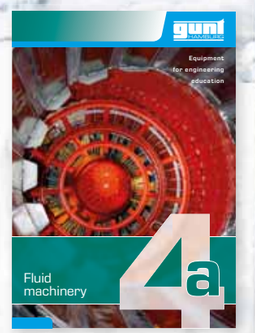
Fluid machinery – an application field of technical fluid mechanics

The field of fluid machinery is a significant area of application of fluid mechanics and thermodynamics. Fluid energy machines are the most important group of machines. This field plays a fundamental role in the training of future engineers.

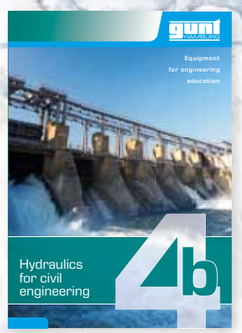
Knowing about the function, setup, properties, and operation of fluid machinery is an essential part of the technical training. The field of machinery in general and the field of systems engineering in particular requires – in addition to general fluid mechanics – separate lectures and practical training on fluid machinery.

This is why the GUNT programme has dedicated an entire catalogue to this extensive subject. The graph below illustrates the structure of the GUNT programme for product sector 4. The field of general fluid mechanics is covered in catalogue 4. Catalogue 4b details the subject of hydraulic engineering and catalogue 4a deals with fluid machinery.



- machine technology
- system engineering
- aeronautics
- automotive engineering
- propulsion technology
- energy technologies

- machine technology
- aeronautics
- applied sciences
- shipbuilding
- energy technologies
- process technology



- hydraulic engineering
- supply engineering
- shipbuilding
- marine technology
- environmental engineering
- geosciences

What can GUNT do for you?

In real applications, fluid energy machines are often part of complex, large plants or systems in locations that are difficult to access, such as diesel engines in container ships or turbines in power plants.

The GUNT team has developed a broad range of laboratory-scale systems from this field that are designed to convey the functionality of these often invisible machines to students in a way that is **accessible** and **understandable**.

The range of GUNT products covers the comprehensive field of fluid machinery almost entirely.

Students can use these laboratory devices to develop an understanding of the many applications of fluid machinery.

The educational concept of the GUNT devices is structured in a way that not only teaches students the actual functions of the fluid energy machine but also allows them to learn about its areas of practical application.

Aircraft engine prior to installation

A marine diesel engine from the Wärtsilä Corporation

Steam turbine system for a paper mill

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The following table is an excerpt from a curriculum as would be common for a technical university based on the tables of contents of reference books on fluid machinery. The GUNT devices cover most of these topics.

Main area	Elements, keywords
Fundamentals	■ fluid mechanics ■ thermodynamics ■ mechanics ■ efficiency, speed, power, velocity of the machines ■ construction methods for the machines ■ control
Turbomachines	■ energy conversion in the rotor ■ axial / radial flow-through direction ■ similarities and key figures ■ working methods ■ cavitation
Positive displacement machines	■ reciprocating piston engines ■ kinematics, forces, mass balancing ■ comparison of turbomachines and positive displacement machines
Driven machines	■ pumps ■ fans ■ compressors
Driving machines	■ hydraulic driving machines: water turbines ■ steam power plants: steam turbines ■ wind turbines ■ gas turbines ■ combustion engines
Steam generators and power plants	■ steam generation systems ■ condensers ■ steam power plant ■ pumped storage power plant
Refrigeration machines	■ cold production ■ evaporator refrigeration system, heat exchanger ■ heat pumps

Structure of the catalogue

Catalogue 4a is divided into five chapters. The first chapter is an introduction to the subject matter. It deals with the fundamentals of fluid mechanics, thermodynamics as well as topics from the field of mechanics and machine dynamics.

Chapters 2 to 4 then cover applications and other practical aspects, by introducing different driving and driven machines, power plants and applied cyclic processes from the GUNT programme.

Chapter 5 provides an overview of the equipment series from the fluid machinery product range. This chapter builds upon the knowledge conveyed in the previous chapters, and includes all of the topics presented in chapters 1 to 4.

