

# Power Hammer Techniques and Applications for Creating Compound Curves in Sheet Metal



## **Jamie Downie**

International ISS Institute/DEEWR Trades Fellowship

Fellowship supported by the Department  
of Education, Employment and Workplace  
Relations, Australian Government



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# Executive Summary

Despite a high demand for metal shaping, there is currently in Australia no formal education course or business providing training in power hammer shaping techniques.

The use of the power hammer as the superior tool in shaping compound curved parts on a limited basis has not been taken up as a possible curriculum option in the panel beating or coach building trades. This is due, in part, to the size and limited scope of the market.

The metal shaping sector largely serves the vehicle restoration industry, with a small demand by local prototype manufactures. The three-dimensional panel shaping market has potential to grow into an industry capable of servicing overseas demand in prototype development.

As manufacturing in Australia continues to confront market challenges from China and India, intellectual property (IP) development will be a niche area of expertise for Australian industry. A quick-to-market panel shaping resource will add value to companies that are involved in the automotive, aviation, marine, architectural and furniture industries. Developing power hammer skills will complement the scope of services available in IP development.

Power hammer shaping in the United States of America (USA) services a wide range of compound curve manufacturing requirements. A power hammer accords a skilled operator the ability to process a two dimensional concept or a replacement part, in the most efficient manner possible.

As the prototype industry operates on shorter lead times from concept to market, skills like power hammer shaping will greatly shorten lead times in this field.

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# *Abbreviations and Acronyms*

AAIA	Australian Automotive Industry Association
AHF	Auto Horizon Foundation
AOMC	Associations of Motoring Clubs Victoria
Amp	Ampere
GMAW	Gas Metal Arc Welding
GTAW	Gas Tungsten Arc Welding
DEEWR	Department of Education, Employment and Workplace Relations
FR1	Fundraiser No.1
IP	Intellectual Property
ISS Institute	International Specialised Skills Institute
MIG	Metal Inert Gas
MSA	Manufacturing Skills Council
OHS	Occupational Health and Safety
SAE	Society of Automotive Engineers
TAFE	Technical and Further Education
TIG	Tungsten Inert Gas
VACC	Victorian Automobile Chamber of Commerce
WD40	Water Displacement – 40th Attempt

# Definitions

## **Air Planishing Hammer**

This is an air-operated sheet-metal shaping tool for light shaping and the smoothing of highs and lows in sheet metal.

## **Amp/Ampere**

An ampere is a unit of electric current. In practical terms, the ampere is a measure of the amount of electric charge passing a point per unit time. In practice, its name is often shortened to amp.

## **Bead Roller**

This is a manual operated machine used for forming a bead or swage in sheet metal.

## **Bead or Swage**

Bead or swage is a technique in which cold metal is formed over a grooved tool for decorative or strengthening purposes.

## **Design**

Design is problem setting and problem solving.

Design is a fundamental economic and business tool. It is embedded in every aspect of commerce and industry and adds high value to any service or product—in business, government, education and training, and the community in general.

Reference: 'Sustainable Policies for a Dynamic Future', Carolynne Bourne AM, ISS Institute 2007.

## **FR1/Fundraiser No.1**

This is a concept car being built by a team of volunteers with the Auto Horizon Foundation. When complete, the car will be auctioned and the money raised will go to four chosen children's charities.

## **Head dolly**

Head dolly is a steel dolly attached to a post or stand.

## **Kick and Hand Shrinker/Stretchers**

These are used for shrinking or stretching small flanges on sheet metal and similar applications.

## **Lathe**

A lathe is a machining tool that spins the work piece in order for the operator to perform various operations like cutting, sanding, knurling and drilling.

## **Metal Inert Gas (MIG) Welder**

Metal Inert Gas (MIG) welding, also known as Gas Metal Arc Welding (GMAW), is an automatic arc welding process in which both a continuous consumable welding electrode and shielding gas are fed through a welding gun.

## **Milling Machine**

This is a machining tool used for shaping metal and other solid materials by utilising cutting attachments.

## **Oxy-acetylene Welding**

This is a welding process that uses an acetylene and oxygen mix as a heat source to melt the weld pool for various types of welding applications with the addition of a filler material.

## **Pan Brake Sheet Metal Folder**

This is a brake used for the bending or folding of sheet metal.

## **Panel Flanging Machine**

This is an automatic machine used for turning an edge or flange on sheet metal parts.

## **Pullmax Machine**

This can be used for louvers, forming a bead or swage and light shaping of sheet metal.

## **Sheet Metal Guillotine**

This is either a foot powered or mechanically operated machine used to cut or shear sheet metal.

