

CURRICULUM VITAE - T. J. WREN

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QUALIFICATIONS: DPhil : Chaotic Communication Schemes
MSc : Systems and Control
BSc (Hons) : Mechanical Engineering

CEng - Chartered Engineer
CMath - Chartered Mathematician
Eur Ing - European Engineer
MIET - Member Institution of Engineering and Technology
MIEEE - Member Institute of Electrical and Electronic Engineers
MIMA - Member Institute of Mathematics and its Applications

EXPERIENCE: Algorithm Design, Development and Implementation
Matlab/Simulink Development
Systems Engineering
Modelling and Simulation
Applied Mathematical Research
Rapid Prototyping
RF/Communications Systems
Digital Signal Processing
Optimization Methods
Control Systems
Discrete Time Simulation
Synthetic Environments
Model Based System Design
Gas Turbine Simulation & Control
Real-Time/Embedded Systems
Systems Software/Hardware Integration
OOD/OOP Software Design

PROGRAMMING: Matlab/Simulink
Python
C#, C++, C
FORTRAN 77, 90
SQL
VBA
Pascal

NATIONALITY: British

PLACE OF BIRTH: Hastings, East Sussex, England

OTHER: Security Clearance (SC), Full Driving Licence, Non-Smoker

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- PAPERS:**
- 'Specific Emitter Identification using Convolutional Neural Networks and Feature Extraction'
2019 Co Author: To be published
July 2019
 - 'Exploring Future Directions of Control'
2014 UKACC International Conference on Control, Loughborough University
July 2014
 - 'Low Cost Size Weight And Power Direction Finding via Interferometry'
7th Electronic Warfare Symposium, Defence Academy, Cranfield University
December 2011
 - 'Optimal Duration Five Bit Orthogonal Chaotic Vector Shift Keying Communication: A Case Study'
IEEE ITST-2011 11th International Conference on ITS Telecommunications, St. Petersburg
August 2011
 - 'Orthogonal Chaotic Vector Shift Keying in Digital Communications'
IET Communications
April 2010
 - 'Multi-Platform Multi-Target Target Tracking Fusion via Covariance Intersection: Using Fuzzy Optimised Modified Kalman Filters with Measurement Noise Covariance Estimation'
IET Tracking & Data Fusion Seminar
April 2008
 - 'On an Improved Chaotic Shift Keying Communication Scheme'
International Conference 'Control 2006'
Paper 29
February 2006

INDUSTRIAL WHITE PAPERS:

- 'The Feasibility of Controlling a Gas Turbine Engine Using Adaptive Control Techniques'
Smiths Industries
1985
- 'The Multivariable Control of a Pegasus Engine'
Smiths Industries
1985
- 'The Offline System Identification of a Pegasus Engine Using Recursive Experiment Design via PRBS Perturbation Methods'
Smiths Industries
1985
- 'Pseudo Real Time Optimisation of Engine Test Cells Using Maximum Gradient Methods'
Talbot Motor Company
1982

CURRICULUM VITAE - T. J. WREN

EMPLOYMENT DETAILS:

Sep 17 – Present

**Mathtech Consultants:
Leonardo Airborne & Space Systems, Luton, Bedfordshire**

Consultant: Tempest EW Concepts and Applied Research

- Developing mathematical algorithms for Low-Band array Direction Finding antennas.
- Part of team receiving an award and recognition of excellence for Radical Innovation on a 'Single Aperture 2D DF SWaP Radar Receiver'. Responsible for development of mathematical approach, implementation and integration.
- Development of antenna coverage and sensitivity application in 'Matlab Application Designer' to assess single or multi aircraft threat detection and combined antenna sensitivities.
- Antenna phasor prediction algorithm for theoretical antenna configurations.
- Research on multi-sensor, multi-platform fusion for target detection.
- Research, development and implementation of HADF antenna misalignment compensation algorithm.
- Algorithm assessment and development of Geospatial positioning and tracking methods in relation to the Tempest EW sensor performance.

Jan 19 – Jul 19

**Mathtech Consultants:
Rowden Technologies, Bristol & Bath Science Park, Bristol**

Consultant: Specific Emitter Identification

- Part of team researching the identification of specific emitters within the hidden battlespace using artificial intelligence in the form of convolutional neural networks and engineered signal processing feature extraction.

