Principles and Practice in Watermill Repair

SPAB Mills Section, 37 Spital Square, London E1 6DY
Tel: 020 7456 0909 / 020 7377 1644 Fax: 020 7247 5296
e-mail millsinfo@spab.org.uk

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The advice given is based upon what the Mills Section S.P.A.B. believes to be sound and satisfactory practice for the repair and preservation of mills generally. This advice is offered in good faith only as a guide.

Due to widely differing circumstances from one mill to another, it cannot be ensured that the practices and methods advised will necessarily be directly applicable or appropriate.

It is therefore the responsibility of those using this document to ensure that the advice given is appropriate to the particular application and for controlling the quality of workmanship and materials. The Society does not accept responsibility for the satisfactory nature of any work carried out.

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Some principles and practice in watermill repair

1. Why protect mills?

Watermills and windmills are a part of our heritage and for many reasons have an important place in our lives. Inventions of the industrial revolution brought the mills to great efficiency and semi automation, the further development of which affects everyone today. As well as their place in social and economic history, mills are a vital part of the history of mechanical engineering and the development of motive power for the processing of raw materials.

The quality and endurance of craftsmanship seen in the great wooden and iron machinery and the beauty of an old mill in the landscape are things we can all appreciate. In today's competitive world the corn mills, once vital to our survival, are places of great interest and quiet industry, and their wholemeal flour is ever increasing in popularity. People may simply enjoy visiting mills with their families and friends, or perhaps take an active part in their restoration, operation and maintenance. Whatever the extent of involvement, mills will contribute to the quality of life.

2. Which mills to repair

2.1 The Best Mills

The majority of watermills have already been lost, spoiled by house conversion, or have been gutted for other uses. Today, any watermill with machinery must be fought for. Complete watermills which are typical of their region and which, through their structure and machinery, illustrate a period in history or several stages of development, whether workable or not, must be the best candidates for restoration.

2.2 Limitations of Ownership

Unfortunately, outstanding mills may have unsympathetic owners, while derelict, incomplete mills often find good owners, and can be the subject of dedicated repair work. Restoration is undertaken by many different people and organisations on mills which are equally variable, from complete and in working order to those in the last stages of dereliction and decay. In willing and competent ownership a mill can be an asset, but to the unwilling or incompetent it will invariably be a liability. Experience over many years has proved that a sound working mill in poor ownership rapidly becomes a potential ruin, while a derelict mill in competent and enthusiastic ownership can, with time, become a working mill again, a credit to the district, and which may even become self supporting.

Clearly then, considerations of ownership will be important, not only in determining which mills can be repaired, but also the degree of repair which is best in each case. Generally speaking, the extent to which a mill can be repaired is proportional to the quality and security of ownership, the degree of dedication of its owner or restorer and, often, the availability of capital.

2.3 Holding Repairs

Those mills eminently worthy of retention, but which, due to limitations of ownership or finance, cannot be properly repaired, should not be `written off'. They should be `listed' and have small grants made available by local authorities, sufficient to enable holding repairs to be carried out, with the aim of keeping the mills standing, weatherproof and complete. Such repairs can often be undertaken successfully by volunteers. In this way, options are kept open and in the course of time new owners may initiate proper repairs. It is hoped that the local authorities will encourage people who badly neglect or cannot afford to maintain listed mills, to sell or lease them to others who would repair and maintain them.

3. Degree of repair

3.1 Range

A wide range of repairs is possible and all are worthwhile. At one end of the scale is the `holding repair'; examples would be repairs to the roof, making window openings watertight and shoring up weakened floor beams. Such work could also include improving drainage to a ground floor where water is seeping in. At the other end of the scale is full restoration, followed by regular working of the mill.

In order that work may progress in a logical manner, it is important that the mill be thoroughly surveyed. Using this information will assist with drawing up a priority list, showing the best order for carrying out the work.

Before commencing any significant repair on a mill, it is important that some research is carried out, which may bring to light things like changes of machinery, evidence for which can be lost completely during restoration. Written records, sketches, paintings, maps and photographs, as well as a detailed study of the mill itself, can all be useful in unravelling its history.

3.2 The value of Modest Repairs

A scheme which proposes conservation of what is there, but does not set out to replace missing parts is still very worthwhile. It could be compared to an archaeological excavation of a Roman villa: nobody would suggest that the remains should not be preserved, simply because the walls and roof were not to be rebuilt. In the past, far too much emphasis has been placed on the external appearance of mills; however, a somewhat run down watermill complete with machinery but without water supply is of far greater historical importance and interest than a mill stripped of machinery and in excellent structural and decorative condition as a house conversion.

3.3 Change from Modest repairs to Full Repairs

There is the dilemma that limited repairs aimed at conserving what still remains could deter further more ambitious repairs to working order at a later date. Work carried out to preserve the mill may have to be removed to make way for full and proper repairs to bring the mill into a sound state. If later it is possible to attempt more ambitious repairs to working order, then the temporary works will have to be removed to allow restoration to take place. The cost of these full repairs is likely to be considerably more than the holding repairs already carried out, but who can say before a project is started if finance and enthusiasm will increase, decrease or remain constant? Experience shows that working order restoration can often follow earlier holding and more modest repairs. If the people concerned are capable of completing such a project, then earlier work, which may have to be modified or even scrapped, should not deter them. If it does, this may signify they are taking on too much.

3.4 Full restoration

There is no doubt that the best way to appreciate a mill is to see it working, doing the job for which it was built; in the case of a corn mill, the production of flour. The difference between a static mill and a working one is life; a comparison can be made with a static locomotive in a railway museum and one on a main line at 70 mph. It should be remembered however that, like any machine, a working mill needs skilled and knowledgeable people to run it and must be maintained to a much higher standard than a static exhibit. Someone must be responsible for it on a day to day basis. Ownership is therefore a key factor in determining which mills to restore fully.