## **Stick or Arc Welding**

This uses a welding power supply to create an electric arc between an electrode and a base material to melt the metals at the welding point.

## **Skill deficiency**

A skill deficiency is where a demand for labour has not been recognised and training is unavailable in Australian education institutions. This arises where skills are acquired on-the-job, gleaned from published material or from working and/or studying overseas.

Reference: 'Directory of Opportunities. Specialised Courses with Italy. Part 1: Veneto Region', ISS Institute, 1991.

There may be individuals or individual firms that have these capabilities. However, individuals in the main do not share their capabilities, but rather keep the intellectual property to themselves. Over time these individuals retire and pass away. Firms likewise come and go.

## **Tungsten Inert Gas (TIG) Welder**

Tungsten inert gas (TIG) welding, also known as Gas Tungsten Arc Welding (GTAW), is a welding process that uses a tungsten electrode to produce the weld. The weld area is shielded by an inert gas and filler metal is used.

## **Wheeling Machine**

This is used for shaping sheet metal.

## **Yoder LK90M and Pettingell Power Hammer**

These are used for shaping sheet metal.

# Acknowledgements

Jamie Downie would like to thank the following individuals and organisations who gave generously of their time and their expertise to assist, advise and guide him throughout the Fellowship program.

## **Awarding Body – International Specialised Skills Institute (ISS Institute)**

The International Specialised Skills Institute Inc is an independent, national organisation that for over two decades has worked with Australian governments, industry and education institutions to enable individuals to gain enhanced skills and experience in traditional trades, professions and leading-edge technologies.

At the heart of the Institute are our Fellows. Under the **Overseas Applied Research Fellowship Program** the Fellows travel overseas. Upon their return, they pass on what they have learnt by:

1. Preparing detailed reports to government departments, industry and education institutions.
2. Recommending improvements to accredited educational courses.
3. Offering training activities including workshops, conferences and forums.

Over 180 Australians have received Fellowships, across many industry sectors.

Recognised experts from overseas also conduct training activities and events. To date, 22 leaders in their field have shared their expertise in Australia.

According to Skills Australia's 'Australian Workforce Futures: A National Workforce Development Strategy 2010':

Australia requires a highly skilled population to maintain and improve our economic position in the face of increasing global competition, and to have the skills to adapt to the introduction of new technology and rapid change.

International and Australian research indicates we need a deeper level of skills than currently exists in the Australian labour market to lift productivity. We need a workforce in which more people have skills, but also multiple and higher level skills and qualifications. Deepening skills across all occupations is crucial to achieving long-term productivity growth. It also reflects the recent trend for jobs to become more complex and the consequent increased demand for higher level skills. This trend is projected to continue regardless of whether we experience strong or weak economic growth in the future. Future environmental challenges will also create demand for more sustainability related skills across a range of industries and occupations.<sup>1</sup>

In this context, the Institute works with Fellows, industry and government to identify specific skills in Australia that require enhancing, where accredited courses are not available through Australian higher education institutions or other Registered Training Organisations. The Fellows' overseas experience sees them broadening and deepening their own professional practice, which they then share with their peers, industry and government upon their return. This is the focus of the Institute's work.

For further information on our Fellows and our work see [www.issinstitute.org.au](http://www.issinstitute.org.au).

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<sup>1</sup> Skills Australia's 'Australian Workforce Futures: A National Workforce Development Strategy 2010', pp. 1-2 [http://www.skillsaustralia.gov.au/PDFs\\_RTFS/WWF\\_strategy.pdf](http://www.skillsaustralia.gov.au/PDFs_RTFS/WWF_strategy.pdf)

# Acknowledgements

## Fellowship Supporter

This Fellowship has been supported by the Department of Education, Employment and Workplace Relations (DEEWR).

DEEWR provides national leadership and works in collaboration with the States and Territories, industry, other agencies and the community in support of the Government's objectives. DEEWR aims to touch the lives of all Australians in a positive way, working towards a vision of creating a productive and inclusive Australia. Jamie Downie would like to thank them for providing funding support for this Fellowship.

