

# Dynamic systems modelling and simulation

Physical and numerical modelling of dynamic systems forms a significant part of our work at Frazer-Nash Consultancy. Dynamic systems modelling is often the start of important investment, system requirements and design decisions.

We have several functional and cross-cutting teams dedicated to the development of these models for our clients in aerospace and transport, clean energy, conventional power, defence and government.

Frazer-Nash has the ability to perform physical modelling using both first-principle approaches and commercial software packages, or a combination of both. We create our own modelling software when required and/or extend the available commercial packages when they are insufficient or lacking in the required features. We are capable of modelling highly nonlinear physical phenomena in order to:

- ▶ Aid design of systems that exhibit these phenomena
- ▶ Characterise the performance and to understand the envelope of operation of these systems
- ▶ Understand how systems' performance degrades due to component failures and through-life degradation
- ▶ Compare modelled performance with required performance and to develop feasible requirements

## OUR CAPABILITIES

We achieve the above by modelling both the system of interest and the operating environment. We frequently create multi-domain physical models for these purposes that include one or more of the following domains:

- ▶ Mechanical: Mechanism and machine modelling – for example for multibody systems, rotating and planar mechanisms, gearboxes, clutches, brakes, hoists, pulley and cable systems such as cranes, kinetic energy storage devices, etc. – and the nonlinearities associated with them, such as friction, backlash, and non-linear material behaviour
- ▶ Fluids and hydraulic/pneumatic: Pipe flow (including multiphase flow), interactions with mechanical systems, fluid power applications (hydraulic motors, valves, pumps, bellows, etc.), gas and aerodynamics, dynamics, marine vessel and marine device response
- ▶ Thermal: As above but also taking into consideration heat flow through fluids, their containing systems, and their thermofluids' interactions
- ▶ Electrical power: Generation, conversion (AC-DC, DC-AC, DC-DC), transmission (transformers, power lines and switchgear), power electronics (low-level modelling

of device behaviour), electrochemical and electrostatic energy storage devices (batteries, fuel cells, and supercapacitors), electrical machinery (motors and generators)

- ▶ Electronic: Low-power component modelling (passive devices such as resistors, capacitors, inductors, diodes and active devices such as transistors and amplifiers), photovoltaics, whole circuit modelling
- ▶ Electromagnetics: Magnetic circuits including transformer and detailed motor/generator models

We also have the capability to analyse systems comprised of one or more of the above domains from a systems perspective, including transfer-function representation for both time- and frequency-domain analyses. We are expert in the design and implementation of control systems and monitoring (e.g. diagnostics and prognostics) for devices involved in these domains.



Examples of our work includes first principles physical modelling of:

- ▶ Numerous wave power devices including Trident's WEC, Aquamarine Power's Oyster<sup>®</sup>, Carnegie's CETO
- ▶ Tethered/towed marine systems
- ▶ Power systems modelling for existing naval marine vessels designs (Type 23, Type 26, Type 45), and future vessel concepts
- ▶ Multidomain modelling of wind turbine systems (the full power generation chain, auxiliary equipment, and infrastructure)
- ▶ Launch and recovery system for a catamaran offshore wind farm servicing vessel (all phases of operation modelled)

We are expert in MATLAB, Simulink, and the Simscape suite of tools for physical modelling. Additionally, we offer expertise in the bond graph mathematical technique for physical modelling. We are the UK MOD's preferred provider of electrical power physical modelling expertise.

For more information about Frazer-Nash please visit our website.

[www.fnc.co.uk](http://www.fnc.co.uk) - [www.fncaustralia.com.au](http://www.fncaustralia.com.au)

Offices throughout the UK and Australia

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