tools – 1-D Simulation

- Gamma Technologies – GT Suite
  - EngSim's software of choice
  - Very stable platform, continued rapid software development, and very good customer support/training/user community
  - Very good pre and post processing
  - Worldwide market leader
  - Wide array of modules
    - Pre/Post Processing
      - GT-ISE, GEM3D, GT-Spaceclaim, GT-Post
    - GT-Suite, VTDesign, Cool3D, GT-Drive+, Converge-Lite
  - Couples well to 3rd party CFD and engine controls software



www.GTIsoft.com



EngSim's Digital Tools – 3-D Simulation

- 3-D Computational Fluid Dynamics (CFD) Simulation Tools
  - Multi-Physics Platforms
    - Flow, Acoustics, Thermal, Mechanical, Chemistry
  - Extensive detail possible for geometry and content
    - Moving or sliding meshes
    - Turbochargers, piston/cylinder, valves, etc.
    - Exhaust after treatment
  - Extensive pre and post processing
  - Distributed computing (multiple CPUs)
  - Coupling to other 3rd party software

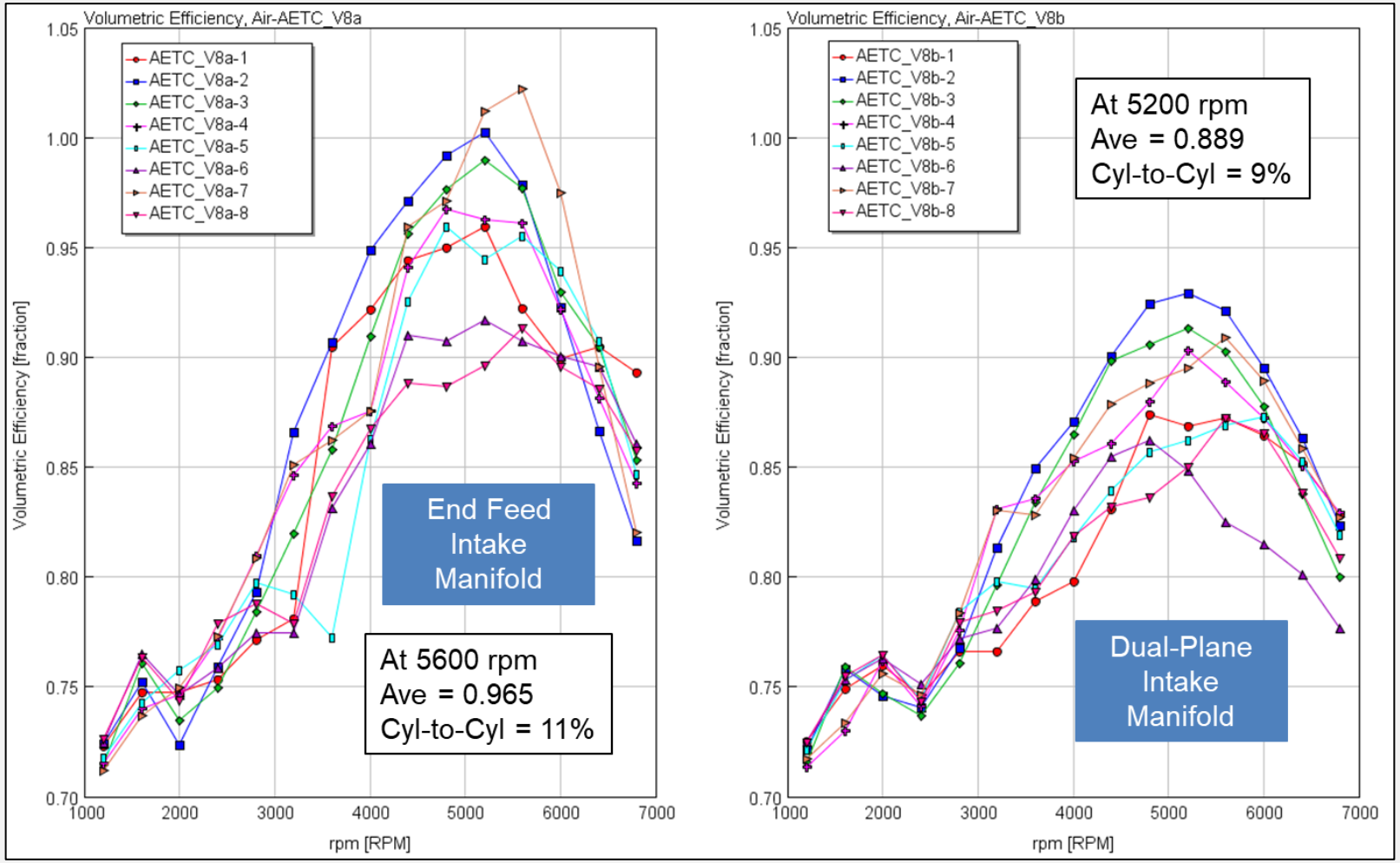
CONVERGE CFD SOFTWARE

The Leader in Powertrain CFD

AVL FIRE™

Select Examples

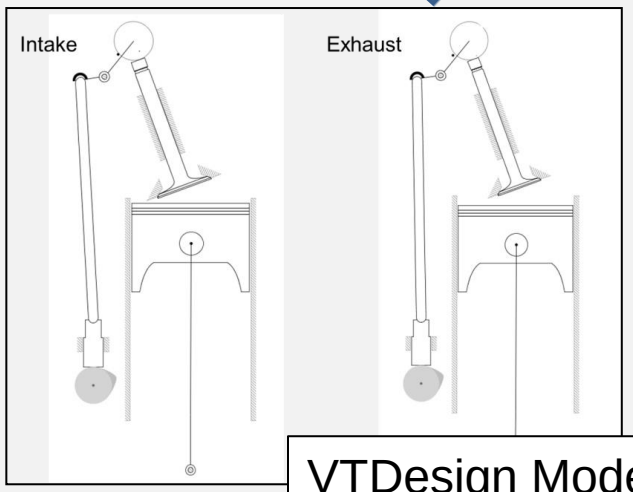
- How can digital testing can enhance understanding…
- Individual cylinder breathing in a running V8 engine without the need for a dyno and individual pressure cylinder pressure measurement.



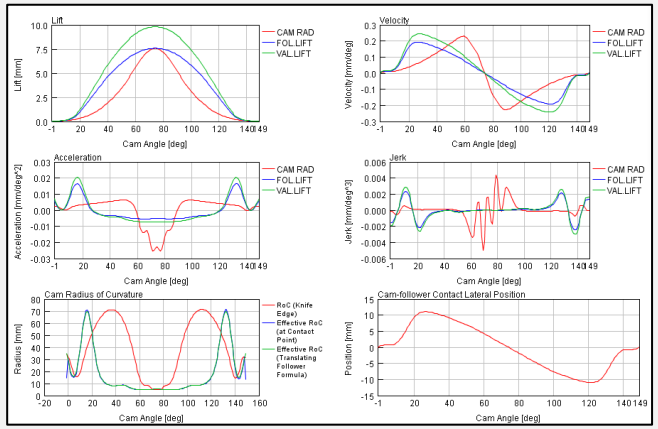
Select Examples

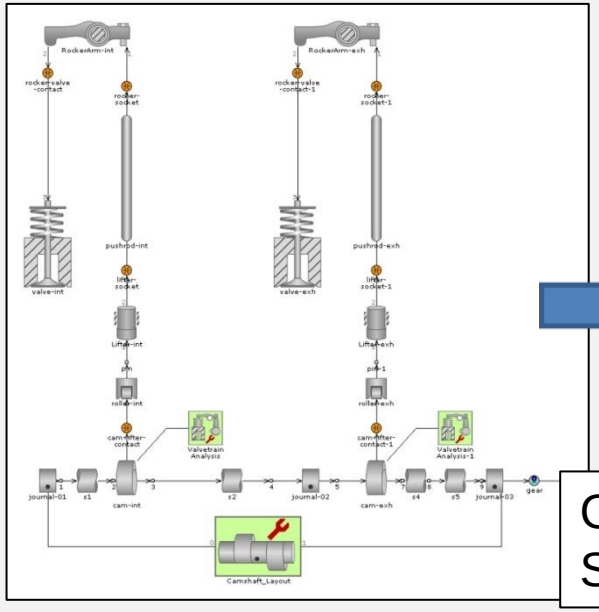
- How digital testing can enhance understanding…
- Valvetrain kinematic and dynamic information without a motoring dyno and sensors.

