

- modelling and simulation
- control design
- system troubleshooting
- technology transfer and training
- energy efficiency investigation
- software tools



## Capability Statement – Automotive Industry

## Industrial Systems and Control Ltd.

Industrial Systems and Control (ISC) Ltd. was set up more than 30 years ago to provide technology transfer between the University of Strathclyde's Industrial Control Centre and industry.

ISC works across industrial sectors and has gained wide experience in a range of applications. It is this peripheral vision which is valuable for automotive companies, which have a complete understanding of current advances in the automotive industry, but might gain from design and technological advances in other sectors.

ISC Ltd. has particular expertise and experience on the following areas and methodologies:

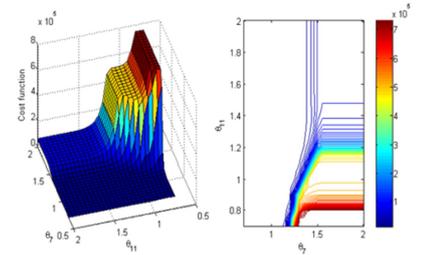
- Physical system modelling and simulation, including training simulators.
- Developing tailored optimal or predictive control solutions for real-world applications.
- Production of bespoke estimation and filtering algorithms for nonlinear control.
- Use of stochastic or robust controls for different industries like wind energy and marine.
- Design of Machine Learning algorithms for industrial and embedded domains.
- Training courses mostly for the automotive industry based in the US.

### How does ISC work?

The degree of cooperation with the companies we serve is probably much closer than with many consulting companies because of our University origin. ISC has long experience in the application of advanced controls across different industrial sectors and this is a strength we bring to the projects. However, the engineers in the companies we work with know more about the applications and this requires close contacts to be maintained and regular reporting. By the end of our projects the engineers we work with know more about the advanced methods that we are applying than ourselves. This is because they are the ones at the sharp end of evaluating the techniques on the engines or other applications.

### Why is ISC a strong partner?

- ISC has been in business for over 30 years, providing consultancy, control system software and training to some of the world's largest engineering companies.
- We have a dedicated and highly professional team of engineers and consultants. See our NI Alliance Partner webpage for projects and testimonials.
- Software is developed bespoke for applications to have the best balance between cost, functionality and usability.
- Technology transfer includes training workshops, source code and documentation.
- ISC is based in Glasgow but most of its automotive projects are in the Detroit area, MI.
- Some of ISC's bespoke control systems software have been operating 24/7 in the harsh North Sea.
- ISC has won the National Instruments' Application of the Year award twice.
- Some ISC staff have security clearance for MoD / BAE Systems work.
- ISC is financially stable. Our accounts are audited annually (audited accounts for the last three years are available on request).
- ISC has both professional and product liability insurances of up to £5m each.



### Our Expertise

- In-depth understanding of control technologies
- Extensive experience in diverse industrial applications
- High-fidelity modelling of system behaviour
- Expert analysis of complex problems
- Proven project management and research skills

### Our Core Competencies

- Dynamic modelling & simulation
- Control strategy design and implementation
- Optimization
- Algorithm development
- Benefits analysis and technology review
- Research & Development
- Troubleshooting
- Training

### Our Philosophy

- Approaching problems with an open mind
- Dedicated to identify practical and innovative solutions without compromising performance
- Imparting understanding and empowering clients to drive improvements themselves.

ISC Limited  
36 Renfield Street  
Glasgow G2 1LU  
Scotland UK

t +44 (0) 141 847 0515  
f +44 (0) 141 221 1706  
e [iscmail@isc-ltd.com](mailto:iscmail@isc-ltd.com)  
w [www.isc-ltd.com](http://www.isc-ltd.com)

Industrial Systems and Control Ltd. wholly owns and manages Applied Control Technology Consortium  
Registered in Scotland 105188



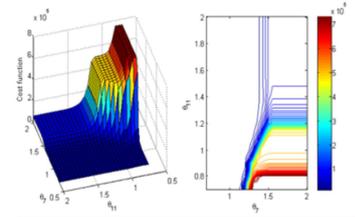
- modelling and simulation
- control design
- system troubleshooting
- technology transfer and training
- energy efficiency investigation
- software tools



## Recent Automotive Projects

### Ford – Dearborn, Work on the Control of Autonomous Vehicles (2016 – 2019)

This project involved the application of advanced predictive control methods to determine if there were advantages and limitations relative to classical solutions for automotive path planning problems. Year 1 and 2 were concerned with the lane merging and changing problem and employed a Nonlinear MPC solution, while Year 3 involved a T-junction scenario and Linear Parameter Varying (LPV)-MPC algorithm for efficient real-time implementation.



