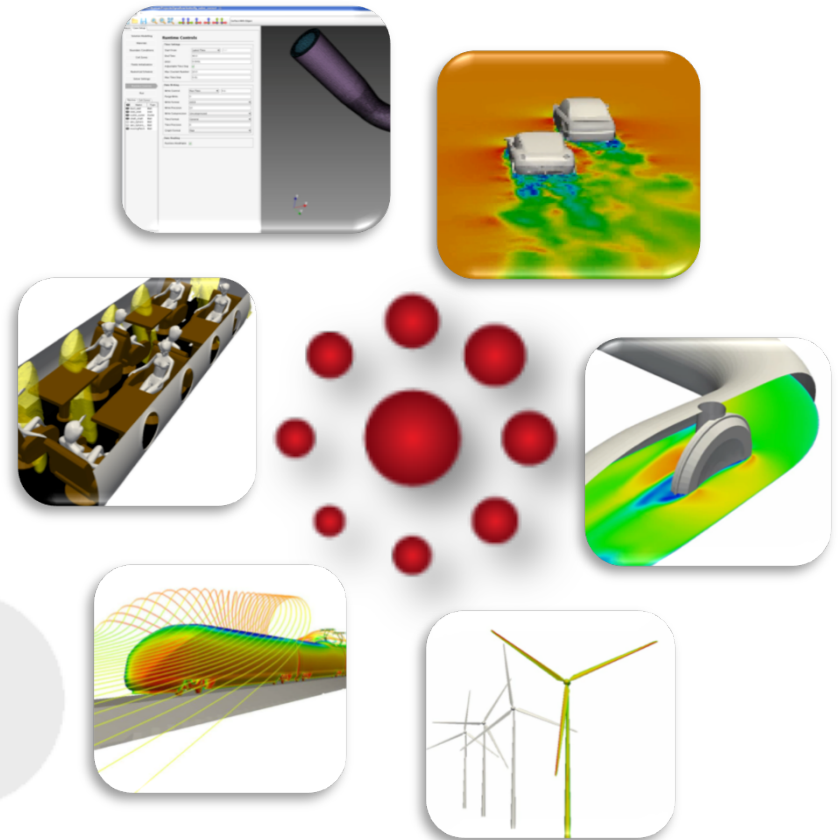


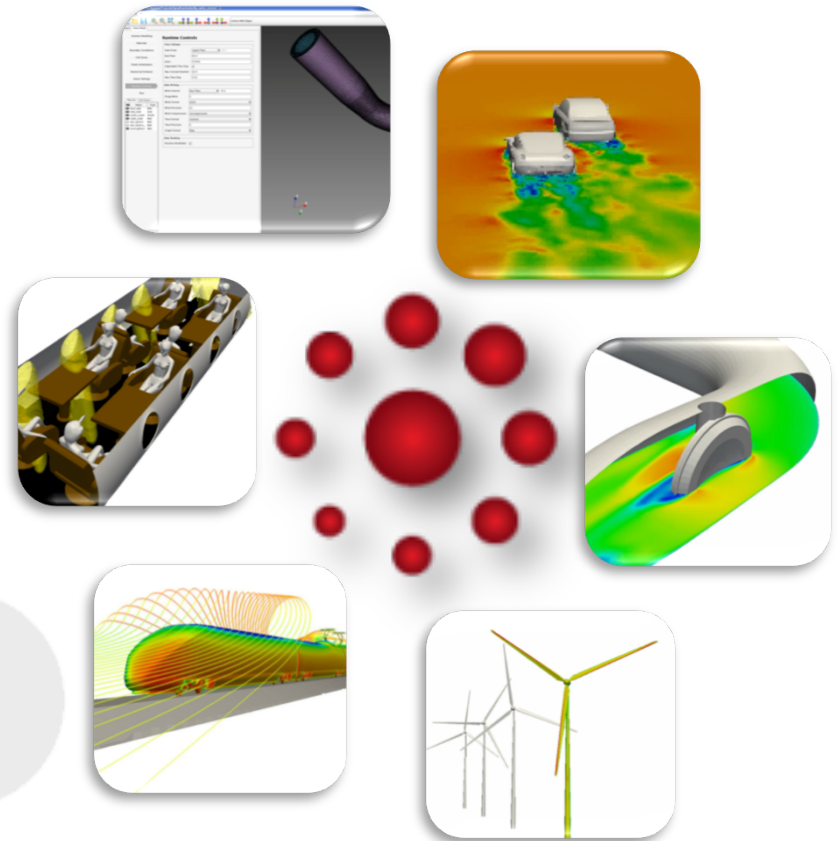
The Open Source CFD revolution?

Eugene de Villiers
Managing Director
June 2013



Contents

- Introduction
- Software & Services
- Core OSS Technology
- Closing



Company | Introduction

- CAE products and services
- Focus on Open Source solutions
- Solution platforms:
 - CFD → HELYX[®]/OPENFOAM[®]
 - Optimisation → DAKOTA
 - GUI → HELYX/HELYX^{OS}
- History:
 - 2009 → founded in the UK
 - 2010 – present → 5 offices worldwide
 - 2012 → Joint Venture with ARC
(Streamline Solutions)




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Company | Locations

 USA (Indianapolis)

 UK (London)

 Germany (Rostock)

 Italy (Trieste)

 Australia (Brisbane)

Company | Vision

- No one can be an expert at everything
- Maintain tight focus and high level of expertise in core disciplines
- Engys strategic focus
 - General, extensible HELYX platform (Core OS software + GUI)
 - Public fork of base code that supports plug-in modules
 - Engage with 3rd-party contributors to provide expert plug-ins
 - Best-in-class customer support
- Engys technical focus
 - LES/DES high resolution transient (models and numerics)
 - Adjoint optimisation for shape and topology
 - Comprehensive thermal modelling platform
 - Mesh generation → good mesh = good solution

Company | Collaborations

- Resellers & Product Partners

- Japan: CAE-SC, Vinas
- USA: A.R.C.
- Netherlands: Dynaflo Research
- South Africa: CSIR



- Strong ties with academia:

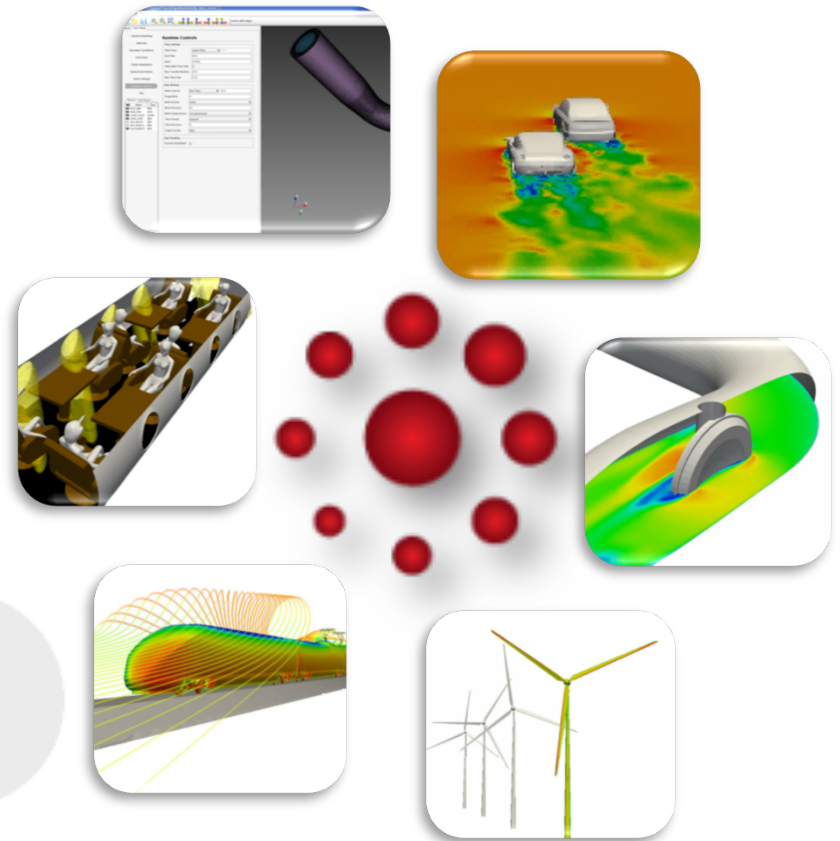
- Queen Mary (UK), Aachen, Rostock, TUB, TUM, TU DS (DE)
- Politecnico di Milano - ICE Group, Trieste, Modena e Reggio Emilia (IT), NTUA (Greece), Hochschule Luzern (Ch), ...
- Niigata (JP)

- Consultants:

- Mositech, MOVE-CSC (DE), WIKKI (UK),
- SKM (DE), CADE (ES)

Contents

- Company Description
- **Software & Services**
- Core OSS Technology
- Closing



Software | Overview



HELYX^{OS}

Open Source GUI for
OPENFOAM[®]

Free Download via
SourceForge



HELYX[®]

Advanced CFD
Software Suite

User Support and
Documentation



ELEMENTS

CAE Package for
Automotive Design

Developed by Engys
and Auto Research
Center

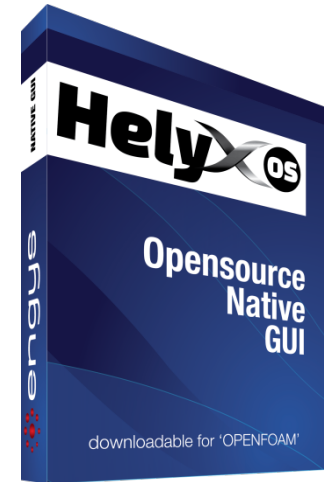
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Software | HELYX^{OS}

- HELYX^{OS} support package
- Entry level support package
 - Provisioning of standard OPENFOAM[®] (Windows & Linux binaries)
 - Provisioning of HELYX^{OS} GUI (Windows & Linux binaries)
 - Fixed number of support hours
 - Tutorial guide
 - GUI bug fixing only
- Secure online portal
 - Download software/upgrades, documentation, issue tracking



