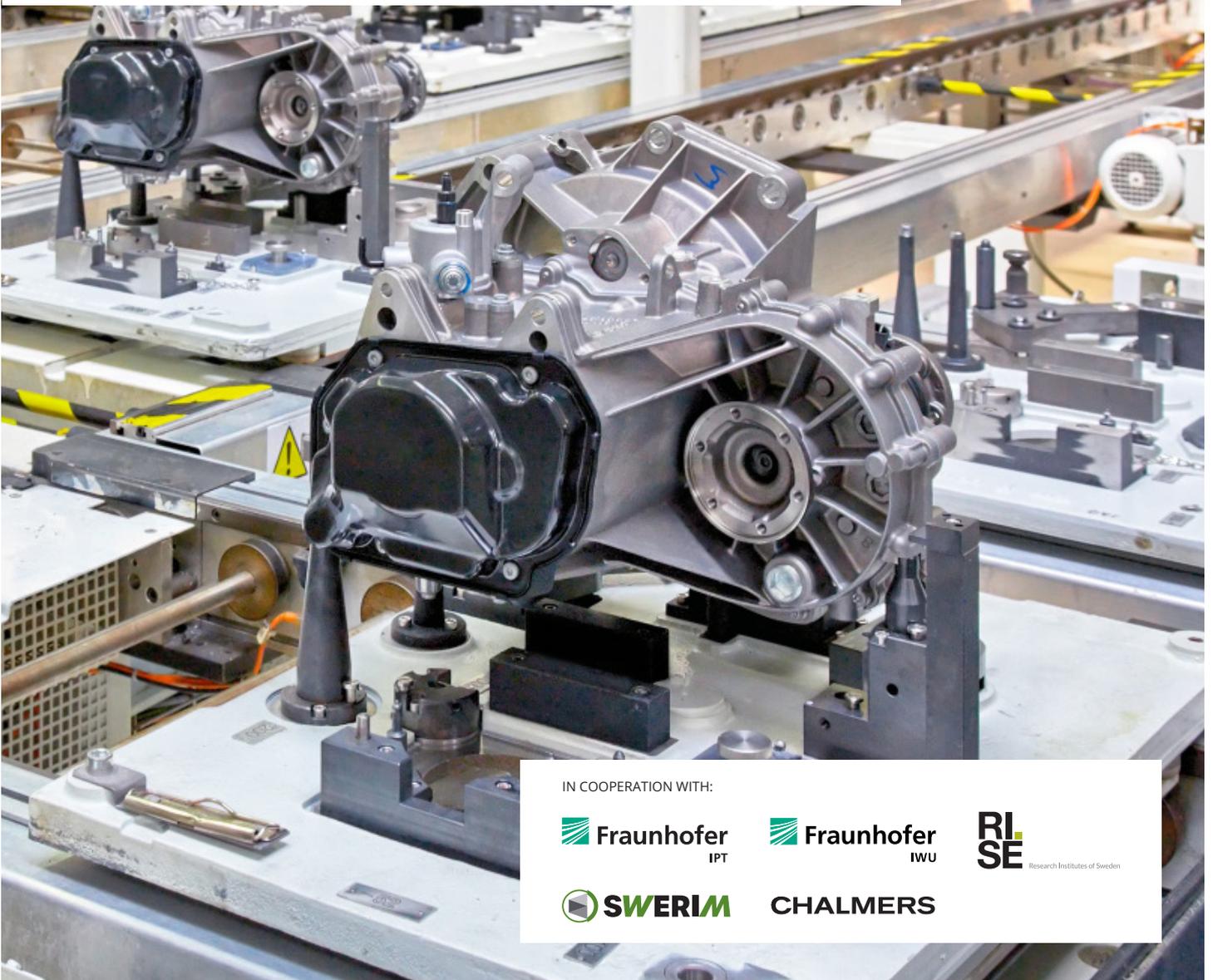


# Powertrain Manufacturing for Heavy Vehicles R&D Cluster

- The next generation of powertrain manufacturing



IN COOPERATION WITH:



CHALMERS



# Motivation

## Industry

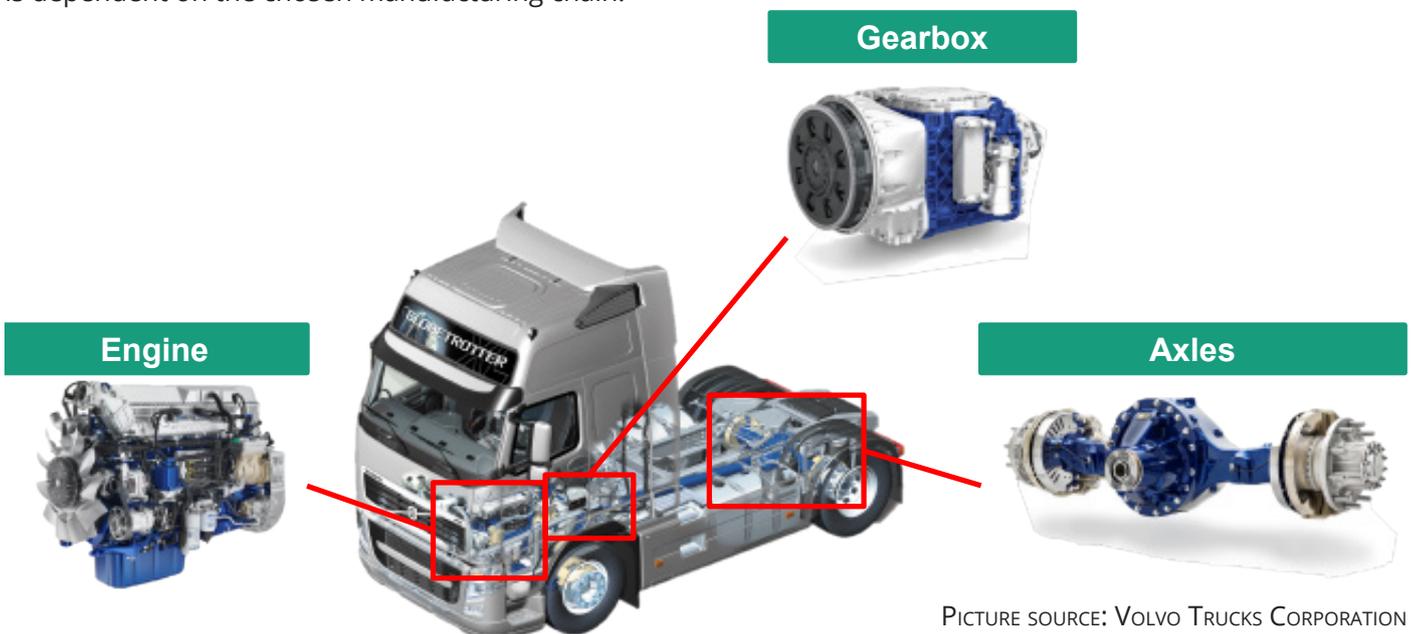
The demand for freight transport has grown constantly over the last years. Road haulage accounts for a major portion of commercial transport for which trucks are generally used as the vehicles of choice. The drivetrain of trucks is composed of engine, gearbox, axles and auxiliary equipment such as air conditioning compressor, power-steering pump or air compressor which are linked to the crankshaft of the engine by a V-belt or a chain drive. Customer demands on the powertrain of heavy vehicles include: High reliability, low costs, environmental sustainability and the availability of spare parts. Moreover, legislation and global competition lead to further ecological and economical demands for heavy vehicle powertrains.

The properties of a heavy vehicle powertrain are strongly affected by the technologies used for manufacturing the powertrain components. This means that the ability to fulfil the above mentioned requirements is dependent on the chosen manufacturing chain.

