'The Slippery Slope' - A Participative Approach to Developing Modified Tables, Equipment and Work Practices to Reduce the Risk of Work-related Musculoskeletal Disorders from Conservation Treatment

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ABSTRACT

Conservation treatments often involve the use of awkward static postures and intensive periods of fine detail work, which can lead to injury. Conservators at Artlab Australia, have worked collaboratively with an Occupational Health Physiotherapist / Ergonomist, over the past ten year and have systematically considered a range of injury risk factors, including movements and postures, load, work organisation, working environment and personal factors. These factors were then evaluated according to a risk rating matrix that is embedded in the risk assessment process. Using this matrix, the risk rating for musculoskeletal disorders of the neck, upper back, shoulders, elbows and wrists was identified as high. Various innovative engineering solutions were developed that involved redesigning standard equipment including electric, height adjustable, multi-component tables and adjustable sloped work surfaces for carrying out conservation treatments. This example of a multi-faceted, participative ergonomics approach, combining innovative engineering controls, with changes to the work practices and improved awareness of risk for injury has been highly successful in reducing the risk of work-related musculoskeletal disorders from conservation treatments at Artlab, Australia.

KEYWORDS*: Art conservation, musculoskeletal injury prevention, hazardous manual tasks, participative ergonomics workplace design, risk management, manuscript*

INTRODUCTION

There is no escaping the fact that undertaking conservation treatments often involves many hours of repetitive tasks using fine hand movements in awkward postures. Whether it is cleaning a painting, removing corrosion from a metal item, doing a backing removal or stitch repairs on a textile, a conservator is often required to work in static postures, performing fine, repetitive and highly precise and detailed work. Such treatments can take anywhere between a handful of hours to several hundred hours.

Many factors can add to the burden of risk, including the large, and often unpredictable, variety and nature of objects needing treatment, the location of the work, the time frames, work load, business constraints and even the health and fitness of the conservator. Conservators at Artlab have long been aware that the nature of their tasks poses a significant risk of developing work-related musculoskeletal disorders, particularly affecting the upper body, including the neck, back, shoulders and arms. Many have already experienced, or are managing, soft tissue pain and injury.

For over ten years conservators at Artlab have been working with an Occupational Health Physiotherapist / Ergonomist to systematically identify, assess and control a range of injury risk factors, including movements and postures, load,

work organisation, working environment and personal factors. These factors were evaluated according to a risk rating matrix that is embedded in the risk assessment process. Using this matrix, the risk rating for musculoskeletal disorders of the neck, upper back, shoulders, elbows and wrists was identified as high. This high rating motivated staff at Artlab to reflect on how they work and what they do and to focus attention on ways of reducing the assessed risk.

As required by contemporary Work Health & Safety legislation (2012), the hierarchy of risk control was applied to ensure the most effective control measures were implemented. The hierarchy involves a "top down" prioritisation of risk control, namely: Elimination, Substitution, Engineering controls (including Isolation), Administrative controls and Personal Protective Equipment. Administrative controls rely on modifying the behaviour and attitudes of the conservator, whilst Engineering controls rely on modifying the nature and design of the task to improve performance and reduce injury risk. Initially staff were educated in Administrative controls to modify their work practices including improving postures and stance, reducing the duration of time spent on a task at any one time or rotating tasks between more personnel.

Whilst these measures have a role to play, they are less effective than engineering and ergonomics interventions in reducing musculoskeletal. This is well documented in the literature in relation to other fields of endeavour, but less well documented in art conservation (Langford et al. 2013). They rely solely on the conservator doing the "right thing" and are readily affected by time constraints, workload pressures, a reluctance to interrupt work flow and resistance to changing habitual work practices.

As Elimination and Substitution, although tempting, are not possible in conservation treatment the highest level of risk control is Engineering. Barriers to successful Engineering controls include a lack of resources and time, difficulty in designing equipment that will suit the enormous range, type and size of objects undergoing conservation treatments and an unwillingness not to change old practices.

The partnership between conservation staff and the Physiotherapist/Ergonomist enabled them to work collaboratively to investigate whether they could develop various innovative Engineering solutions redesigning standard equipment used in conservation work to reduce the risk of injury.

ENGINEERING CONTROLS

Electric-operated, height adjustable work stations, desks and work benches have been available for a number of years. This existing technology has been adapted to construct tables suitable for the treatment of objects. The work surfaces are larger than standard work desks and have electric motorised mechanisms in each leg that operate synchronously. The tables move evenly so the object moves smoothly and copes with heavy objects. This enables the conservator to easily and quickly adjust the height of the work station. An object can then be positioned optimally, so the conservation task can be undertaken as comfortably as possible.

