Non-Destructive Testing (NDT) is the term given to the process of inspection of either a component or structure in which the item being tested is not changed or destroyed. This means that after inspection the item being tested can be used for its originally designed purpose should it not be found to have a fault. As such NDT may be used for the purposes of monitoring quality during manufacture of items such that they may be checked for defects or imperfections, checking fatigue or deterioration of items already in use such as cracking, and assessment of defects where defects are analysed to determine the items suitability to performing the task it was designed for. On this basis, NDT may be seen as a quality management tool, means of failure prevention and mechanism for assuring safety. Just about each and every item of an aircraft can be checked for defects using NDT processes. In aviation its uses are to prevent accidents from occurring, improve reliability of the whole aircraft rather than having the whole fail due to one component or structure failing, provide information about a particular item and determine an item's suitability to the task it has been designed to perform.

There are seven common methods utilised for non destructive testing and the selection of the method depends on the physical properties of the item being tested. These methods are: Visual Inspection, Liquid Penetration Inspection, Acoustic Emission, Magnetic Particle Inspection, Eddy Current Inspection, Ultrasonic Inspection and Radiography. Each of these methods will now be discussed and their applications considered.

Visual Inspection may be used to determine the condition of a welded joint or a component. This process does not require the use of special equipment, however it does require a good knowledge of the component being inspected and quality of a weld. To carry out visual inspection good lighting sources should be used together with good vision on the inspectors part. Magnification equipment may also be used to assist the inspection. The item being inspected should be thoroughly cleaned prior to the inspection and this may include simply wiping the item down with a cloth through to blasting and chemical cleaning. Visual Inspection is a skill which should be regularly practiced by all aviators and builders and can be most enhanced by a knowledge of their machine. Good Visual Inspection can often
prevent costly failure and prevent accidents from happening. This method is suitable for
detection of defects which are visible to the eye, however this is often not the case with many
defects which may occur. As such, other surface and volumetric methods are used to detect
defects which can not readily be seen.

The first of the surface methods is Liquid Penetrant Inspection. This method is applicable in
detection of surface breakage and can be used on any material. The item being tested is
thoroughly cleaned and then coated with a liquid which is drawn into the surface. After
sufficient time has elapsed for the liquid to be drawn into any cracks, the excess liquid is
removed and a second liquid which acts as a developer is applied. The developer draws the
penentrant from the crack which can then be seen. Some penetrants are colored and
require good fluorescent white light to be seen where others require a darkened room with an
ultraviolet light to be seen.

Acoustic Emission Monitoring is another method of NDT which may be used to detect flaws
which may not be seen with the naked eye. This method is useful in testing fibreglass
structures, storage tanks, welds and rotating machinery. An ultrasonic microphone is
attached to the item being tested and the sounds of the item are analysed while placed under
load or in use. The analysis is performed using computer based equipment. The sounds
which are listened for include noise from friction, crack growth, leakage and changes in the
material which may result from corrosion. The equipment picks up sounds which are
inaudible to the human ear and as such can detect minuscule changes. The advantage of
this type of NDT is that the whole structure or component may be tested whilst it is in use.
This means that disassembly time and cost is saved and the process may be used for
ongoing monitoring where applicable.

A method which can be used to find defects on the surface and near the surface in
ferromagnetic materials is that of Magnetic Particle Inspection. This method uses the
application of fine iron particles to the surface of the item being tested with a magnetised
surface. The principle is that the fine iron particles will form along the lines of the magnetic
force from the magnet. These lines will be distorted by flaws and thus the flaws presence will
be revealed. This method is best suited to finding surface flaws but can also locate sub-
surface defects. The ability to detect any sub-surface defects diminishes with the depth of the
defect. There are a number of different ways which the magnetism is applied as there are for
the application of the fine metal particles (wet, dry, in liquid, colored or fluorescent).

