OPTIMIZE THIS! 2014

Presentations from Optimize This! 2014

red cedar TECHNOLOGY
a CD-adapco company

HEEDS

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ABS
FOUNDED 1862

Improving the Propulsive Performance of Ships

Richard Korpus
American Bureau of Shipping

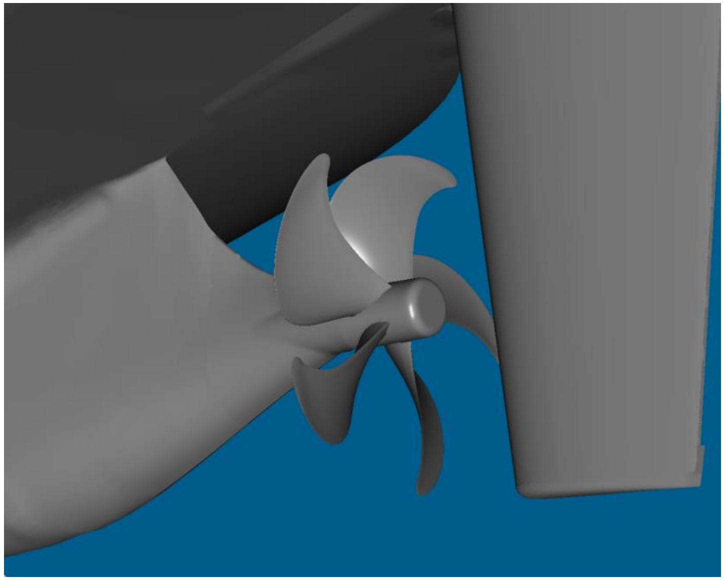
Red Cedar's "Optimize This" Conference
Dearborn, Michigan, October 15, 2014