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Software | HELYX

- Advanced CFD software suite
 - Full HELYX GUI
 - Provisioning of HELYX CORE (OPENFOAM® Engys Edition)
 - Extensive user guide and documentation
 - Assistance using GUI, HELYX CORE, DAKOTA
 - Unlimited support
 - Installation, issue resolution, minor customisation
- Secure online portal
 - Download software/upgrades, documentation, issue tracking
- Derivative products:
 - HELYX^{SAS} – “Setup & Solve” for 3rd party meshing and post-processors
 - HELYX^{MESH} – Engys enhanced mesh generator



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HELYX vs. HELYX-OS | Overview



Helyx OS



Helyx

Availability	Free to download via SourceForge (optional paid Support service)	Paying customers
GUI License	GPL	Proprietary (floating server license)
Kernel Code	Standard OpenFOAM® v2.2.x	Engys' own enhanced version of OpenFOAM® library
Meshing	Standard <i>snappyHexMesh</i>	Improved <i>snappyHexMesh</i> (better mesh quality and performance)
Case Setup	Native file read/write from GUI	Native file read/write from GUI + dedicated <i>caseSetup</i> utility
Solvers	Automatic execution of standard FOAM solvers	Automatic execution of solvers with support for enhanced features
Support	Optional paid support packages available for GUI + OPENFOAM®	Advanced annual support and maintenance for GUI + kernel code
Documentation	Tutorials guide available with Support package	Comprehensive user guide and tutorials for GUI and kernel code

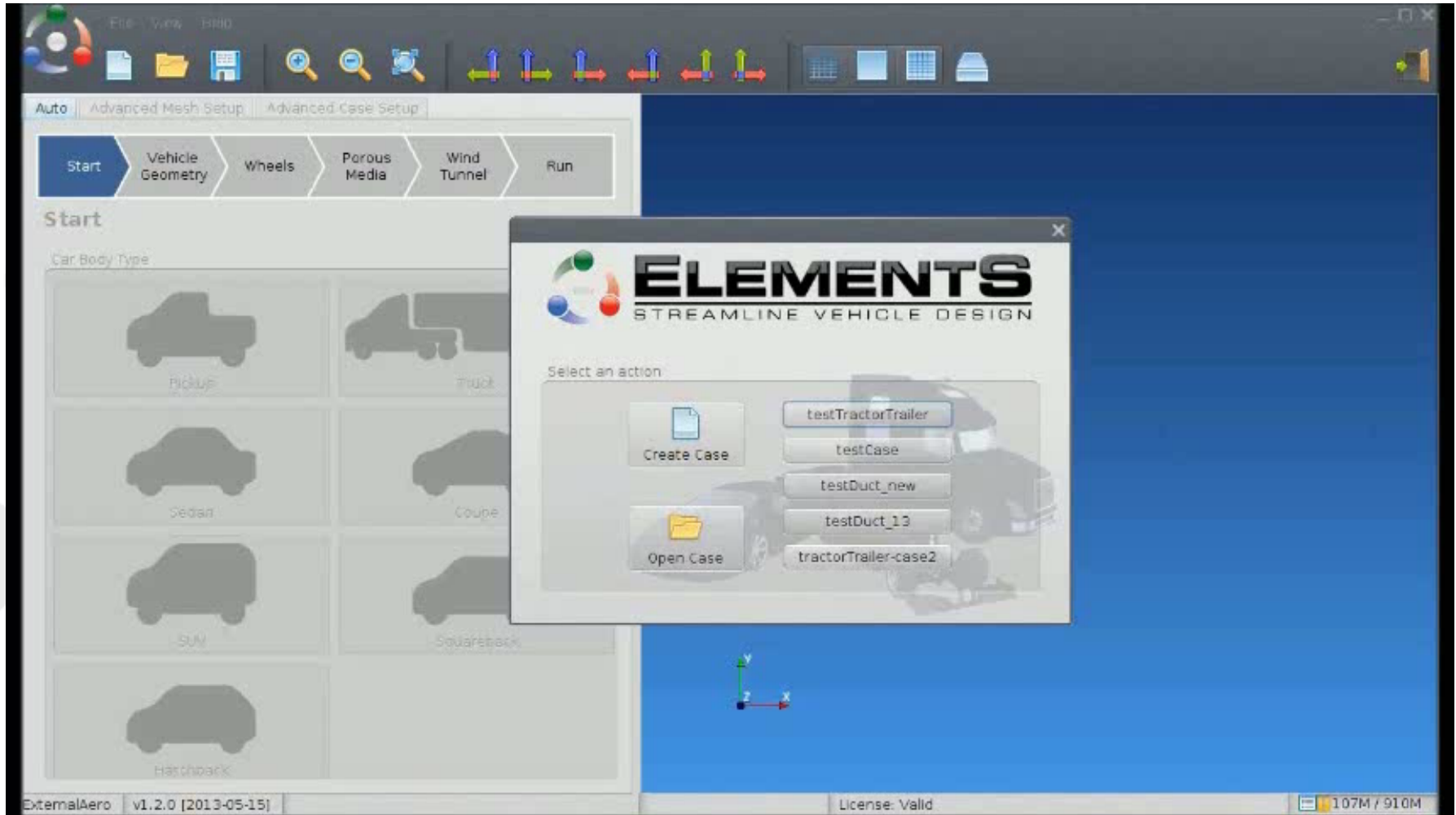
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Software | ELEMENTS

- From Streamline Solutions
- Vertically integrated application for automotive design
 - Design
 - Analyse
 - Visualize
- Powered by HELYX (mesh, custom DES solver and GUI)
- Extensive validation matrix (more than 100 experimental comparisons)
- Comprehensive set of imbedded best practices
- First class user support
- Streamlined GUI based workflow



Software | ELEMENTS | GUI



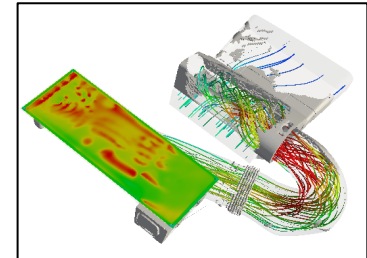
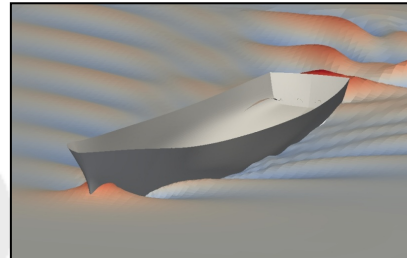
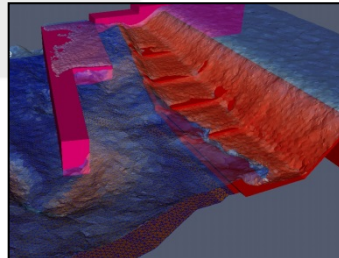
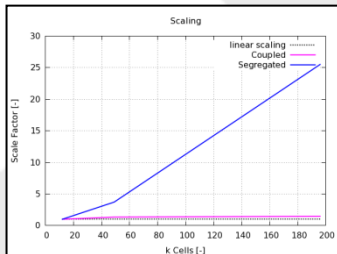
Software | ELEMENTS | Validation

Vehicle No.	Vehicle Model	Grille (open, closed, blanked)	Wind Tunnel Data		Elements			Notes (no. of cells, prism layers, run length, etc.)
			Scale	Ground Simulation	Coefficients			
					CD	CLF	CLR	
1	DRIVAER Estate	n/a	40%	Single Belt	2.40%			Scale Model, 29.5 Cells, 24 hrs, 3 body layers
2	DRIVAER Fast	n/a	40%	Single Belt	-0.41%			Scale Model, 29.7 Cells, 18.4 hrs, 3 body layers
3	DRIVAER Notch	n/a	40%	Single Belt	0.41%			Scale Model, 29 Cells, 24.3 hrs, 3 body layers
4	Sedan 1	open	100%	5 Belt	0.67%	-0.67%	-6.56%	Full Size Model, 49M Cells, 22.5 hrs, 3 body layers
		open	40%	Single Belt	0.00%	-7.19%	4.45%	Scale Model, 46M Cells, 23 hrs, 3 body layers
		closed	40%	Single Belt	1.74%	-2.48%	4.61%	Scale Model, 54.5M Cells, 25.8 hrs, 3 body layers
5	Sedan 2	open	100%	5 Belt	0.00%	-1.87%	-0.37%	45M Cells, 3 Body layers, 22 hrs, Open, Full Size
		blanked	100%	Fixed	1.57%	-26.38%	9.84%	
6	Sedan 3	closed	100%	Fixed	2.35%			42 M Cells, 3 Body Layers, 46 hrs, Full Size
		open	40%	Single Belt	0.32%	-2.27%	-2.27%	Perforated Plate Porous Zones, Simulated ARC tunnel Belt System
		closed	40%	Single Belt	2.03%	-1.35%	2.03%	Perforated Plate Porous Zones, Simulated ARC tunnel Belt System
7	Estate 1	open	40%	Single Belt	-0.32%	11.04%	26.62%	Scale Model In tunnel, 91.5 M Cells, 49.74 hrs, 3 body/belt layers.
8	Estate 2	open	100%	5 Belt	-0.95%	-3.81%	-3.17%	
9	Hatchback 1	open	40%	Single Belt	3.09%	7.21%	19.75%	Scale Model in Tunnel, 101.4M Cells, 25.65 hrs, 3 body/belt layers.
10	Hatchback 2	open	100%	5 Belt	2.18%	-22.55%	12.00%	
11	SUV 1	open	40%	Single Belt	0.81%	6.59%	-16.76%	Scale Model, 47.7M Cells, 13.4 hrs, 3 body layers
12	NASCAR 1		40%	Single Belt	2.22%			Scale Model, 53.4M Cells, 35.6 hrs, 3 body layers
13	NASCAR 2	open	40%	Single Belt	-1.25%	-32.67%	-10.47%	Scale Model
14	Semi-Truck 1	open	12.5%	Single Belt	0.19%			Tractor CD is 0.326/(0.320); trailer CD is 0.207/(0.214) Tunnel/(CFD)
15	Light Truck 1	open	20%	Single Belt	-0.38%	-5.09%	-10.38%	63M Cells, ARC Moving Belt on Floor