## Objective

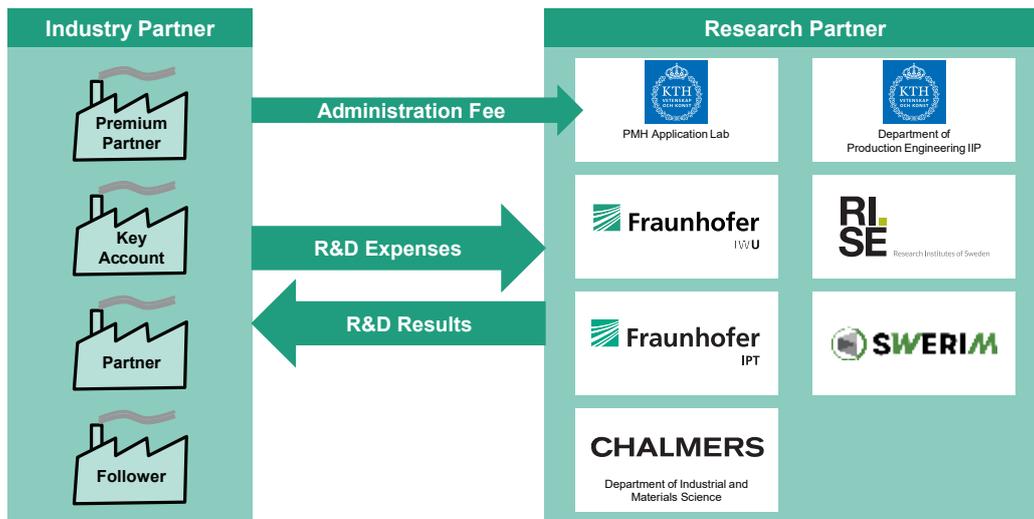
Therefore, KTH Royal Institute of Technology in Stockholm, the German research organization Fraunhofer-Gesellschaft zur Förderung der angewandten Forschung e.V., and RISE – Research Institutes of Sweden have established the "Powertrain Manufacturing for Heavy Vehicles Application Lab – a collaboration between KTH, Fraunhofer and RISE" (PMH Application Lab) which will coordinate and perform research and development projects for the heavy vehicle industry and also provide education, training and dissemination.

A major task of the PMH Application Lab will be the coordination of the Powertrain Manufacturing for Heavy Vehicles R&D Cluster which shall bring together the industrial and research partners of KTH, Fraunhofer and RISE for the purpose of joint research projects. The PMH Application Lab and the R&D Cluster have the objective to enhance the Swedish industry in the field of powertrain manufacturing for heavy vehicles.



PICTURE SOURCE: VOLVO TRUCKS CORPORATION

# About



## Organizational Structure

The Powertrain Manufacturing for Heavy Vehicles R&D Cluster (PMH R&D Cluster) is a collaboration between the Swedish heavy vehicles industry, leading research institutions from Sweden and the Fraunhofer Institutes in Germany. The PMH R&D Cluster is coordinated by the PMH Application Lab. The research partners carry out R&D projects for the partners from the heavy vehicle industry which are financed by R&D expenses of the industrial partners within the PMH R&D Cluster.

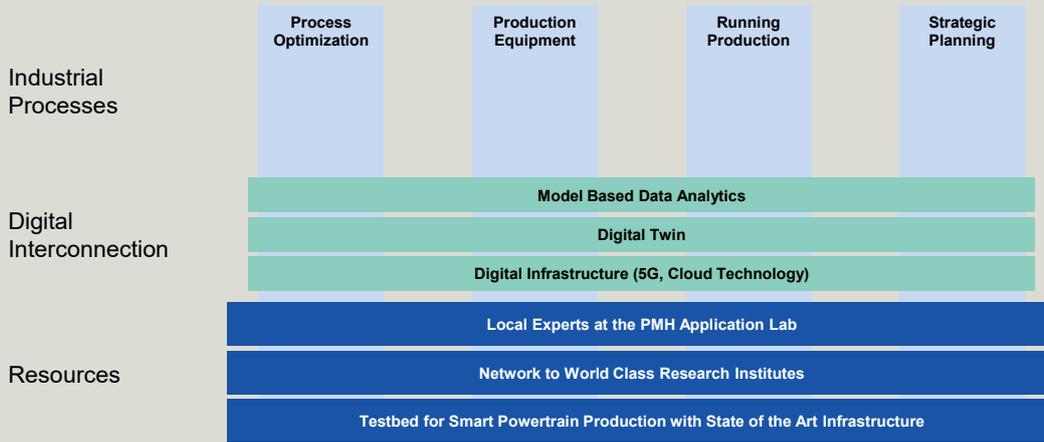
The involved industry partners are members of the PMH R&D Cluster and commit themselves to contribute an administration fee and R&D expenses in order to finance the research work carried out at the PMH R&D Cluster. There are four membership categories and the amount of the administration fees and the R&D expenses differ within these four categories. At the same time, the power of making decisions within the R&D cluster is dependent on the membership category of each industry partner.