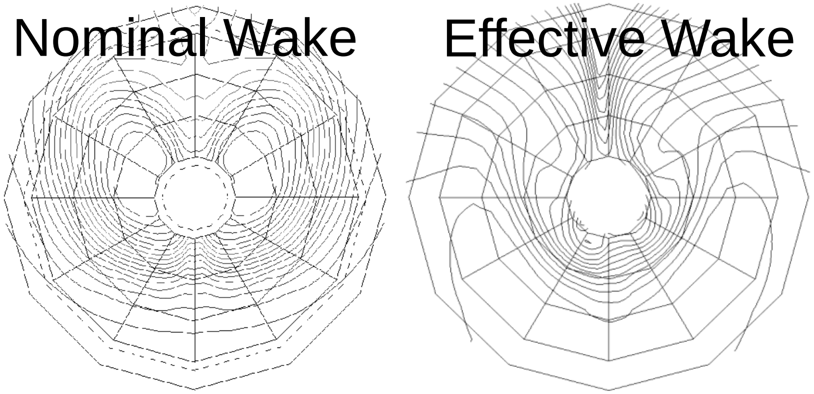
The Maritime Classification Business

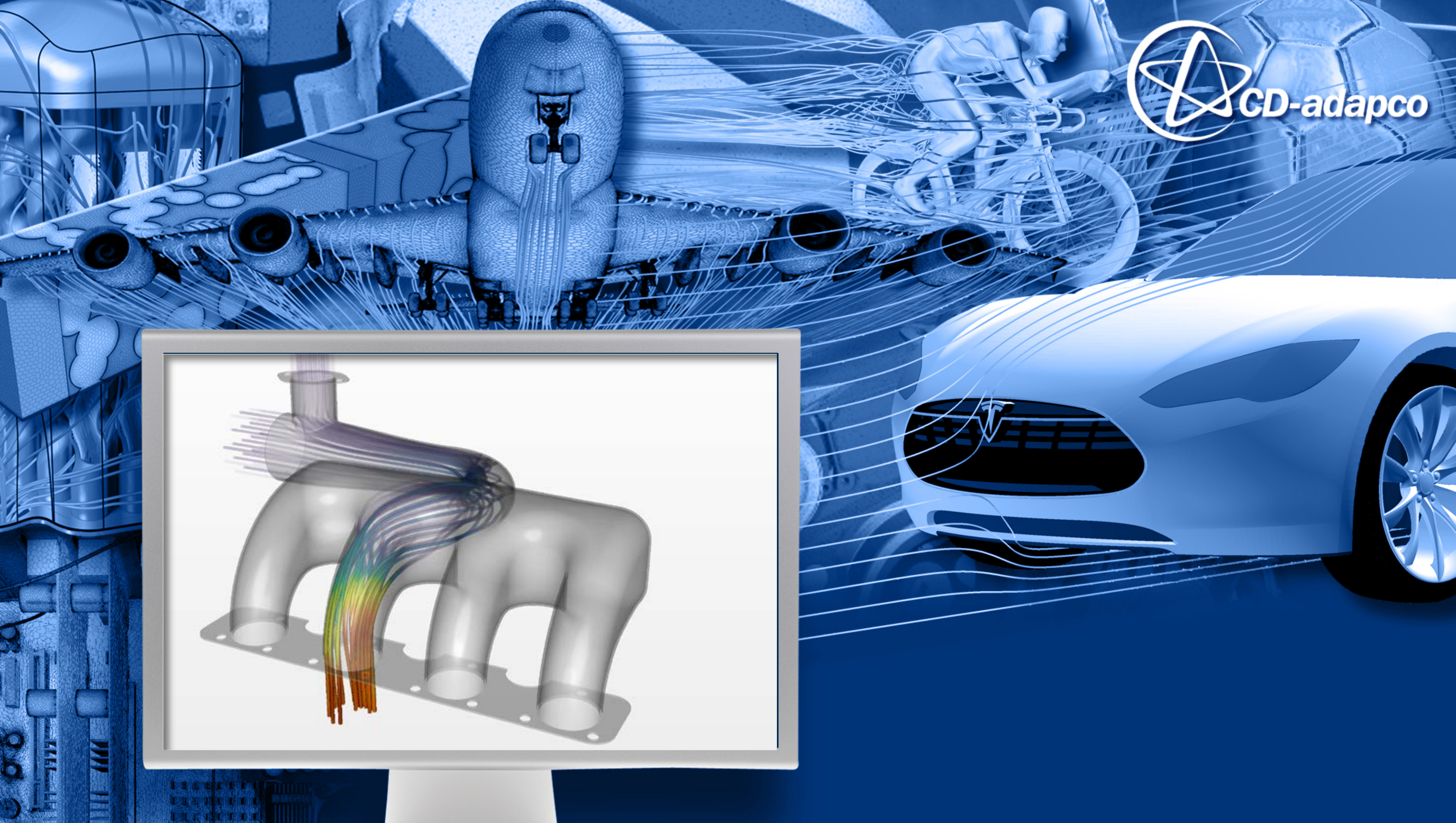
- Insurance companies and international safety & environmental regulatory agencies require expensive and potentially hazardous assets like ships and offshore structures meet design and operational standards set by unbiased and technically competent third parties (“Classification Societies”).
- Designs and owners must meet the rules set forth by Class, and their assets maintained to the Class standard.
- Class Societies offer various services to improve competitiveness. One of ABS’s advantages is state-of-the-art technology to help owners and operators make difficult design decisions.
- Two of the most advanced and versatile technologies available for towards that end are Computational Fluid Dynamics (CFD) and performance improvement.

Biggest Challenge: Propeller Design

- Propellers operate in the non-uniform viscous wake of a hull.
- Optimal propellers need to be designed in their true operating environment.
- Today’s state-of-the-art still assumes steady inflow with corrections for spatial and temporal averages of inflow.
- Hull wake is only available at model scale.







