The Control & Operations core course programme provides a fundamental background in operations research, avionics systems, flight control and automation. The profile courses a student attends are associated with one of three sections (research groups) the student has joined. The 3 to 4 additional elective courses are chosen after consulting with the responsible Section head. After completing the required course programme and the internship, the student performs the literature survey associated with his or her thesis. The literature survey and final thesis project are performed with the same supervisor, working on a specific project of current relevance to the field.
Profile I: Control & Simulation (C&S)
The Control & Simulation section strives to improve the safety of aerospace operations through the design and experimental evaluation of automatic flight control systems, human-machine systems, sense & avoid and air traffic management systems.

The section has three knowledge clusters that each focus on a distinct element of modern aerospace systems. It houses the Micro-Air Vehicle laboratory, MAV-lab, which studies Unmanned Aerial Vehicles (UAVs), the research flight simulator SIMONA and the CESSNA CITATION laboratory aircraft. In these laboratories many of the theoretical innovations are experimentally tested in real or simulated flight.

Aerospace Guidance, Control and Navigation focuses on the development of new generations of flight control systems, with superior performance and the ability to compensate automatically for technical faults. Topics include:

- Nonlinear dynamics, optimization and control
- Adaptive and reconfigurable flight control
- Helicopter flight dynamics and handling qualities
- State estimation and distributed control
- Vision-based autonomous operations

Aerospace Human-Machine Systems aims at supporting the human operator in manual and supervisory control tasks, through developing Machine innovative human-machine interfaces and clever automation tools. Topics include:

- Cybernetic pilot perception and control models
- Haptic control systems, bio-dynamics
- Flight simulators and pilot training
- Ecological interfaces and cognitive systems
- Cockpit and air traffic control interfaces

Communication, Navigation & Surveillance in Air Traffic Management studies the sensors and systems enabling flight operations and Air Traffic Management (ATM), through simulating air traffic and designing novel equipment and algorithms. Topics include:

- Autonomous operations with Airborne Separation Assistance Systems
- Sense and avoid systems in the cockpit, on the ground and for UAVs
- Data-mining and big data applications, e.g., ADS-B
- Complexity of traffic patterns and traffic flows
- Scientific foundations of air traffic management and trajectory planning

Profile II: Aircraft Noise and Climate Effects (ANCE)
The section Aircraft Noise and Climate Effects (ANCE) studies the environmental impact of aviation through developing accurate models for the prediction of aircraft noise, emissions and climate effects. Aircraft noise continues to be a very serious source of disturbance to the public. Current contribution of aircraft emissions to global warming is estimated to lie in between 1.5 and 5.5%, but is predicted to increase significantly. In addition, the level of scientific understanding of the climate effects of aviation is low. The vision of ANCE is that for the growth of aviation (5 % per year) to be sustainable with a decreasing impact on the environment, more accurate modelling of the impact due to noise and emissions is required. ANCE has two knowledge clusters:

Aircraft Noise
For aircraft noise, the modelling chain comprises the acoustic source, that is the aircraft, via the propagation medium, that is the atmosphere, to the final noise impact as perceived on the ground. Research topics include:

- Weather-dependent noise contour modelling, fully accounting for the temperature and wind speed gradients in the atmosphere
- Detailed aircraft noise source modelling, both considering the engines and airframe, also for the assessment of new aircraft technologies

Testimonial Profile I - Control and Simulation
Looking back, my decision to study the MSc profile Control and Simulation at TU Delft was definitely the right choice. The highly-qualified scientific and teaching staff are well-known in their respective fields, but at the same time are easily approachable.

Emmanuel Sunil, MSc (2014)

During the thesis, students are given excellent guidance from expert supervisors and are also given the freedom to use the numerous facilities available, which includes two flight simulators and a laboratory aircraft (amongst others). I feel confident that the MSc programme at Control and Simulation has provided me with the necessary skills needed to pursue a successful professional career in the future.
Acoustic camera imaging for noise source identification on aircraft and in more fundamental aero-acoustic research in wind tunnels.

The aircraft noise research is carried out in close cooperation with NLR and DLR.

**Testimonial Profile II - Aircraft Noise and Climate Effects**

My thesis research about aircraft noise during the final approach phase covered many disciplines. I applied new theories to analyse noise and executed noise measurements at Schiphol Airport. The section provided good guidance and offered a lot of personal attention. Still there is plenty of room for own ideas and to take on opportunities to work with external parties such as the NLR. Also many aerospace disciples come together in the ANCE research field, which really fascinates me. Overall I’m glad that I choose this section to perform my graduation research.