It is vital that all aspects of the restoration task are understood before work is commenced as there is always the danger that a mill will be partly dismantled for repair, and then, through lack of funds or enthusiasm, the project is halted, resulting in the condition of the mill being made worse. Some of the questions which ought to be asked at the outset are:

(a) How much are the planned repairs likely to cost?
(obtain quotes from recognised millwrights as a guide)

(b) How much money is available? (assess total funds available and any likely grant aid)

(c) Are there local sources of materials or services which can be tapped, either at reduced cost or as donations?

(d) How much, if any, of the work can be undertaken by volunteers, bearing in mind their skills, the time they have available and the facilities at their disposal?

What is needed is the ability to identify and manage help from all sources. A good plan is to aim for full working order but to realise that this might not be achieved, through lack of funds or the departure of a key person. If the early work is good the project may become more ambitious at a later date. Have a realistic view of your own abilities. Volunteers can do a lot, but some work is best entrusted to the professional unless you have an unusually skilled team.

3.5 Planning Legislation

Where construction work or a change of use for the mill is proposed, it will be necessary to establish whether Planning Permission is needed. If so, the submission of detailed plans to the local authority will be required. Many mills are now Listed Buildings, which are entitled to the protection which Listed Buildings legislation provides. In addition to Planning Permission, Listed Building Consent may be needed before work proceeds. This procedure is invoked when there is an element of demolition or construction which can include quite minor items as, say, the removal/replacement of windows or other parts. It can apply when either internal or external parts (including machinery) are concerned, whereby the work may change the character of the mill. This, again, will require the submission of plans to the local authority.

In general, where work is planned which lies outside the scope of normal routine building or machinery maintenance, it is recommended that the local authority be consulted at an early stage concerning any formalities or revision of plans which are required to be cleared before work is commenced.

4. Guidelines on repair and restoration

4.1 Introduction

There are four main factors leading to the success or failure of mill repair:

1. Design.
2. Materials.
3. Craftsmanship.
4. Maintenance.

If all four are good, the work will last. Even a century ago one or two of these factors may have been lacking but the others would have been above average and the mills survived. Today, all four may well be below average or absent altogether and the result is rapid decay, a waste of money and disillusionment for everyone concerned.

The survival value of mill repairs is too often neglected. In recent years, expensive new work has sometimes lasted only a few years; poor materials and lack of finance being used as excuses when bad workmanship was really the main cause. If survival value is ignored and large sums of public and private money are wasted, some of our mills could be abandoned as being too costly to maintain. It is therefore vital that the causes of decay, and the materials and methods which can be used to prevent decay, are fully understood by everyone concerned with the restoration and maintenance of watermills.

The SPAB publishes a series of leaflets on the principles and techniques of historical building repair, and these may be consulted for additional information.

4.2 Bad design and the need for guidelines

Repairs to watermills in the years before and after World War Two were in most cases not intended to perpetuate a working condition, but merely to keep the structure standing and safe. Original features were often lost each time a mill was repaired, and this was aggravated by an obsession with external appearance, as if there was nothing of interest within. Incredibly, the machinery of some mills was removed as part of the repairs! As millwrights became scarce, house builders were employed to repair mills, and although some good work was done, results in other cases were disastrous. Even millwrights were not always careful to copy original parts they replaced, and it is not surprising that many watermills today have features which were not part of the mill in its working days. Consequently many mills are changing, and if the trend is not halted they will no longer be interesting, beautiful or accurate examples of early mechanical engineering reflecting their period and region.

4.3 Compromise in Repairs

4.3.1 To what stage in its development should a mill be restored?

As a general rule, a mill should be restored to look as it did when it last worked for trade. In some cases water power was abandoned and the mill finished working by engine power only, and a careful decision will need to be taken in choosing the restoration state to be achieved. Some details may be missing, and a good judgement based on knowledge and experience of mills is required to establish the most appropriate design for any replacement. An important part of the interest in mills is their development from construction date to their last days in use, and care should be taken to identify and retain evidence of this development, whether in structure or machinery. For instance an eighteenth century watermill which had its wooden wheelshaft replaced by a cast iron shaft in the nineteenth century must be kept in the final phase of development, but any evidence of the earlier technology must be scrupulously preserved.

Where compelling circumstances lead to work being done which does not faithfully reproduce the original construction, any replacement should cause minimum injury to the original fabric. Where appropriate, measured drawings or other records should be made so that a proper reconstruction can be made at a later date.

4.3.2 Original `Mistakes' which were traditional practice

When repairing mills it is tempting to correct apparent `mistakes' made by the original builders. This should be avoided at all costs. Such `mistakes' are part of the regional variation and interest of mills, and rationalisation destroys this for future generations. It must be remembered that such mills probably worked well for a hundred years or more.

An exception to this rule is when an undersized timber has broken under stress despite being in good condition, in which case its section may be increased. Here a compromise is made between survival value and historical authenticity.

4.3.3 Old millers' and millwrights' `bodges'

In the last working days of a mill, trade was often in decline and expenditure on the mill was kept to a minimum. Thus some repairs were made with unsuitable materials and with timbers which were not quite of the right size or of the correct type. `Bodges' were also made in later repairs aimed at preservation, long after the mill went out of use. Such sub-standard repairs can be put right in later more enlightened repair work, but great care is needed. For example, what may at first sight seem like a `bodge' may in fact be traditional practice and therefore worthy of retention. Only thorough knowledge and experience of local mills will provide the answer.

4.3.4 Weak original components or strong new ones

When a mill is repaired some parts will be serviceable, some beyond repair and others missing. If it is to be put into working order, it is inevitable that parts of the original structure and gear will have to be replaced. The old material may be strong enough to survive, but could disintegrate under load. In a few cases, such as when very early wooden machinery is completely woodworm-infested, it may be better not to work it, but conserve it as a static display.

