Textile conservation case study
– the Victory sail

In 1805 HMS Victory was the flagship of Admiral Nelson's fleet as he led the Navy to victory in the Battle of Trafalgar.

The ship had many sails but only one of them has survived. It was badly damaged during the battle and has many holes in it from cannon balls and other gun fire. This extensive damage is probably the reason the sail has survived – the other sails were almost certainly cut up and re-used in other ships. Not only is this sail the only surviving one from HMS Victory, it is probably the only remaining sail from the entire fleet.

A picture does not really get across the enormous size of the sail. It is 24 m x 17 m and weighs over half a tonne. It would have been made by hand by experienced sail makers and probably took about 1200 man hours to stitch. It is made of linen, which is a cellulose fibre that comes from the flax plant.

The sail has not always received the treatment and respect that might be expected for such an important relic. It was made in 1803 and went into service on HMS Victory. It remained on HMS Victory until the ship returned for repairs after the Battle of Trafalgar in 1806. What happened to the sail over the next 85 years is not really known. It was displayed at an exhibition in 1891 and was on board HMS Victory for the centenary celebrations of the Battle of Trafalgar in 1905. In 1960 it was discovered in a sail loft in the Navy barracks covered in gym mats. It was returned to the ship to be displayed in a glass cabinet in 1962 then left the ship for good in 1993, when it was found that the sail was deteriorating rapidly and needed urgent conservation work.

The sail was first carefully inspected and documented. Several photographs were taken, along with video footage. The whole sail was mapped and diagrams were drawn. These records will help future historians and conservationists know what was done to the sail at this time.

The conservators need to understand the chemistry of the linen the sail is made of so that they can decide how best to assess and treat it.

After the documentation, the sail was thoroughly vacuumed.
Some fabrics can be washed to remove problem substances like acids, which are formed by the breakdown of the polymer chains that make up the fibres of the fabric. However, washing causes a lot of damage to very old linen so it is not a possible treatment for the Victory sail.

Conservators do not have to rely only on the observations they can make by eye to decide how best to treat an object. As part of the celebrations of the bicentenary of the Battle of Trafalgar, the Navy would have liked to hang the Victory sail in public view once more. However, they did not wish to damage it further so they needed to find out whether the fabric was strong enough to hold its own weight. They did not want it to break when they hung it up. They needed to test the fibres – but if they did so they could have damaged the sail. This is a problem with many objects that conservators work on.

Dr Paul Wyeth and Dr Paul Garside at the Textile Conservation Centre in Winchester have been working on this problem. They are developing ways to assess damage to fibres by using non-invasive and non-destructive tests. They are using infrared spectroscopy to look at how textiles change as they get damaged by age and wear.

**Remember**
Alcohol groups in the linen structure can be oxidised by oxygen in the air to form carboxylic acid groups:

IR (infrared) spectra of new linen and the linen from the Victory sail are shown below.
The top plot is from new linen sailcloth and the middle one is from the Victory sail linen. The bottom plot is done by a computer – it is the Victory sail spectrum minus the new linen one.

The bottom plot shows the differences between the linen from the Victory sail and new linen. By looking at this spectrum it is possible to see how the sail has changed and been damaged with time. The two bands at 2930 cm\(^{-1}\) and 2850 cm\(^{-1}\) show that the canvas has gained some oils or waxes that were not originally present in the sail.

Spectra reproduced with kind permission from P. Wyeth, Textiles Conservation Centre, Winchester Campus, Southampton University
Questions

1. Why was it important to vacuum the sail?

2. Mark and label the bands 2850 cm⁻¹ and 2930 cm⁻¹ showing oils on a copy of the spectra. The difference spectrum (the one at the bottom) has a band at 1720 cm⁻¹. This is typical of a carbonyl group, C=O.

3. Mark and label this band on the spectrum. Explain how the presence of this band supports the idea that the linen from the sail has been oxidised.

4. Does this band confirm that the reaction shown in the equation has occurred? Explain your answer.

5. How can information from IR spectra like these help textile conservators to determine the extent to which linen textiles have been damaged?