Jan 17 – Sep 17

**Mathtech Consultants:
BAE Systems, Filton, Bristol**

Consultant: Performance Analysis & Algorithm Development

- Analysis of Type 26 4.5in Gun performance under various conditions to determine which parameters contribute most significantly to error budgets.
- Algorithm development in Matlab to support performance analysis.

Jun 17

**Mathtech Consultants:
General Dynamics Mission Systems, Hastings, East Sussex**

Consultant: Monte Carlo Test Strategy

- Produced a statistical test strategy for the validation and verification of my previous feasibility study on implementing fixed point Geospatial Coordinate Transforms. It applied a two-tier Monte Carlo approach. Firstly, by testing over a globally distributed set of target and stake positions, with test vectors drawn from suitable distributions; and secondly, an examination of locally chosen sets of test vectors sampled from Gaussian White Noise multivariate distributions. The results are then analysed using Gaussian Mixture modelling.

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Feb 17

**Mathtech Consultants:
General Dynamics Mission Systems, Hastings, East Sussex**

Consultant: Feasibility Study

- Produced a feasibility study on implementing fixed point Geospatial Coordinate Transforms for fast execution times within an existing algorithmic framework.

May 16 – Nov 16

**Mathtech Consultants:
Lockheed Martin, Ampthill, Bedfordshire**

Consultant: Algorithm and GUI Development

- Development of a plotting and analysis GUI to interpret data collected on firing trials.
- Algorithm development for determining probability of target hit error budget.

Oct 15 – May 16

**Mathtech Consultants:
MBDA, Stevenage, Hertfordshire**

Consultant: Simulation & Modelling

- Adapting a battlespace simulation to assess the performance of various missile seekers with differing radar emission patterns.

Dec 13 – Oct 15

**Mathtech Consultants:
Lockheed Martin, Ampthill, Bedfordshire**

Consultant: Algorithms Review, Redesign and Development

- Research and application of a pseudo phase portrait method to evaluate the performance of time delay synchronizers against real trials data.
- Design and implementation of a Kalman Filter to estimate target position and velocity with sparse ranging data.
- Design and implementation of 3 Degrees of Freedom Simulink model of projectile incorporating gyroscopic drift, wind drift, gravity and Coriolis effect algorithms; based on physical modelling of atmosphere, ambient temperature and pressure, geo-location and altitude. Used for comparison against cannon manufacturer's firing tables and subsequent generation of ballistic solution firing tables.
- Characterisation of the nature of system noise from sensors using Gaussian Mixture Models and Expectation Maximization methods.
- Reviewing design of existing algorithms and developing new algorithmic methods for turret fire control systems on Scout SV.

Feb 11 – Dec 13

**Mathtech Consultants:
Dstl Porton Down, Wiltshire:
Electronic Warfare & Navigation Group
Sensors & Countermeasures Department
Emerging Communications Team**

Consultant: Algorithm Research, Design, Development and Implementation

- Research into multipath mitigation algorithms for complex waveforms. Using blind system identification, higher order statistics and correlation methods.

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- Development of a modified Bancroft algorithm to determine transmission positioning using Time Difference of Arrival.
- Clustering algorithm investigation with irregular background clutter using Affinity Mapping, Joint Factor/I-Vector Analysis and Gaussian Mixture Modelling to calculate maximum log likelihood associations for candidate feature vectors multivariate spaces.
- Paper on 'Low Cost Size Weight And Power Direction Finding via Interferometry' presented to 7th Electronic Warfare Symposium, Defence Academy, Cranfield University.
- Managed a small team to design, develop and implement an experimental RF direction finding system. Development of various forms of Eigen Structure algorithms, such as MUSIC and ESPRIT, implemented in Matlab; integration of an Ettus Research USRP SDR, local signal generators, amplifiers and filters into test equipment and the development of a Python GUI for use with the system.
- UAS flight path modelling and guidance project.
- Completed Core 1 & 2 of LabVIEW RF Application Development Course. Designed algorithms for OFDM Wi-Fi signal Direction Finding.