As much original material as possible should be conserved, and with a partly-rotted component it is often difficult to decide whether to repair or replace. It is vital that the restorer understands how old timbers can be saved by scarfing in new sections, cutting back and reinforcing, or by consolidation and building up decayed timbers with epoxy resins. If it is impractical to repair an original and interesting wooden component, then a replica must be constructed using the correct material, and the original treated and displayed in a museum section. (see Section 7.6 below).

4.3.5 Project design

Before starting a restoration project, it is strongly recommended that a full appraisal of the proposed work be carried out and a work programme prepared. This can be examined by experts in the various fields involved, and modified as necessary. The final work programme should then run smoothly, and the mill be restored into its original and traditional form. It will also ensure that the work will have good survival value.

4.3.6 Project management

It is important for a successful restoration project that the various trades are properly managed. This will ensure that the work is carried out according to the original intention, and that any problems are resolved quickly as they occur. Failure to manage the project properly will most likely lead to escalating costs. It is therefore desirable, where the owner is unable to provide this service himself, to appoint a suitable person to carry out this function.

5. Practical details of repair

5.1 Buildings

5.1.1 Brickwork and masonry

The repair of brickwork normally presents few problems, as most of the necessary materials are available today. Worn bricks can be cut out and replaced with matching second-hand bricks, or new bricks if these cannot be obtained. The original lime mortar can be reproduced using mature lime putty, but this takes a long time to harden. A compromise is to use a weak gauged mortar of Portland cement, hydrated lime and sharp sand. A 1:2:9 mix or weaker may be found suitable, but aim to match that of existing work as far as possible.

If dampness due to rainwater penetration is a problem, cutting in new bricks and re-pointing will usually be the cure, but joints must be raked out properly beforehand. Some walls may be rendered, and this rendering can be replaced, but if a wall has not previously been rendered, such a coating should only be used as a last resort, as it will alter the appearance and character of the mill. Portland cement is not a suitable material for repairing render; lime plaster or materials similar to the original should be used. Resist the urge to insert damp courses; mills were not built with them and other methods can be used to keep out moisture. Above all, do not use impervious coatings such as emulsion paint or modern exterior wall paints. Lime-wash is best and can still be obtained from specialist suppliers.

5.1.2 Woodwork in general: The need for survival value

Decay in timberwork starts at joints and other vulnerable points in the structure when run off and wind blown water is driven in, aided by capillary action and the natural absorbency of timber. This causes steel fittings to swell with rust, splitting the timber and further advancing decay.

Decay can be counteracted in three ways:

1. Use of timber with high durability such as oak, elm or pitch pine, supplemented by wood preservatives. If soft woods are used it is vital to treat them with preservative. Components must first be completely finished, with joints cut and holes bored. They should then be treated by vacuum impregnation with an organic solvent or water based preservative to medium or high hazard specification. Dipping, spraying, or brushing on of preservative is barely adequate, but soaking in a bath of preservative for several days is better than nothing. In circumstances where vacuum impregnation is impractical, it is better for components to be made from ready treated timber. In the case of outside walls or where timber is exposed to the elements, when joints have been cut the components should be dipped for 5 10 minutes in a tank of preservative. When using preservatives, care must be exercised to avoid the pollution of watercourses (see the advice given by the Environment Agency in APPENDIX II).

2. Where water or dampness is present, all joints and holes should be painted. It is easy to paint the inside of the full length of a hole by using a rod dipped in paint, or by bunging up the hole and filling it with paint for a few minutes. This should be allowed to dry and further paint should be applied on assembly.

3. Great care should be taken to design and make efficient water run off channels at known vulnerable points on the structure.

Further more detailed advice will be found under the individual headings below.

5.1.3 Structural timberwork

The main danger to mill timberwork, apart from rot, is infestation by wood boring beetle. This may be detected by looking for fresh dust below affected areas, or by listening for the sound of death watch beetles in Spring. The infestation can be eliminated by spraying, applying pastes, or even injecting fluid into timbers under pressure. The materials used are toxic, and the work is best entrusted to a reliable specialist firm, which will guarantee the building against re infestation on completion. It is essential to avoid chemicals polluting the river, and it may not be possible to treat areas in close proximity to the watercourses.

The structural timberwork of mills often needs major repairs, due to long years of neglect. The aim must be to conserve as much original material as possible. This can be done by scarfing in new sections, cutting back and re facing, or by consolidating and building up decayed timbers with epoxy resins. Epoxy resins should be used only if no traditional repair solution is available, as they can deteriorate, particularly under light or wet conditions. They should be used with great care, and specialist advice should be sought.

Weak timbers can be reinforced in the traditional manner by fastening new timbers above or alongside. The use of steel girders (RSJ's) or flitch plates to reinforce existing timbers should be avoided except in cases where lack of space prevents use of timber and cost prevents replacement of the original timber.

When a timber is beyond reasonable repair it should be replaced by a new one of the same species as the original. Such timber should be well seasoned and treated where appropriate. Timber used `green' or fresh may twist or shrink in some applications as it dries out. New work should copy faithfully the original in jointing, mouldings, etc., but original adze marks, pit saw lines and graffiti should not be reproduced. It is recommended that new timbers are date stamped, using small punches, so that repairs or replacements can be identified. The whole timber, its best part, or a representative portion, should be kept in the museum section.

If a timber is very large or of difficult shape, and it is not possible to obtain a replacement in one piece, it

may be constructed from smaller components using resin glue. Laminations are a useful way of replacing large or curved timbers that are not available commercially, but should only be used as a last resort.

The replacement of timbers with steel joists or box sections should always be resisted, even if these are `veneered'. Fire Regulations may require structural steelwork to be clad. Mills are `wooden things' and should be restored as such; they will lose their interest and appeal if they have too much steelwork grafted in. Note that new timber for repair is more `honest', as your repair is part of the history of the mill and can be identified as such by future historians.