Average Error Magnitude 1.2% 9.37% 9.24%

Software | HELYX Modules

- Add-on high performance solver packages for HELYX
- In co-operation with independent development partners
- Full GUI/User support
- Available modules
 - Fully implicit block coupled solvers
 - Enhanced multi-phase environment
 - Rapid ship performance calculator
 - Adjoint topology and shape optimisation
 - HVAC and Built environment

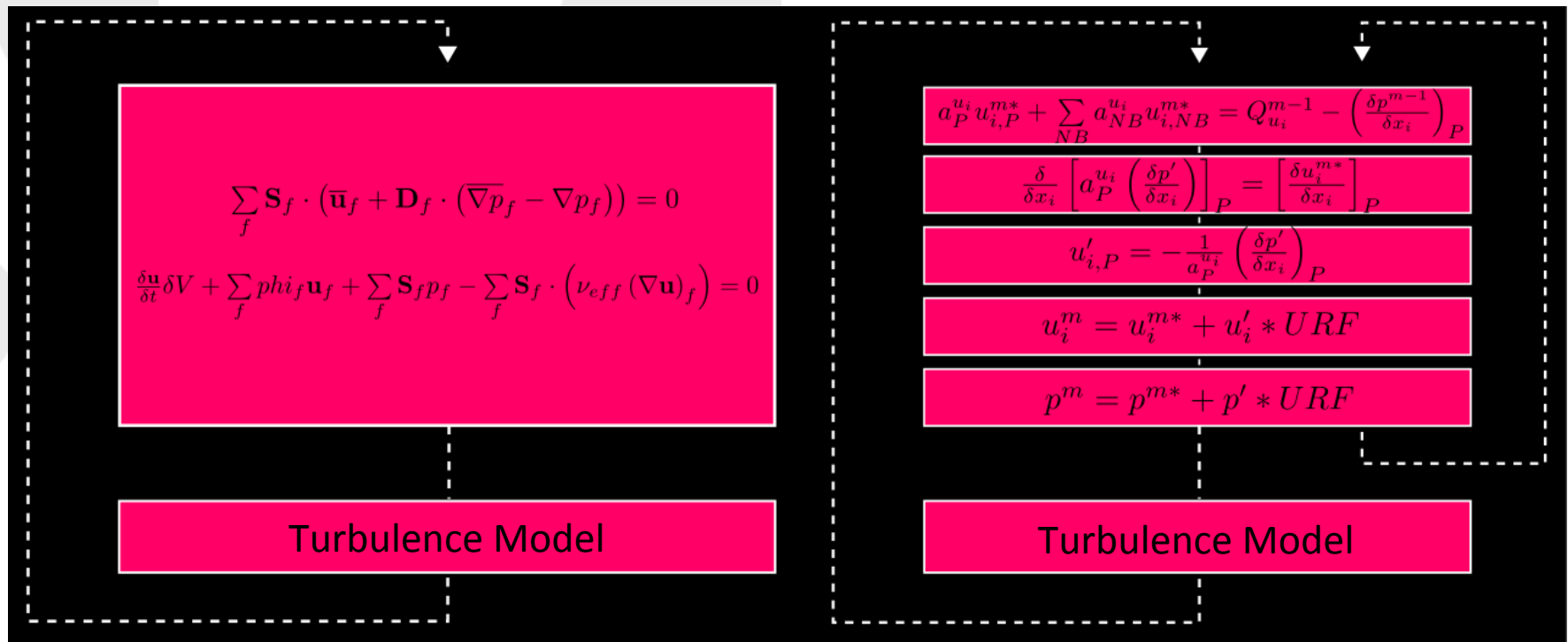


HELYX Modules | Coupled

- Developers:
 - Dr. Luca Mangani – Hochschule Luzern,
 - Prof Marwan Darwish – American University Beirut

Coupled

Segregated

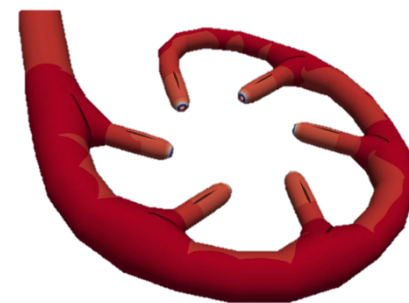
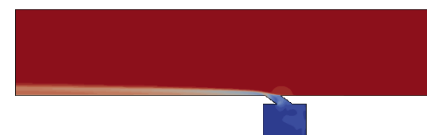
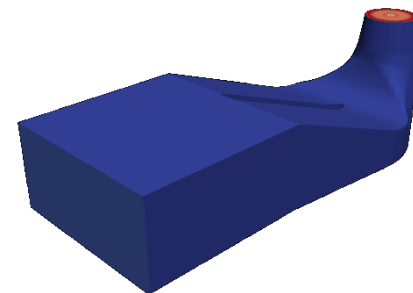
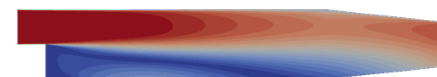
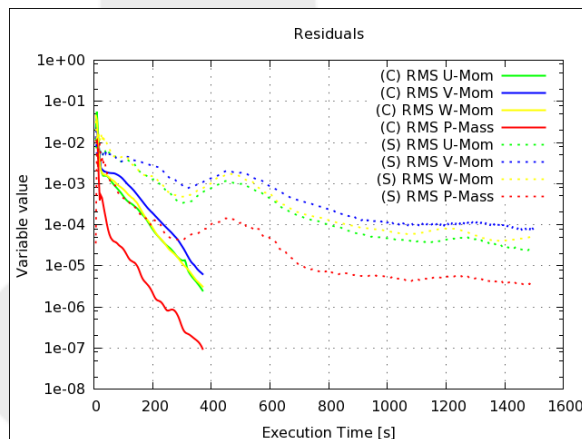
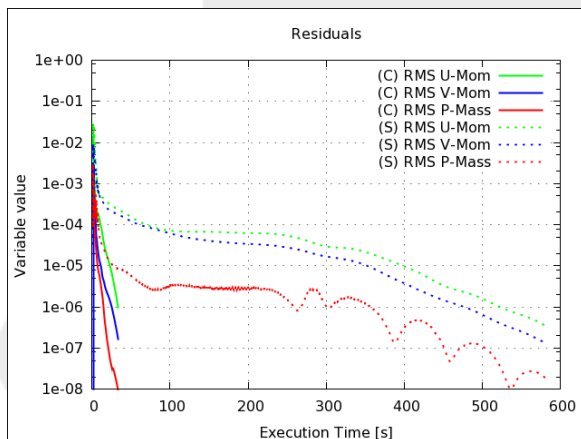


HELYX Modules | Coupled

- Linear scaling with increased cells
- Coupled vs. Segregated for steady incompressible

Case	nCells	Speed-up (S)	Speed-up (CC)
Pitz-Daily	200k	109x	-
Draft tube	200k	6.2x	2x
Film cooling	177k	10x	1.4x
Pelton distributor	3M	Segregated fail	-

- Parallel efficiency ~75%

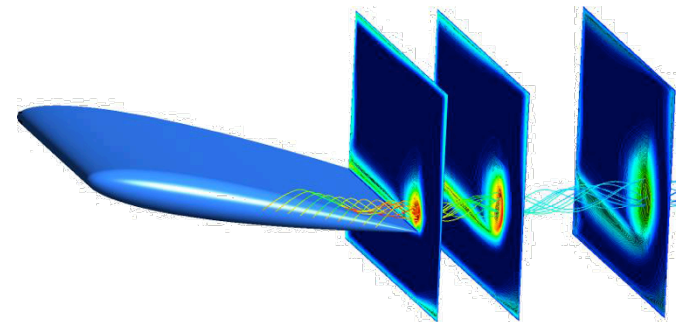
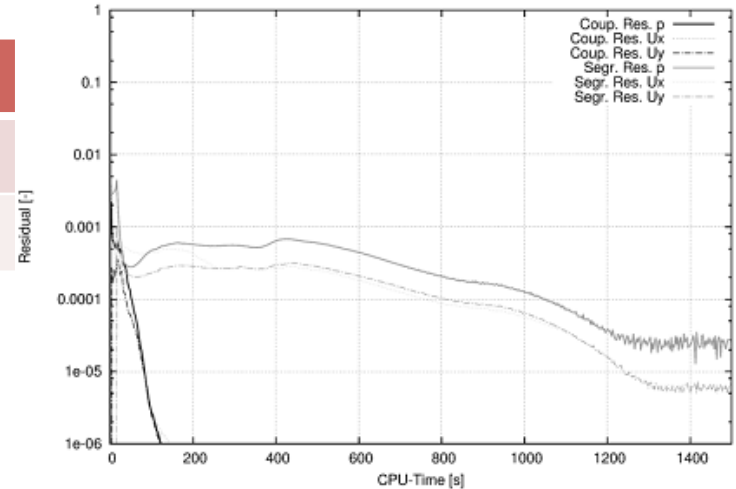
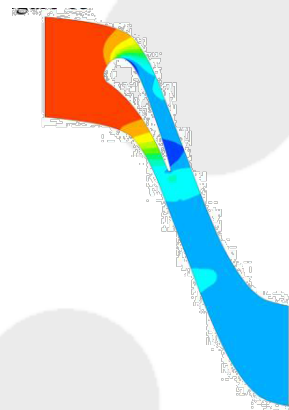
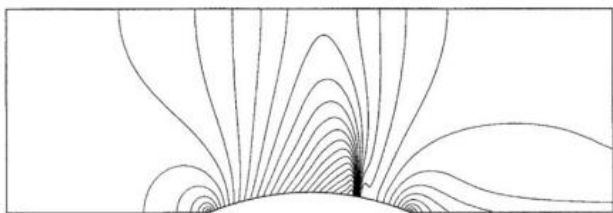
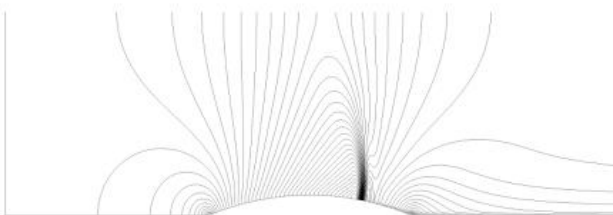


HELYX Modules | Coupled (cont.)