Feb 08 – Feb 14

University of Sussex, Brighton, East Sussex

Visiting Research Fellow

- Paper accepted for the IEEE ITST-2011 11th International Conference on ITS Telecommunications: Paper title 'Optimal Duration Five Bit Orthogonal Chaotic Vector Shift Keying Communication: A Case Study'.
- Paper accepted by the IET Communications Journal: Paper title 'Orthogonal Chaotic Vector Shift Keying in Digital Communications'.
- Further research into 'Orthogonal Chaotic Vector Shift Keying'. Specifically investigating encoding of signals via eigenvalue constellations and researching tuneable nonlinear dynamic systems with specifiable Lyapunov Exponents to generate orthogonal signal sets.

Sept 10 – Feb 11

Lockheed Martin, Ampthill, Bedfordshire

Algorithms Development Lead on the Scout Turret Project

- Algorithms lead for the development of the turret fire control and target tracking systems of the Scout Reconnaissance Vehicle. The architectural design in Rhapsody incorporates models from Matlab and Simulink via Real-time Workshop and Stateflow. It is envisaged that the Top Down Model Based approach will take DOORS system requirements via Rhapsody and auto-generate target code and models suitable for testing within a Synthetic Environment Framework. I have been the instigator of a proposal for an enterprise integration framework which will allow the Matlab/Simulink and other federate models to run seamlessly and interchangeably with real hardware.

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Jul 04 – Sept 10

General Dynamics UK Ltd., Castleham, St. Leonards on Sea, East Sussex

Principal Systems Research Engineer: Mathematical Modelling

- Extension of Graphical Language development to incorporate the IET Tracking and Data Fusion Seminar paper into a Correlation Engine within a federation. This utilized all the Matlab/Simulink interfacing research work.
- Development of Graphical Language techniques for interfacing to Matlab/Simulink. The Graphical Language is a GDUK research development programme allowing the incorporation of 'Best in Class' applications into Discrete Time Simulation Federations.
- Given the brief of addressing the rigorous analysis and implementation of new mathematical and scientific algorithms and techniques for potential project exploitation. Involved in the DIF DTC work undertaken by General Dynamics in collaboration with Cambridge University to track targets using translational and rotational invariant transform methods; specifically the 'Dual Tree Complex Wavelet Transform'.
- Mathematical Modeller for a multiple platform time sensitive target tracking system, a derivative of the SEDS programme. This incorporates a modified structure Kalman filter method and a fuzzy logic measurement noise covariance estimator based on the innovation sequence. Small scale temporal differences, due to different platform observations times and transmission latency, are accounted for, in a positional nonlinear algorithm placed before the Kalman filter. This avoids the use of potentially unstable, state sensitive, Extended Kalman Filter methods without the complexity and computational load of Particle Filters. Disparate observations are combined using a modified Covariance Intersection method and the results are used to cue other assets within the simulation. The Kalman Filter element of the work has been published in a paper presented at the IET Tracking and Data Fusion Seminar. A further paper detailing how the simulation and cueing techniques are implemented will be the subject of a paper to be submitted to the Journal of Simulation this spring.
- Mathematical Modeller for the Synthetic Environment Demonstration System (SEDS). An IRAD designed to investigate the viability of the using a synthetic environment for simulating targeting scenarios. The system incorporated an HLA backbone via a MAK RTI and a series of platforms with attached sensors, modelled in Opnet for network timings and propagation losses, and an in-house modelling behavioural environment which began to address the management of the geo-positioning and intelligent movement of the platforms.
- Under an 'Independent Research and Development' (IRAD) programme developed Head Related Transfer Function 3D Audio capabilities for synthetic sound picture applications. Based on VME processor boards with a DSP accelerator mezzanine card, the system utilizes head tracking, head orientation and distance of apparent source to give the user a synthetic sound picture of their surroundings designed to include synthetic cueing.
- Under another IRAD programme developed a prototype network modelling toolbox, in Matlab and Simulink, for determining potential latency and potential data throughput of processor boards and network interfaces such as Ethernet and VME buses. Modelling of complex objects was based on simple primitive constructs connected via the Simulink graphical interface. This has now been fully developed by the programmes department and was distributed for company wide use in 2007.