Second hand timber should normally be avoided in repairs it is harder to work and its purchase could encourage demolition of other historic buildings. Steel tie rods may be inserted in appropriate places to prevent sagging or spreading of timber or brick structures, although in most cases it is better to find and remedy the cause of the problem if this can be done without excessive destruction of the original structure. Steel brackets and plates may be used to reinforce joints, but they should be carefully made to blend in well with the style of any original ironwork, or to be invisible.

If permanent shoring is required, timber should be used if possible. Steel girders are unsightly and will rust if not protected with paint. Needless to say, when additional reinforcement is added to strengthen a mill, it should be so arranged that it does not prevent machinery from turning.

5.1.4 Windows

It must be remembered that mills are more vulnerable structures than houses. They are unheated, and there are sometimes no gutters and down-pipes. Windows must be designed with no water traps and with good provision to lead away run off water. Drip boards must be provided over the heads, and, unlike house windows, the sills should have a steep fall which continues to the back of the sash. Most failures to windows can be repaired with new timber let in, or by resins and strengthening plates. Any new work should, in general, follow details present when the mill last worked. Good ventilation is vital to a mill, and windows should be able to open. Many mills were provided with sashes which could quickly and easily be lifted out - particularly useful in maintenance.

5.1.5 Cladding – Weatherboards

Overlapping boards were commonly used as cladding to timber frames of mills. In the past, boards of elm, oak and pine were used, but hardwoods are seldom used now because of the high cost. Normally the boards have a tapering section obtained by cutting a standard plank longitudinally at a slight angle. `Shiplap' or rebated profiles should not be used unless, exceptionally, they are historically correct. Planks are usually 7" (175 mm) or 6" (150 mm) wide, two boards being obtained from each plank. The narrow edge should not be less than ¼" (6 mm) thick, and 1/8" (3 mm) is lost in the saw cut, so it will be seen that the thickness of the original plank is important.

Boards may be used with a sawn finish if tar is to be applied, but surfaces to be painted are usually planed. At least 1/8" (3 mm) is lost in the planing, and allowance must be made for this when ordering. As a guide, sawn boards may be 2 ex 7" x 1" (175 mm x 25 mm), and planed boards 2 ex 7" x 1¼" (175 mm x 32 mm) P.A.R. (Planed all round). In case of doubt, ask the sawmill for a sample. It is essential that the boards are of good quality, Joinery quality redwood should be specified, and any boards having shakes (splits) or even hairline cracks should be rejected.

To help ensure long life, the boards must be pressure impregnated with preservative by a double vacuum process to high hazard specification. This may use either organic solvent or water based fluid. If the latter is used, the treated boards must be stacked under cover for a couple of weeks with battens between them so that they can dry prior to painting.

Before fixing, the boards must be primed and undercoated on the whole of the outer face, the lower edge and on the inner face for the extent of the overlap. Once on the mill they should be given a further

undercoat and top coat. If this practice is not followed, water will be drawn up between the boards by surface tension and the absorbency of the wood, resulting in a 'soggy sandwich' with rapid rot.

Overlap varies according to the situation. On vertical walls, 1½" (37 mm) may be sufficient. It is worth remembering that a change in the amount of overlap will alter the appearance of the mill. To prevent boards from splitting they should be thoroughly dry and preferably fitted in the summer. If possible each board should be secured by only one nail to each stud/structural timber to allow seasonal movement. (hence the name weather board). This means that nails pass through a board at a point just above the extent of the overlap, and thus pass just over the top of the board underneath. Nails should be galvanised or stainless, and all holes drilled to prevent splitting, as even a very small split either side of the nail makes a point for water penetration. Nails should not be hammered down too tightly, or a split can result.

Butt joints between boards must be protected by sheet metal "soakers" 7" x 3" (175 mm x 75 mm) fitted behind the butts to protect the framing. Corner joints are often finished with a vertical fillet against which the boards are butted. The faces of the corner post in this case are best protected by `Flashband' or sheet metal flashings fixed in place before the fillet and boards are attached. The flashing should be dressed over the brickwork at the foot, to shed any water admitted. In some areas fillets were not used and alternate boards from each side extend to the corners. In this case, sheet metal `soakers' can be fitted to each row of boarding. The careful use of soakers and sealing band around windows and other vulnerable points will help to exclude water. If aluminium is used for soakers, it is important to secure it with aluminium nails to avoid electrolytic corrosion. Aluminium may be painted but the correct `etching primer' must be used.

5.1.6 Plasterwork

Some timber frames were plastered, and it is essential that any repair or replacement is carried out using the traditional mix of lime putty, sharp sand and hair reinforcement. Modern plasters are very hard, and are likely to crack when subjected to the movement and vibration present in a watermill. Wooden battens may be used, treated against decay, and fastened at least ½" (12 mm) apart with galvanised nails. The completed plaster should be protected by a tallow bound limewash.

5.1.7 Roofs

The roofing materials used on watermills usually reflect local vernacular practice, tile and slate being the most common. Repairs to the roof structure should follow the recommendations in 5.1.3. Other defects may include decayed battens or nail sickness, indicated by sagging courses or slipped tiles/slates.

It may be necessary to strip and re lay the roof if there are major problems. The existing materials are usually re usable in part or whole, but should be removed carefully, inspected and sorted accordingly. Any shortfall should be made up with matching sound second hand clay tiles or natural slates. Any lead valleys, flashings etc., should be checked and renewed as necessary in equivalent thickness lead sheet.

When re laying the roof, pressure impregnated battens should be used, fastened with galvanised nails. The battens should be spaced so that the tiles or slates have the overlap recommended by the appropriate British Standard for the pitch of the roof. The tiles or slates themselves should be fastened by copper or stainless steel nails, or galvanised steel or wooden pegs. Ridge tiles should be bedded in a 1:2:9 mortar mix, and lead ridges fixed with copper clips to the British Standard appropriate for the exposure of the building.