Improving Manifold Design Through Design Exploration and Co-simulation

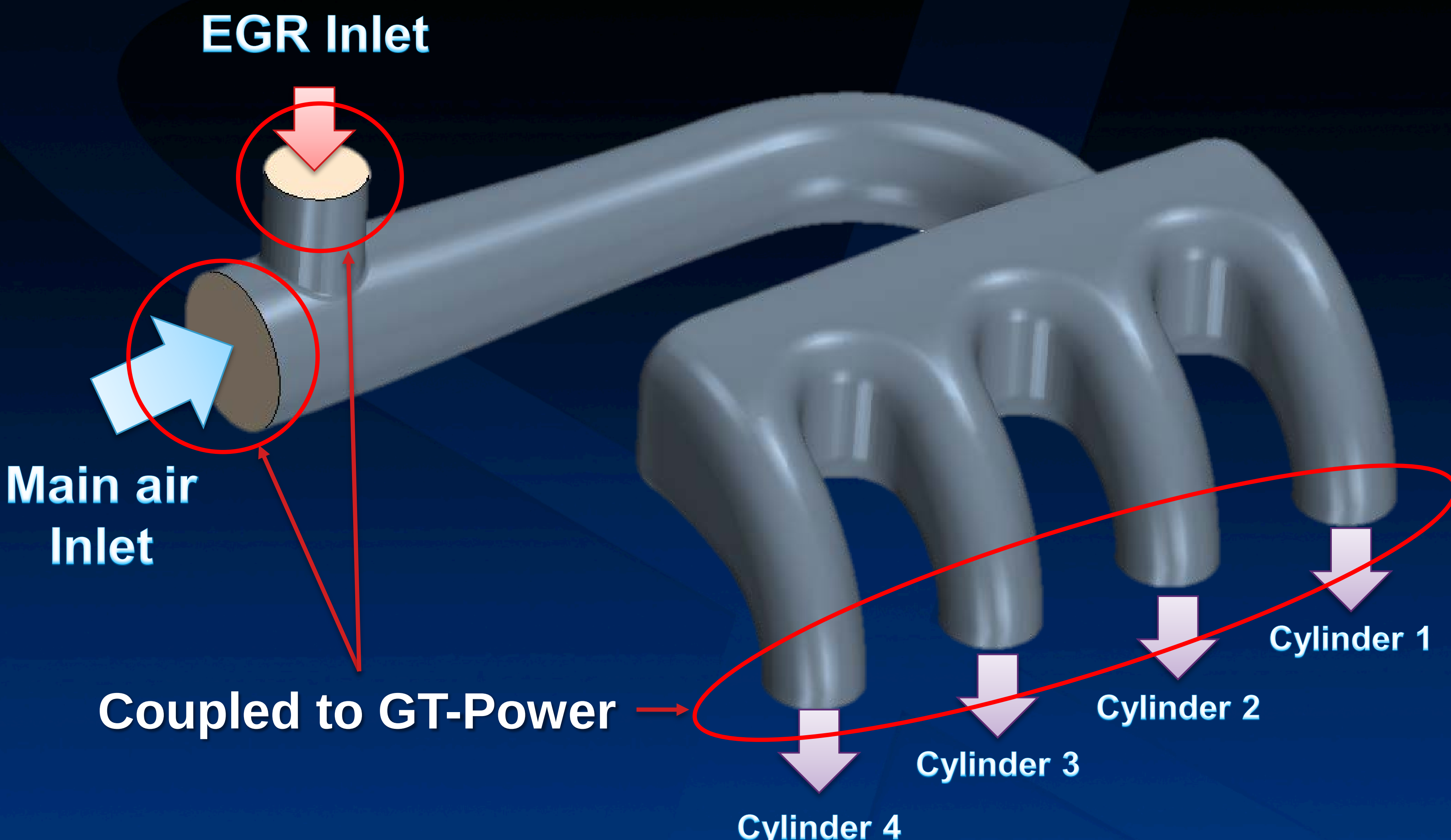
Introduction

- **Two studies presented to demonstrate how HEEDS technology may be used to improve designs involving co-simulation**

- **Design exploration of an inlet manifold**
  - GT-SUITE 1D engine performance model
  - STAR-CCM+ 3D CFD air flow model & 3D internal CAD model
  - Optimate+ for process integration & design exploration