## Supporters

The Fellowship was made possible by the valued support of the following Industry supporters:

- Artisan Coachworks  
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- Auto Horizon Foundation  
Brian Tanti, Director
- CC Consulting  
Colin Cass, Director, Automotive Training Consultant
- Fox Car Collection  
Bill Kelty AC, Chairmen fox trust
- Holden Design  
Tony Stolfo, Director Holden Design
- Manufacturing Skills Australia (MSA)  
Bob Paton, Chief Executive Officer

## Organisations and Individuals Impacted by the Fellowship

### Industry

- Holden Design
- Manufacturing Skills Australia (MSA)
- RACV Motoring Club Register
- Victorian Automobile Chamber of Commerce (VACC) Skills Development Centre
- Classic Car Restoration
- Graeme Cuthbert Automotive
- Historic And Vintage Restorations
- Shannons
- The Hammer Works

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## **Professional Associations**

- Associations of Motoring Clubs Victoria (AOMC)
- Australian Accident Repair Network
- Australian Automotive Industry Association (AAIA)
- Design Institute of Australia
- National Motoring Museum Association
- I-CAR Australia
- Society of Automotive Engineers (SAE)
- The Cadillac Lasalle Club of Australia
- Packard Automobile Club of Australia
- The Sir Henry Royce Foundation

## **Education and Training**

- Automotive Centre of Excellence (ACE), Kangan Batman Institute of TAFE, Melbourne
- Chisholm Institute
- Design and Technology Teachers' Association (DATTA)
- Royal Melbourne Institute of Technology (RMIT)
- Bendigo Regional Institute of TAFE
- Mount Gambier TAFE
- Northern Sydney Institute

## **Community**

- Australian Body Shop News
- Chopped Rod and Custom Magazine
- Cruzin Magazine
- Restored Cars Magazine
- Street Machine Magazine
- National Collision Repairer Magazine
- Paint and Panel magazine

# About the Fellow

**Name:** Jamie Downie

## **Employment**

- Owner/Operator, Kustom Garage

## **Qualifications**

- Certificate III Vehicle Body Building, Kangan Batman Institute of TAFE, completed 2000

## **Memberships**

- Auto Horizon Foundation

The Fellow had a passion for cars from an early age. Having developed an interest in the trades that service the automotive industry, he secured an apprenticeship in vehicle body building and restoration where he was able to combine fabrication with repair skills using purpose-designed hand tools and the wheeling machine. This practical experience and the enjoyment found in working with clients on a personal basis, motivated him to start his own business in 2003.

The Fellow has developed a reputation for excellence in vehicle body fabrication and restoration. Marques such as Rolls Royce, Delage, Alfa Romeo and Aston Martin became his specialty and are commonplace in his workshop.

As well as running his business, the Fellow is involved with The Auto Horizon Foundation (AHF). The Foundation is currently involved in making a car that will be auctioned off to support four children's charities.

His involvement with the AHF also provides the Fellow an opportunity to share his skills and knowledge with apprentices from the Automotive Centre of Excellence who pass through AHF education programs.

# Aims of the Fellowship Program

The purpose of the Fellowship was to undertake an overseas study program in regions of the USA, to gain a comprehensive understanding of the techniques associated with advanced panel shaping machinery.

The study provided the opportunity to work with the power hammer and air planishing hammer to see how they could complement the panel shaping machinery used currently in Australia to create three-dimensional shapes in sheet metal.

The Fellowship provided the opportunity to learn the techniques in advanced panel shaping machinery, in particular:

- Use of the power hammer and the ability to shape higher-strength materials.
- Use and operation of the air planishing hammer.
- Maintenance procedures for the power hammer and air planishing hammer.
- Design and fabrication processes in the manufacture of power hammers.
- The range of products to which this technology can be applied.
- Occupational Health and Safety (OHS) requirements relating to the use of power hammers and associated power tools.

# The Australian Context

At the turn of the 20th century demand for compound curves in sheet metal was growing rapidly. The invention of the wheeling machine saw Australia's sheet metal industry grow in creating three-dimensional shapes.

The wheeling machine was invented in Great Britain. It was an invaluable tool in the Second World War for the building and repair of aircraft and automobiles.

With the advent of metal stamping, the labor-intensive hand-formed methods were limited to the repair and restoration of classic cars, and to low-volume prototype and specialist work. However, the art of shaping metal by hand has become more popular over recent decades. The use of specialist machinery such as the power hammer has paved the way for this surge in popularity. While Australia is renowned for its sheet metal craftsmanship, the Australian sheet metal fabrication industry has shied away from the use of the power hammer.

Currently in Australia there are a variety of techniques for shaping sheet metal. To date, the most commonly used is the wheeling machine, or English wheel as it sometimes called. The wheeling machine is a frame made generally from cast iron and is shaped somewhat like a giant vertical 'G' clamp. It supports two steel rollers or 'wheels', one above the other, between which the sheet metal is placed. The wheel on the top is called the rolling wheel and the wheel on the bottom is called the anvil wheel.



