

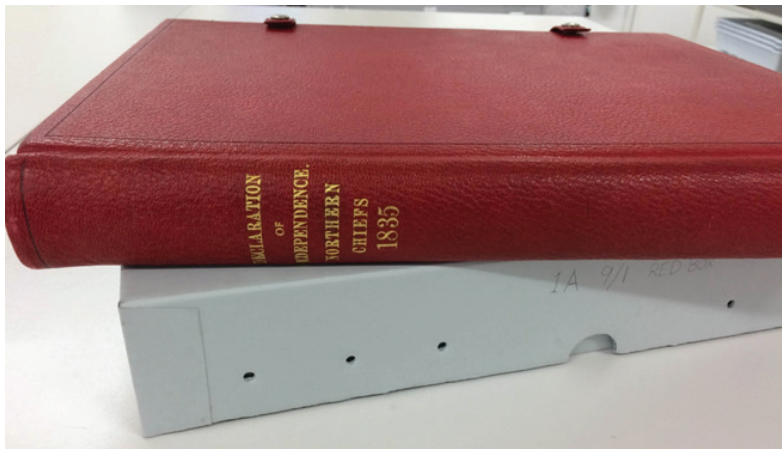
# Plastic Fantastic in the Archives!

## An investigation into the plastic used in 1930s leather-bound enclosures

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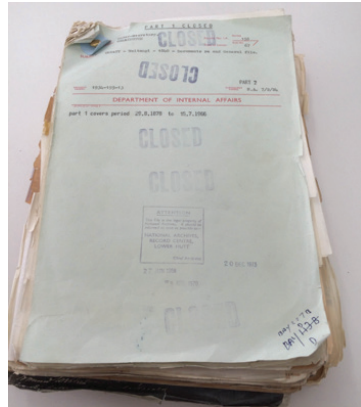
This article is adapted from a lightning talk presented on 16 December, 2016 at the New Zealand Conservators of Cultural Materials Conference, Wellington 17-19 October, 2016.



Published in 2009, Eugenie Samuel Reich's *Plastic Fantastic: How the Biggest Fraud in Physics Shook the Scientific World* exposes a physicist who wilfully deceived the science community. Jan Hendrik Schön fabricated scientific results, duping many of the world's top scientific journals and experts, including Nobel Prize-Winners.

What is the somewhat tenuous connection of this book with my research? You will see that I have been dealing with a similar dearth of substantiated facts, starting with some misleading information in the innocuous-sounding Department of Internal Affairs file 'IA1 158/67' [ACGO 8333 W896 IA1 Box 3001/ 158/67](see Figure 1).<sup>1</sup>

Figure 1: Miscellaneous – Treaty Waitangi documents and general file ACGO 8333 W896 IA1 Box 3001/ 158/67.



Some background first. Throughout 2015 and 2016, in preparation for the He Tohu exhibition, Peter Whitehead, Vicki-Anne Heikell and myself collected information to develop conservation and preservation management plans for the constitutional documents going on display:

- Te Tiriti o Waitangi /Treaty of Waitangi<sup>2</sup>
- He Whakaputanga o te Rangatiratanga o Nu Tirenī (1835 Declaration of Independence)<sup>3</sup>
- 1893 Women’s Suffrage Petition (Te Petihana Whakamana Pōti Wāhine)<sup>4</sup>

Historical data about previous storage conditions and treatments is important to inform our understanding of what happened in the past, and what we can do in the future. The file ‘IA1 158/67’ had information about the storage and conservation of He Whakaputanga. It mentioned the planned use of “non-inflammable celluloid” or “non-inflammable cellophane” loose-leaf sleeves held within leather storage boxes.

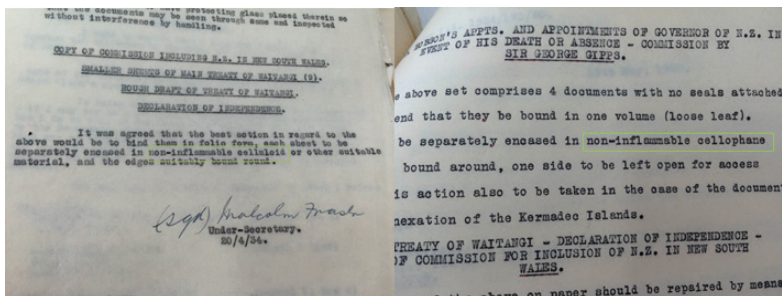


Figure 2: He Whakaputanga storage information from IA1 158/67.  
[Ref. ACGO 8333 W896 IA1 Box 3001/ 158/67]

In March 2016, I coincidentally discovered three red leather-bound boxes in the Lab store room. These contained sleeves; two were empty of records and only held sleeves, the third had documents stored in it. Of the two empty boxes, one had sleeves so seriously degraded that they were barely recognisable as sleeves (Figures 1 and 2). This was the box for IA9/10, the Draft of the Treaty of Waitangi [ref: ACGO 8341 IA9 Box 9/10 Sep 617] (see Appendix A).<sup>5</sup>



Figure 3: Scorched box and degraded sleeves found in the former 'Draft of the Treaty of Waitangi' enclosure.

