PUDDLED IRON

Wrought iron is the old material of the blacksmith. It resists corrosion far better than modern steel as is amply shown by the survival of much of our heritage of wrought ironwork, in many cases, centuries old.

The Real Wrought Iron Company are able to offer genuine wrought iron rolled into all sizes of square, round and flat bars from stock or to your requirements. We specialize in production of iron for the purposes of restoration and can match any existing section. We also make sheet iron for cold repousee work and amour etc. and manufacture special moldings in wrought iron.

Wrought iron owes its rust proof properties to its fibrous nature. In modern terms, the refining of iron is a crude process, and results in the inclusion of non~corrodible slags in the structure of the metal. These slags, and the softness of the material when hot, led to an ease of working by hand which gave rise to a great art form. Wrought Ironwork

CHARCOAL IRON

Before the dawn of the industrial age, the metal of the blacksmith was wrought iron, made and refined in charcoal fires. The iron combined with the elements of the fire to make an individual material whose properties have never been equalled for ornamental ironwork The great wrought ironwork of the eighteenth century was done in such metal, and very many examples exist today. For example the Screens at Hampton Court by Jean Tijou, the work of Thomas Bakewell and the Davies Brothers' gates at Chirk Castle, to name a few.

The close of the eighteenth century brought mass -produced puddled irons. Made in a coal-fired furnace, remote from the fire itself. Puddled iron is the typical engineering material of the nineteenth century, works well hot and resists corrosion. It has, however restrictions for cold working, particularly in sheet form.

Charcoal iron can withstand corrosion for hundreds of years. Traditional ironwork is not easy to maintain. Elements of design are frequently difficult or even impossible to paint This applies particularly to lifework and repousee) especially where elements are back to back or three-dimensional. The only material to use for replacements during conservation is one that is intrinsically proof against corrosion.

Charcoal iron sheet is soft and malleable, when annealed, so that a good depth of cold working, and sharp detail is possible without cracking It is softer and more pleasant to work than mild steel, and responds well to both lead block and pitch block repousee techniques.

Charcoal iron sheet has a smooth surface, largely free of scale, and responds well-to planishing and abrasive polishing) making it ideal for the accurate replication of armour and weaponry.

The Real Wrought Iron Company have lately begun the recycling of old charcoal iron and have pleasure in making it available once again. Sheet is available in standard rolled thicknesses, forged to your specified gauge, or in billet form for your own reduction.

MILD STEEL

Alloy of iron and carbon. Discovered in 1856 in an attempt to mass-produce wrought iron. Made by melting of cast iron and removal of carbon and slag. Small residual carbon content Cast into ingots and rolled into all sections. Cheaper than puddled iron after 1876. Higher strength and better consistency. Poor resistance to corrosion.

WROUGHT IRON

HISTORY Wrought iron has been used in building from the earliest days of civilization, wrought iron door furniture being commonplace in Roman times. The structural use or iron dates from the Middle Ages, when bars of wrought iron would be used occasionally to tie masonry arches and domes. This use of wrought iron in tension guaranteed its use throughout the ascendancy of cast iron in the canal and railway ages, as cast iron is strong only in compression. The ill fated first Tay Bridge was of cast iron beams tied with wrought iron. The demand for higher dynamic loads in bridges and warehouse buildings, and the ever greater spans of train sheds towards the end of the nineteenth century, led the designers of buildings to acquire the technology developed to build ships of iron, and create beams of riveted wrought iron rolled sections. By the turn of the century this had led to buildings completely framed in wrought iron, and later steel, girder sections, and cast iron was once again relegated to an ornamental role.

Our main concern with wrought iron, however, will be in its application to gates and railings, frequently given an ornamental treatment by the blacksmith. There are wrought iron railings in Westminster Abbey from the thirteenth century, which, in essence display all the characteristics which we have come to know as ~ 'wrought

ironwork', although lacking modern refinements such as symmetry and sweetness of line, but the great age of British ironwork, known as the English style began at the end of the seventeenth century. A French fashion for the Baroque style in gates and railings, swept the country houses of Britain, following the import of craftsman by William and Mary, and the greater part of our national stock of good ironwork dates from the early years of the eighteenth century. After the rise of cast iron as an ornamental medium, wrought iron tended often to take a secondary role, owing to its comparative expense, each piece being made by hand, while castings could be repeated ad infinitum, once the patterns were made. Technically, however, the craftsmen of the age of machines, excelled their forebears, as indeed they must while making mechanical components, so that the ornamental blacksmith work of the nineteenth century displays a perfection of manufacture not seen before nor since

After the introduction of mild steel, cheap because of its ability to be mass produced, wrought iron, and the craft skills associated with it, gradually disappeared in accordance with the general decline of craft standards in the twentieth century, until the last ironworks ceased production in 1974. From 1982 Chris Topp & Co. and later The Real Wrought Iron Company, have made available a limited supply of puddled wrought iron, derived from scrap metal. The subsequent years have brought a steadily increasing demand, as the blacksmiths of Britain have slowly taken up again the ancient skills.