*Stand-alone Wheeling Machine*

The rolling wheel is flat and larger in diameter than the bottom wheel. The anvil wheel is interchangeable and one of a set. The anvil wheel sets are all the same diameter, with the first in the set almost flat and the consecutive ones progressively increasing in radii. The different radius on the anvil wheels is important, as the wheels need to be changed as the shape in the panel progresses. The anvil wheel sits in a cradle together with a quick release mechanism that allows the operator to change the wheel and release the tension without affecting the pressure set. This also allows the panel to be removed and placed back efficiently. The pressure is set by a screw thread under the cradle much like the 'G' clamp arrangement, and gives the operator the ability to adjust the pressure as the metal thins during the shaping process.

To use the wheeling machine to make a compound curved part, the operator would place the chosen metal sheet between the top and bottom wheels and manually push and pull the metal back and forth creating a path that has been stretched. As well as pushing and pulling, the operator must steer the metal through a path with great precision in order to track next to or almost overlap the previous path many times over, to enable the desired amount of stretch in the areas needed to create that part. This process is called wheeling. As the wheeling machine creates shape by stretching and thinning the material, three subsequent shapes can be created: low crown, high crown and reverse curve.

## The Australian Context

Examples of a low crown part would be a car door skin, roof turret and bonnet. When a part becomes too large for a single operator a second operator must be available to assist. This is called tailing. The tailing operator must be as skilled as the steering operator to ensure the part is held and supported correctly.



*Photo of wheeling process*



*Photo of wheeling process*

## The Australian Context

The second shape is a high crown. Examples of high crowns are components such as mudguards, wheel wells and nose cones. To create these shapes using a wheeling machine would take an exceptional amount of time. Blocking into a sand bag is one method to assist the shaping process. This involves beating the metal with a large steel mallet into a leather bag filled with sand or lead shot. This method has a deep draw effect on the metal and can cause uneven stretch, as it is hard to have each blow hit at the same pressure. Consequently, this process requires finishing on a wheeling machine.



*Blocking into sandbag*

Tuck shrinking, or pulling a pucker, is another method to help speed up the shaping process. This process involves placing a pronged fork-puckering tool over the edge of the metal to be shrunk and pulling up a tuck, or pucker. After the desired amount of metal is raised it then needs to be compressed into itself. This is done using a hammer and placing the sheet metal over a head dolly. With a lot of time and care a highly skilled operator can finish a part to a very high standard.

# The Australian Context



*Blocking into sandbag*

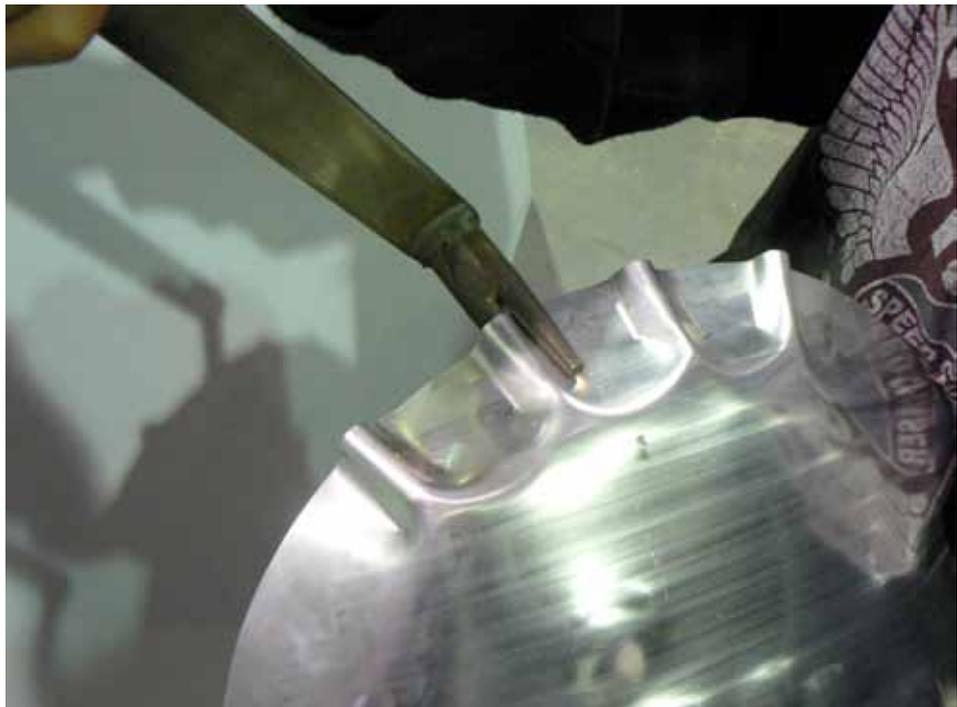


*Finishing in a wheeling machine after blocking*

# The Australian Context



*Finishing in a wheeling machine after blocking*



*Pulling a pucker or tuck*

## The Australian Context



*Compressing a tuck*

The power hammer was developed in the early 20th century from blacksmith hammers in Amesbury, Massachusetts in the USA. The principle of the power hammer is similar to the wheeling machine in that they both shape the metal. While a wheeling machine is operated manually, power hammers generally have a three-horsepower motor. The speed differential between the two machines is significant.