The following surface method of non-destructive testing to be outlined is that of Eddy Current
Inspection. This method may only be used on electrically conductive materials. An energised
coil is placed near the surface of the item to be tested which induces eddy currents into the
item. The currents are effected by the physical properties of the item being tested which
include the conductivity, magnetic permeability, thickness, surface and presence of defects. These eddy currents alter the magnetic field of the coil and as a result its impedance. Changes in the property of the component, such as a defect, then alter the impedance of the coil which can be measured. A difference in the impedance implies a fault, such as a crack or void. This method may be used on components or surfaces which are painted or otherwise coated as the coil does not actually need to contact the component being tested. Further, this method may be used to test components of different depths and thickness, and so has many applications in aviation.

There are two volumetric inspections available. The first of these is Ultrasonic Inspection. This process utilises sound waves to measure material thickness. Pulsed beams of high frequency ultrasound from a transducer are used in the item being tested. Any pulse which returns to the transducer is displayed on a screen giving the amplitude and the time taken to return. Any returned sound is generated by a defect and as such, the distance to the defect and its size can be interpreted. The second of these methods is Radiographic Inspection.

Radiographic Inspection uses X-Rays or gamma rays to examine a component or surface. The X-rays are produced using high voltage X-ray machines and gamma rays are produced using radioactive isotopes. The rays are placed close to the item to be tested such that they may pass through it where they are then captured on film. The film is processed and the result is a series of grey shades which will show any defects (as the ray passes through them differently then the surrounding material).

Aside from the above mentioned seven types of NDT, there is also a process referred to as Optical Non-Destructive Testing. This process is suitable for testing items on an aircraft including composite panels, turbine blades and tyres. The inspection is based on the capture and processing of images of a component which is illuminated by laser light. A control image is taken then the component is subjected to a change such as deformation, pressure modification, loading or heating and a second image is taken. A difference image is then generated with information about defects being the result.

In order to carry out NDT, the inspector must possess the relevant operator training, certificates and approvals. The procedure should also be approved by relevant authorities and the equipment used must be correctly maintained and calibrated. The results of the test must be comprehensively reported as should the procedure and format of the test and the testing activity should be subjected to surveillance. Should any of these components not be met, the results of the test should not confidently be considered as accurate, nor legal for that matter. Given these requirements, NDT requirements may be met by organisations who specialise in these services. As an example (one that I bumped into on the internet), Australian NDT Services, Morwell Laboratory, Victoria. They have a public testing service.
and are able to carry out testing using radiographic examination, ultrasonic examination, magnetic particle testing, penetrant testing, eddy current testing and visual inspection of materials using nationally recognised standards.

The Australian Ultralight Federation Inc (AUF) Technical Manual (Issue 2, Section 4.1) points out that all holders of an AUF pilot certificate are "accredited with the minimum qualifications necessary to maintain their own aircraft". AUF pilots are automatically granted this level of accreditation which is referred to as a Level One Maintenance Authority. This means that an owner-operator of an ultralight aircraft is entitled to perform the following maintenance on their own aircraft: Post assembly, daily and scheduled inspection, repairs, modifications, airworthy notice, heavy landing inspection, component overhaul and replacement, engine installation and welded repairs (Issue 2, Section 4.0 Annex A) so long as the aircraft is not used for hire and reward. The use of NDT provides a useful tool for owners of aircraft to use to ensure the safety of the machine they fly and the major objective of this article was to point out the various methods of NDT available for that purpose.

The major sources of information for this article have been: the Non Destructive Testing Association of New Zealand whose web site can be found at www.winzurf.co.nz/ndta/; the National NDT Centre in UK, who can be found on the web at www.aeat.co.uk/ndt/eddy/eddy.html; Australian NDT Services, Morwell Laboratory, information about which can be found at www.crnet.com.au/services/testing/00/25/29.html; AOS Technology Ltd, UK; Materials Engineering (UK) Ltd, UK, whose web site is www.meg.co.uk/meg/app09.htm. Each of the references mentioned here contains more information about NDT than is described by this article and those of you who are interested in further information and with internet access should pay them a visit, likewise follow the links to other sites they may provide.

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