

# Restoration of Musical Organs: Analysis of Rubber Cloth and Other Historical Materials

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## Introduction

### Background

Musical organ conservation has historically been done by instrument mechanics, but restoration increasingly necessitates a background in materials and chemistry. Conservation has become more specialized and often research must be done into individual objects. Thus, in depth analysis is required for period accurate restoration.

### Motivation

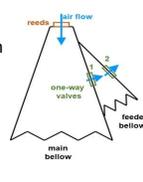
Over time, bellows rubber cloth has changed in structure, manufacturing, and performance. Techniques in materials analysis can identify and support more culturally aware restoration. Furthermore, it provides insight into the manufacturing and repair of musical organs.

### Objective

The purpose of this project is to mechanically restore a Beckwith reed organ from ca. 1908 and analyze the rubber cloth and adhesives for the organ while preserving the cultural heritage.



[1] 1908 advertisement for a Beckwith reed organ



## Experimental Details

### Scanning Electron Microscopy (SEM)

- Produces an image from backscattered electrons
- Provides visualization of material microstructure

### Energy Dispersive X-Ray Spectroscopy (EDS)

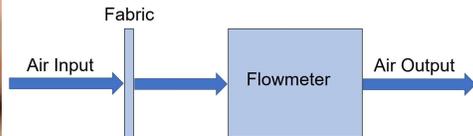
- Identifies heavy inorganic elements
- Detects additives from historical manufacturing

### Fourier Transform Infrared Spectroscopy (FTIR)

- Scans material with infrared light
- Identifies organic compounds for comparison of original and replacement materials

### Permeability

- Evaluates the ability of the rubber cloths to maintain pressure

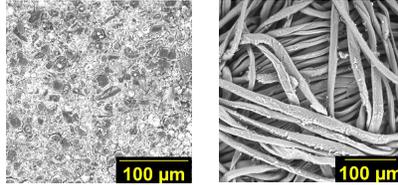


## Results & Discussion

### Optical Images of Bellows Rubber Cloth



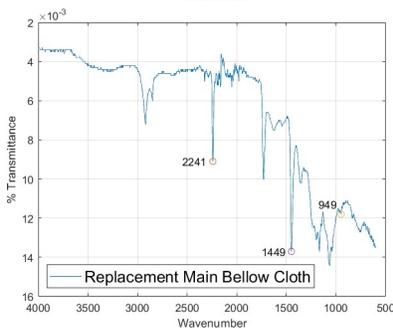
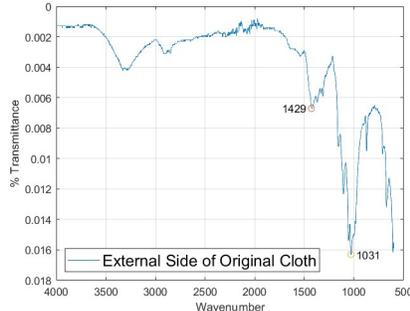
### SEM Micrographs of Bellows Rubber Cloth



### EDS: Bellows Rubber Cloth

Scans of the original cloth displayed lead (Pb) and antimony (Sb). These elements were used as catalysts in the historical rubber making process. Scans of the replacement cloth showed only the expected organic elements.

### FTIR: Bellows Rubber Cloth



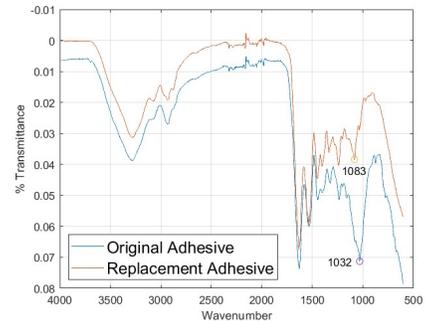
The original cloth contains isoprene, a common component of natural rubbers sourced from the gutta-percha tree. The replacement cloth shows peaks at 1438 and 950, which indicates the presence of vinyl. There is also a peak near 2290, which indicates nitrile.

## Discussion

### Permeability: Bellows Rubber Cloth

The original bellows cloth lets much more air through, 18 times more, than the replacement cloth.

### Adhesives Analysis



The original and replacement adhesives are similar; both are glues derived from animal proteins. The major difference is that the original has a larger peak near 1072, showing higher levels of aliphatic amines. Aliphatic amines are additives used to improve the curing properties.

## Conclusion



### Conclusion

In a single semester, the organ was successfully restored to a playable condition. Key to the restoration, the bellows were refurbished. The deteriorating original cloth was replaced with available modern materials. Analysis of the original cloth found lead and antimony and should not be reproduced given contemporary safety standards. The replacement cloth showed PVC and nitrile structures, meaning it should not be left near uncured PVC glue. The replacement cloth is significantly less permeable than the original and is well suited for mechanical restorations of organs. The glue used to apply the replacement rubber cloth is nearly identical to the original hide glue from the organ. This project demonstrates that materials analysis has a critical role to play for mechanical, cultural, and aesthetic instrument restoration.

### Acknowledgements

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### References

[1] R. C. Sears. *Beckwith Organ Catalog*, Sears, Roebuck & Company, Chicago, circa 1908, p. 51.



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