The IA9/10 box looked scorched and blackened around the edges and on the inside of the lid, which was a cause for alarm. I thought it prudent to check around the Archives to see if there were any more, and if they were in a similar state.

We found many more similar leather-bound boxes in the Object store room (below), including one entitled "Declaration of Independence" [He Whakaputanga]<sup>6</sup> (AAAC 6248 W292 Sep 618). This container included two empty sleeves of the same thick, yellowing plastic as the others, but intact.



Figure 4: Leather-bound boxes found in an Archives New Zealand Object Room.



Figure 5: The leather-bound box and sleeves that once contained He Whakaputanga.



Figure 6: Yellowing plastic sleeves from the He Whakaputanga box.

Ah-ha, so is this the box referred to in file 'IA1 158/67', supposedly made with non-flammable celluloid or cellophane? But what about the identical box which had scorch marks? It didn't seem to make sense. We therefore embarked rather hurriedly on a programme of risk management, in regards to there being potentially flammable plastic sleeves in the storage areas.



Figure 7: Degraded plastic sleeves.

First, we removed all the sleeves from the boxes in the Object Store. The sleeves of all boxes were intact, except one. This one (shown above) had degraded like the contents of our scorched box. However unlike that one, there was no scorching to be seen on the box edges and lid.

Once removed from the store, we retained the sleeves in a portfolio for appropriate disposal. With wanting to retain the He Whakaputanga box complete, with including its, as yet intact sleeves, for documentation and historic reasons, it became important to know exactly what we were dealing with.

We had a few options. We could carry out a float test, a burn test, and Fourier Transform Infrared (FTIR analysis). With help from our conservator colleagues at the Alexander Turnbull Library, we tried the float test. This can help to distinguish between the three plastics commonly found in archives; cellulose acetate, cellulose nitrate and biaxially-oriented polyethylene terephthalate, otherwise known as polyester!

Samples of sleeve from the scorched box were placed in trichloroethylene, and they floated, which indicated that it was cellulose acetate. At the same time the test was carried out with a sample known to be cellulose nitrate film. This was tested, and sank. So, from this we may deduce that our sample was indeed cellulose acetate.

I had already tried a burn test, (in my fireplace at home as I didn't want to burn the archives down...). I found the sleeve plastic burned extremely brightly and fiercely, even burning downwards, but readily extinguished when I placed it in a cup of water. I also burnt a known acetate film sample and this was much more reluctant to burn and would not burn downwards.

From the inconclusive results of the float and burn tests, I decided we needed a definitive answer through FTIR testing. FTIR, or Fourier

transform infrared, the preferred method of infrared spectroscopy. When infrared radiation is passed through a sample, some radiation is absorbed by the sample and some passes through, is transmitted. The resulting signal at the detector is a spectrum representing a molecular 'fingerprint' of the sample. The usefulness of infrared spectroscopy arises because different chemical structures (molecules) produce different spectral fingerprints.

