THE WINSTON CHURCHILL MEMORIAL TRUST

CHURCHILL FELLOWSHIP 2003

ADVANCE TRAINING IN GLASS OCULAR PROSTHETIC TECHNIQUES
WITH PARTICULAR EMPHASIS ON COLOUR MATCHING

‘FACIAL HARMONY IS IN THE EYE OF THE BEHOLDER’

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Signed : Paul McClarin Dated : 15 March 2004
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1. PRECIS AND ACKNOWLEDGEMENTS

This report details the findings from a 2003 Churchill Fellowship visit to Germany for advanced training in glass ocular prosthetic techniques with particular emphasis on colour matching. Specific techniques studied include:

- Production of prosthesis; to form a normal appearance of the bulbus (eyeball) iris and lid.
- Special pathological features pertaining to the colour matching within the iris.
- The new technique of mixing a range of colours for the diversity of colour in the iris.
- Overcoming problems due to complications of the orbit.

As the only Glass Ocularist in Australia, this trip to Germany allowed me the opportunity to upgrade my skills and expertise. The invaluable training, experiences and interaction with the people I met would not have been possible without;

- the financial assistance given to me by The Winston Churchill Memorial Trust that enabled me to have hands on experience for ten weeks with a Master Ocularist.
- the invitation from Mr. F. Müller-Uri to attend an advanced training course on glass ocular prosthesis
- the willingness shown by other German eye makers to extend their professional expertise through information, training and assistance in everyway possible.
- The assistance of Mr. Frank Müller-Uri and Mr. Stefan Birke in helping me to obtain extremely rare and specialised equipment:

The welcome I received from the management and staff of glass factory ‘Farbglashütte’ Lauscha, and their interest in the Churchill Fellowship helped open many doors. Many thanks go to Mr. René Seiffirth for his invaluable help given to me in choosing and picking the glass I required from such a vast range produced in the factory, and also to Ms Susanne Todt for all her help both as a tour guide for me through the factory and for providing much information and history about the manufacturing processes and procedures of the glass works.

I am also indebted to the love, support and encouragement of my wife Margaret who accompanied me to Germany for two weeks and the many telephone calls I received from my daughters Caroline and Pauline during my time away from home.
2. EXECUTIVE SUMMARY

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Fellowship objective:
Intensive study of latest techniques for the manufacture and fitting of glass ocular prosthesis, with particular emphasis on colour matching, pattern definition with the remaining natural eye, and contour adjustment to the human eye socket.

Fellowship highlights:
1. Advance Training Course on Glass Ocular Prostheses – a ten week course participating and studying under Mr. Frank Müller-Uri a Master Craftsman with glass ocular prosthetics in Lauscha Germany.

2. Travelling to Various Clinics – Invited to travel with Mr. Frank Müller-Uri to visit several clinics to watch him attend to clients.

3. Working with other Ocularists – Learning different techniques from each of the other glass-eye makers, as each had their own particular style of working.

4. Individual Eyemakers – Invited to work with Mr. Tobis Müller-Uri and Mr. Stefan Birke in their workrooms. They were very helpful and willing to share many ‘Trade Secrets’

4. Glass Factory – I was given an extensive tour of the Farbglashütte (glass factory) and shown the full production process.

Findings:
The ‘art’ of glass eye making is a very productive industry in Germany with many apprentices still seeking to master this age-old craft. My findings included :-

- Various unique processes of mixing and twisting of coloured glass rods
- The comparative differences between the surface of the glass ocular prosthesis and the acrylic prosthesis.
- Ophthalmologists need to be aware of the problems caused by the acrylic prosthesis to the eye socket and to ensure patients are not subjected to unnecessary discomfort. Glass is inert and causes little or no problems.
- Possibility of sharing at a future Ophthalmology conference.
3. PROGRAMME

Germany / Lauscha             13 October – 18 December 2003

• Advance training seminar:

10 week intensive study of latest techniques for the manufacture and fitting of glass ocular prosthesis, with supervised practical work and training under the guidance of Mr. Frank Müller-Uri a Master Ocularist.

• Working with other Ocularists:

a) Studying and working with Mr. Tobis Müller-Uri from Ulm
b) Studying and working with Mr. Stefan Birke from Newhaus.