Awkward postures, such as bending, stooping, twisting and reaching can be greatly reduced. For optimum effectiveness, the tables should always be plugged in as any barrier to ease of adjustment will reduce use.

Figure 1: Use of a height adjustable table for positioning object at optimal working position

FRAME CONSERVATION

The conservation of frames poses particular challenges. Traditionally, large frames are treated flat on work benches. If the frame has a deep profile, treatment usually requires the conservator to reach up and over the frame member and to look down into the frame, flexing the neck and placing the arms and wrists at awkward angles.

The engineering solutions devised to reduce these identified risks involve two different approaches. For smaller frames, a height adjustable tilt table has been custom designed and built.

The front edge includes a channel under the work surface into which brackets slide. For treatment, a frame is placed on the table, the brackets inserted into the channel and adjusted to secure the front edge of the frame and the surface is then tilted to a comfortable working angle. The height adjustment aids in optimising operator posturing and comfort.

As this approach is not practicable for very large frames, the work system includes two long, narrow, mobile tables, which allow the frame to be suspended between them. The conservator can then stand inside the frame to carry out work on the inner profile, markedly reducing stress on the neck, spine and arms.

Being height adjustable as well enables the frame to be easily adjusted to the best working position. Although the tables are narrow, there is still enough space to place materials and equipment adjacent to the work being performed.

Both systems have received strong acceptance by staff and have proved to be very effective in reducing the incidence of musculoskeletal discomfort. An unexpected advantage of the narrow tables is that it is now easier to lift frames onto them.

One edge of the frame is placed on one table and the other side is then lifted, while the second table is wheeled in to support the opposite side, eliminating the need for a full lift. Having the tables plugged in at all times remains a minor hindrance, but the modification of longer power cords has reduced this problem.

Figure 2: Use of tilting table for the conservation of frames

Figure 3: Two component system for the conservation of large frames

SLOPED WORK SURFACES FOR UNDERTAKING TEXTILE CONSERVATION TREATMENTS

The sloped work surfaces now used in the textile conservation lab have resulted from a prolonged process of consultation, concept development and implementation. A significant barrier to overcome was the resistance to change on the part of the conservators. Carrying out stitching on a flat table is a long established textile conservation practice. Laying the textile flat assists in holding the various layers needing stitching or patching in place.

However, the resultant postures required to sew on a flat surface carries with it a very high risk of injury.

Common postures involved extreme neck flexion (or bending), particularly when using a very fine thread, sustained arm elevation without arm support, awkward, bent and tilted wrist positions, combined with strong precision pinch grip to grasp very fine needles. Stitching in textile conservation treatments is often the major component of the work required and can take hundreds of hours.

One project that illustrates the application of sloped work surfaces to improve work performance and reduce injury risk was the stitching of the Eureka Flag to a new lining. The Flag is large, with dimensions of approximately 2 m x 4 m. It was fully lined onto a new backing and required stitching using fine thread.

There was a limited time frame for the project, which involved approximately 300 hours of stitching. An occupational risk assessment was carried out for the task and it was assessed as a high risk for static postures and overuse musculoskeletal injury. Engineering controls to reduce the risk of injury were conceived by the Senior Objects Conservator. The work table (in this case the old backboard from the flag) was modified, so that it could be raised to make the work surface sloped, which vastly improved visual and manual access to the flag, at the same time reducing the risk of neck and postural strain.

Once a section of the flag was completed, the flag was moved down the table, over the rounded end of the work table and was then rolled face out onto a roller suspended underneath the table. The system incorporated a padded bar suspended along the front edge of the table, with a 50 mm gap between the bar and the rounded end of the work surface. This bar protected the surface of the flag, allowing the conservators to lean their weight against the bar, reducing back strain.

The padding provided support for the elbows and arms, which, in turn, provided support for the worker's upper torso body weight, greatly reducing the muscular strain associated with unsupported static postures. A number of other interventions to improve seating and lighting and to increase task rotation was also implemented as part of the Eureka Flag conservation project and there were no instances or reports of musculoskeletal discomfort throughout its duration.