IDENTIFICATION

Wrought iron is unlike cast, in that it is not brittle, and seldom breaks. For this reason, wrought ironwork is frequently far more delicate, although years of paint can obscure this. Cast iron is most frequently identified by its repetitive nature, and forms, which could be carved in a wooden pattern, but not made by hammer and anvil.

Telling wrought iron from mild steel is often more difficult, as both will bend, and not break Frequently, however, work in mild steel is readily identified by the lower standards of workmanship often used. Look for evidence of electric welding Also mild steel is often given away by more active corrosion, which tends to run out of the joints in a steel gate, and stain the paintwork, where this is seldom the case with wrought iron. Wrought iron may also be dated, approximately by its texture. Until the very end of the eighteenth century, sections of wrought iron were derived by forging of billets by hand or water power, this resulted in a more or less uneven surface texture, and very sharp corners. A foreshortened view of a bar displays well the irregularities of the surface. Rolled bars, on the other hand, produced from the beginning of the nineteenth century, are perfectly smooth, and the corners can display a small radius. Nineteenth century wrought iron is known as 'puddled iron'.

ALTERNATIVES

The modern replacement for wrought iron is mild steel. Many metalworkers are perfectly content to use this much cheaper metal both for new work and the refurbishment of old. I would like to suggest the reasons why this is not acceptable, while wrought iron is yet available.
1. The weathering properties of wrought iron are well known. While it does of course rust in time; with reasonable maintenance this can indeed by a very long time.
The fact that so much ornamental work survives from three hundred years ago says a lot for the material. On the other hand, steel is well known for its corrodibility, and the intricate forms and water traps of 'wrought ironwork', only encourage corrosion. Hence it is normal practice to coat steelwork with zinc, which does indeed delay corrosion, but neither galvanizing nor zinc spraying can effectively be applied to complex forms.

2. Modern conservation practice insists on the replacement of materials with like materials. When wrought iron is available for the repair and replication of wrought ironwork, why use mild steel?

3.The craft of the ornamental blacksmith, as previously practiced to a high degree of skill was virtually eradicated by the shift to mild steel, with its ready application to 'high tech' techniques such as electric welding. As mentioned above, some of the blacksmiths are learning again the old skills. Only by use of the traditional methods and materials can work of an appropriate standard by produced.

SPECIFICATION

There is a wide disparity in cost between the cheapest of work, and the best. Without a sufficiently tight specification, work acquired on a competitive basis will tend towards the lower order. There is a need for a standard form of words which can be use to specify ironwork of the highest order. Definition of the materials is a good start, for example 'puddled wrought iron' rather than just 'wrought iron', which is often misinterpreted. Mention of specific techniques is important, 'all welding to done in the fire" is often used, or less positively, 'no use of electric welding'. Assurance of quality, however, can only be guaranteed by examination of the track record of the workman, or from the submission of samples. (for more detailed specification see A recent specification...)

MAINTENANCE

Ironwork is commonly supposed to be nearly free of maintenance. Unlike wood work which is religiously subjected to a stern regime of regular painting, ironwork is frequently left to rust undisturbed for long periods, so much so that the only attention that much even important ironwork receives, is periodic major overhaul, at great expense. This could be avoided by frequent small attention. Insistence on frequent inspection would be of benefit, perhaps once a year, with immediate, and usually trivial remedial work to arrest any developing problems.

FUTURE SUPPLIES

At present, supplies of puddled iron are derived from old material of large size, which can be rolled directly into bar form. Although, to date, such raw material has been available, we are installing the plant required to process general wrought iron scrap, which by a forge welding process produces an iron of high quality. As there are nearly limitless supplies of such scrap, the future of wrought iron seems secure.

WROUGHT IRON - TECHNIQUES OF RENOVATION.