5.1.8 Provision for water run off

Good provision for water run off is essential if work is to survive. Obvious vulnerable points include roof junctions and valleys. In a valley gutter it may be acceptable to alter the original levels to increase the run off in heavy rain. Adequate flashing should be used to the original pattern where possible, where roofs and walls meet. Gutters and downpipes should be kept clear of debris and water should not be discharged where it can flow into the foundations and damage the structure.

5.1.9 Machinery

The machinery is the essence of a mill and it should receive the most careful attention in any restoration or repair. Unfortunately, this has not always been the case in the past and, as a result, much of interest has been lost or compromised. Later auxiliary machinery (including engines), may be contentious, but it is important as part of the development of the mill.

Machinery should never be removed from a mill except as a temporary measure pending repairs. In the past millstones and gear have been taken out permanently in order to lighten mills, thus removing their most important and interesting features. If weight is a problem in an ailing structure it is better to shore up underneath until proper repairs can be started. In major repairs, great care should be taken to replace machinery exactly as it was, and correctly aligned, even if the mill is not intended to work. Bins, spouts, twist pegs, bell alarms and all furniture and fittings must all be carefully reinstated. To ensure accuracy, photographs, measured drawings and notes should be made before and during dismantling. A missing machine may leave no more evidence than a few empty mortises or bolt holes. Making a record of such evidence will help to determine the history of the mill.

It is very important that machinery is repaired as it was originally made and fitted, and that it is set up to run as smoothly and efficiently as possible, resulting in less wear and less need for further repair or replacement. The romantic notion of the `old creaking mill' should not be followed.

For sieves, in view of the relatively short life of woven steel mesh it is recommended that stainless steel woven mesh (of correct gauge) be used for restoration purposes.

Cast-iron parts which are beyond repair should be replaced by new castings and not by fabricated mild steel sections. Wrought iron is difficult to obtain, and missing or unserviceable parts can be made from mild steel, provided it is done well. Care must be taken over appearance, and welds must be ground smooth and edges and corners bevelled.

On a safety matter, if a cosmetic repair has been made which would not have sufficient strength to withstand working forces, steps should be taken to ensure that the part cannot be worked. An example would be a broken cast iron shaft that has been welded. It may look satisfactory but is unlikely to have the strength needed for operating.

Ironwork in mills will usually be painted or wax coated, especially if some mild steel parts have been made. Care and restraint are needed when choosing colours. A brown red paint similar in colour to ochre or rust is often suitable, but extra brackets and ties will be rendered less obtrusive if painted black. Not all internal ironwork was painted, and if such is found it should be left unpainted. Internal ironwork should be re painted to the original colour scheme. Working parts such as tentering screws etc., (whether old or new) should not be painted but cleaned down and protected by being lightly oiled or greased.

Today, square nuts have been superseded by hexagonal, but are still available from specialist suppliers, or can be made from standard square section bar, sawn, drilled and tapped. If correct style replacement bolts are not available, they should be forged up. (All millwrights should be able to do this). Alternatively, they may be made from mild steel rod, the head being formed by screwing a nut tightly on to a short piece of thread and then cutting the rod off flush with the nut. Only sufficient thread should be put on the other end to suit the job in hand. Threaded stud should never be used for bolt making except in low cost `holding' work. It has low survival value and if used in moving parts will cut into the wood, allowing water penetration.

Any missing machinery or small parts needing replacement should be studied carefully in similar mills and good copies made. The design of milling machinery was evolved over nearly a thousand years of tradition and practical experience, resulting in the often refined form of the surviving mills. There are sound practical reasons behind the layout of each mill, and the repairer can learn much from someone experienced in running that particular, or indeed any other, mill.

5.1.10 Floors
Good floors are particularly important in a working mill as they need to be swept regularly. If there are gaps between the boards this job is made very difficult, and it is virtually impossible to avoid trapping meal, which can become mite-infested, and difficult to eradicate.

Floor boards of oak, elm or pine, preferably of the same wood variety, thickness and pattern as originally used, should be stacked a year or so under cover, but with good air circulation. They should be fitted in the summer months. Where boards are not tongued and grooved, their edges should be grooved to fit metal cross tongues to allow for seasonal movements without gaps appearing. These tongues should be made of galvanised steel strip approximately 1" x 1/16" (25 x 1.5 mm) cross section.

As with all flooring, floorboard cramps are essential for a good tight fit, and the correct flooring nails (not round wire nails) must be used. A preference should be given for boards a nominal 1¼" (32 mm) thick, rather than for 1" (25 mm).

5.2 Civil works

5.2.1 Foundations
Foundations should be carefully inspected, and if necessary repaired before new work is added. Seemingly difficult foundation work can be undertaken a small area at a time, leaving reinforcing rods projecting to help join in the next area. Specialist advice should however be obtained before any underpinning is attempted, especially in waterlogged situations. Expensive foundation work is not always necessary. Iron tie rods or straps are a cheaper and traditional solution to structural movement.

5.2.2 Watercourses, dams and ponds etc.
It is most important that where a water supply is available at a mill, whether workable or not, the various elements are maintained in a good and safe condition. Where practical, the water system should be maintained in working condition, even if the mill is not going to use it. If nothing else, such waterways can form a most attractive feature for the garden of a mill which has already been house converted. They also have historical value.

Problems can arise when, for example, road works or other developments cause a blockage or restriction to the flow of water to or from a mill. Water abstraction can also ruin the supply to a mill. Owners and occupiers are advised to be vigilant and to take action when necessary to protect the water rights of their mills.

If works which affect the water course are necessary, it is best to contact the Environment Agency for advice and/or permission. They have experience in this field and may be willing to help. In case of difficulty in connection with water rights, contact or the Mills Section of the S.P.A.B. or your local Mills Group

1. Dams and Weirs
   A weir may be set across a river or stream to intercept water and divert it into a leat leading to the mill, or a dam may be set across a valley to hold back the stream to form a millpond. The first type has no material hazard associated with it as the quantity of water impounded is usually quite small and weir failure would have the result only of starving the mill of water.