• Visitation to eye clinics

a) Weisbaden 23-24 October
b) Ausburg 27-31 October
c) Halle 25-27 November
d) Chemnitz 28 November
e) Gera Meiningen 10-11 November

• Farbglashütte (Glass Factory) – frequent visits to observe and study production techniques, methods and processes.
Egyptian and Mesopotamian statues dating back to the 5th – 4th century BC were discovered by archaeologists to have eyes made of shiny ceramic type stones, indicating the use of artificial eyes has been around for “centuries”.

Lauscha is a small town with a population today of approximately 4,000 people situated 3,000 feet above sea level, high in the Thuringian Mountains. Glassblowing Monks found the wood in the Thuringian forest, needed to fuel the furnaces and to produce potash, and in the ground there was available the right type of glass sand. Discoveries from diggings and documents proved that glass houses had been found in these mountains since the 12th century. In the 16th century the glassworks in the forest developed into settlements and villages.

In 1597 the Duke of Saxony – Coberg granted to Hans Greiner and Christoph Müller the concession to build a glassworks in the valley of the small stream of Lauscha.

The sons of the two families soon founded new glass works and the glass industry developed into a stable factor of economy. People said, “The colours of Greiner are the best ones!”.

Ludwig Adolf Müller, Lauscha/ Thüringen

Founder of the eye making art in Germany and inventor of the "Reform eye"
The 17th century saw the glassblowers beginning to paint and decorate the blown ball with bright colours, symbols, and religious motifs, and also to cut and engrave the surface with fine detail.

Coloured pearls were the first shapes to be blown in front of a glassblowing lamp at the beginning of the 18th century.

In 1832 Ludwig Müller – Uri made the first medical Glass Eye for patients, the forerunner of what we know them to be today - and so a whole new industry began.

### 4.1 Farbglashütte and the Technology of Glass

Glass has been produced in Lauscha since 1597. Today’s master craftsmen are immensely proud of their high level of skill and production methods developed and finely honed over the last 400 years.

Founders Elias Greiner Vetter’s Sohn and his son Septimus, had a high and special knowledge about the production of colours. They opened the glass factory in 1853 and until 1972 the Farbglashütte was owned and run by family members of the founders. From then until 1990 the company was nationally owned as a result of political and economic restrictions of the DDR Government. It was renamed “VEB Farbglaswerk Lauscha”.

Today the “Fabglasshütte Lausch” as the name suggests, produces a great variety of coloured glasses not only tubes and rods for making the glass eyes, but also glass necessary for the manufacturing of their other products e.g. Christmas balls, domestic glassware and decorations, which are renowned world wide.

**Production of the glass**

The glass mixtures are melted over night to about 1420deg C. This process takes some 12 hours so that when the glassworkers arrive in the morning, the mixture is approximately 1200 deg C, the best temperature for working with the molten glass.

The glass tubes are drawn in 40 meter lengths, and then cut into more manageable sizes about one metre long. About 15 – 20 “drawings” take place in one day, before a new batch of glass is made ready for the workers the next morning.

Each batch of glass will invariably have some different characteristics due to the make up of the chemical composition, and so the eye maker must take some samples of the tubes and try them. When they feel they have a good working glass tube that suits their style of work, they will then purchase stock of that tubing. The coloured rods and crystal glass must also be tested in the same way before purchasing.

Composition of the glass is made up of three main components. The essential ingredient is sand of quartz (65 – 75%). This is a siliciumdioxide or silicate. On its own, the melting point of silica is very high and so the composition needs an alkali (10 - 20%) namely bicarbonate of soda or potash to liquefy and to reduce the melting point. The natural alcalis, like limestone and magnesium a.s.o., ensure the strength and durability of the glass. These are ground into powder, mixed together and melted in the furnace for about 15 hours at 1200 – 1600deg C. The composition of the raw materials can vary and the mixture influences the chemical and physical properties of the glass. Glass is viscous, and in the standard temperature, is in a state of a solidified liquid.
**Colouring of the glass:**

Glass dissolves metals at high temperatures, and these oxides make the colouring of glass possible.