## Collaborative and Individual R&D

The research partners carry out research projects for the industry partners who, in return, finance these projects from their R&D expenses. The nature of the projects can be either collaborative or individual R&D. Collaborative R&D projects are jointly carried out by the research partners and the results are shared between all involved parties, thus allowing for high synergies and significant benefits of cooperation particularly for pre-competitive issues. Different R&D projects are carried out by one or several research partners for individual industry partners and have a confidential character. This gives the industrial partners the possibility to obtain solutions for individual challenges concerning powertrain production.

## How to join the PMH R&D Cluster

Interested companies can apply for a membership in the PMH R&D Cluster by sending an application letter to the PMH Application Lab. The decision about the application is taken by a steering group consisting of representatives from the industry partners in the PMH R&D Cluster. The PMH Application Lab coordinates the application process. The contact details can be found on the rear page of this brochure.



# Focus and Competences

## Process Optimization

- Process design and optimization
- Tool wear analysis
- Machining of advanced materials
- Tool design and optimization (geometries, grades, coatings)
- Reduction of vibrations, increase of process stability
- High performance cutting
- Cooling technology
- Design for additive manufacturing
- Qualification of alloys for additive manufacturing
- Near net shape approaches
- Process chain integration for manufacturing and repair
- Assembly engineering
- Hybrid machining
- Process and material evaluation for component and surface integrity
- Robust and adaptive design for manufacturing and repair
- Post-processing of additive manufactured components, forgings and friction welded parts
- Process control design and condition monitoring
- Process automation and CAM module development
- Design and manufacturing for reuse, manufacturing and recycling- requires some attention

## Production Equipment

- Machine tool development, design and characterization
- New production line layouts
- Integrated solutions for fixtures, clamping and referencing
- Precision technology and plastic replication
- Fiber-reinforced plastics and laser system technology
- Multi-tasking production processes
- Wear characterisation

## Running Production

- Production quality
- Production metrology
- Predictive maintenance
- Technology intelligence
- Tribometry
- Geometry assurance
- Quality assurance and CAQ systems
- Lifecycle analysis (LCA/LCE)

## Strategic Planning

- Production management
- Market analysis
- Technology purchasing
- Technology forecasting and technology planning
- Technology evaluation and benchmarking
- Customized repair by additive manufacturing and recontouring for different materials and components
- Energy and chemical mapping
- Accreditation and certification

## Model Based Data Analytics

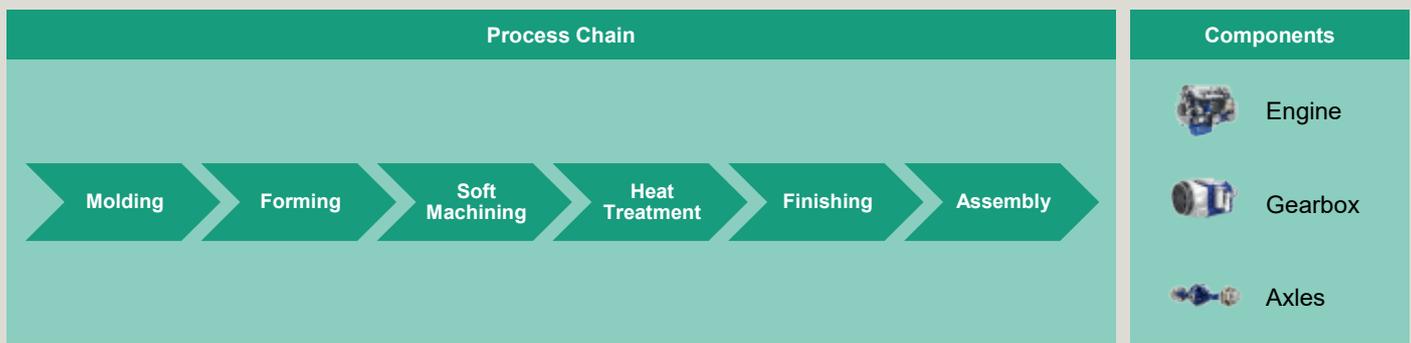
- Model based process simulation
- Digital factory
- Smart manufacturing approaches