2. River weirs
   It is desirable to keep a river weir in reasonable condition so that it adequately supplies the mill. Weirs can take the form of fabricated masonry works set across the river or simply banks of rocks. Repairs will need to be compatible with the existing construction details.

3. Pond dams
   If a dam holding back water in a millpond is to maintain the water level in the pond safely, it needs to

be kept in good condition. Such a dam is usually holding back quite a large quantity of water, and if this was released suddenly on failure of the dam, it might well cause much damage downstream. Such responsibility would be considered to be the dam owner's.

It is usual for the signs of impending failure to be apparent long before a dam actually fails. The `dry' side of the embankment should be regularly inspected for danger signs such as unaccountable wetness, or water trickling through or under the dam. Immediate steps should be taken to remedy the problem. If the flow seems to be increasing before remedial work can be put in place, it is strongly recommended that the pond be drained. Provided that the seepage rate was small, it is probable that no permanent damage will have been done to the dam structure, the problem having been resolved by draining the pond. The area of the pond in the vicinity of the leakage points should be treated by cleaning out any deposits containing plant growth and a layer of clay some 2" (approx. 50 mm) thick should be `puddled' over the area to seal it. It would also be a wise precaution to seek the advice of an expert as to the correct course of action.

Puddling should be done with a type of clay which becomes impervious when worked with sufficient water to form a stiff `dough like' consistency. The material is then spread and pressed (puddled) over and around the area through which the water appears to be escaping. If the puddling is allowed to dry out, it may crack and lose its sealing quality.

Trees should not be allowed to grow on or close to a dam as their roots can disturb and loosen the structure, leading to leakage; neither should any dead roots be tolerated, as, when rotted, they can provide water channels through the dam. There is also the possibility of a tree blowing over, taking part of the dam with it.

4. Millponds

There is no need for a millpond to be deep. The significant part of the pond is that above the lowest point to which it can be drained when supplying the waterwheel. to discourage the growth of water plants which can, in time, spread to cover the whole pond.

Ponds are found which have been formed on ground which is pervious to water and, while the water loss may be of little significance to the running of the mill, leakage may cause scouring which will increase the leakage rate. Such a pond may be sealed with a layer of clay approximately 2" (approx. 50 mm) thick `puddled' over the pervious area. Ponds which have previously been watertight have been known to leak following cleaning out. It is therefore advised that millponds are only cleaned out if some good reason is apparent. Careless use of a mechanical excavator is likely to damage the `puddle' and make the pond leak.

5. Spillways

An `overflow' or `spillway' returns water to the main stream that is not wanted by the mill. It can be subject to substantial scouring effects from the water and should receive regular inspection and maintenance to keep it in good condition. Spillways take many forms and remedial action appropriate to the style of construction should be carried out when required. It will normally be necessary to lower the pond level to dry out the spillway in order to carry out repairs.

6. Leats

Leats water channels cut in the earth or formed by embankments, need to be kept clear of plant growth and rubbish if they are to contain water. Even if they do not contain water, for historical reasons they should be kept in the same condition as when the mill was working.

Where leats have an embanked side and are required to hold water, a watch should be made for possible seepage through the embankment. If ignored, the ultimate result will be embankment failure and water escape. Treatment should generally follow that recommended for pond dams.

7. Tail-races
   Tail-races take the water away from a waterwheel and return it to the stream. They need to be kept clear of growth and rubbish in order to allow water discharging from a working waterwheel to escape freely. If the way is not clear, water will build up to submerge the lower part of the wheel and greatly reduce its efficiency and output power. Provided they are kept clear, tail races should cause little problem. However, it must be noted that in some cases, ownership of the tail race may have passed into other hands and lead to problems of access and maintenance. Such problems can also affect the route of water supply to the mill and it is incumbent upon the owner to strike up a good relationship with his neighbours to enable maintenance procedures to be carried out on their land.

8. Wheel-pits
   In the case of brickwork or masonry in and around the wheel-pits of waterwheels, it is essential to check on whether movement or distortion of the faces which abut the wheel has taken place. If it has, a rebuild of the defective section will be required. Replacement work will need to be at least as good if not better than the original work to ensure that movement does not take place again. The advice of an expert relating to such structures is recommended. Where the sides of the wheelpit are reasonably stable, minor repairs should be carried out as required. Take care that any new work does not obstruct the rotation of the wheel.

5.3 Woodwork subject to contact with river water

Woodwork exposed to river water, both when under continuous wet conditions, such as at sluices, and intermittently as on waterwheels, presents a problem in terms of its long term survival. There is little value in trying to keep such timberwork painted and there is a possible problem with river pollution if a poisonous preservative is used. This may give rise to legitimate reasons for complaint by downstream users. Much will depend on the nature of the watercourse. Only types of timber having the most long lasting quality under the prevailing conditions should be used. If pre treatment with preservative is contemplated, advice should be sought from the Environment Agency. The reply from the N.R.A. to the Society's general enquiry is shown in APPENDIX II.

5.3.1 Sluices and sluice gates

Where continuous wet conditions are experienced, such as with sluice gates, heartwood oak, pitch pine or elm are recommended for repair/replacement. Pressure impregnated larch or Douglas fir may be considered. The use of iroko or other non indigenous wood for replacement purposes is of questionable legitimacy and is not recommended.

All mild steel parts such as screws and bolts need to be galvanised, or stainless steel should be used, and all metal parts should be painted black, bituminous paint being recommended. Wooden parts above the water may be painted or tarred as appropriate, to match original finishes, where these can be identified.

5.3.2 Waterwheels

For such items as wooden floats and buckets, elm boards were traditionally used. As alternatives, pitch pine or oak is good, but pressure impregnated larch or Douglas fir may be considered. A good word preservative such as Creosene may be used as long as surfaces are cleaned down first, to remove any loose surface material and organic growth, and they must be dry. As with all preservatives care must be taken to avoid water pollution.