Chapter 1 Fundamentals and introduction

Fluid Mechanics	Thermodynamics	Machine Dynamics

Application and practical aspects

Chapter 2	Chapter 3	Chapter 4
Driving Machines	Driven Machines	Power Plants and Applied Cyclic Processes

Chapter 5 Equipment series

GUNT-Labline	GUNT-FEMLine

The GUNT equipment series were developed with the goal of covering an entire field of interest and offering the necessary detailed knowledge on the individual requirements and aspects of this field.

The different devices in a series are all related, and build on each other. Even though each device focuses on a different issue or question, the topics are interrelated and constitute a complete subject area.

The **GUNT-Labline** offers a selection of compact and easy-to-handle devices that are suitable for both demonstrations and experiments, such as pumps, turbines and compressors.

The **GUNT-FEMLine** devices are larger and more powerful. This group combines different trainers to form a complete experimental setup. This opens up the possibility of a comprehensive and in-depth range of experiments for an entire subject field.

Using the Labline and FEMLine concepts, the GUNT development team has created two series from the subject field of **fluid machinery**. Please see chapter 5 of this catalogue for more detailed information on both series.

Classification of fluid machinery

"Fluid machinery" is an umbrella term used to describe all machines that convert energy with the help of a fluid.

For the purpose of classification, fluid energy machines can be divided into groups of machines. There are two basic criteria:

1. we distinguish between driven machines and driving machines based on the **energy flow** and the **direction of energy transfer**. Driving machines are also known as prime movers.
2. turbomachines differ from positive displacement machines in their **mode of operation and pressurisation.**

Moreover, the following differentiations are made:

- depending on the **physical properties of the fluid:** compressible, incompressible
- depending on the **mode of operation:** rotating or oscillating, normal suction or self-priming, single-stage, multi-stage...
- depending on the **direction of flow** of the fluid: radial, axial, diagonal...
- depending on the **design:** reciprocating engine, membrane, gear...
- depending on **use:** supply, drainage, circulation, site of operation...
- depending on the **source of energy:** thermal power, hydroelectric power, wind energy, electrical energy

A fluid energy machine can belong to several groups. The decision about which group the fluid energy machine is assigned to depends on the perspective of the observer. If the focus is, for example, on the **working medium**, the categorisation is made by differentiating between **hydraulic** fluid energy machines with **incompressible fluids** and **thermal** fluid machinery with **compressible fluids**. GUNT catalogues 3 and 4 are based on this categorisation. Catalogue 3 covers part of the thermal fluid energy machines. Catalogue 4, among other things, deals with hydraulic fluid energy machines.

This catalogue offers an overview of the whole range of fluid machinery. The machines are classified according to the way they convert energy. The graph below illustrates this.

Fluid energy machine
a machine that transfers energy by means of a liquid or gaseous fluid

Driving machine, also known as prime mover
energy is removed from the fluid

Driven machine
energy is added to the fluid

Turbomachine
transfer of energy between the fluid and the machine by means of flow forces

Positive displacement machine
transfer of energy between the fluid and the machine by means of a variable volume, generated by a displacement device

Driven Machines
Energy is added to the fluid

Turbomachines
Transfer of energy between the fluid and the machine by means of flow forces

Hydraulic
- centrifugal pump
- propeller pump
- jet pump

Thermal
- ventilator
- fan
- radial compressor

Positive displacement machines
Transfer of energy between the fluid and the machine by means of a variable volume, generated by a displacement device

Hydraulic
- piston pump
- vane pump
- gear pump
- spindle pump

Thermal
- piston compressor
- screw compressor
- vane compressor

Driving Machines
Energy is removed from the fluid

Turbomachines
Transfer of energy between the fluid and the machine by means of flow forces

Hydraulic
- water turbine

Thermal
- wind turbine
- steam turbine
- gas turbine
- jet engine

Positive displacement machines
Transfer of energy between the fluid and the machine by means of a variable volume, generated by a displacement device

Hydraulic
- hydraulic engine

Thermal
- internal combustion engine
- steam engine
- Stirling engine
- gas expansion engine