STRUCTURAL HEALTH MONITORING USING STATISTICAL PATTERN RECOGNITION
Manchester, UK, July 7 - 9, 2018

Time	Day 1 July 7th	Time	Day 2 July 8th
8:00-9:00	**Registration & Introductions**		
9:00-9:55	**1. Introduction (Farrar)** - Course overview - Definition of Damage and SHM - Motivation for SHM, (NDE vs SHM) - Statistical pattern recognition paradigm - Historical overview: aerospace /civil/mechanical application	8:30-9:25	**8. SHM Sensing Technologies I (Todd)** - Excitation methods - Conventional force/pressure sensing - Conventional strain sensing - Conventional acceleration sensing - Acoustic emission sensing - Fiber optic sensing
9:55-10:20	**2. Operational Evaluation (Farrar)** - Economic/Life-safety justification for SHM - Defining the damage to be detected - Constraints on the SHM process - Case Study	9:25-10:20	**9. SHM Sensing Technologies II (Flynn)** - Piezoelectric materials - Commercial transducers/actuators - Custom transducers/actuators - Design consideration - Instrumentation techniques
10:20-10:40	**Coffee Break**	**10:20-10:40**	**Coffee Break**
10:40-11:45	**3. Review of NDE Methods (Todd)** - Ultrasound - Thermography - Eddy Current - Radiography - Limitations	10:40-11:45	**10. SHM Sensing Technologies III (Todd)** - Laser-based non-contact measurements - Video-based non-contact measurements - Robotic devices used for SHM sensing - Specialty sensors developed for SHM (comparative vacuum monitoring, pressurized aircraft tubing, HERT, Underwater system) - Emerging sensing and data visualization hardware
11:45-12:45	**4. Sensing & Data Acquisition (Todd)** - Sensor and sensor system overview - Sensor performance metrics - Signal conditioning issues - Telemetry and power - Embedded systems - Sensor network paradigms	11:45-12:45	**11. Introduction to SHM Features (Farrar)** - Define "features' in the context of SHM - Features in the context of detection theory - Sufficient statistic - Feature types - Examples (frequencies, mode shapes)
12:45-14:20	**Lunch**	**12:45-14:20**	**Lunch**
14:20-15:20	**5. Signal Processing (Flynn)** - Conditioning signals - Analyzing Signals - Time, Frequency &Time-frequency Methods - Correlation methods - Input-output methods	14:20-15:20	**12. Ultrasonic Methods (Flynn)** - Acoustic emissions - Impedance method - Sensor self-diagnostics - Guides waves - Nonlinear acoustics -Integration with other SHM technologies
15:20-15:40	**Coffee Break**	**15:20-15:40**	**Coffee Break**
15:40-16:40	**6. Basic Statistics (Farrar)** - Statistical moments/distributions - Density estimation - Confidence limits - Central limit theorem - Principal component analysis	15:40-16:40	**13. Advanced Features (Todd)** - Nonlinear response concepts - Waveform comparisons (nonlinear) - Nonlinear time series modeling - Residual errors - Chaotic interrogation methods
16:40-17:40	**7. SHMTools Demonstration: Signal Analysis (Flynn)** - Using SHMTools & mFUSE - Function & process assembly - Data import - Statistical analysis - Signal processing	16:40-17:40	**14. SHMTools Demonstration (Flynn)** - Feature extraction with time series models - Rotating machinery example - Guided wave example

Time	Day 3 July 9TH
8:30-9:25	**15. Damage Detection: Unsupervised Learning Methods (Farrar)** - Motivation for statistical decision analysis - Define supervised and unsupervised learning methods in the context of SHM - Cluster analysis - Outlier (Novelty) detection - Statistical process control
9:25-10:20	**16. Damage Detection/Classification: Supervised Learning Methods (Todd)** - Group classification & regression - Neural networks - Radial basis function - Support vector machines - Automated feature selection
10:20-10:40	**Coffee Break**
10:40-11:45	**17. Data Normalization (Farrar)** -Environmental/operational effects on SHM -Parametric modeling environmental effects -Look-up table technique -Machine learning techniques -SHM system design for normalization
11:45-12:45	**18. SHM System Design I: Detection and Location (Todd)** - Bayesian risk framework - Classical detection theory - Detector design - Detection/location examples
12:45-14:20	**Lunch**
14:20-15:20	**19. SHM System Design II: Optimization and Robustness (Todd)** - Probability of detection - Design examples - Robustness assessment - Comparative study
15:20-15:40	**Break**
15:40-16:40	**20. SHMTools Demonstration Detection & Classification (Flynn)** - Outlier detection - Data normalization - Supervised learning example
16:40-17:30	**21. Fundamental Axioms & Closing Remarks (Farrar)** - Recap the statistical pattern recognition paradigm - Fundamental axioms of SHM - Other sources of information - Course survey