The power hammer has more direct compressive force and can be used for both stretching and cold shrinking, thereby enabling the operator to make much larger parts without employing assistants. The finish of a part depends on the skill level of the operator. The power hammer is made from cast iron with a top and bottom arm bolted to a pedestal, with provision to have a second set of arms bolted to the opposing side.

Having a power hammer with two sets of arms gives the operator the ability to shrink, planish and stretch without changing dies. The power hammer can be arranged with a set of shrinking dies in one side and stretching dies in the other so the operator can move between the two, making the shaping of parts much faster.

The top arm has an electric motor mounted within a cradle. The electric motor powers a friction clutch that is engaged by a hydraulic foot control. This gives the operator the ability to run the machine at different speeds to place more shape where desired, and the ability to start and stop the machine instantly. The clutch is connected via a shaft to a rotary head that has provision for adjustment and can be quickly regulated to strike a blow from zero to 125 pounds depending on the size of the power hammer. Linked to the rotary head is the ram or plunger. The ram is suspended from a flexible belt that is attached to a heavy leaf spring connected to the rotary head.

## The Australian Context

The ram also holds the top die, which is flat for stretching. A special matched set is required for shrinking and linear stretching. The lower arm has a heavy anvil attached to it that holds the lower dies directly below the ram. All the dies are held in with a tapered wedge key that allows for the dies to be changed quickly. A standard 12-die set consists of shaping dies, linear stretch and shrinking dies.



*The power hammer*

To use the power hammer to make a part the operator would first spray the top and bottom of the sheet metal with WD40 or a similar lubricant. This is necessary to protect the metal from being gored as it passes through the reciprocating forces of the machine. It also acts as a barrier to preserve the surface finish of the sheet metal. Next, the operator then places the sheet metal over the bottom die, presses the foot pedal to start the machine and then tracks the sheet from side to side, overlapping each pass until the desired shape is created. If stretching alone is not enough to reach the desired shape then shrinking dies can be installed to assist the shaping process. The ability to shrink and stretch sheet metal is important when shaping. A well made part will have minimal thickness change and will be a lot stronger, more dent resistant and longer lasting.



*Shrinking on a power hammer*

## The Australian Context



*Shrinking on a power hammer*



*Shrinking on a power hammer*

Using sheet metal shaping equipment such as the wheeling machine to create compound curve shapes is much slower than the power hammer. Power hammers are faster, provide more control in the shaping of high-volume areas and they are more time efficient. The power hammer has the ability to shape a 0.125 inch single sheet of steel, shrink fourteen gauge steel sheet and stretch four sheets of 0.057 inch thick steel stacked together.



*Stretching on the power hammer*

# The Australian Context



*Stretching on the power hammer*



*Stretching on the power hammer*

## The Australian Context

Depending on the application the air planishing hammer can be both hand held or utilised on a stand. The air planishing hammer has a longer reach capacity into the centre of very large panels than the conventional hammer and dolly. It also complements the power hammer in smoothing shapes and blending slight highs and lows in panels.



*Air planishing hammer*

# The Australian Context

## SWOT Analysis

### Strengths

- Power hammer is user-friendly
- Improves productivity
- Existing knowledge base
- Demand for reduced panel fabrication times
- Existing industry demand for panel fabrication skills
- Has capacity to shape larger parts without assistance

### Weaknesses

- Industry reluctance to change
- Lack of training support
- No knowledge in the techniques of hammer shaping
- No available machinery in Australia
- Lack of local research and development capacity
- Noisy to operate – ear protection required

### Opportunities

- Defines new markets for aviation, marine, furniture fabrication and artistic projects
- Defines existing markets better
- Facilitates new supply chain model
- Develop research and development capacity beyond current level

### Threats

- Reduced lead times for panel fabrication
- Technology gap with overseas competitors

# Identifying the Skills Deficiencies

## 1. Basic panel shaping using the power hammer

- Learn the art of shaping and forming three-dimensional metal objects using the power hammer.
- Develop skills in using installed dies that give the capability of cold shrinking metal.
- Develop skills to control the amount of stretch in metal when using the power hammer.
- Determine the appropriate selection of metals suitable for working with the power hammer.

*Aim: To become skilled in the use of the power hammer and gain the ability to work with higher-strength materials.*

## 2. Effective operation of the air planishing hammer

- Through hands-on training, learn specialised metal finishing techniques such as light shaping, smoothing and planishing.