The use of galvanised or stainless steel bolts and other fixtures and fittings is recommended to minimise problems with corrosion, but these components should be assembled and subsequently painted with a black bituminous paint. Despite these construction details, a working life as short as 20 years may apply to an all wooden wheel. Wooden waterwheel arms should be of heartwood oak or pitch pine.

A wholly or partly wooden wheel should be turned frequently. If only a part of it is constantly wet, the wheel will go out of balance and the dry wooden buckets will leak. Localised decay may also occur.

Broken cast-iron parts of waterwheels should be considered for replacement by new castings. However, plating is a traditional method of repair and may enable important parts such as a shroud with the maker's name cast in it to be retained. Repairs made using mild steel should not necessarily be regarded as permanent as it corrodes more readily than cast iron. Note that in chemically active water, mild steel in contact with cast iron may corrode due to electrolytic action. Welding repair may be suitable, but is unreliable on cast iron. "Stitching" may be an alternative method to use.

If corrosion of an iron waterwheel proves to be a problem, the use of `cathodic protection' may be considered, and `sacrificial' zinc anodes may help by suppressing electrolytic corrosion (as used on ships). Ships chandlers can supply these.

Cast iron parts should be protected with black bituminous paint. In some districts the waterwheel will become coated with a protective layer deposited by the water, which is best left undisturbed.

Waterwheels which have sheet metal floats or buckets may need replacements. If possible, it is recommended that these should be replaced with wrought iron, which is expensive. If mild steel must be used, it should be galvanised and painted. It is important that all shaping is done, and the fixing holes made, before galvanising. Mild steel has a relatively poor survival factor on a waterwheel and it is considered worthwhile to seek re worked wrought iron If possible. Black bituminous paint is a good preservative, but other paints will need the galvanised surfaces to be etched and primed before painting.

5.3.3 Launders etc.
Where launders and similar items need repair or replacement, the original design should be followed as closely as possible, consulting all available information, including photographs where available, to ensure a faithful reproduction. Elm and pitch pine were traditional woods used for such structures, but where elm is repeatedly wetted and dried, its life is shortened. Oak is good, and pressure impregnated larch or Douglas fir may be considered for sluices and launders. Unless the woodwork which holds the water is kept regularly wetted, considerable leakage can be expected at joints between the boards. Well seasoned and dry boards should be provided with loose marine plywood or galvanised steel tongues, fitted into grooves, or the boards may be butt jointed with bitumen or mastic. To minimise leakage, the boards should be fitted using cramps to get tightly fitting joints, and steel tie rods should be inserted. Screws, bolts and any metal parts other than cast iron should be galvanised or stainless, and may subsequently be carefully painted black. avoiding spreading paint on to the woodwork. Galvanised surfaces will turn a dull grey in water washed situations.

5.3.4 Bridges and wooden exterior walkways
Woodwork for these structures should follow the original design as closely as possible, but vacuum impregnated softwood may be an acceptable alternative to the original wood type if known. All mild steel components, bolts, nails etc. should be galvanised. `Cut' nails should be used in preference to round wire nails. In general, painting is not recommended except for those parts which were known to be painted in the mill's working days. In particular, painted walkways can be dangerously slippery when wet as indeed can unpainted woodwork. Where this is a problem, the walkways may be painted with a non slip textured yacht deck paint. Alternatively, fine mesh `chicken wire' can be stapled down on to parts which are walked on, but maintenance care will be needed to ensure that no jagged edges develop, and that no loose places can create a risk of tripping.

Safety may dictate the use of more fencing and handrails than were found during the mill's working life. Select a style which is in character with the original structure; generally the plainer the better.

6. Routine maintenance

6.1 Maintenance

Maintenance must be aimed at survival and should not be just cosmetic. Good ventilation is very important and, on a fine day after a spell of wet weather, the doors and windows should be opened and a current of air encouraged to pass through the mill. This happened automatically in the mill's working days, but now many are left closed and damp all winter. A local person who cares for the mill could perform this simple duty. Those responsible for maintenance must be able to identify help from all sources and manage it to the mill's advantage, and while major work may well have to be tackled by professionals, volunteers can often carry out more routine work. It is irresponsible to stick stubbornly to a notion of independence or to a `regulation' way of doing things if the effective maintenance of the mill is prejudiced.

Ideally every mill should have someone living nearby who knows the mill well and is capable of carrying out small repairs, operating sluices etc. At the moment few mills receive such care, and only when boards fall off or other signs of failure are apparent do those responsible consider maintenance. For a mill in working order, `on the spot' maintenance is essential, and if this is not available then it must be questionable whether restoration to this level is justified. If no day to day care is possible, then the mill should receive a thorough inspection at least once a year by a millwright or knowledgeable amateur. Remember that regular maintenance is the best way to preserve the original structure and to avoid the cost of major repairs.

6.2 Paintwork

External woodwork should be painted, using white or colours based only on surviving evidence. For example, buff, or in Wales a purple red colour, while ironwork was generally painted black. Old photographs can sometimes reveal detail of how a mill was painted, and the original painting scheme should be followed as closely as possible.
Traditional white lead paint can still be obtained and is probably still the best finish, but its use is now restricted to Grade I and II* Listed Buildings, and permission to use it must be obtained in advance (See APPENDIX 1 for details). It is a soft paint which gradually powders rather than peels, covers nail heads well (vital in the protection of weatherboarding) and soon weathers to a light grey. Modern soft paints may exhibit the problem of not covering metal well. Avoid titanium based `brilliant white' paints, which give mills a garish look, contrasting with the soft white or light grey of their working days. If a modern paint is used the addition of a little black will achieve the required authentic colour. For masonry, brick, or plastered surfaces, where lime wash was originally used, its continued use is recommended; or alternatively a microporous masonry paint.

