STRUCTURAL HEALTH MONITORING USING STATISTICAL PATTERN RECOGNITION
Nantes, France July 5-7, 2014

Time	Day 1 July 5	Time	Day 2 July 6
9:00-9:30	**Instructor and Participant Introductions**	8:30-9:30	**7 . Embedded Sensing: Piezoelectric Active Sensing & Guided Waves (Todd)** - Lamb wave theory - Signal processing for guided waves - Nonlinear acoustics/time reversal acoustics - Integration with other SHM technologies - Applications
9:30-10:30	**1. Introduction (Farrar)** - Motivation for SHM, (NDE vs SHM) - Statistical pattern recognition paradigm - Historical overview: aerospace /civil/mechanical application - Operational evaluation	9:30-10:30	**8. Telemetry (Todd)** - Embedded systems overview - Data Acquisition - Autonomous Intelligence - Wireless communications - System integration - Localized computing
10:30-10:45	**Break**	**10:30-10:45**	**Break**
10:45-11:45	**2. Data Acquisition I (Todd)** - Sensor network components - Sensor performance metrics - Signal conditioning issues - Sensor network paradigms - Excitation	10:45-11:45	**9. MEMS & Multi-functional Materials for SHM (Todd)** - Basic micro-fabrication process - Various applications - MEMS accelerometers - Enabling nanotechnologies - Material characterization - Examples of self-sensing materials
11:45-12:45	**3. Data Acquisition II (Farrar)** - Introduction to piezoelectric materials - Impedance method - Sensor self-diagnostics	11:45-12:45	**10. Basic Statistical Tools (Farrar)** - Statistical moments/distributions - Density estimation - Confidence limits - Central limit theorem - Principal component analysis
12:45-14:00	**Lunch**	**12:45-14:00**	**Lunch**
14:00-15:00	**4. Software Exercises (Group Instruction)** - Software development overview - Functions & process assembly overview - Introduction to SHM process building - Power spectral estimation - Condition-based monitoring example	14:00-15:00	**11. Software Exercises (Group Instruction)** - Optimal sensor placement - Fisher information matrix method - Maximum norm approach - Guide-wave active sensing
15:00-15:15	**Break**	**15:00-15:15**	**Break**
15:15-16:15	**5. Embedded Sensing: Fiber Optics (Todd)** - Basic fiber optic sensing concepts (interferometry, multiplexing) - Common sensing methods - Performance comparison - Examples (I-10, patrol boat)	15:15-16:15	**12. Damage Sensitive Features I (Farrar)** - Feature selection criteria - Feature vs metric - Waveform/image comparisons - Basic statistics - Model parameters (inverse modeling) - Physical, time series models
16:15-16:30	**Break**	16:15-16:30	**Break**
16:30-17:30	**6. Embedded Sensing: Acoustic Emissions (Farrar)** -Sensing systems -Data analysis -Performance comparison and discussion -Applications to aerospace structures	16:30-17:30	**13. Damage Sensitive Features II (Todd)** - Nonlinear response concepts - Waveform comparisons: Nonlinear detection - Nonlinear time series modeling - Residual errors - Chaotic interrogation methods - Automated feature selection

Time	Day 3 July 7
8:30-9:30	**14. Introduction to Statistical Inference (Farrar)** - Supervised vs. unsupervised learning - Group Classification - Regression modeling - Outlier (novelty) detection - Outlier analysis - Hypothesis testing
9:30-10:30	**15. Supervised Learning Methods (Worden)** - Neural networks - Radial basis function - Support vector machines - Regression analysis
10:30-10:45	**Break**
10:45-11:45	**16. Unsupervised Learning Methods (Worden)** -Outlier analysis -Statistical process control - Projection techniques
11:45-12:45	**17. Data Normalization (Farrar)** -Environmental/operational effects on SHM -Parametric modeling environmental effects -Look-up table technique -Machine learning techniques -Experimental design
12:45-14:00	**Lunch**
14:00-15:00	**18. Software Exercises (Group Instruction)** - Intro to 3-storey data sets - Feature extraction w/ time series models - Outlier detection - Modifying an SHM procedure
15:00-15:15	**Break**
15:15-16:30	**19. SHM System Design I: Optimization (Todd)** -Sensor optimization -Bayesian risk analysis -Detector design -System design framework
16:30-17:00	**20. Closing Remarks and Survey (Farrar)** - Recap the statistical pattern recognition paradigm - Fundamental axioms - Other sources of information - Course survey