- Compressible

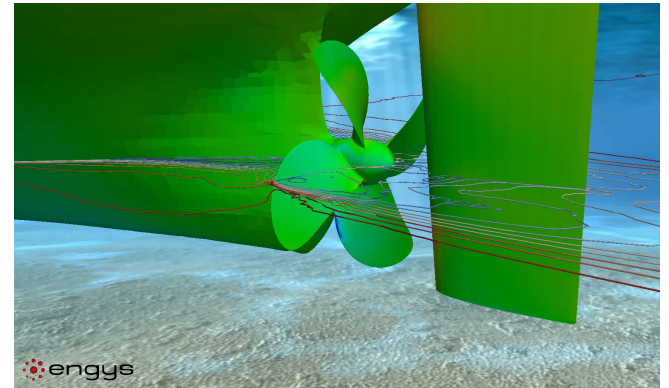
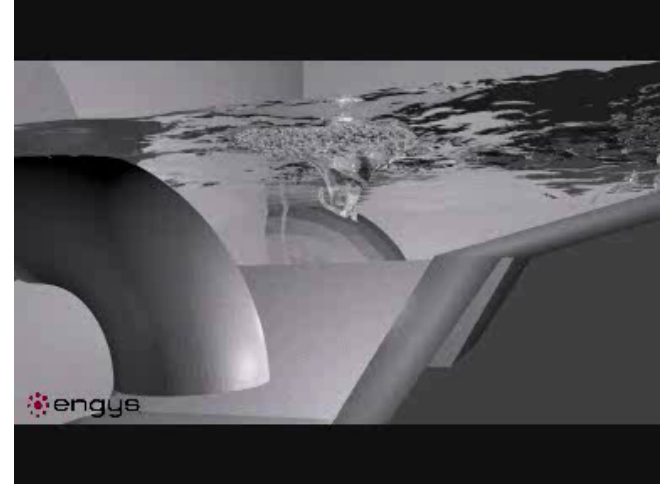
Case	nCells	Speed-up
Turbine blade (C3X)	44k	21x
NACA 0012	650k	10x

- K- ω SST model
- All Mach numbers



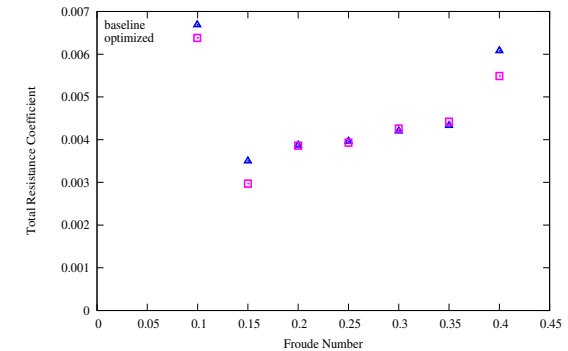
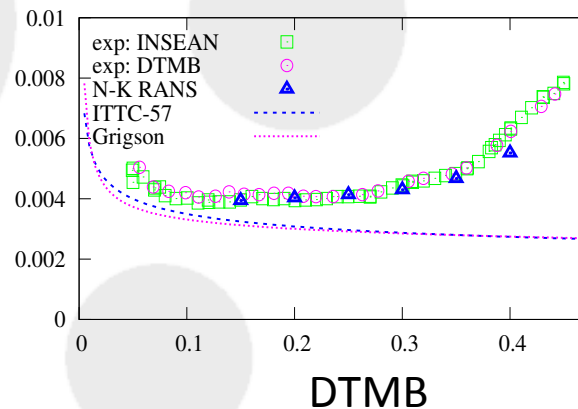
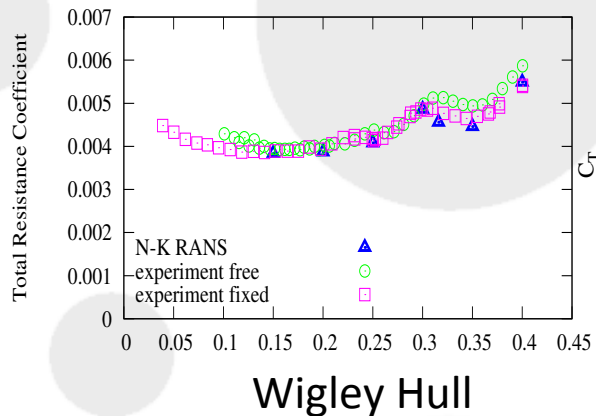
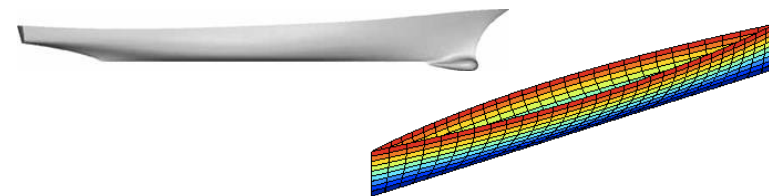
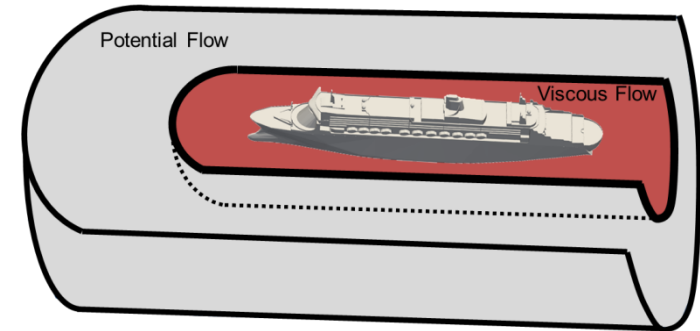
HELYX Modules | Hydro

- (In development)
- Consists of:
 - Advanced VOF multiphase solver
 - Robust numerics
 - Compressible gas phase
 - Extensive boundary conditions for wave handling
 - Specialised initialisation tools
 - Moving mesh
- Applications
 - Tank sloshing / filling
 - Civil/hydraulic engineering
 - Coastal Engineering
 - Marine
- Extensively validated



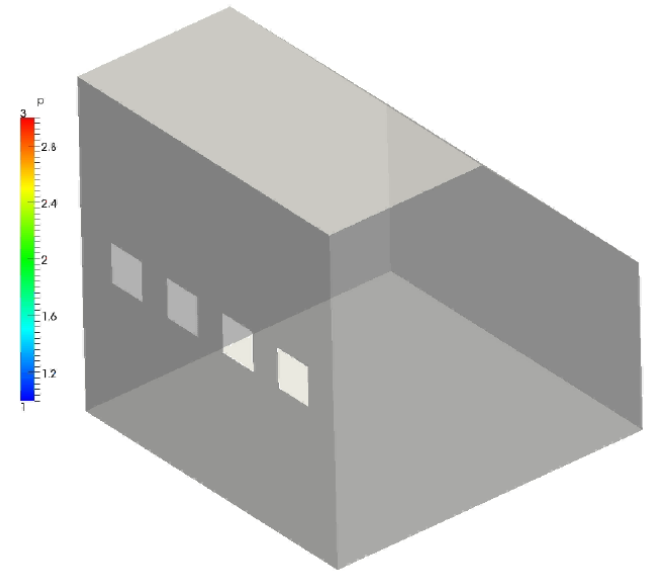
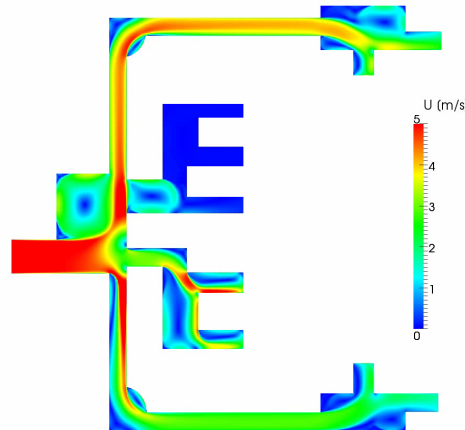
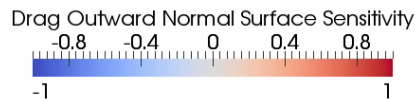
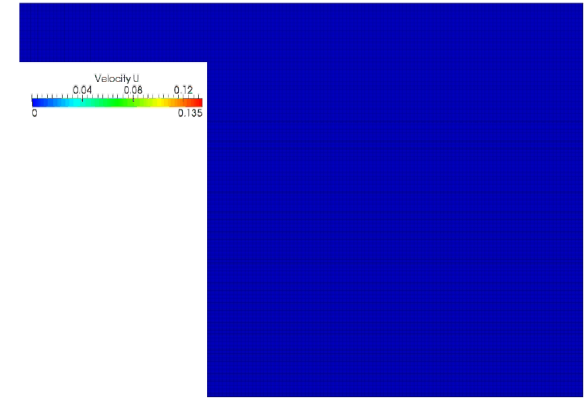
HELYX Modules | ecoMarine

- Developed by: Dr Kevin Maki – Univ. of Michigan, Paolo Geremia – Engys Italy
- Zonal inviscid/RANS viscous flow solution
- Advanced free-surface effect
- 300 times faster than multi-phase solver
- Dynamic sink and trim
- Included Dakota optimisation framework
- Extensively validated