### General Motors Engine Controls – Warren and Pontiac, Michigan

ISC has worked with General Motors for about two decades with annual projects that have mostly been concerned with the application of nonlinear controls to SI engines. These involved torque and lambda control, Variable Cam Timing and variable displacement engines, nonlinear multivariable solutions and/or scheduled linear and nonlinear MPC algorithms. Further, the opportunities for the use of artificial intelligence and machine learning were investigated and a survey completed.

### Fiat Chrysler Automotive - Auburn Hills, Michigan

The 2017/18 projects with FCA involved the assessment of nonlinear controllers for use in electronic throttles and also in thermal control of engines. One of the features was to compare different advanced control solutions including restricted structure predictive controls, and considering the relative merits between advanced algorithms and benchmark classical solutions.

### Cummins – Columbus, Indiana

The main project with Cummins involved a survey to determine the areas of advanced control where research was necessary to service the future needs of the company. An assessment was made of the current research activities and recommendations were given for important new directions or to simplify the implementation of the current tools they were exploring. A technology transfer review of advanced controls and future opportunities was provided.

### NXP - Glasgow and Austin Texas

This two-year current project is on the application of advanced nonlinear predictive and constrained control in the latest NXP micro-controller devices. Model based predictive control and AI based methods have been applied to the control of hybrid electric vehicles with the aim of minimizing energy and reducing battery degradation whilst maintaining good performance. The focus of the second year of the project is on battery aging and thermal management for pure electric vehicles. Performance is to be optimized while reducing battery degradation to extend its useable lifetime.

***"Approaching a problem with an open mind is an important aspect of ISC philosophy, as is using the simplest, most cost effective solution."***

### ISC Automotive Training Courses

The training courses are provided at company premises and are tailored to the company's requirements. The courses are classified as introductory, intermediate and advanced levels and range from simple introductory material which is suitable for non-control engineers up to advanced courses on the state of the art.

The structure for courses was agreed with the Boeing Company in Seattle and for automotive systems they have been provided to Ford in Dearborn on an annual basis for almost two decades. The courses can be helpful in encouraging cooperation since engineers raise problems they have in the discussion sessions or at the lunch and coffee breaks. Normally an engineer in a company will provide an indication of the level of the course they require, and the type of topics to be covered. We then iterate to define a suitable course. Once this has been agreed ISC will provide a quotation for the course and companies can decide whether it is good value.

### ISC as a Business

The company was established 3 decades ago by the University of Strathclyde to encourage technology transfer in advanced control methods. It ran a training and technology transfer program under the ACTC (Applied Control Technology Consortium) that involved many of the world's leading companies across business sectors. The training courses now offered by ISC build upon that material and experience. Many of the engineers in ISC first researched in the University but have now worked within the company for many years. One of the advantages of ISC, relative to Universities, is that it has permanent staff and can undertake confidential work in a professional way in terms of schedules and quality of deliverables. The fact that companies can return to ISC after a few years and gain access to the same engineers and software for further developments is often immensely valuable.

### Clients Include

- General Motors: SI engine control.
- General Motors: SCR system identification.
- General Motors: Control model calibration.
- Toyota: Diesel engine control.
- Cummins: Diesel engine design methods assessment.
- Ford: Autonomous vehicle control.
- FCA: Training Activity via Electronic throttle design study.
- NXP: Hybrid Electric powertrain control.
- Torotrak: variable transmission system.
- Visteon: applying LabVIEW to automotive power control.

### Recent Automotive Courses

- Ford at Dearborn annual courses between 2004-2019
- Cummins at Columbus, 2018
- Toyota, Ann Arbor 2014, 2018
- Chrysler, Auburn Hills 2011-2016
- Freescale in Glasgow and Detroit 2008
- NXP in Glasgow 2018
- GM Detroit 2015
- Jaguar in Coventry and Gaydon 2006 & 2009
- Riccardi in Leamington and Shoreham 2006 & 2009
- Visteon in Detroit 2004

### Regular Reporting

On most projects, we have the following reporting arrangements:

- A webinar held typically every 3 weeks.
- A mid-project face to face meeting.
- An end of project technology transfer workshop, held a few weeks before the end of the project so that corrections and updates can be made.