The large, sloped table used for the Eureka Flag was not practical for use with other conservation tasks in the lab and it was deconstructed once the treatment was complete. However, as the concept of the sloped work surface had been so effective in improving operator comfort and efficiency, there was a strong commitment to adapt work surfaces to use sloped surfaces in the lab in the future. Initially, ready-made tilt tables were purchased and used for smaller textiles.

Whilst these were relatively effective, their small size and difficulty to set up meant that they were not frequently used. It was decided that the preferred design was to have a tenting system built into the work tables. This would allow the tables to be used flat when required and to adapt quickly and easily to become a sloped surface. The tables also needed to be interchangeable, so they could cater for a wide range of sizes.

The final design involves flexible work surfaces incorporating hinged leaves. When a sloping gradient is required, a motorised system pushes the front leaf up, causing it to raise and tilt. As it lifts and tilts, the other leaves slide forward across the solid table top below to form a sloping surface. Along the front edge of the table, different systems can be screwed to the underside of the table which can be easily modified as required.

Generally, a timber trough is in place in which a roller can be placed allowing the textile to be rolled, facilitating progressive access to sections of the textile needing treatment. The front edge of the trough is padded, which allows conservators to support their wrists and arms. When not needed for a roller it also provides a convenient location for tools. This trough can be changed as required and a roller can be suspended under the table to roll the textile, as was done for the Eureka Flag.

The new work system was installed in mid-2013 and although not practicable for all situations, so far, has proved to be highly effective. The work surfaces are used flat whilst a patch or lining is prepared or alignment takes place. The textile is then easily tilted to the required angle, with the touch of a button. Having the same sized hinged leaves on all of the work stations ensures that the system retains maximal flexibility, textiles up to 4 metres in width could be treated using all of the tables.

The added feature of height adjustability further enhances their adaptability to all conservation applications and can allow work in both sitting and standing. Using a fully adjustable ergonomic office or drafting chair allows the conservator to adjust the seat as required and to place feet flat on the floor or the foot ring depending on their preference.

A minor drawback of the current design is the disruption of the flush work surface by the hinges. This has been resolved by the use of a piece of thick Mylar over the joins. It would also be desirable to incorporate a way in which magnets could be used to secure the textiles on the sloped surface reducing the need for pins. Having the system plugged in at all times is also a minor inconvenience, due to cabling potentially causing obstruction to work. Floor mounted electric plugs would be extremely beneficial with these tables.

Figure 4: Sloped work surface for stitching repair on textiles

BRIDGE FOR SPANNING LARGE, FLAT OBJECTS

A treatment was undertaken on a large 3.2 m x 4 m silk, trade union banner in extremely poor condition. Its fragility meant that it was too fragile to roll. It was not possible to reach the centre of the banner without some kind of bridge to span the textile. To overcome these issues, it was decided to place the banner on a large timber and ply backboard that could be raised and lowered, so that work could be undertaken both at table height and on the floor.

When working on the edges of the banner, the backboard was placed on top of a large work table at bench height. For work on the inner sections of the banner, the backboard was lowered and placed on the floor. A wooden bridge was constructed, spanning the banner at a height of 30 cm above the floor surface.

Working at this lower level significantly reduced the risk of falls and no handrail was required. The bridge was progressively pulled along the floor across the textile as work progressed. This removed the need for lockable castors or other securing devices.

To use the bridge, the conservator lay face down, with head and shoulders suspended over the front edge of the bridge, to reach the underlying banner. There remained a significant risk of fatigue and strain to the neck and shoulders in this position. In consultation with the Physiotherapist /Ergonomist, headrests were purchased, similar to those used on treatment and massage tables. The padded headrest was modified so only the forehead was supported.

Each headrest was screwed to a plywood panel on the bridge, over which suitable padding was placed. The conservator's work posture thus involved lying face down on the padded bridge, above the banner, with their head resting on the headrest.

The headrest is adjustable for height and length to suit the individual conservator. This allows the head to be supported, with the arms free to work on the underlying banner.

Figure 5: Head support for working on low bridge

ADDITIONAL ADMINISTRATIVE CONTROLS

Informed by the Risk Assessment process, Safe Operating Procedures are routinely developed for all high risk conservation tasks and may include actions to be taken prior to performing the task, during the task and after the task, such as:

- Preparation prior to the task (as advised by the Physiotherapist/Ergonomist), including seat and posture adjustment, use of the padded bar to support forearms;
- Positioning optimum lighting;
- Placement of trolleys and other equipment for easy access;
- Adhering to a program of strict work breaks and task rotation, utilising timers;
- Utilising all "Micro-pauses" to interrupt static postures and to vary postures and movements;
- Early intervention by the physiotherapist to monitor staff welfare, provide treatment as required and provide ergonomic and other advice, such as to avoid fine sewing or similar precision activities for the rest of the day;
- Advice on regular stretching, aerobic and therapeutic exercise, although this has always had poor staff take up.