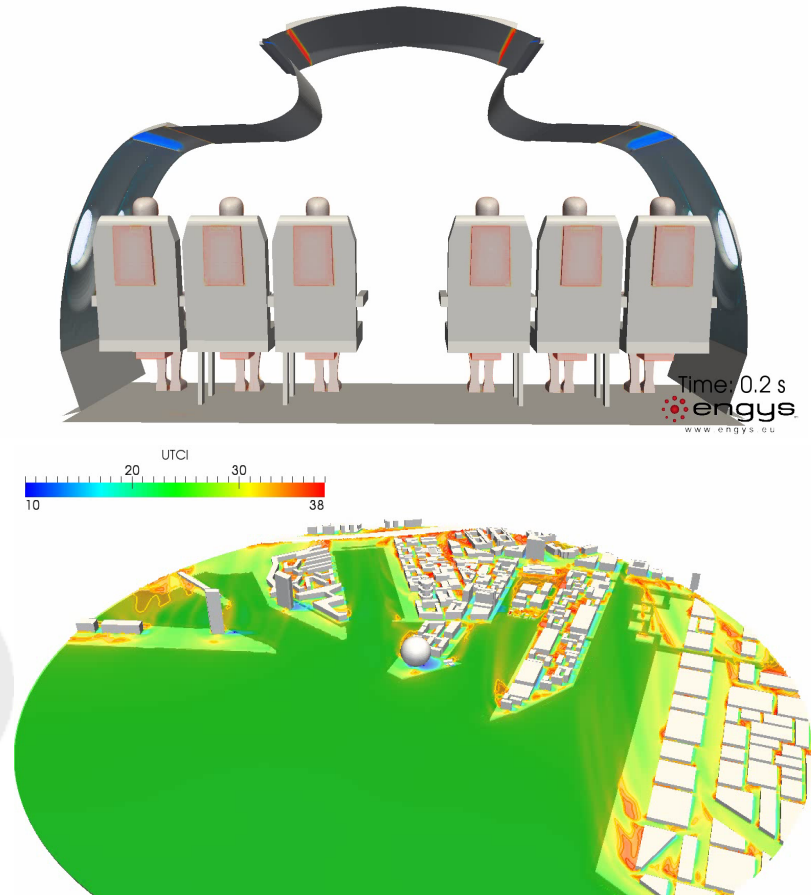
HELYX Modules | Adjoint Optimisation

- Developed by: Carsten Othmer – VW Research, Eugene de Villiers – Engys UK
- Continuous adjoint solver
- Integrated topology/shape optimisation environment
- Multi-objective with heuristic control



HELYX Modules | HVAC

- Integrated Engys module
- Improved radiation
 - Radiation coupling to boundaries
 - Solar/environmental radiation
 - Radiation baffles (glass)
 - Enhanced solver performance
- Extended features
 - Simple human models
 - Contaminant dispersal
 - Humidity + condensation/evaporation
- Radtherm coupling
- Thermal comfort post-processing
 - PPV, DR, PMV, UTCI, AoA ...



Services | Overview

SERVICES

**HELYX/HELYX^{OS} /
ELEMENTS
Training**

**DAKOTA
Optimisation
Support &
Training**

**HPC
On Demand**

**HELYX/
HELYX^{CORE} /
ELEMENTS
Development &
Customization**

**Adjoint CFD
Optimisation
Consultancy**

**Analysis, Design,
Consultancy**

Services | Development

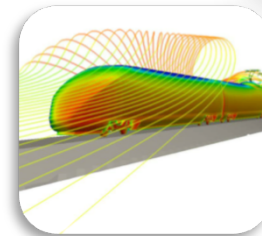
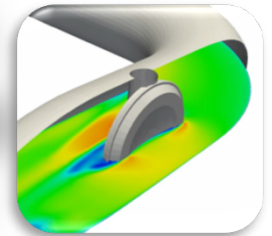
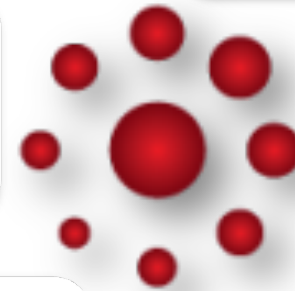
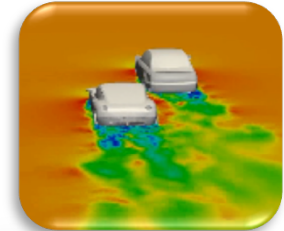
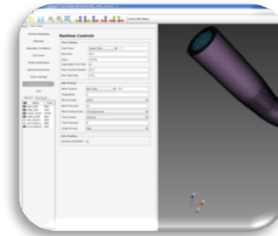
- Customised software and methods development
 - 14+ year development track-record using FOAM/OPENFOAM®
 - Dr. Eugene de Villiers: US → Imperial College → Nabla → Icon → Engys
 - Dr. Andrew Jackson: UMIST → Imperial College → ARA → Icon → Engys
 - Dr. Dan Combest: Accenture → Washington U. Illinois → Engys
 - Georgios Carpouzas: NTUA → Engys
 - Stefano Valeri: University of Trieste → Esteco → Engys
 - Davide Ciani: University of Udine → Esteco → Engys
 - Paolo Geremia: University of Trieste → Esteco → Engys
- Mesh generation/motion, models, solvers, block coupled algorithms, pre-/post- utilities, fundamental framework, adjoint, multi-physics ...

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- Company Description
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- **Core OSS Technology**
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Technology | Overview

- HELYX CORE Based on OPENFOAM® (2.2 Q3 2013)
 - Full integration of Engys enhanced features
- Instant updates with online repository
- Support for latest ParaView with parallel cases
- Single file caseSetup for batch execution
 - Multiphase
 - Arbitrary mesh interfaces
 - User customisable modules for a large range of solvers
- Enhanced meshing
- Improved, fully integrated radiation (thermal and solar)
- Humidity transport with wall evaporation/condensation

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Technology | Overview

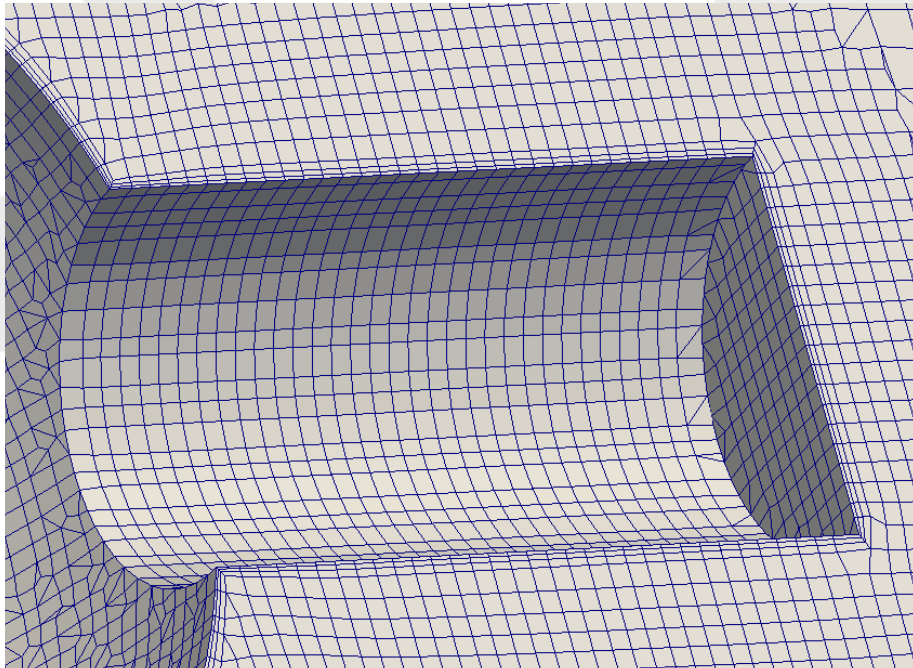
- 50+ new boundary conditions
 - Improved wall functions and simplified turbulent inlets
 - 0D lumped capacitance transient thermal boundaries
 - Resistive outlet
- swak4Foam and other Extend feature integration
- Coupling with RadTherm
- Accelerated CHT
- Improved solver stability (DES, multiphase)
- Run time output of Enight data
- ...

Technology | HELYX Mesh | Comparison

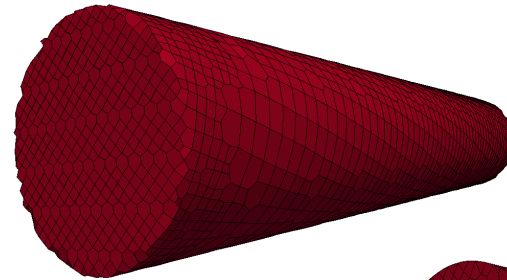
Feature	HELYX snappyHexMesh	2.2.0 snappyHexMesh
Automatic blockMesh	✓	✗
Feature Line	✓ (Automatic and Implicit)	✓ (Manual and Explicit)
Searchable surface feature Lines	✓	✗
Multi-region support	✓	✗
Non-manifold splitting (robustness)	✓	✗
Edge collapsing	✓	✗
Proximity refinement	✓	✗
Volumetric smoothing	✓	✗
Parallel	✓ (scaling above 60 cores)	✓ (no scaling above 60 cores)
Layer control	✓ (10 different methods available)	✓ (3 different methods available)
Small leak closure	✓	✗
Wrapping	✓	✗
Interior Layers	✓	✗
Automatic AMI setup	✓	✗

Technology | HELYX Mesh

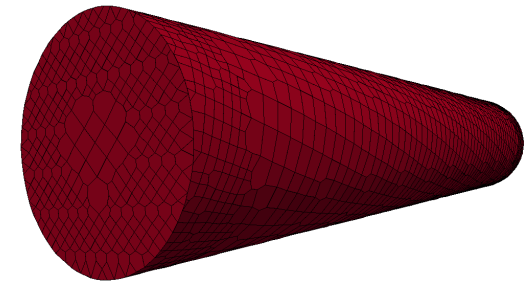
- Automatic feature edge capturing (no need for *.eMesh*)
- Improved surface snapping
- Full projection of near-wall layers to inlets, outlet, symmetry planes



Comparison *snappyHexMesh*
(*searchableCylinder*)