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Oct 03 – Oct 07

University of Sussex, Brighton, East Sussex

- Read for a DPhil in Engineering. Researched into multidimensional chaotic shift keying communication schemes, for secure communications, using encoded sets of orthogonal chaotic signals.
- Paper presented at the International Conference in Control 2006 – 'On an Improved Chaotic Shift Keying Communication Scheme'

DPhil Thesis:

- 'Orthogonal Chaotic Vector Shift Keying in Digital Communications'

Feb 00 – Feb 03

DERA (Bedford)/QinetiQ (Bedford), Thurleigh Airfield, Bedford

Contractor/Principal Engineer (Research and Development)

- Led a small team to develop a Windows Application for 'Shell/Norway Oil Production' to optimally find and evaluate proposed deep ocean pipeline routes, using similar techniques developed for fast aircraft routing, based on costing a series of optimally chosen routes. To ensure a fast accurate solution to the problem the force and moment calculations for pipe chasm spanning stress calculations were simplified by using candidate characterization functions which were only increased in complexity if two optimal routes had the same cost. The application was developed in C++ using Borland C++ Builder 6.0 Professional and terrain and pipeline visualization was achieved using OpenGL.
- Led a small team for research, development and flight-testing of an integrated 'Terrain following and Threat Avoidance' real time routing 'Capability Demonstrator'. A VME multiprocessor rack with Power PC 750 processor cards running VxWorks real time kernels, communicating with aircraft/simulation I/O via Arinc 429/IEEE 1553 interfaces and database DTED map data. Written in C using Wind River's Tornado II IDE, the system has levels of real time routing generating deterministic and non-deterministic routes optimally or fixed phase routing managed by a dynamic event queue generated by pilot selected mission scenarios or other flight circumstances.
- Design and implementation of a real time Windows based virtual monitoring and logging application for handling Ethernet UDP messages from a number of multi-processor VME racks. Written in C++ using the Borland C++ Builder IDE, the application spawned multiple display and logging threads as required with dedicated buffering threads ensuring minimal data loss.
- Extensive use of Matlab/Simulink for aircraft model simulation, design and implementation of LabVIEW generic VI's and CIN nodes for communicating and monitoring VME processor racks.

Jan 99 – Feb 00

Parametric Systems Ltd., Dorchester, Dorset

- Borland Delphi 3.0 Design and Development of a Pricing and Cost Estimation package for an Antique Gilded Frames Restoration company. The system allowed for detailed materials costing, repair visualisation and work, time estimate reports and customer quotes for highly ornate antique frames.
- Design and development of Access based Database for billing, accounting and driver assignment for a Dorset Taxi Firm.

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May 98 - Jan 99

Thompson Marconi Sonar Ltd., Weymouth, Dorset

Principal Software Engineer (Research and Development)

- Initial development of underwater communications system for diver to ship/ship to submarine covert communications using SHARC processors and Apex 'C++', Node Simulator and Post-Mortem debugger.

Dec 96 - Jan 98

Delta Technical Services, Portsmouth, Hampshire

Contractor

- Design, development and integration of 'C++' based software for a remote hydrological data logger and telemetry system; the prime considerations being high integrity data storage, transmission and extremely low power consumption. The system was based on a dedicated board incorporating an Intel 8051 microprocessor and the software was written using an IAR 'C++' Cross Compiler and an Ashling ICE using the Pathfinder symbolic debugger.

Jan 96 - Sep 96

Radiodetection Limited, Bristol

Contractor

- Design and development of a remote data retrieval system for interrogating dedicated systems in China and Italy, via modem, monitoring the integrity of optical fibre telephone line outer sheaths. The system was PC based using the IAR 'C++' and Greenleaf Commlib 'C' library functions.
- Development and integration of 'C' based software for an embedded H8/300 Hitachi processor-based board in a 'boring' machine positional/attitude sensor 'Sonde' communicating via 'Quadrature Phase Shift Keying' over a low power radio link to a base station at ground level.

Jun 95 - Oct 95

RACAL Instruments Ltd., Slough, Berkshire

Contractor

- Implementation of a frequency-hopping algorithm for the GSM digital phone and base station 6103/6113 test sets. Using the Microtec MCC68K 'C' Cross Compiler and the Codewright Environment and managed via VCS.

Feb 94 - Jun 95

Cotech Technology Ltd., Bramley, Hampshire

Senior Software/Systems Engineer

- Design, development and integration of embedded software for a series of 68000 based 'Transducer Simulation Boards' driving output signals to a VME Bus. Control of the bus was by a VxWorks Real Time Kernel running on a dedicated 68040 board and communicating with a Sun Workstation via an Ethernet connection. The source was written for a Microtec MCC68K 'C' Cross Compiler and integrated using the Microtec XRAY symbolic debugger and USD3 Analyser via a 'MICE'.