V.S. Viswanath Dhanisetty, MSc (2014)

**Profile III Air Transport Operations (ATO)**

The section Air Transport Operations (ATO) studies the efficiency and safety of aerospace operations through quantitative engineering and agent-based models that predict and optimize indicators such as capacity, cost and safety. It has two knowledge clusters: Air Transport Performance Optimisation focuses on the multidisciplinary modelling and optimization of key air transport performance criteria such as operational efficiency, capacity, and cost. The two main research themes are:

- **Aircraft Performance Optimisation** the optimisation of trajectories, flight plans, efficient operations and airport ground movements. This theme focuses on investigating detailed influencing parameters that need to be optimally incorporated into flight planning.

- **Airline Performance Optimisation** this includes operational and maintenance expertise. Operational fields of interest include the optimisation of networks, fleet configuration, fuel economy, and scheduling. Maintenance includes RAMS (Reliability, Availability, Maintainability, Supportability) expertise in general and subthemes such as: reliability modelling, efficient maintenance process analysis and logistics optimisation.

**Testimonial Profile III - Air Transport Operations**

One of the reasons I chose to study here is because of the international student mix, connections to worldwide experts, and a wide array of opportunities. I am an Indian, but I’ve lived the majority of my life in foreign countries, and I feel perfectly comfortable in this faculty. While studying ATO, I took opportunities that I never would have or even thought of taking. For instance, I was the first TU Delft student to do an internship in Albania for an airline called Belle Air. It ended up being one of the most exciting parts of extending my studies in ATO into the real world, putting my engineering education to the test.
Air Traffic Management (ATM)

Safety focuses on the socio-technical and safety-critical aspects of air transport. Although the potential number of fatalities in air traffic is low, the more demanding aspect of it is the highly-distributed nature of its agents, including crew and air traffic control. This implies network of interactions between many human and technical systems which pose complementary challenges to safety risk analysis. The basic approaches used are agent-based modelling and analysis of socio-technical systems, including:

- Safety/capacity analysis of advanced ATM concepts of operations
- Improving resilience of commercial aviation to disturbances
- Agent-based modelling of the impact of human coordination on air transport system performance

This research is executed in close cooperation with NLR.

Academic Staff

- Professor J.M. (Jacco) Hoekstra Control and Simulation (C&S)
- Professor M. (Max) Mulder Control and Simulation (C&S)
- Professor D.G. (Dick) Simons Aircraft Noise, Emissions and Climate Effects (ANCE)
- Professor H.A.P. (Henk) Blom Air Transport & Operations (ATO)
- Professor R. (Ricky) Curran Air Transport & Operations (ATO)
- Dr (Clark) Borst, Profile coordinator Control and Simulation (C&S)
- Professor V. (Volker) Grewe (ANCE) Climate Effects of Aviation

Job perspectives

The job perspectives for C&O students continue to be extremely bright, and many students have several job offers before they graduate. The versatile character of the MSC track leads to high-quality graduates with a great variety of where they start their societal career. Examples are large multinational industries (Boeing, Airbus/ EADS, Eurocopter, BMW, Mercedes, Shell, ASML, AirFrance/ KLM), established research laboratories (NLR, DLR, Eurocontrol, Max Planck, NASA), and consultancy and finance (McKinsey, Bain, BCG, ING, Deutsche Bank). A considerable number of students go and work directly in air transport, entering air traffic control, or even become pilots. Finally, a significant number of our students enter academic life and become a PhD student at high-ranking universities.

Research programmes and internships

The research programmes are identical to the three profiles summarized above, for more information contact the professors or consult the three Section’s web sites. Most of the C&O students do their internships abroad at major international companies (e.g., BMW, Boeing, Airbus, Nissan) or research laboratories (NASA, Max Planck, DLR). About half of the C&O internships are organized by the section at which the student has enrolled, using the personal network of the responsible professors. The internship is not necessarily aligned to the C&O knowledge base. On the contrary, students are free to search for an internship themselves, using their own network or with help from the Faculty’s internship coordinator. Internships can be done on all subjects of interest, as long as they have an academic component.

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.

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

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-ornuclear-related-courses-of-study

More information on the MSc track “Control & Operations” can be obtained at: www.lr.tudelft.nl/co

Alternatively, you can also contact the MSc track coordinator:
Dr. ir. Clark Borst
E c.borst@tudelft.nl
T +31 15 27 89099
Room number: 0.26

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

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

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