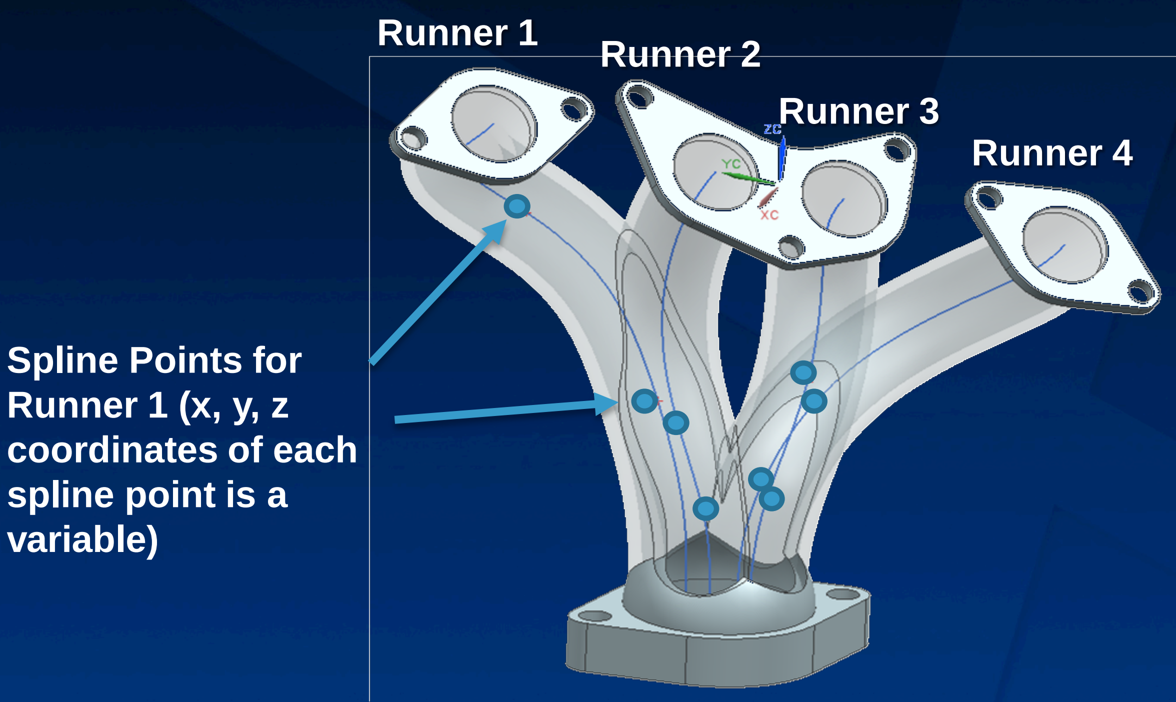
- **Design exploration of an exhaust manifold**
  - NX CAD model
  - Abaqus 3D structural/thermal model
  - STAR-CCM+ 3D CFD air flow model
  - HEEDS for process integration & design exploration

Case 1 – Inlet manifold



Case 2 – Exhaust manifold

- **Parametric 3D geometry modelled in Siemens NX CAD**
  - Each of the four runners is defined using a spline
  - The points defining the spline are varied by + or – 10% of the baseline position
    - – x, y, z coordinates of two interior points for four runners (24 variables in total)



Multi-Objective Optimization of a 3R Robotic Manipulator Equipped with Nonlinear Transmission Joints

David Fredriksson, Foad Mohammadi

CAEValue

Optimization Driven Innovation

The aim

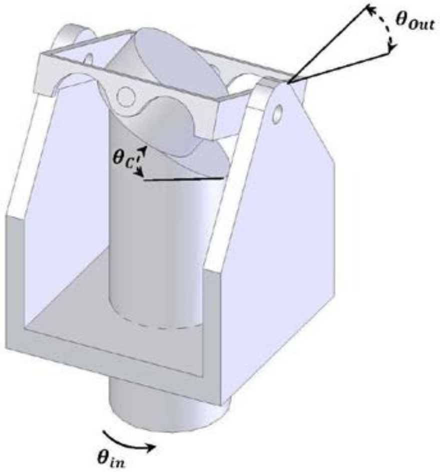


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Image: KUKA

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Investigate the possibility of using a nonlinear transmission joint in a robotic arm to decrease the power consumption of the arm while maintaining (or potentially improving) manipulability and payload performance, by exploiting the unique characteristics of the joint.

Agenda

- The nonlinear transmission joint
- The 3R manipulator
- Inverse Kinematics & Manipulability Ellipsoid Analysis
- The optimization setup
- Results
- Conclusion

Collaborative Design Optimization Process

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Velayudham Ganesan
Manager, CAE, EDAG Inc.