Original CAD

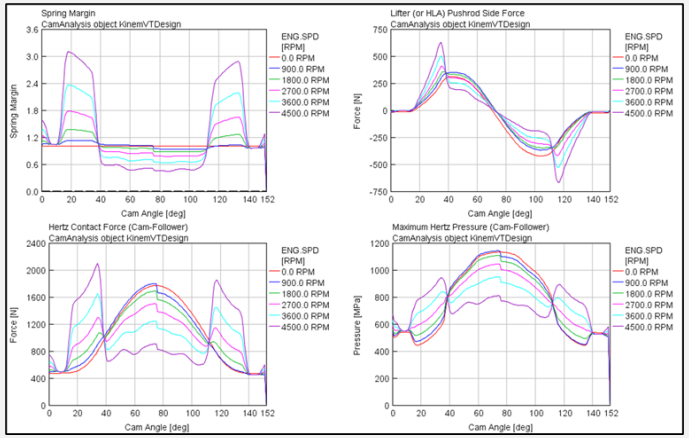


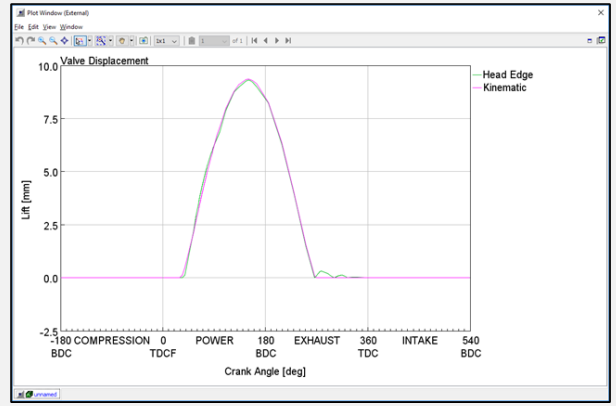
VTDesign Model





GT-Suite VT System Model

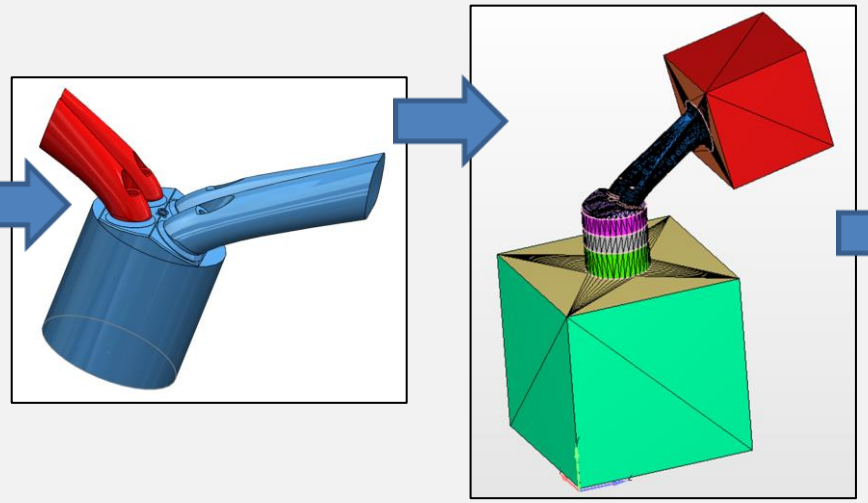




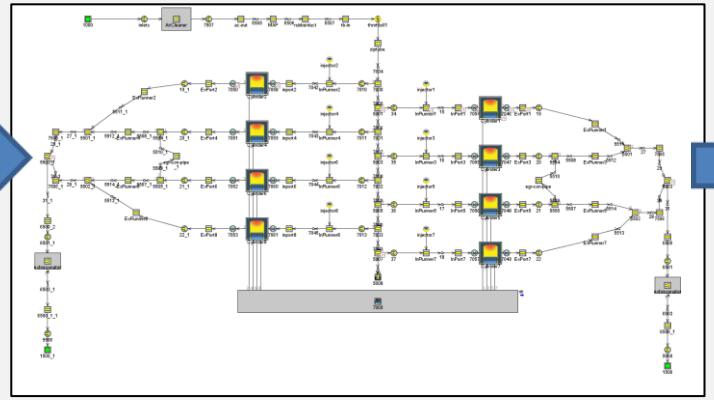
Select Examples

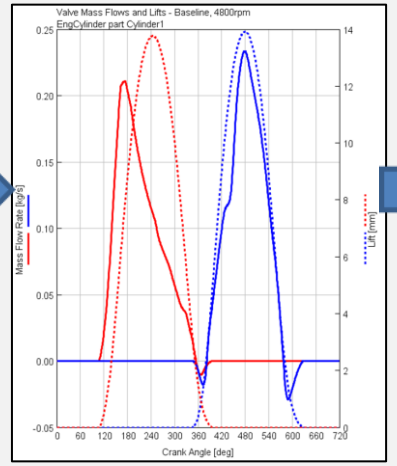
- How digital testing can enhance understanding…
- Port flow visualization and instantaneous port flow and pressure – try and get this with your flow bench or dyno without combustion equipment!