There are two types of wrought iron. The irons of antiquity, now known collectively as "charcoal iron", and a mass-produced iron, produced in the 19th century and early 20th century, known as "puddled iron". Although pre-18th century wrought ironwork is, of course composed of charcoal iron, it is normal to make repairs and replacements in Puddle iron, owing to its similar properties. On no account should mild steel be used on external work without zinc coating by galvanizing or hot metal spraying. As neither of these treatments is permissible nor effective with ancient work, the use of mild steel is effectively ruled out.

Removal From Site.

Most work is ideally carried out in workshop conditions, and it is frequently the case that iron components can be removed easily from site. In the case, however, of railings, gate Piers etc which may be fixed into stonework, usually in lead~filled sockets, removal may not be possible without sacrificing expensive stonework. Lead may be removed from sockets by mechanical means, but this is very laborious and any attempt to melt the lead will inevitably result in failure, and damaged stonework unless the Socket can be held horizontally to enable the lead to run out.

Cleaning

Ironwork is generally covered in paint and frequently a build-up of rust in water traps etc. Commonly, paint and some of the rust are removed by grit blasting. There are, however good arguments against grit blasting, as follows, so that it should be regarded as a last resort.
Grit blasting will remove the outer surface of the iron, known as mill scale. This mill scale, which is typically 90% intact on work 300 years old or more, is the original surface to which paint was applied, and as such is as worthy of conservation as the rest of the iron. Further, the mill scale, in such a case has a proven record of keeping corrosion at bay. It is a protective surface in its own right, and hence of value. Further still, grit blasting will render all of the iron surfaces the same, thus removing permanently any evidence which may be present on the surface of the iron. For example, a component, which has been renewed, and is thus not original, will exhibit a different color of mill scale to the original. It is often the case that successive generations of repair can be detected, on the basis of color alone. A surface which was originally polished for, say, indoor use, may still retain its bright appearance, under the paint, giving us evidence, perhaps of a former use. Likewise, file marks etc, giving evidence of techniques of manufacture, will be removed by grit blasting.
Where possible, we will always recommend paint stripping by chemical means, with a thorough removal of the chemical agents, usually by steam cleaning. This will result, for the most part in the restoration of the piece to its original appearance as it was immediately prior to painting. Rust deposits are normally dealt with by the application of heat. Rust scale does not expand when heated to the same extent as does the iron. The differential in expansion causes the rust to lose its grip, when it may be shaken or brushed off. Heating the area to a red heat also results in the reduction of the surface layer of the metal to a consistency similar to mill scale. Often, where there has been a considerable accumulation of rust, the application of heat is needed anyway as part of the remedial process. (**SAFETY NOTE:** Wrought iron is frequently coated with lead based paints, often with a 75% lead content. Care must therefore be taken, particularly with grit blasting, to ensure that both operatives and the public are protected and that the lead working regulations are adhered to)

Dismantling

Ironwork is often fastened together with riveted, or tenoned joints. It is not possible to part such joints without at least some damage, or weakening becoming evident on re-assembly. It is worth avoiding the parting of frame joints etc, merely to gain access to corroded components, as the frame will never be as strong again. Where tenoned joints must be parted, it is nearly always necessary to replace the tenon with a screw or screwed tenon, in order to gain adequate strength.

Repairs and Replacements

As a matter of course, the replication of components should be carried out in a manner similar to that which was used for the original creation of the piece, and in similar materials. Ideally, all work to an ancient piece should use the old techniques of forge welding, tenoning, riveting and collaring etc. so that a high degree of blacksmithing skill is generally required.

However, it is often the case that components cannot be completely removed from the job, or that only small work is need to a large component. In this case, recourse must be taken to more modern techniques.

For structural purposes, where part replacement is required, as, for example in the case of a gate back stile, which may be rusted away at the bottom, arc/mig welding is used to join on the new part. No special equipment is required for the electric welding of wrought iron, only that normally used for the welding of mild steel; however, mild steel electrodes or MIG wire are not acceptable, a ferrous non-corrodable alloy must be used. Care must be taken in preparation however, as wrought iron is a laminar material, and welding must be carried out through the full depth of the section. Attaching components to the surface of wrought iron sections is not very strong. Alternatively, gas welding or brazing may be used, and are often useful for the attachment of components such as waterleaves, where the original method of forge welding or riveting cannot be done.

Sections which are heavily pitted, or wasted, but which are still structurally sound, may be repaired by the puddling in of new wrought iron, in the form of thin rods by the gas welding process. Iron thus deposited has no laminar structure, and hence little tensile strength, but otherwise appears to exhibit the properties of the parent metal. Alternatively, these sections can be built up by electric welding, but again use must be made of a suitable alloy. Care should be taken to avoid distortion of any section so treated.

