Join us in the exploration of future aircraft and propulsion systems!

At TU Delft we offer you a leading academic programme in aerospace engineering and technology in Europe. Our internationally-oriented programme prepares you to respond effectively and rapidly to the needs in the aerospace sector with solutions that are innovative, technically feasible and commercially viable. At our state-of-the-art test and laboratory facilities you acquire the engineering skills needed in advanced industrial applications. During your specialisation phase – the MSc track – you will develop into an independently-thinking, professionally-oriented, innovative engineer and researcher.

The master track Flight Performance and Propulsion teaches students about design aspects of innovative solutions for the modern and next-generation aircraft, and about cutting-edge engines, their components and power systems. Therefore, aircraft-engine integration is also an important topic in the lectures we provide, and of research performed by our group. These research areas are highly relevant if we want to contribute to the ambitious targets to reduce the environmental impact of aviation, as proposed by the Advisory Committee for Aeronautics Research in Europe (ACARE).

MSc Track structure

<table>
<thead>
<tr>
<th>Course</th>
<th>Description</th>
<th>EC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Core courses</td>
<td>Gain a broad view on a field of expertise</td>
<td>≥ 18</td>
</tr>
<tr>
<td>Profile courses</td>
<td>Focus on a particular subfield</td>
<td>≥ 13</td>
</tr>
<tr>
<td>Elective courses</td>
<td>Specialise in a particular area of expertise or add multidisciplinary elements, repair educational deficiencies or address a personal interest</td>
<td>+/- 15</td>
</tr>
<tr>
<td>Literature study</td>
<td>Prepare for the thesis subject</td>
<td>12</td>
</tr>
<tr>
<td>Research methodologies</td>
<td>Prepare for the thesis subject</td>
<td>2</td>
</tr>
<tr>
<td>Internship</td>
<td>Acquire professional skills during a three-month internship at a Dutch or international company or institute</td>
<td>18</td>
</tr>
<tr>
<td>MSc thesis</td>
<td>An in-depth research project or design assignment in your subject of choice</td>
<td>42</td>
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</tbody>
</table>

*Optionally abroad
Our mission is to advance the design of innovative aircraft configurations and propulsion concepts, by exploration of:

- new technologies and unconventional airplane configurations
- advanced flight physics modelling to improve the prediction and simulation of air-vehicle performance
- new methods and tools to improve the quality effectiveness of the design process

The research and education activities within this Master track are pursued and coordinated by two full time professors, one part-time professor, four assistant professors and five dedicated lecturers. Each of the staff members has a different expertise, varying from air-breathing propulsion systems, turbo-machinery and power systems to flight mechanics and aircraft design and integration.

The educational programme is designed to provide the students with in-depth fundamental knowledge of these key areas.

**Profile**

The Flight Performance and Propulsion Master track has a single profile. The educational programme consists of a fixed set of mandatory courses that deepens the knowledge of the students in the fields of propulsion and power, flight mechanics and aircraft design & design methodologies. Elective courses are typically selected in consultation with the master track coordinator such that the student becomes an expert in one of these fields. For example, students interested in the field of propulsion and power are recommended to take the courses ‘Heat transfer problems in gas turbines’ and ‘Gas turbine simulation / application.’ Students who would like to focus on flight performance and aircraft design will benefit for example from courses on computational fluid dynamics and mathematical optimisation techniques. Perhaps the most important part of the Master track is the final year, where the students have to conduct research for their Master thesis. This is where all the knowledge from the first year can be put into practice and where students can take an active part in our wide range of research projects.

**Academic staff**

- Professor Leo Veldhuis
  Expertise: Aerodynamic design
- Professor Piero Colonna
  Expertise: Propulsion and Power
- Professor Georg Eitelberg
  Expertise: Experimental aerodynamics
- Dr M. Voskuijl, Master track coordinator
  Expertise: Flight mechanics

**Job perspectives**

The job perspective for graduates of the FPP track is great. Most graduates already find a job prior to their graduation. Many of our graduates decide to pursue a career in the aerospace field, either in industry or research institutes, both nationally and abroad. In the Netherlands popular employers are Fokker Aerostructures, the Dutch National Aerospace Laboratory (NLR), Atkins, Fokker Elmo, Royal Dutch Shell and Ke-Works. Many of our graduates aspire an international career. They work for example for companies dedicated to designing and building aircraft and propulsion systems, such as Airbus, Rolls Royce, MTU Aero Engines, Pilatus Aircraft and Siemens. Other students start their own companies or work in consultancy and finance. Finally, some choose to pursue a PhD degree.
Research programmes

Propeller Integration
To achieve a step-change in the propulsive efficiency of future aircraft, a shift to propeller propulsion might be required. Therefore, in recent years propeller research has gained increased momentum in the international community. Within the FPP group research is performed focusing on the aerodynamic and acoustic performance of propellers integrated on the airframe. Apart from the analysis and optimisation of the isolated propeller system, also the interactions between the airframe and the propeller need to be considered. The goal of the investigations is to reduce the performance and noise penalties associated with these airframe interaction effects. Students involved in the project perform experiments in the faculty’s various wind tunnel facilities using powered propeller test rigs and advanced measurement techniques, while also CFD tools are applied for numerical evaluations.