## Digital Twin

- Automated data acquisition
- Data management and CAx framework
- Virtual reality

## Digital Infrastructure

- 5G
- Cloud technology
- Sensor technology
- Sensors for automated production processes
- Mechatronics/adaptronics



# Technology Portfolio

## Molding

- Casting
- Sintering
- Steel making
- Metal foam

## Forming

- Hydro forming
- Sheet metal forming
- Bulk metal forming
- Gear rolling
- Cross-wedge rolling
- Incremental forming
- Micro forming
- Close die forging
- Cast-forging

## Machining and Material Removal

- Turning
- Milling
- Drilling
- Deep hole drilling
- Broaching
- Gear hobbing
- Power skiving
- InvoMilling
- Bevel gear cutting
- Electro chemical machining (ECM)
- Electrical discharge machining (EDM)
- Water jet cutting
- Laser ablation
- Laser drilling
- Laser cutting

- Gear grinding
- Gear honing
- Bevel gear grinding
- Cylinder honing
- Polishing

## Joining

- Laser welding
- Laser brazing
- Arc welding
- Hybrid joining
- Resistance welding
- Clinching
- Fasteners (bolts, rivets)
- Adhesive bonding

## Additive Manufacturing

- Laser metal deposition (LMD)
- Selective laser melting (SLM)
- Electron beam melting (EBM)

## Change Material Properties

- Case hardening
- Induction hardening
- Through hardening
- Carburizing
- Quenching
- Tempering
- Nitriding
- Laser based heat treatment
- Super finishing
- Laser polishing
- Laser structuring

# Access and Benefits

## Follower

A Follower membership is the smallest membership category in the R&D Cluster and gives access to the community. A Follower pays an annual membership fee for community management of EUR 2 500. A follower participates in the preparation process for collaborative R&D projects and may suggest new project ideas. Furthermore a Follower receives mailings about all matters in the R&D Cluster, may participate in the annual conference and gets reduced seminar fees. The participation in collaborative R&D projects which enables a Follower to receive project results and gives access to the sessions about collaborative R&D projects in the annual colloquium is optional and requires additional financial expenses of EUR 27 500. The option to join and contribute to the collaborative R&D projects has to be chosen at least every third year.

## Partner

A Partner pays an annual fee for community management of EUR 2 500 and expenses for collaborative R&D in the amount of EUR 27 500. Furthermore a Partner commits to annual expenses of at least EUR 50 000 for individual R&D projects. In addition to the above mentioned Follower benefits a Partner has a seat in the Steering Group in which the representative may distribute 8 points for the first selection of collaborative R&D projects. In other decisions all Partners have a collective vote in the Steering Group.

## Key-Account

The third category is the Key-Account category. A Key-Account pays a fee for community management of EUR 2 500 per year and expenses for collaborative R&D in the amount of EUR 47 500. Furthermore a Partner commits to annual expenses of at least EUR 150 000 for individual R&D projects. In addition to the above mentioned Follower & Partner benefits, a Key-Account may distribute 20 points for the first selection of collaborative R&D projects and has an own vote in all other decision. Furthermore Key-Accounts receive a key-account manager as contact person for all R&D Cluster matters and receives an annual finance report.

## Premium

A Premium Partner pays the same annual expenses for community management and collaborative R&D as a Key-Account but commits itself to higher annual expenses for individual R&D in the amount of EUR 300 000. In addition to the above mentioned Key Account benefits, a Premium Partner may distribute 35 points in the first selection of collaborative R&D projects and gets two votes in the Steering Group.