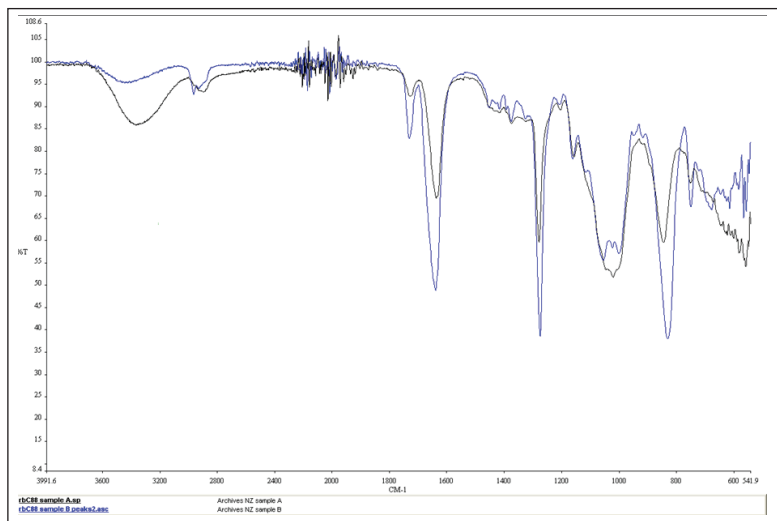


Table 1: FTIR spectra of samples A and B overlaid

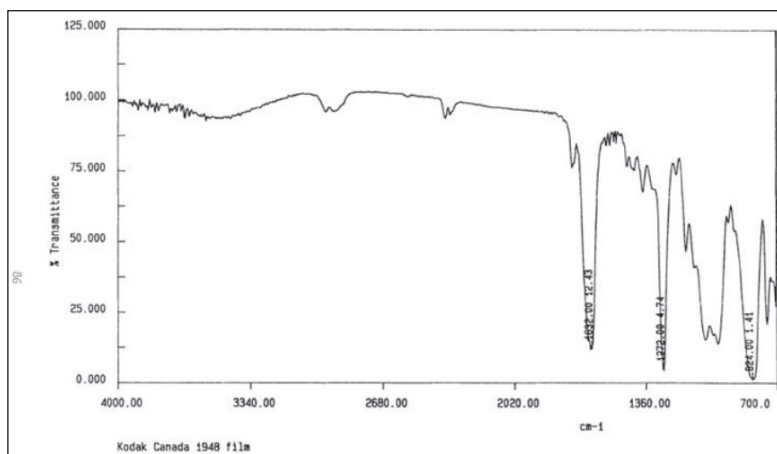


Table 2: Example of cellulose nitrate FTIR spectrum from the literature

The FTIR testing was done off-site by Callaghan Innovation, and the results were surprisingly straightforward. They tested two samples of the sleeve material, one from the Rough Draft of the Treaty of Waitangi box, the scorched box, (Sample A), and the other from the intact He Whakaputanga box (Sample B). The test can identify peaks corresponding to the chemical composition of a material and in this case, even with slight differences between the two samples, both spectra showed characteristic nitrate peaks.

The difference between the two was explained by the fact that the burnt sample had exhibited a loss of nitrate on degradation, so its spectra was less intense. Cellulose nitrate degrades to produce acidic and oxidizing nitrogen oxide gases (including nitrous oxide, nitric oxide, and nitrogen dioxide). It was the release of these acidic gases that had caused the scorching on the box.

In the literature we have clear guidelines how to store cellulose nitrate material, and knowledge of what temperatures it can auto-ignite at. Research from the Canadian Conservation Institute (CCI), titled 'Display and Storage of Museum Objects containing Cellulose Nitrate', gives an explanation why our degraded sleeves are in their current state. The report states:

“high concentrations of these gases build up that can embrittle and accelerate degradation of objects. In photographic film and objects in thin cross-section, the problem is less acute because the gases diffuse out of the object quickly and can be vented away. For objects of thick cross-section, diffusion is much slower. The gases are trapped for longer periods and have a greater chance to catalyse degradation. A vicious circle forms: faster decomposition increases the concentrations of nitrogen oxide gases, which in turn increases the rate of decomposition. The accompanying heating of the object can cause spontaneous ignition.”<sup>7</sup>

The sleeves were around 500microns thick, much thicker than photographic film which is about 150 microns.

The CCI also noted that “foul odours come from the nitrogen oxide gases.”<sup>8</sup> There was an unpleasant smell coming from our sleeves in question.

Our investigation results were supported by the science, so all in all I am happy that we have our diagnosis and cause for the current degraded state.

Finally, a note on future storage of the sleeves, back to the CCI report:

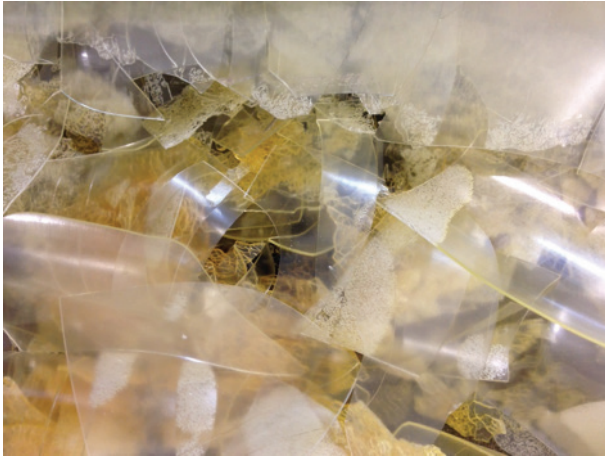


Figure 8: Detail of the degraded Cellulose Nitrate sleeves.