May 93 - Jan 94

Extended Sabbatical in South Africa

- Spent seven months travelling extensively around South Africa and Zimbabwe.

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Nov 92 - Apr 93

Smiths Industries plc., Basingstoke, Hampshire

Systems Engineer

- Initial specification of hardware/software products for the Rig Test Facility for the RR/BMW BR710 engine controller. Hardware and software requirements specification for the 'Transducer Simulation Boards'.

Apr 91 - Nov 92

EMA Video Productions Limited, Cranleigh, Surrey

Contractor/Consultant

- Design of a 'C++' based 'MAZE' board game and management shell for a 'Basic Food Hygiene package' for the food industry. I managed two other team members, liaised between the Managing Director and Production Manager and completed the project on time and to budget.

Apr 90 - Apr 91

British Aerospace plc., Hatfield, Hertfordshire

Contractor

- Part of a team simulating, designing control laws and analysing the landing flare of the BAe 146 for CAT 3B certification. Development took place on a VAX 8800 cluster using the TSIM simulation language. The system was adapted from one used on the McDonnell Douglas MD 11.

Jun 89 - Apr 90

Smiths Industries plc., Basingstoke, Hampshire

Contractor

- Proposal for a generic control system for the Allison 250 engines series.
- Test bed development and system identification of the Rolls Royce Tay 650 control law software for an Engine Control Demonstrator at Staverton Test Bed.

Aug 88 - Jun 89

Royal Aircraft Establishment, Pyestock, Hampshire

Senior Scientific Officer

- Development of Thermodynamic and Partial Derivative simulations of Gas Turbines using the TSIM Fortran based simulation language.
- Development of Advanced Multivariable Engine Control Strategies using MATLAB.

Sep 87 - Dec 87

Convergent Communications Plc., London

Contractor

- Design and development of a PC based interactive training video management system, allowing multiple users performance to be monitored over a number of different interactive applications.

Nov 83 - Sep 87

Smiths Industries plc., Basingstoke, Hampshire

Control Systems Engineer

- Research for a Technical Assessment Report: 'The Feasibility of Controlling a Gas Turbine Engine using Adaptive Control techniques'.
- Research for a Technical Assessment Report: 'The Multivariable Control of a Pegasus Engine'.

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- Research for a Technical Assessment Report: 'The offline System Identification of a Pegasus engine, using Recursive Experiment PRBS perturbation methods, at Staverton Test Bed'.
- Design and Development of Control System software written in 'PASCAL' for System Identification, Inverse Nyquist Array, Luenberger Observers, Kalman Filters, Controller Design and Correlation Analysis.

Oct 82 – Oct 83

University of Manchester Institute of Science and Technology, Manchester

- Read for an MSc in Systems and Control.

MSc Dissertation:

- 'Multivariable Control of a Compound Diesel Engine Simulation'

Jul 81 – Sep 82

Talbot Motor Company Ltd., Coventry, West Midlands

Graduate Engineer

- Research for a Technical Assessment Report: 'Pseudo Real Time Optimisation of Engine Test Cells Using Maximum Gradient Methods'. This allowed an engine's optimal running parameter settings to be found in a fraction of the existing method's time.
- Development of 'FORTRAN' modules within a CAD package for Computer Controlled Milling machines.
- Design of interfaces for a Finite Element package allowing 'Wire Models' to be converted into Nodal Meshes for Stress Analysis.

Jan 80 - Sep 80

Talbot Motor Company Ltd., Coventry, West Midlands

Student Engineer

- Design of fabricated engine mounting bracket using Finite Element methods.
- Prediction of Prop shaft 'Whirl' using Receptance techniques.
- Modal Analysis of Chassis Vibration using an HP Fourier Analyser.

Jun 78 - Dec 78

British Nuclear Fuels Ltd., Windscale, Cumbria

Student Engineer

- Design and construction of stress test rig for cutting oxide fuel rods.
- Workshop Training.

Oct 77 - Jun 81

Coventry University, Coventry, West Midlands

- Read for a BSc (Hons) in Mechanical Engineering.

Final Year Project:

- 'Large Scale Deflection of a Leaf Spring using Finite Difference Methods'