A range of other administrative control measures have been implemented at Artlab, in conjunction with the written Safe Operating Procedures and engineering controls.

These include:

- Regular ergonomics audits of all work areas, with individual assessments of staff work practices by the Physiotherapist/Ergonomist, with recommendations on chair, workplace and work method adjustment and modification;
- A framework of education and training in hazardous manual tasks risk management and ergonomics for all staff, developed and delivered by the Physiotherapist/Ergonomist, in line with contemporary Work Health and Safety legislation dealing with Hazardous Manual Tasks;
- Development of poster materials to support the training program;
- Establishing an exercise station within each work area to enable staff to perform exercises during work breaks, to counteract the effects of repetitive, static work postures. It must be noted that use of these station compliance with recommended exercise has always been very low;
- Increasing staff numbers for high risk or protracted tasks if indicated.

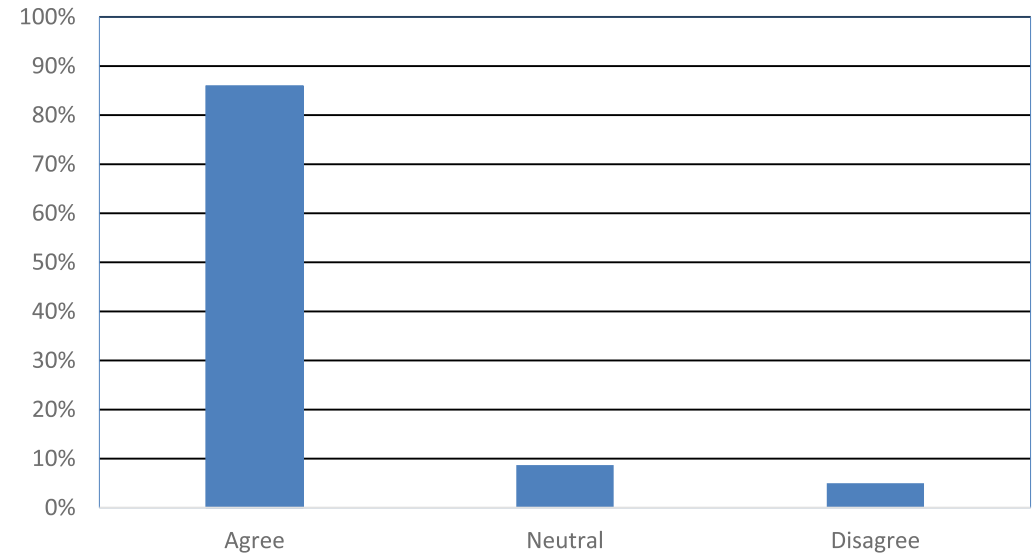
RESULTS OF 2014 STAFF QUESTIONNAIRE

To gain feedback from staff on their perceptions of the effectiveness of the improvements in equipment design and the ongoing ergonomics interventions, the Physiotherapist/Ergonomist undertook a questionnaire which was distributed in 2014, achieving a 92% response rate. Staff feedback indicated that, compared with 5 years ago, the vast majority of conservators agreed mildly or strongly that their work is less likely to cause them an injury; that they have the right equipment to do their work; that they better understand the risks associated with their work; that they take more care of their health and safety; that they feel strongly that their employer is committed to improving their health and safety; while two thirds feel physically better. The height-adjustable tables and sloping work surfaces received strong support from staff. The main barrier to working more safely was perceived to be time pressures and work deadlines.