“the changes mentioned are accompanied by progressive decreases in auto-ignition temperatures”. Fresh, undegraded cellulose nitrate auto-ignites (or self-combusts) at 150°C, whereas the powdery or foamy mass of cellulose nitrate in the last stages of decomposition can auto-ignite at temperatures as low as 50°C. This temperature can easily be reached near light bulbs, radiators, attics in summer, etc.”

In our case, we are now storing the remaining box containing intact sleeves, the He Whakapūtanga box, safely in our cold stores. And the disposal of the cleared-out sleeves languishing in the portfolio? – well, we tasked our friendly neighbourhood Army guys to take them away for “disposal”, that is, maybe for setting fire to them or blowing them up!

So to conclude, it was a happy chance that we found the reference to the “non-inflammable celluloid” in file ‘IA/9 158/67’ when we did, and that the first three boxes presented themselves to us when they did. As a conservator you do question what you are told, and investigation is an exciting part of the job. We were able to extricate ourselves from the misleading statements of the past, and the misleading initial test results.

I will never be a Nobel Prize winner, but I am happy that our plastic fantastic story has a transparent ending!

### Acknowledgements

Past and present staff of Archives New Zealand and Alexander Turnbull Library.

Images courtesy of Anna Whitehead

### PostScript

New information added in Dec 2016:

A photograph of archivist Ken Scadden holding the Rough Draft of the Treaty of Waitangi box came to light in November 2016. This was either taken or published in the Evening Post on 9/7/1988.



Figure 8: Ken Scadden with Drafts of the Treaty of Waitangi (Te Tiriti o Waitangi), Evening Post Collection, Alexander Turnbull Library. Ref. EP/1988/27443.<sup>9</sup>

This means this badly deteriorated box was still intact in 1988. One can only wonder at the circumstances that have led to the accelerated degradation to the degree we now see today.

In email correspondence with Jonathan London [former preservation manager, Archives New Zealand], he commented: “the Declaration of Independence – this may have been one of a suite of documents that were, until about 1989/1990 housed in leather-covered boxes made by the Govt printing Office back in the 50s/60s?, with post binding holding clear PVC pages in which were housed the smaller documents. I remember documents being removed from these as the PVC had become brittle and

discoloured. I don't remember any repairs being undertaken".<sup>10</sup>

This is useful information, especially about the dates of removing documents from the sleeves, as well as the reference to repairs.

#### Endnotes

1. Archives New Zealand (1967). *Miscellaneous – Treaty Waitangi documents and general file*. ACGO 8333 W896 IA1 Box 3001/ 158/67.
2. Archives New Zealand (1840). *Te Tiriti o Waitangi/Treaty of Waitangi*. ACGO 8341 IA9 Box 8, Sheets 1-9.
3. Archives New Zealand (1835). *He Whakaputanga o te Rangatiratanga o Nu Tirenī* [The Declaration of Independence of the United Tribes of New Zealand, Made to the British Resident in New Zealand on 28 October 1835 – Signed Manuscript]. AAAC 6248 W292 IA9/1
4. Archives New Zealand (1893). *1893 Women's Suffrage Petition [Te Petihana Whakamana Pōti Wahine]*. ABKH 7366 W4437 NF431, Sheets 1 – 549.
5. Archives New Zealand (1804? – 1845?). *Drafts of the Treaty of Waitangi, most of it in Busby's hand – Registered as 45/522 in the Protector of Aborigines Department*. ACGO 8341 IA9 Box 9/10 SEP 617.
6. AAAC 6248 W292 SEP 618
7. Williams, R. S. (1994) Display and Storage of Museum Objects containing Cellulose Nitrate. *CCI Notes*. Canadian Conservation Institute.
8. *Ibid*
9. Alexander Turnbull Library (1988). *Evening Post Collection*. EP/1988/2744.
10. London, Jonathan (7 October, 1916) Email correspondence with Anna Whitehouse.

#### References

- Ibid*.
- Alexander Turnbull Library (1988). *Evening Post Collection*. EP/1988/2744.
- London, Jonathan (7 October, 1916) Email correspondence with Anna Whitehouse.
- Reich, E. S. (2009). *Plastic Fantastic: How the Biggest Fraud in Physics Shook the Scientific World*. St Martin's Press, New York.