*Aim: To become skilled in the effective use and operation of the air planishing hammer.*

## 3. Maintenance of power hammers

- Perform guided and recommended maintenance operations on power hammers.

*Aim: To develop a clear understanding of the maintenance procedures associated with power hammers.*

## 4. Fabrication and design of power hammers

- Analyse and inspect manufacturing companies' operations/interview representatives.

*Aim: To gain a better understanding of the design and fabrication processes in the manufacture of power hammers.*

## 5. Applications related to products developed using power hammers

- Determine the range of products that can be produced using power hammers.

*Aim: To gain an understanding of the range of products to which this technology can be applied.*

## 6. OHS issues in relation to the use of power hammers and other equipment

- Evaluate the workplace safety requirements in environments in which power hammers and other power tools are used.

*Aim: To gain an understanding of all OH&S requirements relating to the use of power hammers and associated power tools.*

# The International Experience

The international component of the Fellowship involved travel to the USA where the Fellow visited state-of-the-art metal shaping workshops in Massachusetts, New Jersey, Tennessee, Utah and California.

## Fay Butler Fabrication and Metal Shaping, Massachusetts

**Contact:** Fay Butler

Fay Butler Fab/Metal Shaping is a family owned business established by Fay Butler and his family in 1977. The business creates compound curve sheet metal parts for the aircraft, automobile, architectural and art industries. Butler is also a dedicated educator who conducts seminars on metal shaping.

The Fellow was fortunate to undertake a one-on-one seminar with Butler over a five-day period. The seminar sessions provided the opportunity to obtain base-line theoretical and practical knowledge of metal shaping and techniques adopted when using the power hammer and air planishing hammer. The five-day seminar conducted by Butler covered the following topics:

- Structure of metals, language of metals and theoretical metallurgy.
- The way metals are smelted, numbered, produced, heat treated and strengthened.
- Principles of welding and re-smelting.
- Methodologies of compound curve development from flat sheets, shrinking and stretching, plastic deformation and understanding strain concentrations.
- Introduction to effective use of power equipment.
- Tungsten Inert Gas (TIG), Metal Inert Gas (MIG), Oxy-acetylene, Stick welding.
- TIG process—highlight constant current (amp) machines.
- OHS welding protection.

### Day One

Butler gave the Fellow a tour of his workshop and the machinery he uses. The workshop included the following equipment:

- Miller advanced inverter TIG welders
- pan brake sheet metal folder
- sheet metal guillotine
- kick and hand shrinker
- flanging machine
- Pullmax
- Yoder Power hammer
- air planishing hammer
- milling machines
- lathe.

# The International Experience

The preliminary session provided an overview of the science of metal. Time was also spent learning shrinking and stretching techniques on the power hammer and the Pullmax machine.

## Days Two and Three

On each day of the seminar the Fellow and Butler reviewed what had been learnt the previous day. Because of his professionalism and commitment to effective pedagogy, Butler insisted that the Fellow had a clear understanding of what had been learnt in previous sessions before moving on to the next level.

Over the second and third days the Fellow spent a considerable amount of time making an automotive guard and fender section. This consisted of producing a paper pattern off the sample guard that then had to be marked accurately on the sheet steel. Butler explained the importance of paper patterning and how the pattern is used to guide the shaping procedure.

After the section was cut out the Fellow installed thumbnail dies in the power hammer and performed the shrinking of the high crown shape. After the desired shape was created by shrinking, the correct stretching dies were selected by use of the radius gauge and installed in the power hammer. The Fellow then performed a wash over: a general smoothing of the panel.

## Day Four

During this session, continuation of guard section and the importance of welding was explained. This included:

- Controlling the chemistry of the weld pool.
- Eliminating surface oxides and contaminants.
- Planning for shrinkage.
- Getting the right heat in the right area.
- Understanding the numbering system used to determine the correct filler material.
- Effects of alloying elements.

After a theory lesson, time was spent producing sample welds with both steel and aluminium. The Fellow then continued fabrication of the guard section begun on Day Two. The next step in the fabrication was smoothing in the air planishing hammer. Smoothing is the blending or stretching of the low sections in the panel until the desired shape is created.

When smoothing, maximum die contact is needed and correct die choice is critical. After the desired shape was created the next stage was to turn a flange on the lower edge of the guard to provide strength. Forming a bead or swage with the Pullmax machine along the lower part of the panel parallel to the lower edge was the final step. A bead can be used for both decorative and strengthening purposes.