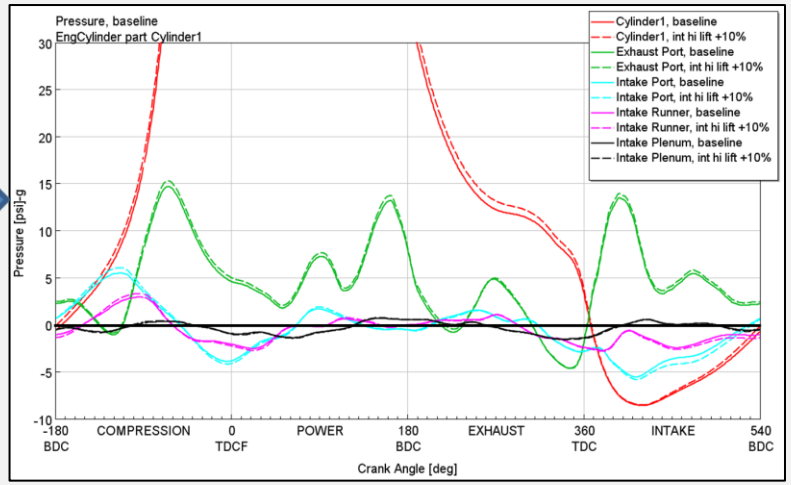
3-D Engine Model



1-D Engine Model

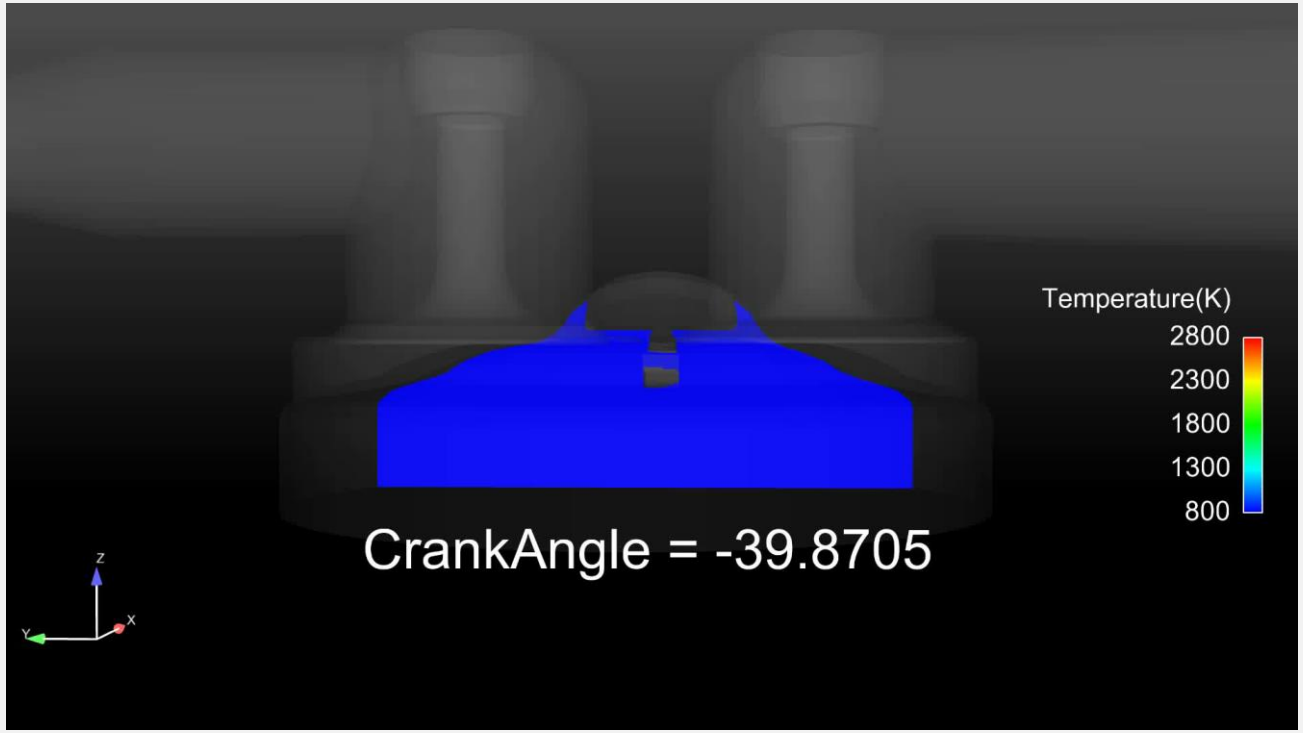


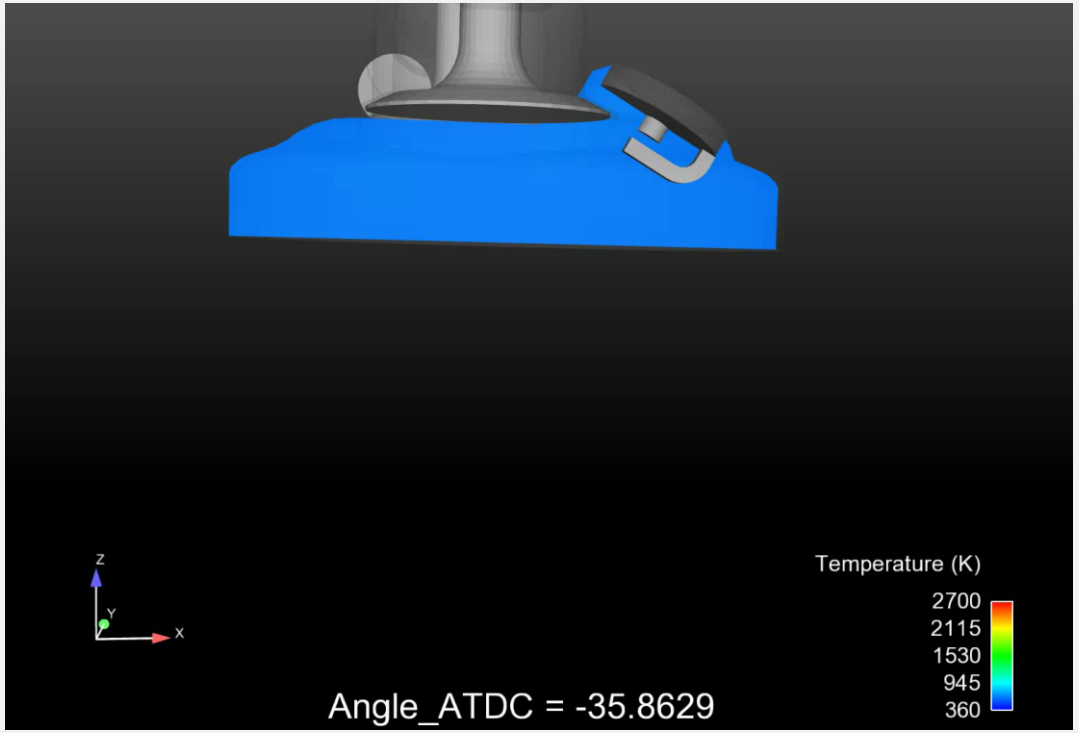




Select Examples

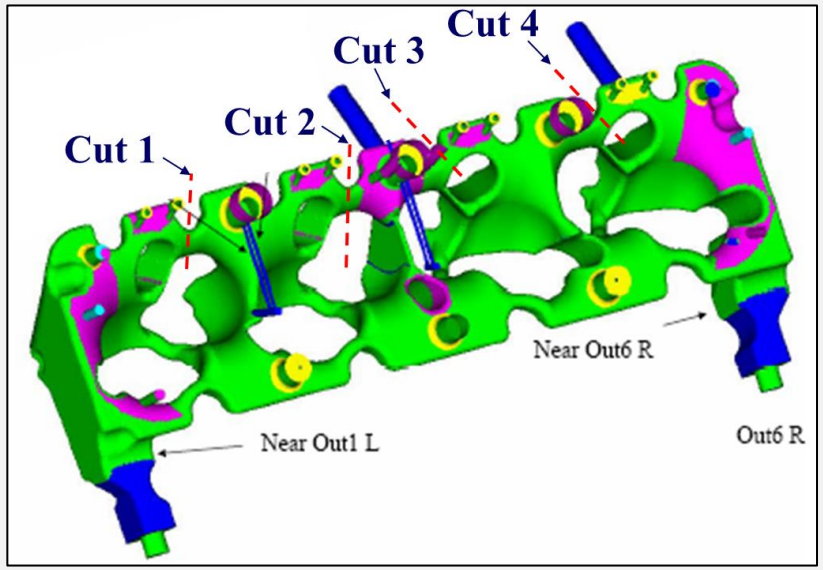
- How digital testing can enhance understanding…
- In-cylinder flow and combustion, looking at the effect of various port flows, spark plug locations, spark energies, combustion chamber shapes…