	Follower	Partner	Key-Account	Premium
<b>Membership Fees</b>				
Membership fee for community management	2 500 €	2 500 €	2 500 €	2 500 €
Collaborative R&D expenses (incl. administration fee)	27 500 € (optional*)	27 500 €	47 500 €	47 500 €
Individual R&D Expenses	(optional*)	50 000 €	150 000 €	300 000 €
<b>Collaborative R&amp;D</b>				
Planning workshop (project suggestions)	√	√	√	√
First project selection by the steering group	-	8 points	20 points	35 points
Decision workshop (final project selection)	(optional*)	√	√	√
Value cheques for projects (à 2500 €)	9 (optional*)	9	15	15
Receive results of collaborative R&D	(optional)	√	√	√
<b>Individual R&amp;D</b>				
Individual research roadmap	-	-	√	√
Key account manager in Sweden	-	-	√	√
Annual finance report	-	-	√	√
<b>Others</b>				
Receive mailings	√	√	√	√
Reduced seminar fees	√	√	√	√
Participate in the annual colloquium	(√)**	√	√	√
Steering group	-	(√)***	√	√√

\* This option has to be selected at least every third year

\*\* Sessions about results of collaborative R&D require a financial contribution to the collaborative R&D projects

\*\*\* One shared vote for all partners in strategic decisions



# Research Partners

## Powertrain Manufacturing for Heavy Vehicles Application Lab

The Powertrain Manufacturing for Heavy Vehicles Application Lab (PMH Application Lab) is a research center at KTH which is operated in collaboration with the German research organization Fraunhofer and the Swedish network of research and technology organizations RISE with its associate Swerea AB. The PMH Application Lab works in research and development for the improvement of technologies in the field of powertrain manufacturing for heavy vehicles on high technology readiness levels to strengthen the competence of the Swedish heavy vehicle industry in this area. This comprises project execution, project coordination and dissemination with the goal to validate technologies and to accelerate the transfer of these technologies into industrial application.

## KTH Royal Institute of Technology

KTH is Sweden's largest technical research and learning institution and home to students, researchers and faculty from around the world. From KTH the Department of Production Engineering and the Powertrain Manufacturing for Heavy Vehicles Application Lab are active partners in the PMH R&D Cluster.

## Fraunhofer IPT

Fraunhofer IPT is an institute of Fraunhofer-Gesellschaft and is located in Aachen, Germany. In the areas of process technology, production machines, production metrology and quality as well as technology management, IPT offers partners and customers tailor made solutions for a connected, adaptive production.

## Fraunhofer IWU

Fraunhofer IWU is an institute of Fraunhofer-Gesellschaft and is located in Chemnitz, Germany. The main focus of Fraunhofer IWU's work is on application-oriented research and development in the field of production technology for the automotive and mechanical engineering sectors focusing the entire process chain.

## RISE

RISE is the Swedish Research Institute and innovation partner. In international collaboration with industry, academia and the public sector, RISE ensures the competitiveness of the business community and contribute to a sustainable society. The employees of RISE support and promote all manner of innovative processes. RISE is an independent, state-owned research institute that offers unique expertise, testbeds and demonstration facilities, instrumental in future-proofing technologies, products and services.

## Swerim

Swerim, an associate to the RISE group, is located in Stockholm, Sweden. Swerim conducts applied research within mining engineering, process metallurgy, materials and applications, mainly for the mining, steel and metal industries

## Chalmers University of Technology

Chalmers is a highly progressive university situated in Gothenburg which is known for education, research and innovation with focuses on technology, natural science, architecture, maritime and other management areas. From Chalmers the Department of Industrial and Materials Science is active in the PHM R&D Cluster.

# Contact

## Powertrain Manufacturing for Heavy Vehicles Application Lab - a collaboration between KTH, Fraunhofer and RISE

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[www.pmh.itm.kth.se](http://www.pmh.itm.kth.se)

## Our Research Partners:

KTH Royal Institute of Technology  
[www.kth.se](http://www.kth.se)

Fraunhofer IPT  
[www.ipt.fraunhofer.de](http://www.ipt.fraunhofer.de)

Fraunhofer IWU  
[www.iwu.fraunhofer.de](http://www.iwu.fraunhofer.de)

RISE  
[www.ri.se](http://www.ri.se)

Swerim  
[www.swerim.se](http://www.swerim.se)

Chalmers University of Technology  
[www.chalmers.se](http://www.chalmers.se)

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