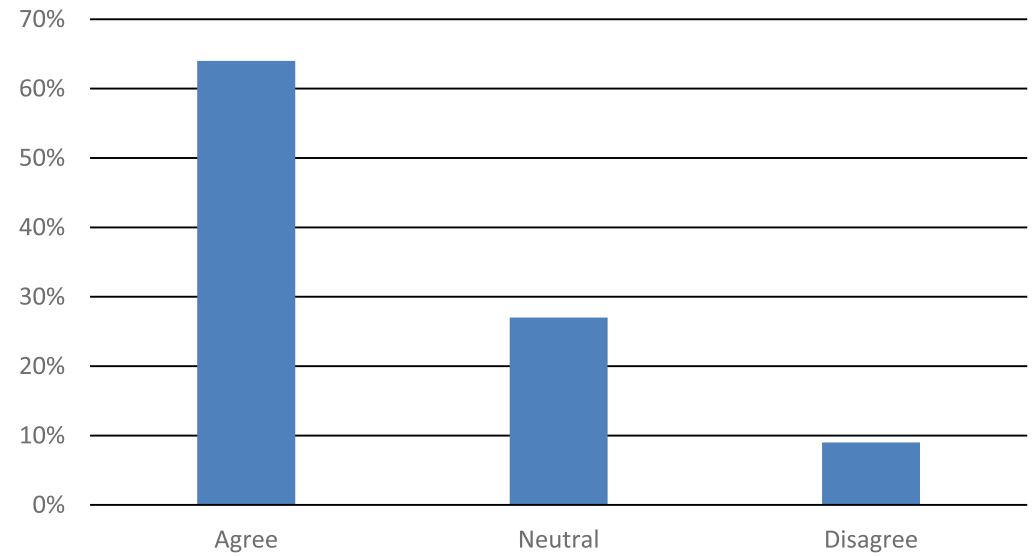
(Extracts from staff questionaire - see summary overleaf.)

EXTRACTS FROM STAFF QUESTIONAIRE

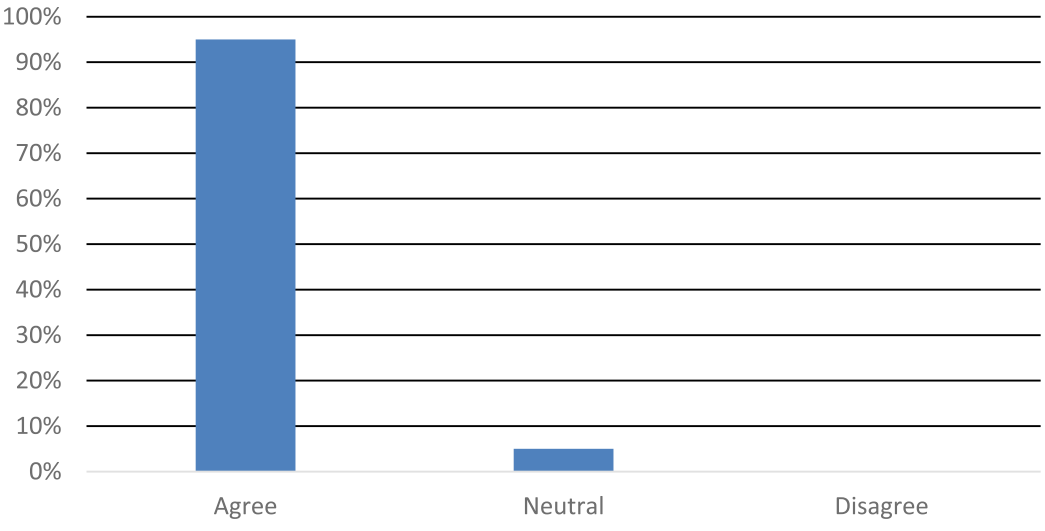
The way I work now is less likely to cause me an injury compared with 5 years ago