October 2014

Presentation Themes

1 Introduction
Mass reduction feasibility study

2 Weight Optimization
Strategies, CAE Based Optimization

3 Collaborative Optimization Process
Sub-systems, Full Vehicle, Optimization Stages

4 Strategy Analysis
Sub-systems and Full Vehicle Strategies

5 Cost Impact
MDO Output, Optimized LWV

6 LWV Performance Assessment
Trade-off

7 References

Introduction
Weight Reduction Feasibility Study

- Weight Reduction Studies initiated by EPA
- Collaborative optimization carried out for:
  - Toyota Venza, mid size cross over utility (CUV)
  - Pick-up Truck

- The studies were performed by considering the following parameters:
  - Only technologies and techniques currently feasible for manufacturability were considered
  - Options had to be cost effective for a MY 2017, 2020 high volume production vehicles respectively [1].
  - The vehicle NVH modal characteristics and crash performance had to be maintained
  - The total cost impact needed to be minimal
  - The overall vehicle safety performance had to be maintained

Introduction
Weight Reduction Feasibility Study

- Weight Reduction Scope
- Body-In-White (BIW), a prime system typically comprises of 20-25% of the total curb weight
  - Uni-Body, typically cabin BIW (e.g: Sedan, CUV, ...)
  - Body-On-Frame, typically pick-up trucks
- Closures & Bumpers
  - Doors, Fenders, Hood and Tailgate
  - Front and Rear Bumpers
- The weight reduction and cost effects [5] of multiple lightweight designs were analyzed and evaluated together using advanced optimization and engineering tools
- **This presentation is about the processes used for the evaluation of the body system**
  - Sub-systems and Integrated Full Vehicle
- **Utilizing advanced cooperative optimization computer-aided engineering (CAE) tools including HEEDS MDO**

Recent Developments in Evolutionary Multi-objective Optimization

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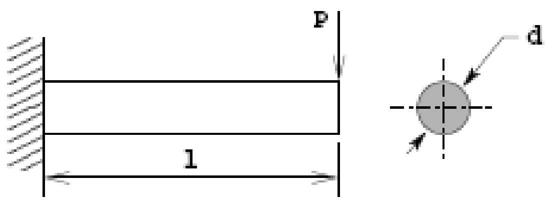
BEACON
An NSF Center for the Study of Evolution in Action

Multi-Objective Optimization

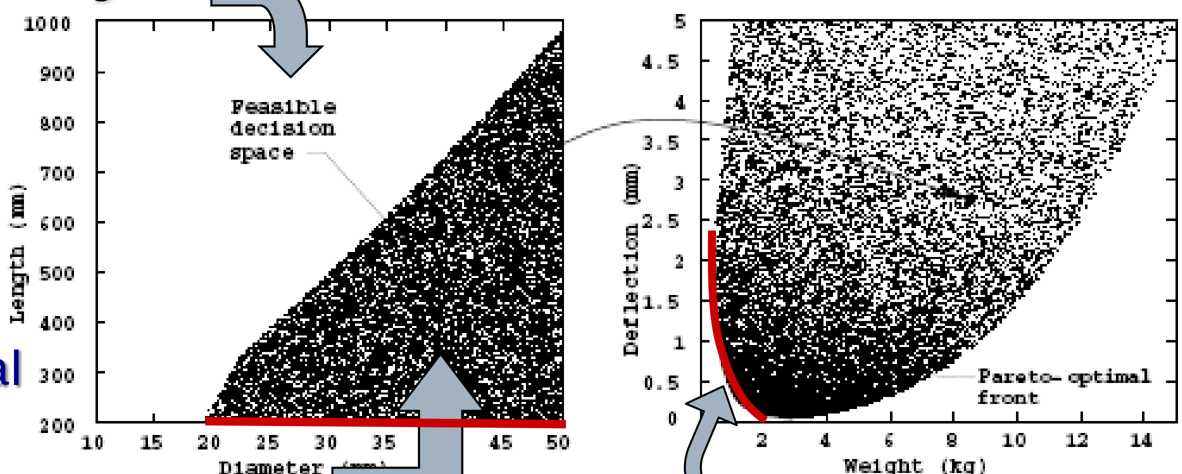


$$
\begin{aligned}
\text{Minimize} \quad & f_1(d,l) = \rho \frac{\pi d^2}{4} l \\
\text{Minimize} \quad & f_2(d,l) = \delta = \frac{64 P l^3}{3 E \pi d^4} \\
\text{subject to} \quad & \sigma_{\max} \le S_y \\
& \delta \le \delta_{\max}
\end{aligned}
$$