# The International Experience



*The Fellow smoothing in the air planishing hammer.*



*Bead or swage in panel.*

# The International Experience

## Day Five

This session consisted of the shaping of a vintage car door skin on the power hammer. A car door skin is a perfect example of a low crown shape. During this shaping process the following techniques were learnt:

- Choosing and installing dies to create the desired amount of stretch.
- Varying the speed of the power hammer to create the desired shape.
- Smoothing the door skin.

At the conclusion of the five-day seminar Butler gave the Fellow a tour of Boston. Spending time with Butler outside the workshop environment provided a unique opportunity for the Fellow to discuss with him the various aspects of their trade. Butler's willingness to share his extensive experience opened the Fellow's eyes to the myriad fabrication possibilities using power equipment. Of particular interest were his insights into the possibilities of using power equipment for metal shaping in the architecture, furniture and art sectors.

A visit to an exhibition at the Boston Museum of Fine Art on the Arts and Crafts Movement during the early 20th century reinforced to the Fellow the potential use of power hammer metal shaping beyond the traditional automotive and general transport industries. The works by Greene & Greene of Pasadena, California, displayed in the exhibition generated new insights into the many aspects of design and the eras our work is defined by. Their work also highlighted that to understand the language of our trade, we need an understanding of where those principles of design originated. Butler discussed how metal parts could be shaped and suggested furniture style as another possible avenue for these skills in metal shaping.

## Contour Metal Shaping Inc, Plainfield, New Jersey

**Contact:** Tommy Caruso

Contour Metal Shaping is small automotive restoration business. Founded in 1989 by Tommy Caruso, Contour Metal Shaping Inc is dedicated to the art of classic custom car restoration.

Contour is fully equipped with machines and tooling to handle a wide variety of specialised projects in metal, from classic car bodies to rare architectural pieces.

Equipment used in the shop includes:

- Yoder LK90M Power Hammer
- Pettingell Power Hammer
- wheeling Machine
- air planishing hammer
- shrinker/stretchers
- panel flanging machine
- P7 Pullmax
- bead rollers
- Miller Syncrowave TIG Welder.

# The International Experience

The visit to Contour Metal Shaping gave the Fellow the opportunity to see how the power hammer can be used to complement the equipment found in Australian professional restoration workshops.

It also provided the Fellow an opportunity to run the power hammer and perform the following techniques:

- Set up and paper pattern of buck for a Ferrari rear quarter.
- Laying out of patterns, marking and cutting out material.
- Installation of dies and shrinking and stretching techniques to achieve the shaping of quarter panel to fit the buck.

## Metal Craft Tools, Crossville, Tennessee

**Contact:** Cal Davis

Metal Craft Tools is a family owned company dedicated to training in metal shaping, powder coating and welding. The metal shaping classes run by Davis are structured from beginners to advanced. The training programs include:

- Learning differences between shape and form.
- Shaping metal by hand.
- How to shrink metal by compression.
- How to stretch metal by compression.
- Introduction to the English wheel.
- Introduction to the Pullmax.
- Introduction to the power hammer.

The visit included a tour of the company's skills centre and the opportunity to see the power hammer designed and built by Metal Craft Tools with the assistance of Fay Butler. It is an affordable and effective small machine that can be easily assembled and function in any workshop as an alternative to the Yoder Power Hammer. The Fellow was given the opportunity to run the machine and perform shrinking and stretching techniques

## Rare Fab, Cedar City, Utah

**Contact:** Josh Bullock

Rare Fab caters to the street rod and restoration industry. The company specialises in traditional methods of metal shaping using equipment such as the Yoder Power Hammer, shrinkers and stretchers, Pullmax machines, milling machines and lathes.

Josh Bullock is a young talented tradesman who is a graduate of Fay Butler's seminar and apprenticeship program. The visit to Rare Fab gave the Fellow an important insight into how a young restoration shop can grow by utilising power equipment to perform all the necessary procedures involved in creating quality parts.

This visit was particularly beneficial as it established what will hopefully be an ongoing professional relationship with a craftsman of similar age and experience to the Fellow.

# The International Experience

## Walden Speed Shop LLC, Pomona, California

**Contact:** Bobby Walden

Bobby and Melinda Walden established the Walden Speed Shop in 2005 to service the hot rod restoration industry. Bobby Walden is yet another alumni of the Fay Butler apprenticeship program. The visit provided the Fellow with important insights into the use of the power hammers for general restoration and low-run production parts.

Bobby Walden demonstrated speed and uniformity with two panels, both being shaped by him without assistance. The first was a roof insert. This panel was shaped in two hours using the power hammer. The surface finish was perfect, with no additional smoothing required. Given the size of this panel, it would have taken two skilled tradespersons using the wheeling machine a total of eight working hours to finish the job.