AGILE - Aircraft 3rd Generation MDO for Innovative Collaboration of Heterogeneous Teams of Experts
This EC sponsored project targets advanced multidisciplinary optimisation of aircraft using distributed analysis frameworks. Advanced optimisation techniques and strategies will be developed in order to exploit available computing systems and to gain faster convergence to optimal solutions. Knowledge-enabled information technologies will be developed in order to support complex collaborative design process. The methods and tools that will be developed in AGILE will be tested and verified using realistic overall aircraft design tasks for conventional, strut-braced, box-wing and BWB configurations, including UAVs. The project is set up to proof a speed up of 40% for solving realistic MDO problems compared to today’s state-of-the-art. This will enable also a more agile way of collaboration between OEMs and suppliers, open opportunities for joint aircraft development and experimenting on innovative products. Airbus, Alenia, Bombardier, Fokker, Saab, NLR, DLR, ONERA, Noesis and KE-works are just some of the 20 partners which will collaborate with the TU Delft in the coming 3 years, providing opportunities for MSc and PhD projects.

Crispijn Huijts

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During my BSc I discovered that my interests of study courses are very broad, I like mathematics, aircraft performance, aerodynamics, aircraft design and many more subjects. In selecting a Master Track, I first had some difficulty. Due to this wide interest, many tracks seemed like a good choice to me. However, the combination of the focus areas flight mechanics and aircraft design, offered by Flight Performance and Propulsion, seemed to be the a perfect fit for my interests.
A varying Master programme can be chosen in which you can focus on your personal preference, but still have a complete portfolio full of different aircraft design courses (and not only focusing on one area). With the programme you learn a lot about air breathing engines, aerodynamics, aircraft design and design optimisation. This makes you a student with a broad range of knowledge, ready for the aerospace industry!
Currently I am writing my MSc thesis about the impact of control allocation (CA) techniques on trim drag for various (new) aircraft configurations. I have been able to do wind tunnel tests for my research, where I analysed the performance of the control allocation algorithms. This is done by deflecting various control surfaces on a blended wing body aircraft model and logging the model’s coefficients. After the tests, the second part of the research consisted of implementing the CA algorithms in a conceptual design tool for (un)conventional aircraft. This software tool is developed by the department of FPP itself and by adding a trim module, I can help develop this tool further.
By combining wind tunnel tests and the implementation in the design tool, I am not only working on one programme for 8 months, but also have a practical touch with performing wind tunnel tests, which has been amazing and made me even more enthusiastic about the subject.”
Bosch project
Distributed generation of electricity, heating and cooling for buildings from solar radiation can have a large impact on the path to a renewable energy future. Constraints on cost, efficiency, energy storage, reliability, materials, scalability and complexity have so-far prevented widespread adoption of solar energy technologies. A small (5 – 50 kWe) concentrated solar power (CSP) system based on the Organic Rankine Cycle (ORC) concept features unique advantages: its average electrical efficiency could be very high (= 20%), and in addition it would allow for thermal energy storage, together with cogeneration of heating and cooling. This system would boast an unparalleled total conversion efficiency (up to 95%), and a high utilisation factor throughout the year, which would put it well above competing technologies. ORC turbogenerators of this size are not on the market, and miniaturisation involves a number of challenges related to the turbine: highly supersonic and very small volumetric flow, very high expansion ratio, need to limit secondary losses, strong dense-gas effects.

The main aim of this project is to highlight possible high-impact solutions. Notably, the focus is on the development of the mini-turbine for a solar Organic Rankine Cycle system in the power range 5 – 50 kWe for the green building of the future. The system is powered by solar troughs and generate simultaneously electricity, cooling and heating. The commercial product will be suitable for buildings like shopping malls, warehouses, hospitals, hotels, military installations, airports, banks, apartment blocks, condominiums, university campuses, factories, stadiums in world areas with an average yearly solar irradiation between 1500 and 2000 kWh/m2.

Admission requirements:
- a Dutch BSc degree in Aerospace Engineering, Mechanical Engineering, Maritime Engineering, Electrical Engineering, Civil Engineering, Physics, Applied Physics, or Physics & Astronomy or
- A BSc degree in Military Systems & Technology of the Netherlands Defense Academy (NLDA) or
- a Dutch degree of a University of Applied Sciences in Aeronautics, Aviation, Mechanical Engineering, Maritime Engineering, Civil Engineering, Design & Innovation. These students have to complete a special bridging programme prior to enrolment on the MSc.

Ideally you have obtained either a BSc degree in Aerospace or Mechanical Engineering at a top level University. In case of a mechanical engineering background, the program followed should have a strong emphasis on fluid mechanics, thermodynamics and power and propulsion systems. Formal admission requirements are listed below.

Details about the admission with a BSc degree from a non-Dutch university are available on the TU Delft website: www.lr.tudelft.nl/masterprogrammes/applicationandadmission

For further information
More information on the MSc track “Flight Performance and Propulsion” can be obtained at: www.lr.tudelft.nl/fpp

Alternatively, you can also contact the MSc track coordinator:
Dr.ir. M. Voskuijl
T +31 15 27 83992
E m.voskuijl@tudelft.nl
Room number: 7.08

International students are recommended to visit: www.lr.tudelft.nl/en/study/master-of-science-programme/information-request

All questions regarding international admissions should be directed to our international office: internationaloffice@tudelft.nl

Permission for doing research within this track of this Master is partly dependent on a screening under the Missile and Nuclear Research Exemption scheme: www.government.nl/issues/education/exemption-certain-engineering-or-nuclear-related-courses-of-study

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www.campus.tudelft.nl

March 2015