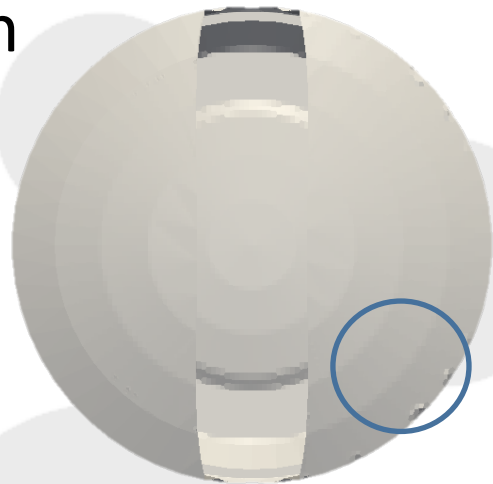
Standard v2.2



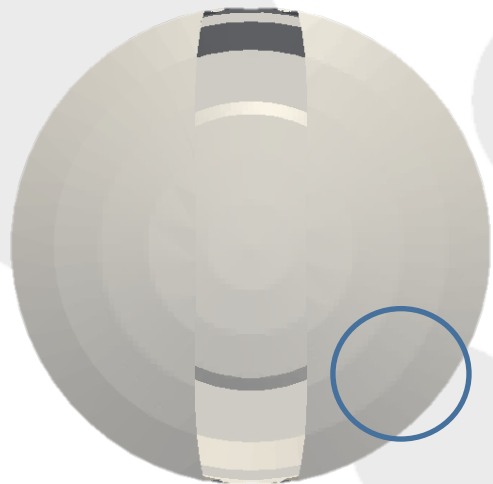
HELYX 2.1

Technology | HELYX Mesh

- Implicit feature snapping and automated feature extraction



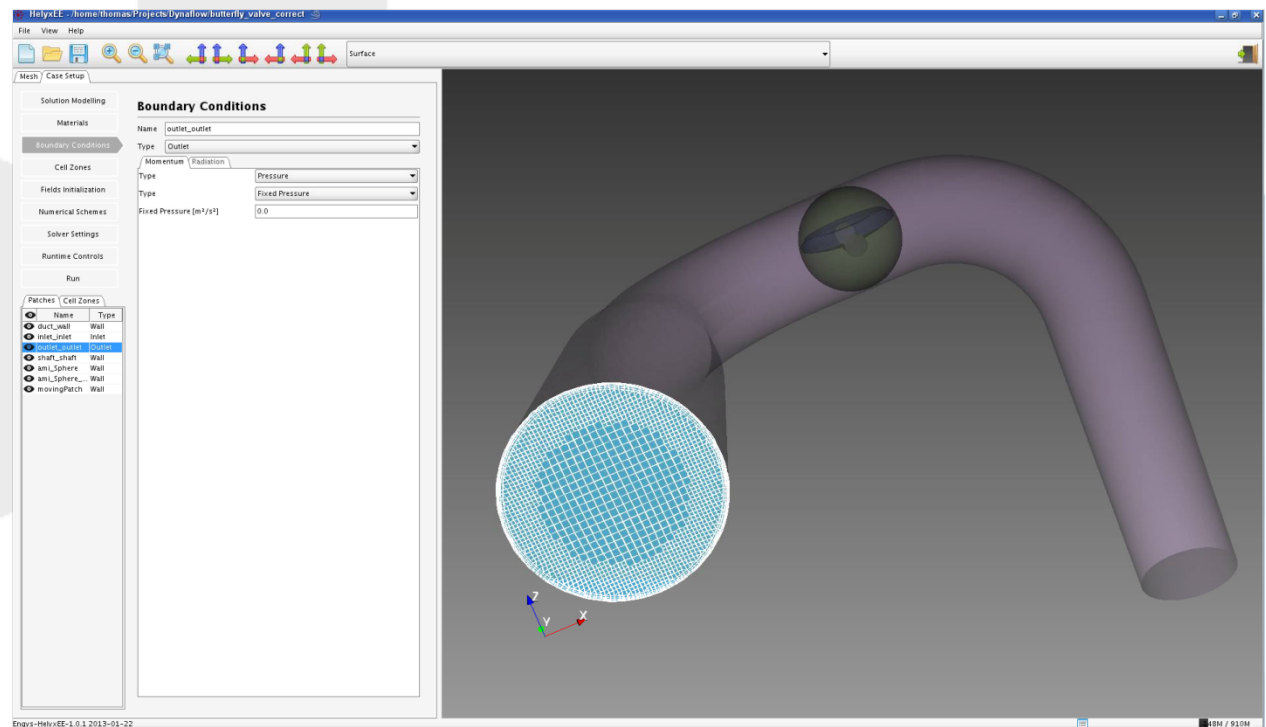
Standard
v2.2



Engys
v2.1

Technology | HELYX Mesh

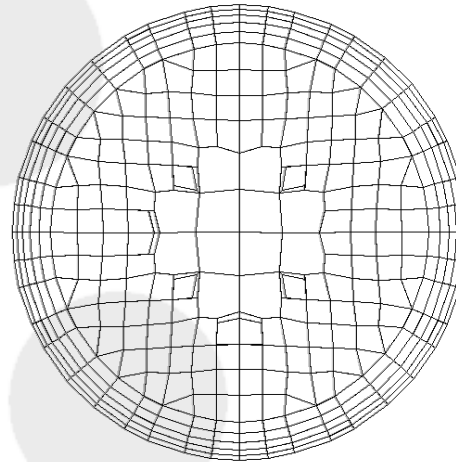
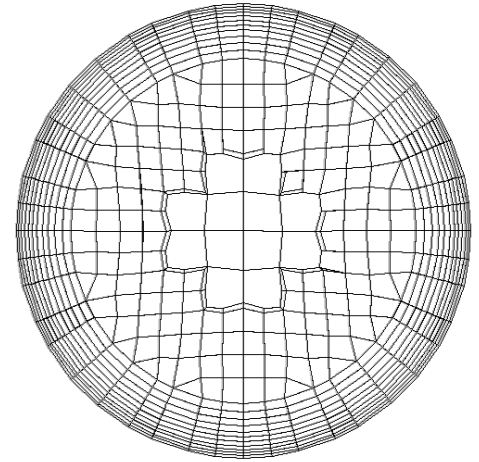
- Multi-region support (CHT, AMI)
- Automatic AMI setup (re-patching & zoning)
- Volumetric smoothing (stops mesh tangling)



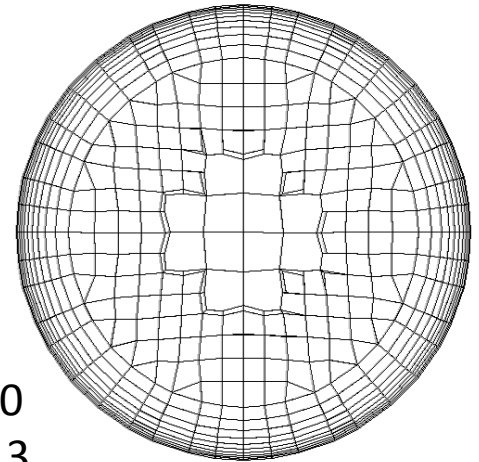
Technology | HELYX Mesh

- Extended layer controls
- Can now specify any 3 of the following:
 - first cell height (t_0)
 - final cell height (t_f)
 - expansion ratio (R)
 - number of layers (N)
 - total layer thickness (T)
- Improved handling of high aspect ratio elements