The second panel was a door skin. It was shaped in 45 minutes on the power hammer. One operator could shape the same panel with a wheeling machine in about four hours.

In the making of reproduction parts, prototypes, useable arts or any other application, the power hammer cuts down labour time considerably. As the prototype industry in particular operates on shorter lead times from concept to market, skills like hammer forming greatly reduce lead times in this field.

# Knowledge Transfer: Applying the Outcomes

Australia has an excellent skills training system and the power and air planishing hammers could easily be fitted into already existing TAFE metal work curricula. The wider use of these machines would give the automotive industry the capacity for faster builds and the ability to better accommodate small volume production. A skills upgrade through the wider use of the power hammer would make the panel forming industry in Australia more competitive for automotive and wider applications.



*The Fellow and his power hammer*

## Knowledge Transfer: Applying the Outcomes

For any specific trade profession to be accepted by an industry it is required to adhere to agreed professional standards. The first step in achieving these standards is to have an accepted language that is documented and well defined. The language should be based on science, be simple, descriptive and should honour the past history of the trade. The language of a particular trade or craft is the basis for the effective communication of information between craftsmen and the development of new ideas. Currently, the metal fabrication and shaping trade has neither accepted standards nor a common language.

Metal shapers need to understand their materials, including the selection, purchase and application of materials in their different available alloys. An understanding of how metals move at the atomic level, the effects of plastic deformation as a strengthening mechanism, and the effects of the introduction of heat are important in understanding how to produce parts that will perform in the required service.

The established science and language in metallurgy must be the basis of any beginner's course in metal shaping. A professional metal shaper should have the ability to understand and use the wide range of reference materials available in metallurgy and engineering.

A professional metal shaper also requires a scientific understanding of welding. An understanding of how to control the chemistry of the puddle, eliminating surface oxides and contaminants, planning for the shrinkage due to the temperature differentials, and the use of the electric current as a heat source are required to accomplish quality welds.

Understanding the three shapes of compound curves, high crown, low crown and reverse curve is crucial. Also, an understanding in design and design language is important.

After a basic knowledge is gained, the issue of tools and equipment can then be addressed. Powered equipment will always develop more force compared to tools requiring human power. For the professional, this translates into higher productivity. The best force machine is the American style power hammer. Other machines can supplement the power hammer for light smoothing and detailing and strengthening the edges of a panel.

Although the power and air planishing hammers are commonly used in the USA, the Australian industry still utilises the English wheel. The focus of any knowledge transfer should be to highlight what the power and air planishing hammers can do compared to the English wheel.

After completing some research upon his return from the USA the Fellow secured the only known Yoder Power Hammer in Australia. The best method to transfer knowledge on the use of the power hammer is by way of demonstration. This will be done by the Fellow at his workshop in Bayswater, Victoria. Invitations to see these demonstrations will be made to local and interstate commercial restoration and fabrication businesses, car clubs, TAFE trainers and apprentices.

Through the Fellow's involvement with the Auto Horizon Foundation he will demonstrate the power hammer to apprentices completing volunteer work with FR1.

# Recommendations

## Government

### Recommendations:

- The power hammer is made predominantly in the USA, to reduce importing costs it is recommended that incentives are offered for the importation of power hammers.
- Assistance/Grants be offered to businesses for local manufacturing of the power hammer onshore.

## Education

### Recommendations:

- That the Automotive Centre of Excellence (ACE), located at Kangan TAFE, utilise the skills gained by the Fellow and incorporate into its curricula practical demonstrations of the power hammer available at the Fellow's workshop.
- Influence TAFE and private providers to incorporate power hammer skills into stand-alone competencies or as an elective, so that providers can set training plans according to the car restoration segment of the body repair industry.
- To demonstrate the importance of the benefits the power hammer would bring to the industry the Fellow would run open nights for training providers with a view to promote investing in a power hammer for the benefit of current and future students.

## Industry Associations

### Recommendations:

- That automotive clubs access the knowledge and skills gained by the Fellow to understand better the potential of power hammer technology in the restoration and repairing of motor vehicles.
- That this Fellowship be used to raise awareness of the productivity potential to automotive repair, design, useable art and similar companies in the utilisation of power hammer technology in delivering faster and better quality product for their customers.

## ISS Institute

### Recommendation:

- That the ISS Institute work with the Fellow to arrange a series of practical workshops on power hammer use.

# References

## Further Reading

Moniz, BJ 2007, *Metallurgy 4th Edition*

Bohnart, Edward R 2005, *TIG Handbook for GTAW Gas Tungsten Arc Welding* with Welding Education & Consulting & the staff of Miller Electric Mfg.Co.

Miller Electric Training Dept., revised 1994, *Miller Gas Metal Arc Welding*