Infeasible region

Decision space

Pareto-optimal set



Objective space

Efficient set

Feasible region

A number of solutions are optimal

Using HEEDS to Determine Required System Complexity Early in the Design Cycle

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Background

- We are all familiar with how to use HEEDS to find the optimal solution to a design project.
- But can HEEDS be used to help define the system topology early on in the design cycle?
- This presentation shows an example on how HEEDS was used to not only find a feasible solution, but also how it was used to determine that a cheaper damper could be used.

Factors, objectives and constraints

- Requirement summary:
  - Find ride elements that:
    - Satisfy the constraints
    - Optimizes the ride criteria

Simulation	Constraint	#
10" half-round GVW	Vertical accel	4
10" half-round CVW	Vertical accel	4
Drop-off GVW	Ride frequencies	4
	Ride damping	4
Drop-off CVW	Ride frequencies	4
	Ride damping	4
Offroad CVW	Absorbed power	4
Offroad GVW	Absorbed power	4
Step steer	Yaw overshoot	1
	Roll overshoot	1
	Yaw damping	1
	Roll damping	1
Constant radius	Understeer gradient	2
	Max lateral accel	1
	Roll gradient	1
Total		**40**

Factors		
Front	Dual rate spring	5
	Position sensitive damper	13
	Anti-roll bar	3
	Geometry	3
Rear	Dual rate spring	5
	Position sensitive damper	13
	Anti-roll bar	3
	Geometry	1
Total		**46**

Objective: Minimize the sum of the ride measures

Safety Driven Optimization of Offshore Platform Orientation for Oil & Gas

Gerard Reynolds

October 15th, 2014

Optimize This! 2014 International HEEDS User Conference

Plan Design Enable

Background Information

- Type: Tension Leg Platform (TLP)
- Size: 300 ft x 300 ft x 100 ft
- Personnel on Board: 180
- Access: 90 min by Helicopter
- Cost: $3.5 bn
- Production: $10 MM/day

Consequences

Piper Alpha

Thunderhorse

Deepwater Horizon

Petronas 36

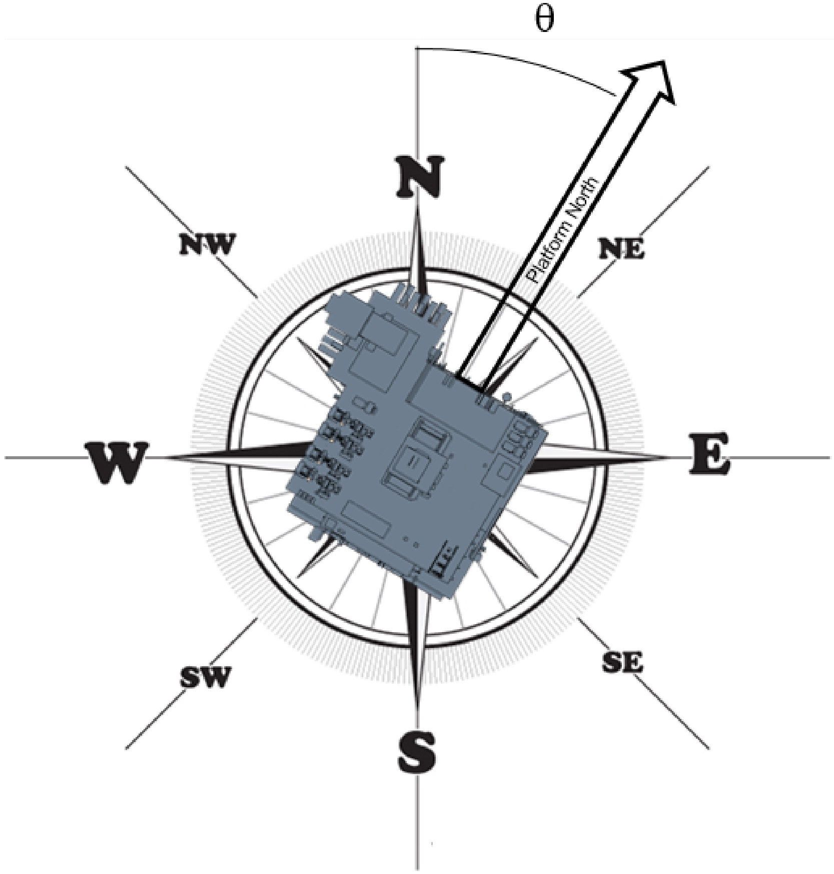
Problem Statement

Considering:

- Ventilation
- Helideck Impairment from Turbine Exhaust

Find:

- Optimum Platform Orientation



HEEDS/ DARS-Basic
Global Mechanism Optimization

Megan Karalus, PhD

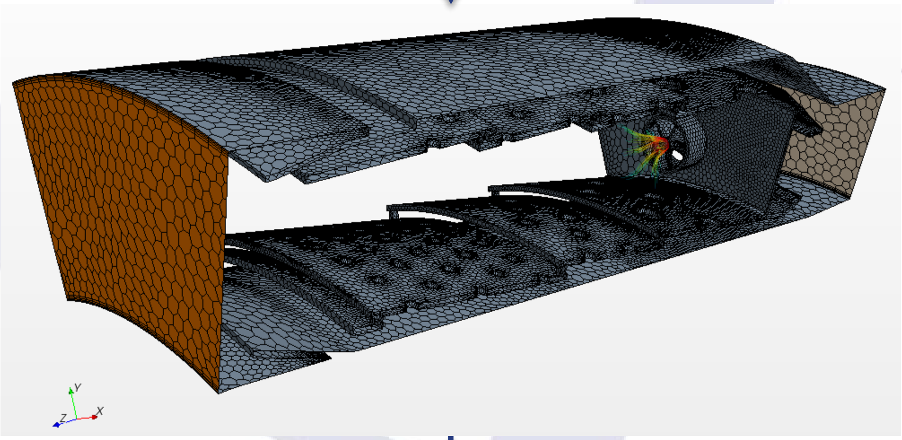
CD-adapco

October 2014

Why optimize a global mechanism?