T 2
 t_f 0.3
 t_0 1mm



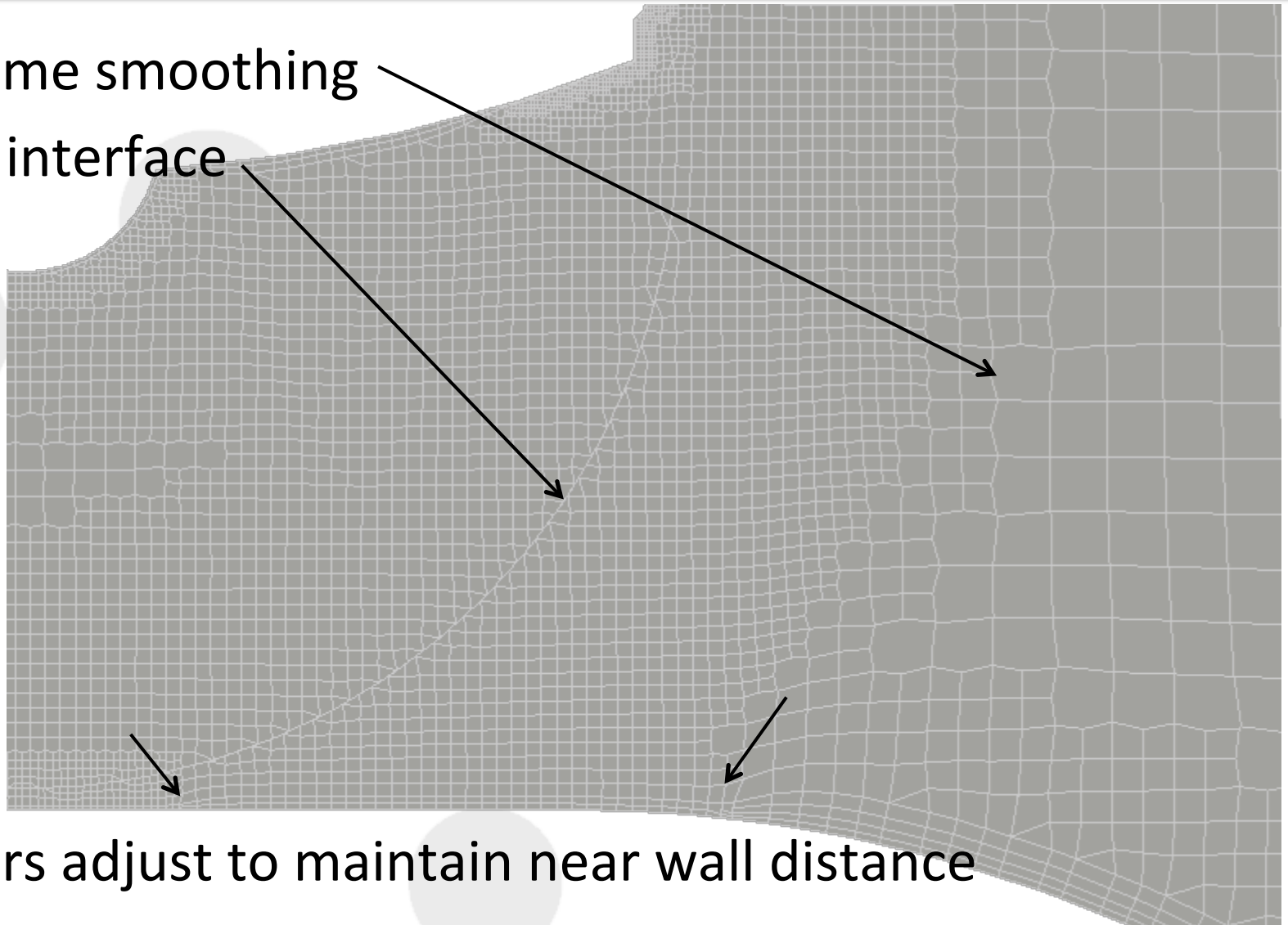
N 5
R 1.3
 T_f 0.4



N 10
R 1.3
 T_0 1mm

Technology | HELYX Mesh

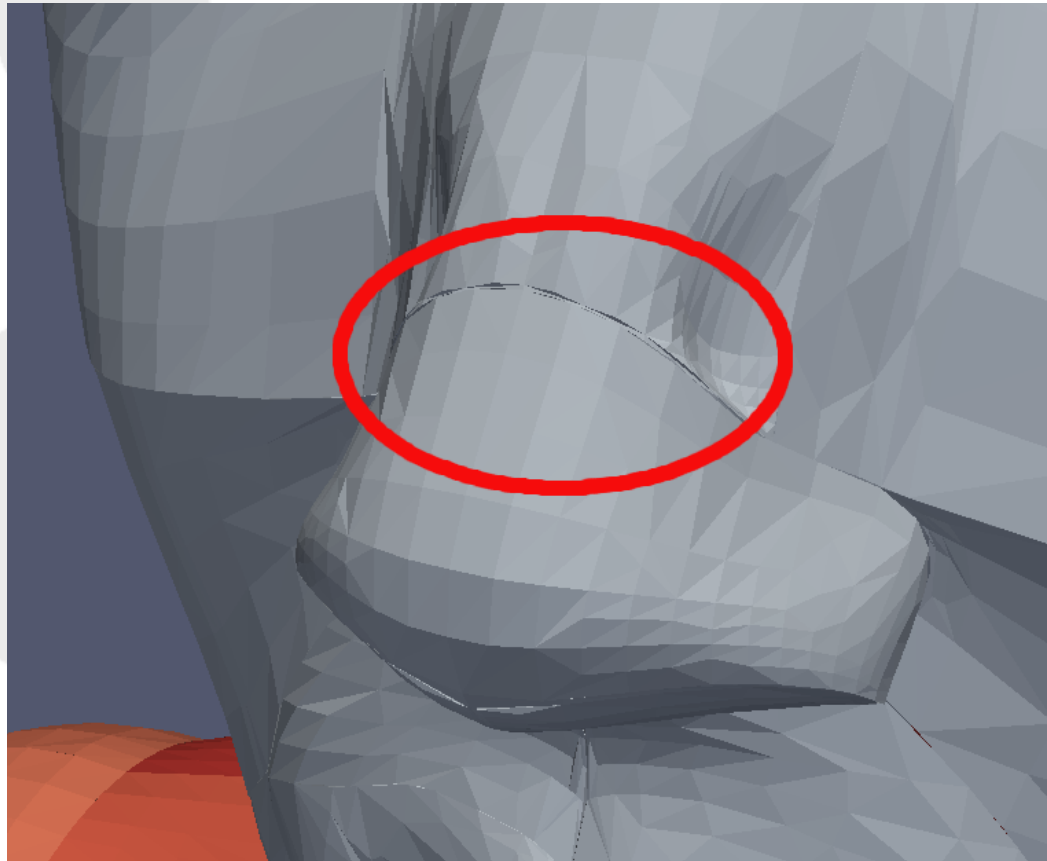
- Volume smoothing
- AMI interface



- Layers adjust to maintain near wall distance

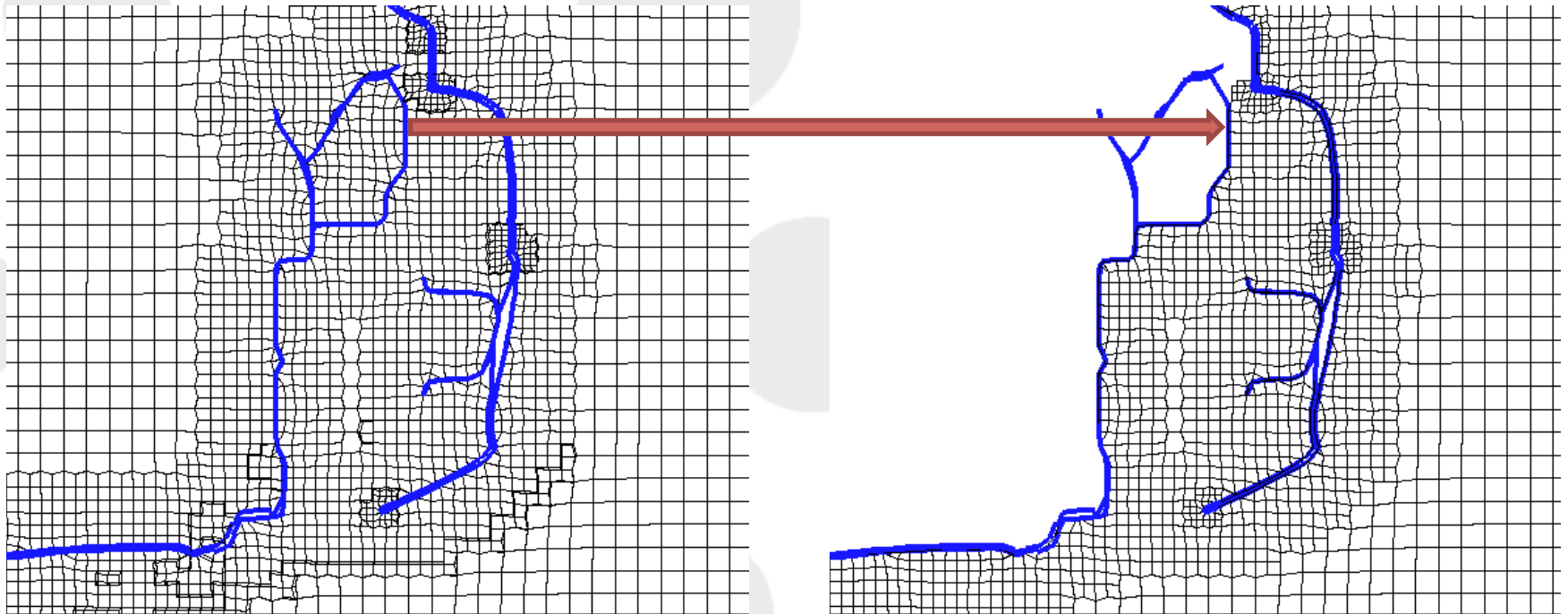
Technology | HELYX Mesh

- Small leak/crack detection and repair feature
 - Repair to user-defined tolerance



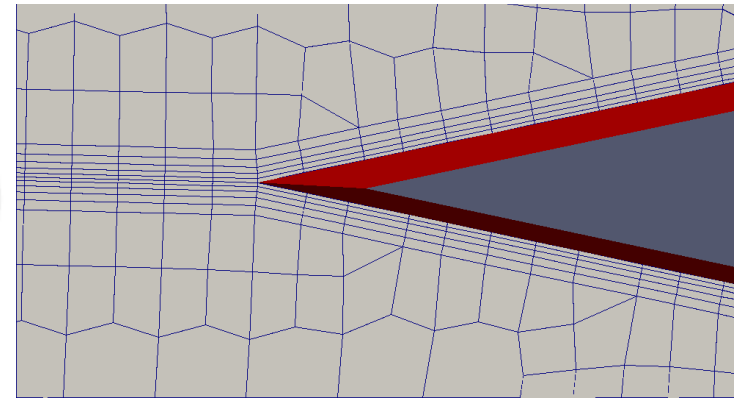
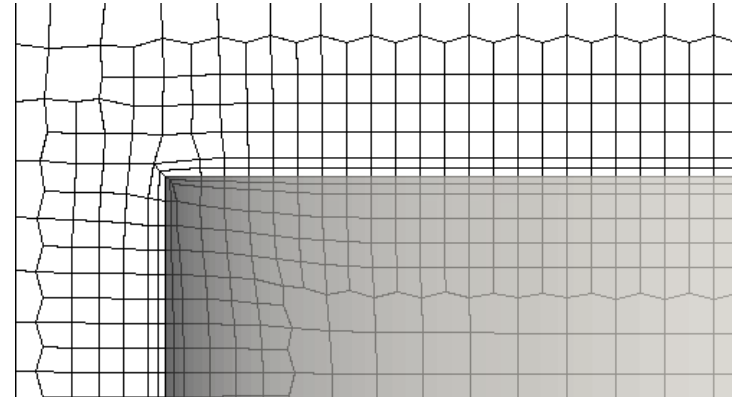
Technology | HELYX Mesh