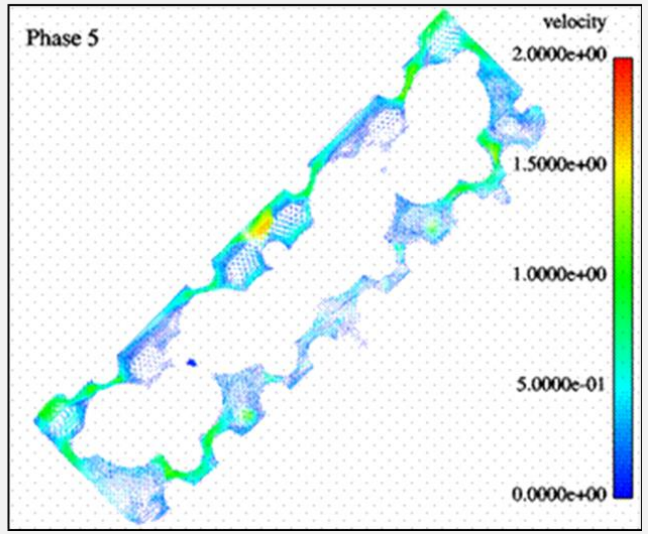




Select Examples

- How digital testing can enhance understanding…
- Cooling system (cold flow) in cylinder head to look for flow uniformity and dead spots.
- Can also be used for heat flux evaluations.



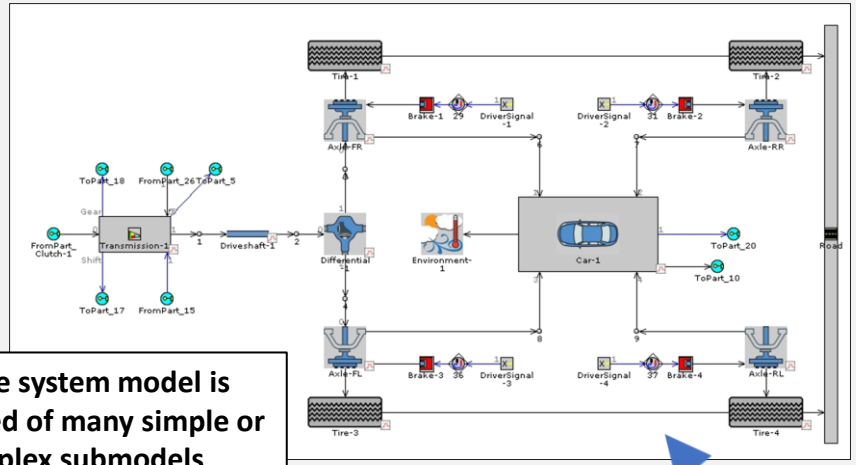


CFD CYLINDER HEAD COOLANT FLOW RATE (gpm)

	GASKET DESIGN	WATER-IN LOCATION	CYL. HEAD WATER JACKET CROSS-SECTION LOCATION				
			#1 Exhaust	#3 Exhaust	#5 Exhaust	#7 Exhaust	AVERAGE
Case 1	Fel-Pro 1034	Front & Side	1.03	0.53	1.96	2.41	**1.48**
Case 2	Fel-Pro 1034	Side Only	1.98	1.46	0.79	1.43	**1.42**
Case 3	Gasket #2	Side Only	3.51	1.02	1.15	3.73	**2.35**
Case 4	Gasket #3	Side Only	2.91	1.51	1.29	2.85	**2.14**
Case 5	Gasket #4	Side Only	3.44	1.75	1.66	3.42	**2.57**
Case 6	Gasket #4	Front & Side	3.39	1.43	1.27	3.37	**2.37**