Sheet work, such as leaves, being often impossible to access for the painting of both sides, is the usual candidate for replacement. For many years, there was no commercially available supply of iron suitable for the often-deep distortion necessary in repousee work. Copper was often used, but it is soft enough to be easily bent, and will not hold paint well, while mild steel, particularly in thin sheet form will soon rust away. Chris Topp & Co, a few years ago addressed this need, and by recycling the scrap iron resulting from the restoration of pre-19th century wrought ironwork, now produce a sheet charcoal iron of superior quality, for repousee work etc.

It must be said that often, the repousee leafwork found on ancient work, is of such a high standard of craftsmanship, that one cannot hope to accurately replicate it. In this case, we often make a point of preserving, at all costs, at least one of the originals, in order to give future students at least a clue. When a piece of sheetwork is reduced virtually to lace, it may still be conserved, by scrupulous cleaning and the application of a layer of epoxy-resin to the rear surface. The detail can then often be restored by careful carving into any resin protruding on the front surface, with files etc.

Reassembly

The most common reason for the rusting of wrought ironwork, is the gathering of water in places which will not dry. Wrought iron will last indefinitely, with reasonable maintenance, if rainwater is kept at bay. Such bad places are the joints between members which lie alongside one another, for example, between a shadow bar and its mate, touching points of scrolls, particularly on a horizontal surface, water leaf sockets which are upward facing, and any area which is constantly submerged in vegetation.

When work is assembled, care should be taken to ensure that mating surfaces are protected by paint, as well as are visible surfaces, and that a suitable filler is applied before the work is assembled. We use a modern silicone mastic, which sticks very well, and is totally waterproof. Red lead putty is the traditional one, and if well sealed with paint, at regular intervals, will serve well. Waterleaf sockets may be filled with epoxy resin, poured in until it overflows, or pitch can be used, on the basis that in the summer, it will melt and renew its seal with the iron. Lead poured hot was often used, but as this does not stick to the iron, and water will be able to penetrate, it seems to me to be worse than useless.

Protection.

Galvanising and zinc spraying have been mentioned, There are good reasons why these will not do. Galvanising depends upon dipping the work, after cleaning in acid, in a bath of molten zinc, which leaves a rather thick layer of zinc on the surface. Drips frequently form which must be ground off. Wrought iron is often etched very deeply by the action of the process. If you add to this that the small joints will remain full of acid after the treatment, it is easy to see why this process is not appropriate to delicate and complex wrought ironwork. (Additionally, in certain circumstances, the galvanising process can deeply etch the surface of wrought iron causing irreversible damage to the piece.)

Zinc spraying is a far less brutal process. It is a hand method, which consists of removal of all mill scale by grit blasting, and the immediate application of a zinc coating with a type of flame gun. The objections to grit blasting have been enumerated above. Further, it is not possible to clean very small joints by grit blasting, from the physical restrictions imposed by the size of a grain of grit, neither is it possible to clean nor spray material which is not accessible to line of sight. The water traps in wrought ironwork are just such small joints and out-of-the-way places.

Owing to the natural ability of wrought irons to resist corrosion, by reason of their in-built barriers of slags, it is sufficient to protect ironwork by a good coating of paint. However, I cannot stress too strongly that, in common with other items placed out of doors, such as woodwork, wrought ironwork needs regular maintenance. Chips and developing problems should be dealt with at the earliest dry opportunity, and the work should be painted at least every five years. See elsewhere for our preferred paint system.

NOTES ON MAINTENANCE OF WROUGHT IRONWORK

Suggest the establishment of a rolling programme of maintenance, of all items of ironwork, based upon the following schedule.

1. Initial attention in the form of repair or restoration.
2. Annual inspection, both rigorous and minute, of every detail of ironwork. Look particularly for signs of rust seeping from, or water lodging in joints. Any chipping of well-ventilated areas is not too significant.
3. Attend to any problems at the earliest opportunity, but only in periods of warm and dry weather when joints can thoroughly dry out. Any rust scale should be removed, preferably by local heating.
4. Try injection of low viscosity, oil based rust inhibitor into joints, followed by resealing of damaged areas by touch-up paintwork.
5. Thoroughly re-paint ironwork periodically, but at most five-yearly.
6. Long term plan for stripping of accumulated layers of old paint, accompanied by any repairs. Stripping preferably by purely mechanical and chemical means, rather than by grit blasting, this removes the iron's own original protective layer of oxide.