- Automatic wrapping functionality
 - Heal missing geometry
 - Fix big holes



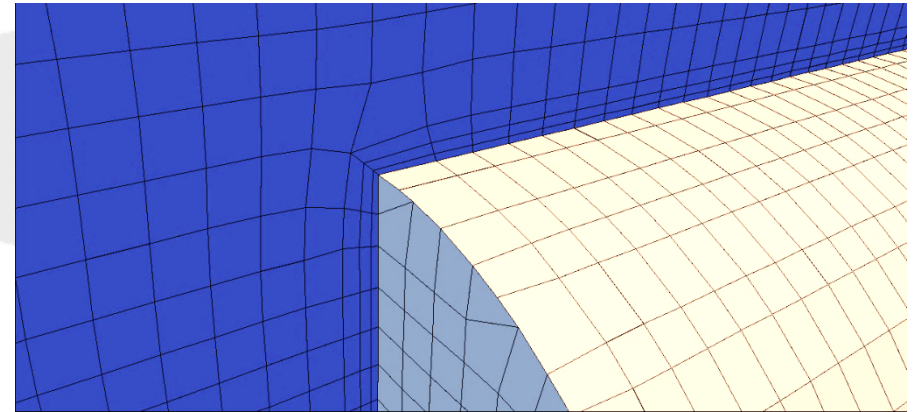
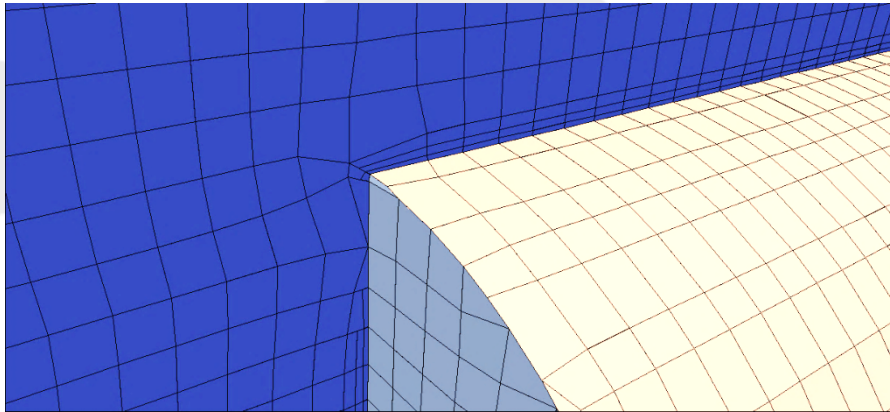
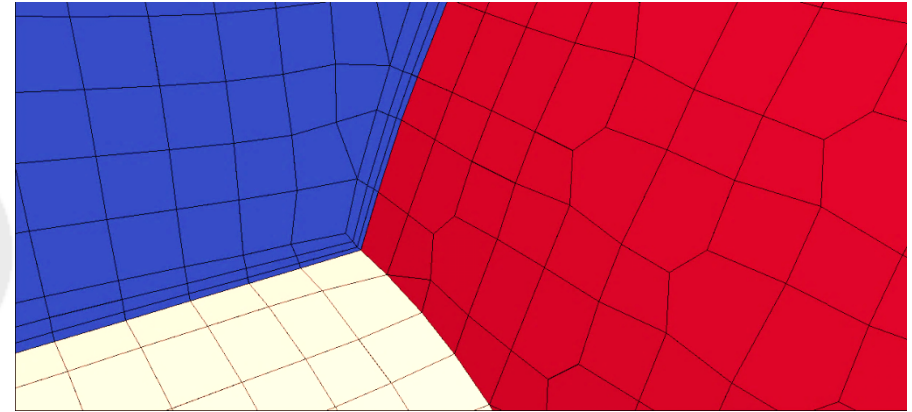
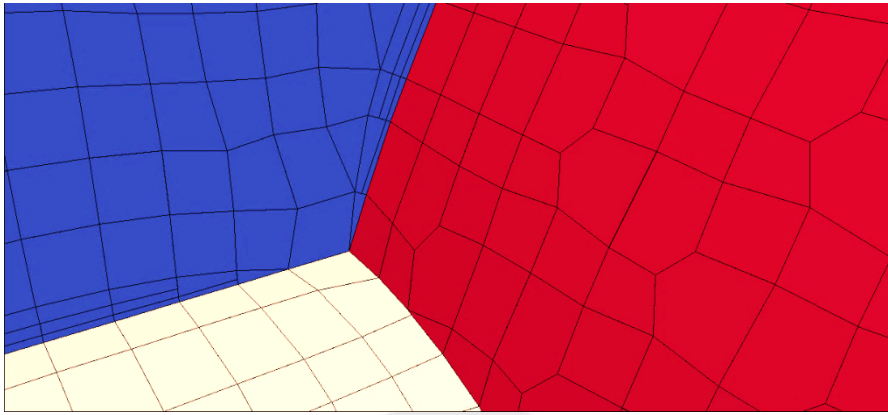
Technology | HELYX Mesh

- Layers on internal boundaries and virtual surface
- CHT/FSI mesh generation
 - Improved interior boundary capturing
 - Interior feature lines
 - 2-sided layer generation
- Virtual surface layer generation for wakes and mixing layers
 - Specification using tri-surface or primitive



Technology | HELYX Mesh

- Layers on concave and convex edges

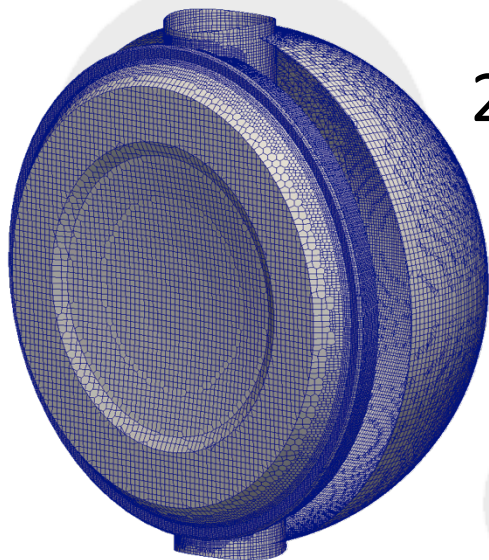


Standard v2.2

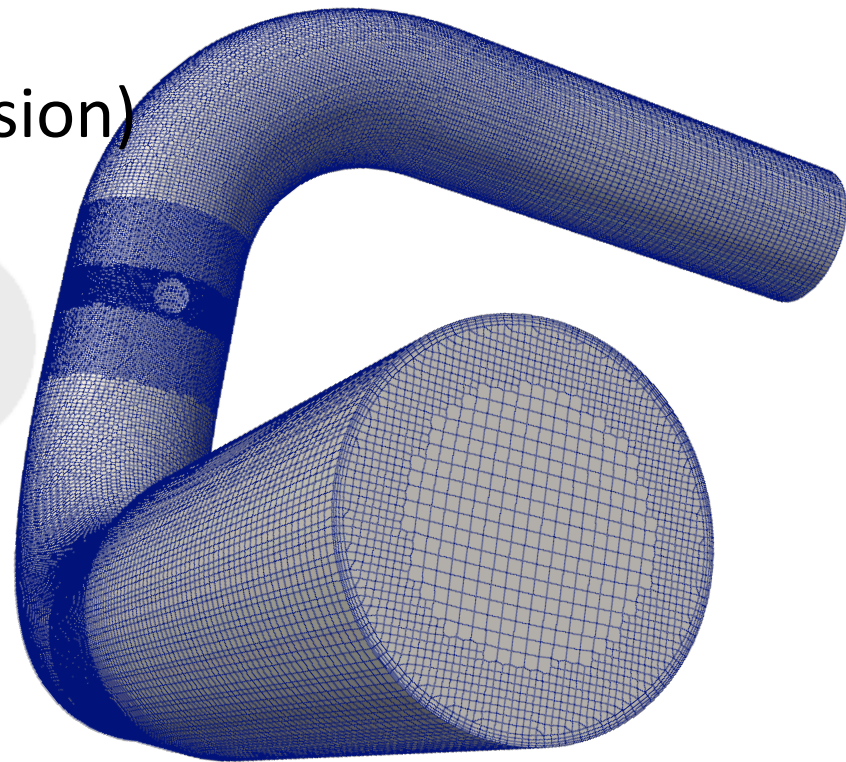
HELIX

Technology | HELYX Mesh | Example

- HELYX Mesh 50% faster than standard snappyHexMesh
- Solution 30% faster than on standard snappyHexMesh
- Mesh related run failures $>5\% \rightarrow <1\%$
- Near wall layers: 97% coverage
(95.7% from standard 2.2.x version)

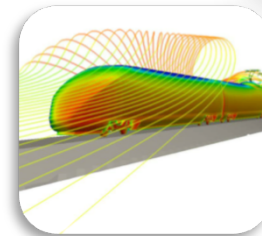
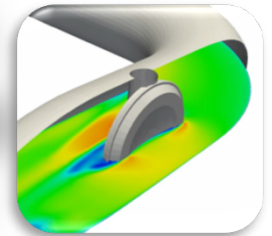
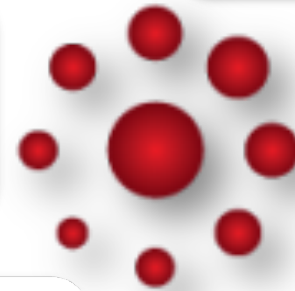
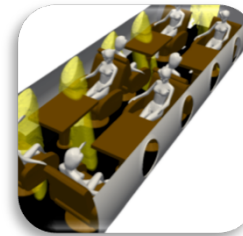
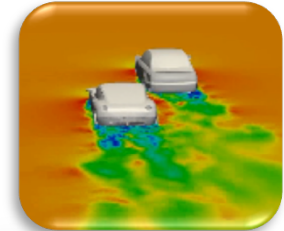
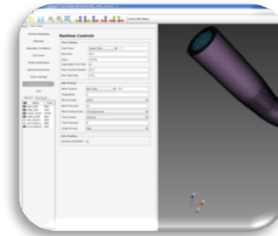


2M cells



Contents

- Company Description
- Software & Services
- Core OSS Technology
- **Closing**



Closing | The road ahead

- Crowd sourcing development
 - One of the main advantages of OSS
 - Lacking in OPENFOAM® : requires paid support and copyright transfer
- Platform
 - Public HELYX CORE repository
 - Community administered fork in partnership with Engys
 - Based on new modular framework
 - Actively encourage and support 3rd party contributions
 - Improve HELYX/HELIX^{OS} GUIs
 - More applications
 - Client/Server
 - Windows support



Closing | The road ahead

- Support other Open Source initiatives
 - CoCoons: Open Document Project
 - Global Workshop Sponsor
 - Regional initiatives
- Technical developments
 - Adjoint optimisation
 - Improved numerics for DES/LES
 - Fast aero-acoustic solver (generation and near-field propagation)
 - Thermal extensions (radiation/CHT)
 - Adaptive mesh generation
- More module contributors welcome.

Closing

Thank you

info@engys.com | Tel: +44 (0)20 32393041 | Fax: +44 (0)20 33573123 | www.engys.com