For example:

<table>
<thead>
<tr>
<th>METALS</th>
<th>COLOURS OBTAINED</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iron</td>
<td>Green</td>
</tr>
<tr>
<td>Copper</td>
<td>Red</td>
</tr>
<tr>
<td>Cobalt</td>
<td>Blue</td>
</tr>
<tr>
<td>Chrome</td>
<td>Yellow</td>
</tr>
<tr>
<td>Gold</td>
<td>Pink</td>
</tr>
<tr>
<td>Silver</td>
<td>Yellow</td>
</tr>
<tr>
<td>Selenium</td>
<td>Pink</td>
</tr>
<tr>
<td>Antimony</td>
<td>Brown</td>
</tr>
<tr>
<td>Manganese</td>
<td>Violet</td>
</tr>
</tbody>
</table>

This process has been developed over the years with unique colours being manufactured. These colours are the very essence for the Iris colouring of ocular prostheses.
4.2 Glass and Acrylic

There are the two main types of artificial eyes used today for fitting into the socket:

- **glass eye** --- natural substance -- cryolith (surface hygroscopic -- retains natural eye fluids)
- **acrylic eye** --- synthetic material -- PMMA (surface is water repellant)

Bernd Schreiner (Augenprothetik) from the Institute for Artificial Eyes, shows the comparisons between the two materials and compares the retention of fluid on the artificial eyes. This is critical to the comfort of the wearer. In the diagrams below he shows how a drop of fluid reacts over both surfaces.

**Acrylic Eye**

| The acrylic rejects the drop. | On the acrylic surface (which does not get covered by the tears) it comes to a formation of drops. | By the prosthesis of acrylic material an interruption of the tear fluid can occur. The liquid forms drops. These can irritate the lids and can lead to inflammation. |

**Glass eye**

| The fluidity on the glass surface (which can be covered by the tears) is quite natural. | The liquid dispenses itself evenly over the glass surface. | In the case of the artificial eye of special glass, there is always an even distribution of the liquid covering the surface. The tear fluid acts as a gliding film between lids and prosthesis. |
In the photographs below Bernd Schreiner also describes the surface difference between the glass and acrylic substances under an Electron microscope.

The Two Surfaces Under the Electron Microscope

<table>
<thead>
<tr>
<th>Special Glass (cryolith)</th>
<th>Acrylic Material (PMMA)</th>
</tr>
</thead>
</table>
| **Unworn Eye of Special glass:**
The fire polished surface appears more smooth also with extreme enlargement. (Notice the 25-fold stronger enlargement opposite in the other pictures) | **Unworn artificial eye of acrylic material:**
Additionally to the surface defects, there are also recognisable parallel dispersed scratches (for these prostheses typical). These are produced at the last stage of manufacture, at the polishing. |
| **Artificial eye of special glass: 1 year wearing time**
Scratches from inferior depth and expansion, dispersed into different directions are recognisable. | **Artificial eye of acrylic material: 1 year wearing time**
Many defects, with up to 150µms, are recognisable, which makes this prosthesis comparable to a microscopic “grater”. |

4.3 Implants

In a paper presented to the German Ophthalmological Society in Berlin, Prof. Christoph Hintschich M.D. of the Eye Clinic at Ludwig Maximilian University in Munich stated that following a questionnaire many ocularists recommended an orbital implant be inserted in the socket after enucleation. The most preferred type by the German Ocularists was the demofat graft but as an orbital implant this is rarely used, so the “baseball” implant was the second choice.

The Ocularists were all unanimous about the need for orbital implants but they must not be too big – no larger than 18mm in diameter: and they all totally rejected the “peg implant”. However the ocularists did show some scepticism regarding the long term effects of the implant. They stated that some orbital implants had a tendency to migrate from their original position and also showed concern for secondary corrective surgery as there was not always an improvement following a secondary implant. They stated that it would be better to have no secondary implant once an implant had been rejected as they believed that the risks were too high and pointed to the importance of the lower fornix and the condition of the conjunctiva.
**5. TEN WEEK INTENSIVE TRAINING**

Mr. Frank. Müller-Uri a Master on Glass Ocular Prosthetic manufacturing invited me to attend his advanced training seminar concerning new work techniques to be held from October to December. This invitation was both an honour and a privilege to be able to work with one of Europe's Masters in this field of ocular prosthetic making.

I attended Mr. Frank Müller-Uri’s factory in Lauscha where I had hands on experience under his supervision. This training has been an invaluable source of information. The finer points demonstrated and taught included the reproduction of normal, abnormal and pathological appearance of the eyeball, iris and lids, and advanced forms and shapes forfitting the more difficult sockets, especially those with complications of the orbit and adnexa (adnex'a oc'u'li – accessory organs of the eye) due to disease or injuries.