Simple Chemistry

STAR-CCM+



Predict
CO Emissions
Flame Behavior

CD-adapco

Centrifugal Pump Optimization

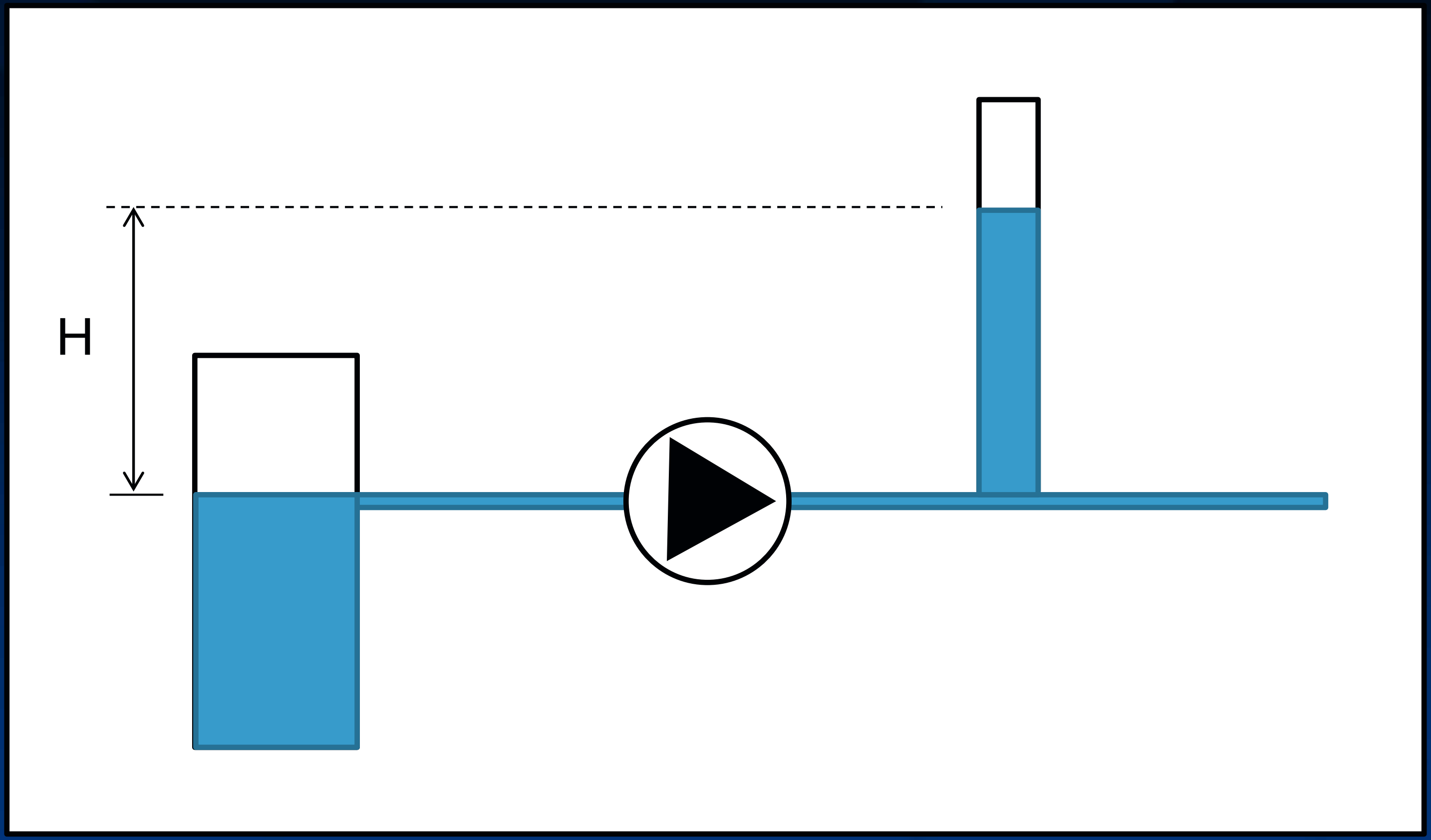
Chad Custer

Outline

- Background
- Optimization objective
- Analysis tools
- Results

Background

- **Pumps are designed to:**
  - Move a certain volume of liquid
  - Produce a certain exit pressure, which is measured in meters of head



Background

- **Reducing the power required to drive the pump:**
  - Allows for a smaller motor
  - Reduces operating cost
- **A small reduction in required power translates to large cost savings**


grundfos.com

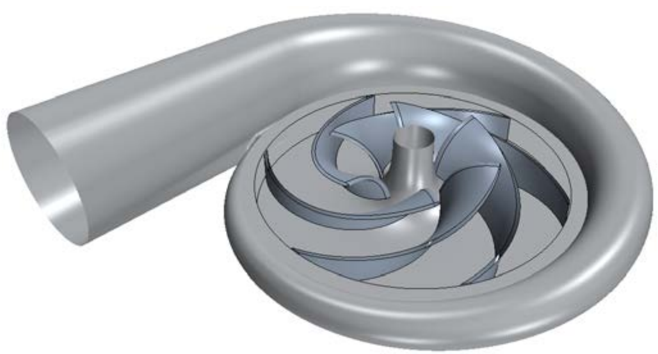
Optimization Statement

Objective

1. **Reduce the power required to drive the pump**

Constraints

- **Retrofit the impeller only (same casing)**
- **Maintain the specified volumetric flow rate**
- **Maintain the specified outlet pressure**



Existing Design
Flow rate = 400 m^3/h
Pressure head = 30 m
Power required = 38.4 kW

→ ?

Making use of Advanced Simulation to Support Race Car Testing

2014 - BTCC

Quantel Bifold
BTCC RACING TEAM

Testing Programme

- The current generation of BTCC car has not tested at Guadix before
- Drivers Marc Hynes and Sam Tordoff had not been to Guadix before
- 2009 was Triple Eights last visit to the circuit for which we have a lot of historical data
- How did we approach these issues with simulation?

Circuito Guadix

European Race Track

- Commonly used for testing
- Located in southern Spain
- New to 888 Racing
- How to prepare both cars and drivers for testing?

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