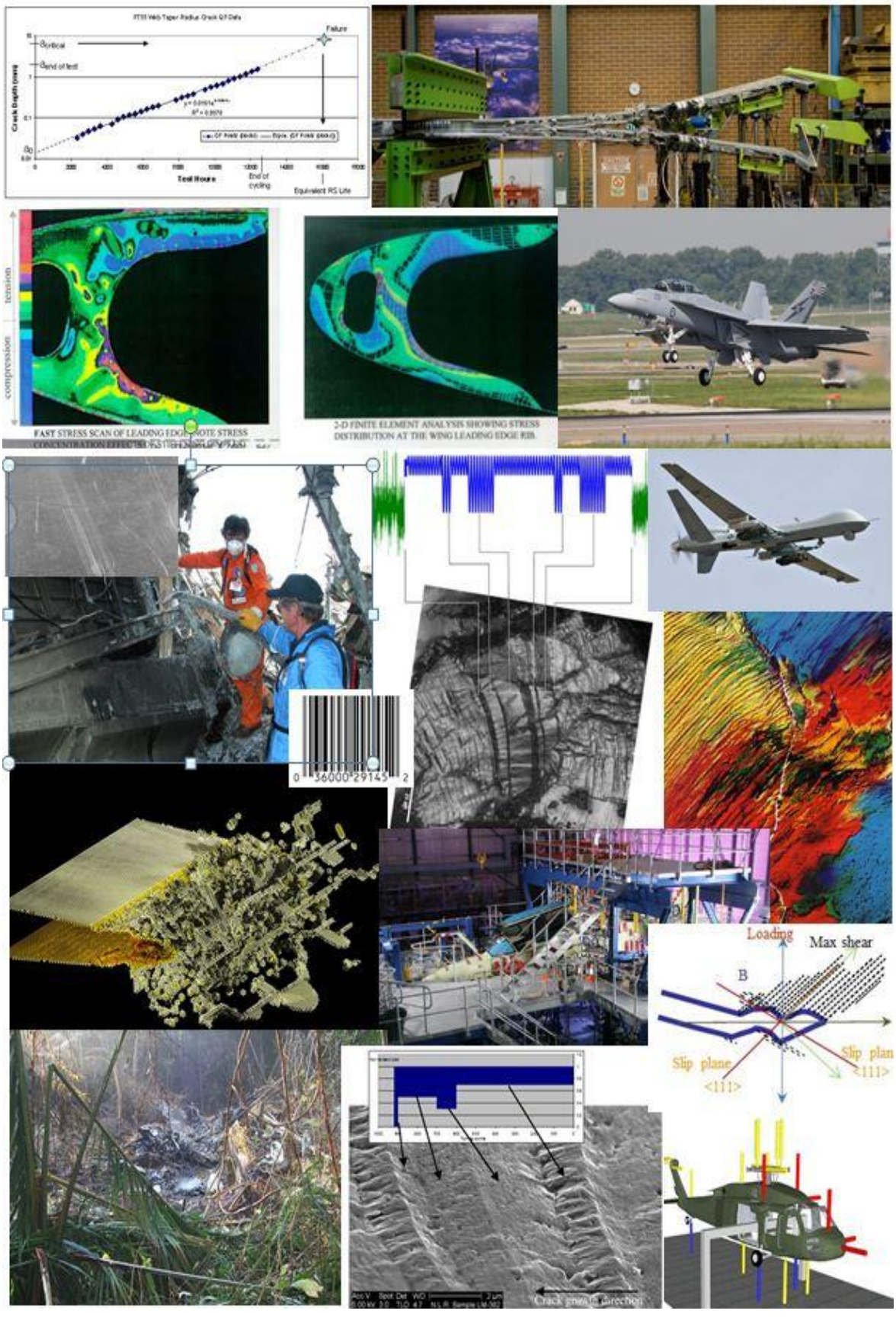
Fatigue Design and Testing of Military Aircraft at Full Scale Course



1.	Introduction & Aims. Who am I?	Overview and aims of the course i.e. the conduct and analyses of aircraft full-scale fatigue tests (FSFTs)
2.	Fatigue design	Covers regulations mandating FSFT of aircraft.
	2.1. Aircraft Structural Integrity Management Plan (ASIMP) over-view	Need for FSFTs
	2.2. Standard practices followed for military aircraft fatigue design (Including required Test Lifetimes, LOV etc). USAF vs UK etc	Primarily UK and USA requirements
	2.3. Scatter in Fatigue. Basis/Methodology for deciding Scatter Factor for fatigue analysis and fatigue testing including the SAFE SN method	What is fatigue scatter? What factors to use in FSFT interpretation
	2.4. Methodology for fatigue life computation using a. Stress analysis results and b. test strain data.	
	2.5. Damage tolerant design	
	2.6. Properties derivation based on similar material compositions e.g. AA2124	
	2.7. Need for coupon Testing	
	2.8. Test Lab, Equipment and NDI	What skills and laboratory equipment required for FSFT
	2.9. Composite fatigue (metal or composite test…)	Differences in FSFT for metal/composites/hybrids
	2.10. Metal-Composite joint fatigue design	
3.	The fatigue story: Classic Accidents and what we have learnt	What have we learnt about what aircraft metal fatigue is from classic air accidents. Here we commence the journey to FSFT interpretation, life extension etc
4.	Test article requirements	Considerations and requirements for choosing a FSFT article
	4.1. Selection criteria for the test article (including symmetry considerations)	
	4.2. Record of concessions / deviations	
	4.3. Sole Operator Programs (SOP) of aircraft parts should be considered for testing at Full Scale, Brackets for loading	What to do when you lose cover from someone else's Lead-the-Fleet protection
	4.4. Extent of instrumentation of test article for fatigue testing	
	4.5. Restraints	