The specialised techniques for the manufacturing of the ‘base’ colours and the ‘coloured twists’ required for the stroma formation of the iris have all been upgraded. I was given instruction and the opportunity to practise these new techniques, avoiding any difficulties that might have arisen when I came back to Australia.

### 5.1 Work Plan

**Lauscha Germany**

**October - December 2003**

1. Hot forming of glass  
(special technology)

<table>
<thead>
<tr>
<th>1.1 Reproduction of normal, abnormal and pathological appearance of the bulbus (eyeball), iris and lids</th>
<th>a) size of iris and pupils of the eye</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>- macro cornea (iris more than 12 mm)</td>
</tr>
<tr>
<td></td>
<td>- micro cornea (iris less then 10 mm)</td>
</tr>
<tr>
<td></td>
<td>- Miosis pupil (abnormally small)</td>
</tr>
<tr>
<td></td>
<td>- Mydriasis pupil (abnormally large)</td>
</tr>
<tr>
<td></td>
<td>b) pathological features of the iris</td>
</tr>
<tr>
<td></td>
<td>- extraordinary colours</td>
</tr>
<tr>
<td></td>
<td>- heterochromy (different colours)</td>
</tr>
<tr>
<td></td>
<td>- unusual pigmentation</td>
</tr>
<tr>
<td></td>
<td>- colombom of the iris (defect)</td>
</tr>
<tr>
<td></td>
<td>c) pathological appearance of the cornea</td>
</tr>
<tr>
<td></td>
<td>- Arcus lipoids (opaque/fatty cornea)</td>
</tr>
<tr>
<td></td>
<td>- Keratoconus (irregular astigmatism)</td>
</tr>
<tr>
<td></td>
<td>- scary form of cornea</td>
</tr>
<tr>
<td></td>
<td>- extreme volume of the front cave</td>
</tr>
<tr>
<td></td>
<td>d) pathological appearance of the sclera</td>
</tr>
<tr>
<td></td>
<td>- coloured sclera and veins</td>
</tr>
<tr>
<td></td>
<td>- special methods of handling of opaque glasses</td>
</tr>
</tbody>
</table>
e) pathological appearance of the lids
- lid lifter
- complementing and reproduction of lids
- upper lid
- lower lid

1.2 Production of prosthesis
Exercises in practice
Forming after a model

a) reform eyes
b) bulbus reform eyes
c) ball eyes
d) ball eyes for epithesis
e) scleral ball eyes

1.3 Production of prosthesis
Exercises in practice
Shape forming for patients

a) reform eyes

normal eyes
deformation lower lid fornix
atrophic lower lid fornix

b) bulbus reform eyes

bulbus or implantation
abnormal locations thereof

c) ball eyes

normal, atrophic lower lid fornix,
scarred forms, etc.

d) scleral ball eyes
bulbus and implants,
abnormal location thereof,
hydroxy-apatite implants,
scarred forms thereof

1.4 Warm-up and reforming
already existing prosthesis

general warm-up
warm-up for correction

1.5 Special problems of forming,
breakage (damage),
in case of non-existing models
in case of non-suitable models

a) selection suitable models
b) production of suitable pre-prosthesis,
individual cases
1) double-layer prosthesis
2) single layer
c) conformer service

1.6 Special problems of forming,
complications of the orbit or adnexa
heavy injuries

a) after
b) after burnings
c) after radio therapy
d) after plastic-surgical operations
e) after plastic-reconstruction surgery
f) after lid lifting
1.7 Consultation, adaptation and hints
advice to the handling of artificial eyes

1.8 Safe guarding, protection of quality
a) quality parameters, typical mistakes
during processing and their reasons
b) proof of prosthesis according to the
quality standards
1) Production quality
2) colours and adaptation
3) fitting of the eye prosthesis
4) overall appearance, cosmetics.

5.2 Working Environment

Mr. Frank Müller–Uri, a Master Ocularist is a direct descendent from Ludwig Müller–Uri
now devotes most of his time to the shaping and fitting of the glass ocular prostheses for
patients, and teaching and training apprentices, travelling to various clinics on a regular
basis throughout Germany.