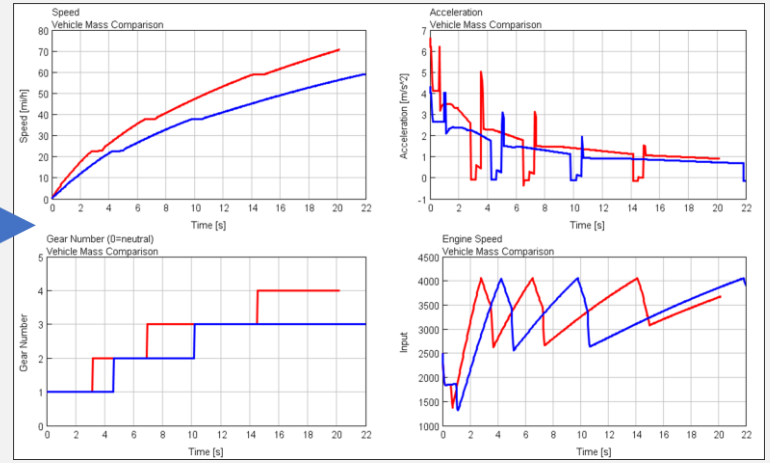
Select Examples

- How digital testing can enhance understanding…
- Hybrid/Electric vehicle race car modeling without ever building a car.

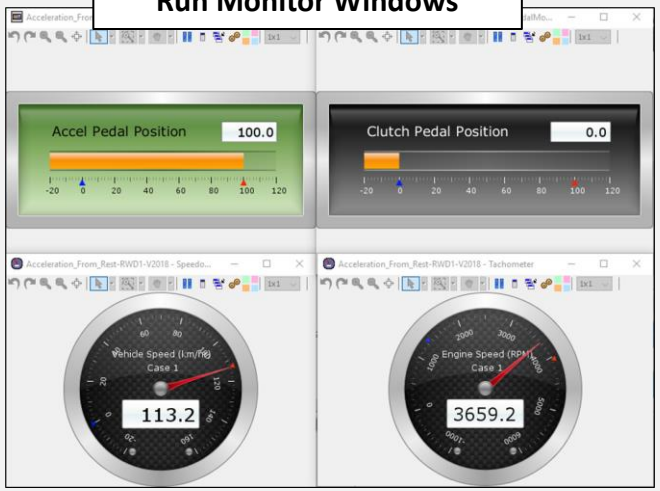


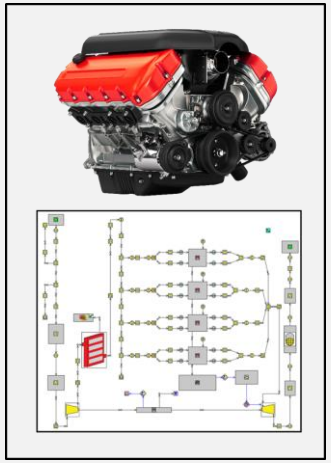
Vehicle system model is comprised of many simple or complex submodels