5.	F111 Sole Operator Program (SOP) story	The importance of knowing what to expect before flying beyond established limits
6.	Test Rig design for full scale fatigue testing	FSFT Design “Manual”
	6.1. Examples of Rig Types	
	6.2. Design Requirements and considerations	
	6.3. Whiffle tree design, application of tensile loading on composite skins. Load pad design	
7.	Test spectrum derivation	Considerations for the development of FSFT loads spectra
	7.1. Flight loads (Important: Focus on fighter type aircraft where gust loads are **not** a significant contributor to fatigue)	
	7.2. Consideration of manoeuvre, gust load, Undercarriage, Ground handling loads	
	7.3. Fatigue spectra on different components e.g Brake parachute, Air intake, doors etc	
	7.4. Consideration of environmental aspects on airframe testing	
	7.5. Flight-by-flight fatigue testing methodology	
	7.6. Points-In-The-Sky (PITS)	
	7.7. Flight test requirements	
8.	What is Aircraft Fatigue?	Aircraft are not carefully prepared laboratory specimens
9.	Test loading arrangement	Applying load distributions to FSFT
	9.1. Flight Loads/Distribution	
	9.2. Whiffle tree design, application of tensile loading on composite skins	
	9.3. Choosing optimum number of actuators and its capacity	
	9.4. Ensuring all S. M and T are applied	
	9.5. Approach to account other systems mass/forces on airframe structure	
	9.6. Effect of loading Frequency (covered in Fatigue)	
	9.7. Load and strain. Safety tips	
	9.8. Control surface deflections	
10.	The lead crack framework (introduction in interpreting cracks for lifing purposes)	Summary of conventional fatigue design tools limitations. The foundational Lead Crack method used by the RAAF (Hornet, Pc9, F111 etc) for FSFT interpretation, life extension etc.

11.	Calibration pre-test	The need and means of conducting flight test aircraft calibration for FSFT loads development
	11.1. Strain gauge & Displacement Transducer locations and correlation of test results with the in-flight strain values. Gauge ID. On or off aircraft calibration etc.	
	11.2. Advanced techniques like Digital image correlation, Fiber optics etc	
	11.3. Correlation with analysis	
12.	Introduction to Quantitative Fractography (QF)	QF is a key tool in the analyses of Fatigue (including failures) and the method is briefly described. Data generated through QF was used to develop the CG tools
13.	Test	Test conduct and importance of documentation.
	13.1. Conducting the test, Online/Automatic monitoring aspects	
	13.2. Inspections (type, inaccessible area, periodicity, instruments, inspection cards etc) during the test	
	13.3. Fatigue life clearance strategy for any failures / repairs during test	
	13.4. Repairs – Best practices	
	13.5. Damage tolerance tests	
	13.6. Guidelines to conduct Teardown Inspection	
	13.7. Databases, Notice of Structural Deficiencies (NSDs), Fracto Reports, Defect definitions etc (examples provided)	
14.	The F/A-18 FSFT Program (including buffet test)	Description of the joint Aust/Canadian FSFT of the Hornet aircraft including real-time buffet testing of the aft fuselage
15.	The F/A-18 enhanced Teardown & Life Extension Program	Through teardown comes knowledge. Example of the enhanced teardown of ex-service Hornet centre fuselages. Results subsequently used for life extension program.
16.	Test Interpretation	How to determine FSFT demonstrated lives. Approach for fatigue life extension of military aircraft based on FSFT or Operational Fleet Findings
	Multi-Site Damage considerations (including Limit of Validity (LOV))	

17.	Test Interpretation Tools (Includes the Cubic Rule, Effective Block approach etc.)	The lead crack framework is extended and produces practical lifing tools.
18.	Fatigue Index computation	Aircraft loads monitoring applied to fatigue life usage indices. Individual aircraft fatigue tracking 101.
19.	Choice of Case Studies e.g.: 20.1. Macchi in-flight wing failure 20.2. Pc9 ASIP 20.3. P3C Leading Edge Failure 20.4. P3C QF Example	

There is no available textbook on the issue of FSFT. All materials developed by L. Molent