I feel physically better when performing work tasks compared with 5 years ago

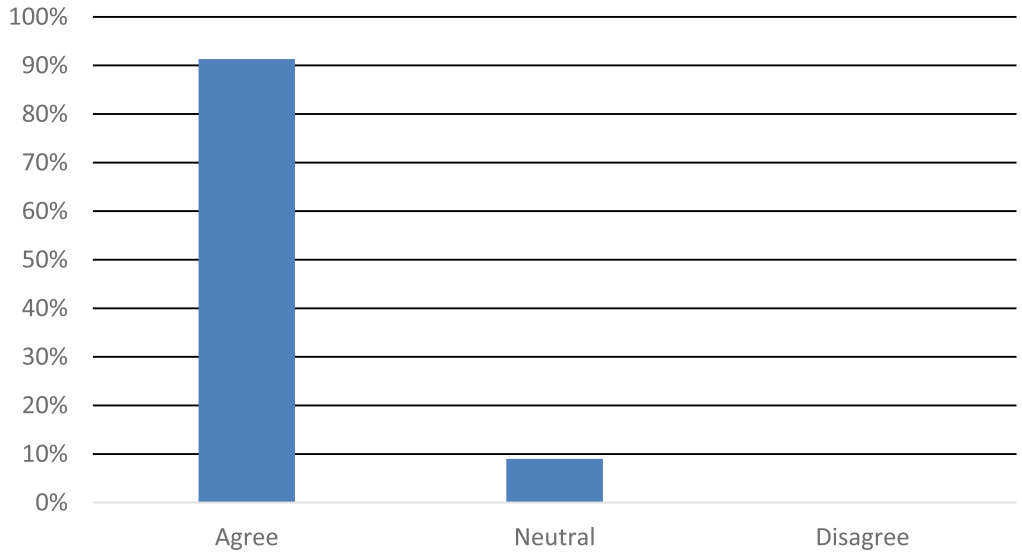


I better understand the risks associated with my work compared with 5 years ago

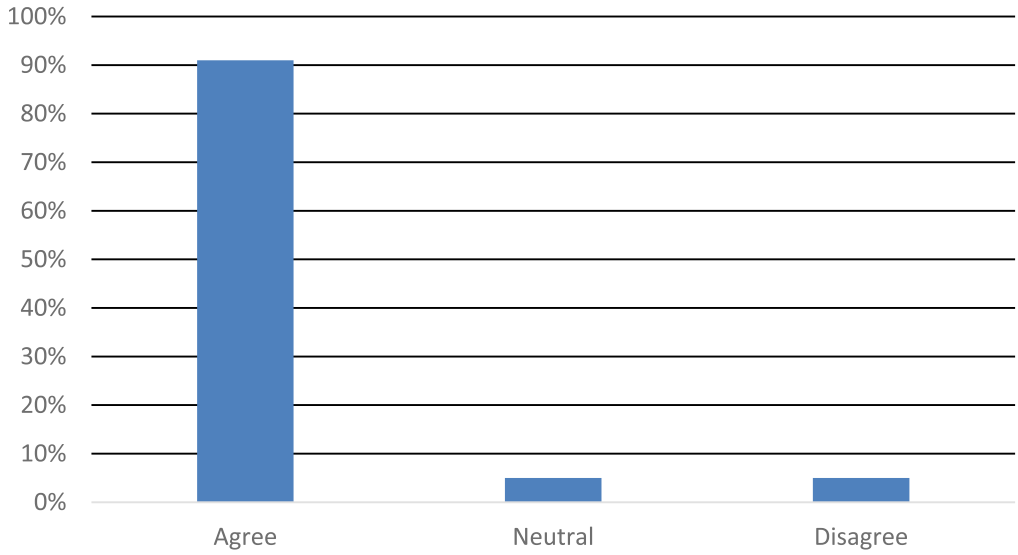


EXTRACTS FROM STAFF QUESTIONAIRE

I feel my employer is committed to improving my health and safety



I now have the right resources and equipment to work safely



SUMMARY

In summary, the process of how conservators undertake hazardous manual tasks will continue to evolve and change as new equipment is developed and adapted. The multi-faceted, participative ergonomics approach described in this paper, which combines innovative engineering controls with a comprehensive range of administrative controls, has been highly effective in reducing the risk of work-related musculoskeletal disorders from performing conservation treatments at Artlab Australia.

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Jo Bills [GDOH, DipTechPhysio, Cert IV TAACPMSIA, RSP(Aust), Member APA & HFESAOccupational Health Physiotherapist /Ergonomist Nationally Accredited Trainer & Assessor Director, PhysioLink] is a registered physiotherapist, who established PhysioLink in 1989. She has been working in Occupational Health and Safety (OHS) for over 25 years, providing on-site physiotherapy services to industry, consultant ergonomics services, OHS consultancy and training, injury prevention and management programs and Rehabilitation Services for injured workers.

She completed tertiary studies in Occupational Health at the University of Adelaide in 1994 and was awarded the Safety Institute of Australia's academic prize. Her special interest lies in musculoskeletal injury prevention from performing hazardous manual tasks, with emphasis on workplace design and redesign, specifically in art conservation and courtroom design, as well as office and dental ergonomics.

Justin Gare was originally a Carpenter and Joiner, he retrained as an objects conservator and holds a Bachelor of Applied Science from the University of Canberra. He has worked as a conservator at Artlab since 2001. As a senior objects conservator in the objects conservation team he works on a wide range of material types and specialises storage solutions for complex objects. He retains an enduring interest in furniture and built heritage.