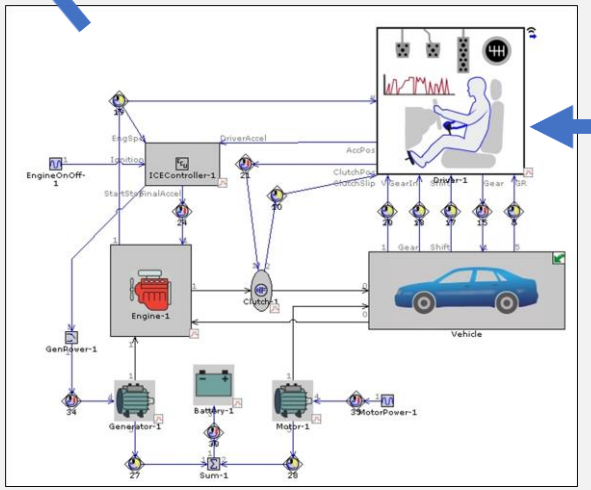
Many output parameters can be optimized



Run Monitor Windows

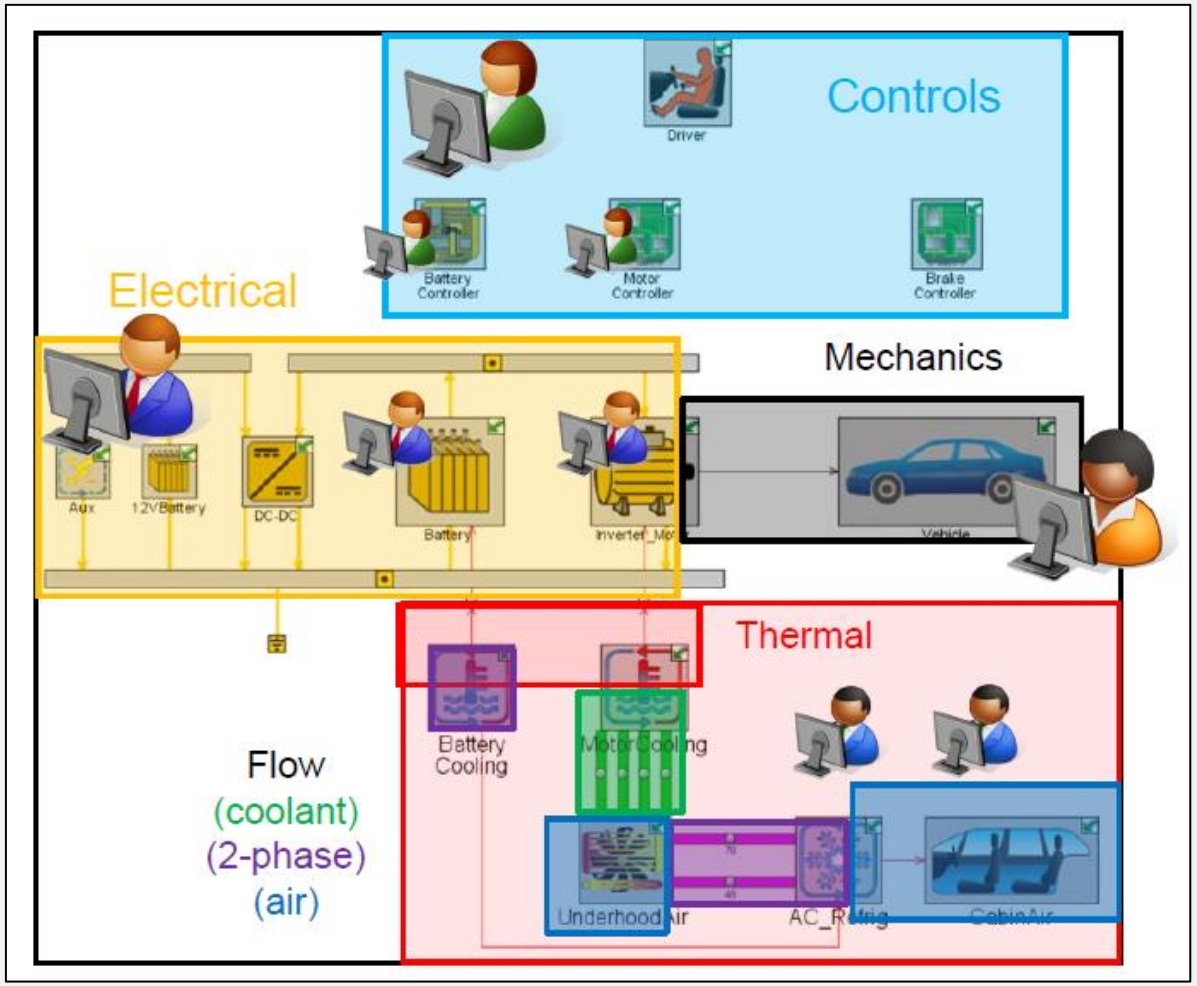






Outlook and Summary

- Continued and rapid evolution.
  - Applications and **simulation tools**
- Continued development of battery, combustion, emissions, and exhaust aftertreatment sub-models.
- More “Integrated Modeling”
  - Multi-domain
  - Adaptable levels of fidelity
  - Collaborative across departments and suppliers/OEMs
- All this will continue to make simulations an ever increasing “go-to” tool to speed up development, reduce cost, and increase understanding.



“Integrated BEV & HEV Modeling in GT-Suite”,
Joe Wimmer, Peter Stopp, Gamma Technologies