I was invited to travel to some of these clinics with him, and study him working with his
patients in getting the right colour definition and the contour adjustments required to fit the
individual eye socket.

The course included instruction in the finer points of making a perfect iris; the various
techniques in making ground colours and the different types of twist that are required to
build up the iris. The coloured rods for the base colour are made by mixing 3-5 small
pieces of the raw coloured materials to give a blend of colour suitable to build the twists
upon. The twists are made in a variety of different ways, each one to specifically enhance
the colour build up of the eye. Starting with the solid twist then semi-transparent,
transparent, and crystal colours, each is used to uniquely build up the different rings of
colour in the eye. They are then covered with a clear crystal glass to bring the natural
colours to life and give the perception of depth.

The art of making the coloured iris is very complex. It takes many years of experience to
reproduce an iris as an exact copy of the original eye. The two eye makers I met in the
factory specialise in the manufacture of the semi-formed eye and are experts in the
 technique of colour matching of the iris. This unique process of mixing and twisting of
coloured glass rods and the amount of time taken for each twist is of paramount
importance for the exact colour matching and pattern definition of the finished product.

In Germany, there are two levels of eye makers, each with their own skill. Some work in
the area of shaping and fitting the finished prosthesis and others make the semi formed
eyes – that is making the iris on a white ball of glass. They quite often work as a team
because the demand for the glass ocular prosthesis throughout Germany and into most
parts of Europe requires a rapid response and high production level.

The shaping and fitting of the eye too, is very complex because it has to accurately match
the shape of the patients good eye. The craftsman’s aim is that no difference between the
good eye and the artificial eye can be detected. The shape, curvature and setting of the
eye and the position of the iris are critical to allow for good movement within the socket
and obtain a natural look for the patient.
While the loss of an eye is very traumatic and can never be replaced the use of natural glass in the construction of an artificial eye is unmatched in the re-creation of the beauty and appearance of the original eye. It helps with facial harmony and gives the wearer reassurance and self-confidence.

Mr. Tobias Müller-Uri, a consultant ocularist in Ulm, also specialises in the shaping and fitting of the eyes. I had the opportunity to spend some time with him again studying his style and technique of working.

I also spent time at Newhaus with Mr. Stefan Birke and Mr. Stefan Karl, both of whom make the semi-formed eyes. Each eye maker has his own unique way of working. It was interesting to compare their different techniques. I learned many valuable lessons from their expertise and shared ‘trade tips’ handed down through generations of family ocularists. I have been able to develop and adapt their techniques to my own style of working.
6. CONCLUSIONS AND RECOMMENDATIONS

- There is a need to increase awareness in the Australian community about the benefits and advantages of glass ocular prosthesis.

- An urgent need also exists to instigate a programme for the training of glass ocularists. There are no other people in Australia apart from myself, with the technical expertise to continue this work, although there are a number of the acrylic ocularists

- Ophthalmic Specialists need to be educated about the benefits of glass ocular prosthesis for their patients. Most problems that occur with acrylic prostheses can readily be overcome by a glass prosthesis.

According to an article presented by Prof. C. Hintschich M.D.

“ The ocularist’s task is to ensure that anophthalmic patients are provided with an artificial eye that fits properly, matches the patient’s existing eye and is as comfortable as possible.

In fulfilling this task the ocularist makes an important contribution to the rehabilitation of anophthalmic patients and is the first person the patient turns to if there are problems with the prosthesis”.

7. SOURCES OF INFORMATION

I acknowledge with gratitude, the technical information contained in the following publications :-

BERND SCHRIENER of the INSTITUTE FOR ARTIFICIAL EYES: ‘The effects of fluid drops on different type of eye materials.’

BERND SCHRIENER of the INSTITUTE FOR ARTIFICIAL EYES: ‘The comparison between the two different surfaces of glass and acrylic under the electron microscope.’

PROF. C. HINTSCHICH M.D. of the Eye Clinic at Ludwig Maximillian University in Munich’s article at the 97th Annual Meeting of the German Ophthalmological Society on a survey to ascertain the opinion of ocularists regarding orbital implants.

MUSEUM FÜR GLASKUNST LAUSCHA: ‘Technology of Glass.’

MUSEUM FÜR GLASKUNST LAUSCHA: ‘History of Thuringian Glass’

FARBGLASHÜTTE LAUSCHA: DAS ORIGINAL: ‘History of glass factory’