For interior surfaces a traditional finish is limewash, which is cheap, reduces condensation and allows the building to `breathe', but painted parts are sometimes to be found, and evidence of such treatment should be used as a basis for restoration. If painted originally, internal ironwork should be re painted to the original colour scheme, but much ironwork was never painted, and should be left so. Working parts such as tentering screws (whether old or new) must never be painted. They should be cleaned down and protected by being lightly oiled or greased.

7. Other aspects of mill preservation

7.1 Lightning conductors

In the interests of survival, it may be considered prudent to fit lightning conductors to watermills, as a powerful strike could result in total destruction. It is accepted however that the risk of lightning striking a watermill is, in general, less than for a windmill, due to it being situated in a less exposed position. Some parts of the country are more subject to electrical storms than others.

A conductor should be as unobtrusive as possible and be designed to the specifications of British Standard Codes of Practice (BS6651 for lightning protection and BS7430 for earthing requirements). Conductors are commonly made from 1" x 1/8" (25 x 3 mm) aluminium strip.

7.2 Ancillary buildings

Sometimes when a mill has been restored, outbuildings have been demolished, and the surroundings grassed over or redeveloped. This destroys the mill's context. A corn mill was nearly always part of a group of buildings which included mill house, granary, engine shed, office, stable, cart shed, pigsties and some land for the horse. Where such groups have survived they are often very attractive, and as they give an all round picture of the mill's operation, they should be retained.

7.3 Mills in trade

Today, with the increasing popularity of wholefoods such as stone ground flour there are new opportunities for mills to earn their living again in regular work, supplemented perhaps by income from tourism. While this trend is to be encouraged, it may result in compromises in preservation. If flour is to be sold for human consumption mills must comply with the regulations applying to food production premises. Requirements will vary from one local authority to another, depending on how strictly the regulations are interpreted and enforced, but the overall aim will be one of cleanliness. Rodents must be controlled, and grain and meal stored in rodent proof bins. Metal linings may have to be fitted to spouts. With care this can be achieved without spoiling the traditional interior of the mill. If people are employed in the mill, legislation requires adequate levels of safety (including escape from fire), heating and lighting. Proper guards to moving machinery should be provided in all cases (see Section 8 below). In a mill which works full time, both original structure and machinery can be further threatened by parts wearing out and by pressure for greater efficiency and increased output. As far as the former is concerned, care must be taken to replace old parts with properly made new ones to a similar design.

The temptation to `up grade' the machinery must be resisted, as collectively many small changes can endanger the historical value of the mill. The extensive application of modern technology so as to compromise the character of a mill must be avoided. The scale of a traditional mill is usually unsuited to modern milling and efficient bulk handling. However, it may be permissible in a working mill to introduce modern grain handling equipment if so doing could save a mill and keep it in work. Such introductions should be handled as sensitively as possible and be sited unobtrusively.

If new machinery is needed, it should not be installed at the expense of the old, but might, for example, be housed in a well designed extension or separate building.

The question of millers and their training is considered in Section 9.2.

7.4 Removal of working parts and fittings

On occasions the repair of a mill will be prejudiced because parts have been removed for use in other mills. It is now a breach of the law to permanently remove working parts from a Listed mill and removing parts from a non Listed mill which is not under threat cannot be condoned. It is impossible to say with certainty that the donor mill will never be restored. A future owner may indeed be keen to restore it. Millwrights and good amateur repairers should be able to make mill machinery and small fittings in the traditional way. The removal of any parts (including millstones) should only be considered if:

1. The donor mill is certain to be demolished or gutted for house conversion, with planning permission given and work about to start. This is extremely important, as it has been known for an owner to obtain planning permission to convert, which includes removal of working parts, and then to sell the mill. The new owner may not act on the permission and could wish to restore the mill instead.

2. Listed Building Consent has been given for removal of machinery (if this is necessary).

3. (In cases where it is proposed to re use machinery at another mill) That machinery fits reasonably well with the local traditions of the recipient mill.

If, as a last resort, machinery has to be removed to save it from destruction, but with no recipient mill in mind, then the following points must be heeded:

(a) All items should be photographed and recorded in detail before being touched.

(b) Removed gear should be given free of charge to prevent a market developing in salvaged machinery. It is to be hoped that the local authority would make it a condition of the planning permission that if a mill to be gutted, then the machinery should be given to a local mills group or an industrial archaeology society.

(c) Secure and weatherproof storage is required.

(d) Parts should be kept as locally as possible, preferably at suitable mills, as the mixing of regional traditions must be avoided.

7.5. Removal of mills for preservation

The removal of a mill from its original site is not normally acceptable unless it is threatened with imminent certain destruction. Experience shows that there is a danger of the mill never being rebuilt due to under estimation of the sheer size and cost of such a project, especially if it is proposed by people with little knowledge of the subject. Removal and rebuild schemes by bona fide museums are better, although even then some of the mill's character is too fragile to survive.

Removal of a waterwheel or water turbine from a mill site for preservation should only be permitted if specific planning permission has been given for its removal, and there is the serious risk of its destruction. Attention is drawn to the protection which may be afforded by Listing.

The farm wheel, which was typically used to drive farm machinery in a barn, is commonly not protected by the Listing procedure and is particularly at risk of removal for preservation or re use. Every effort should be made to keep in place this interesting type of waterwheel, which is becoming rare in its working environment.

7.6. The Museum and interpretation section

This is very important if the history of the mill is not to be obliterated through repair. All too often in the past, components which demonstrate development over the centuries have been burned or left to rot outside. For example, a wheel that is badly worm eaten or partly rotted will have to be replaced if the mill is to work again. It may show mortices where it was originally fitted with compass arms to an earlier wooden shaft and may have old wooden cogs sawn off with an iron-toothed ring bolted on. A decision would be necessary as to whether the toothed ring is left on the old wheel or transferred to the replacement. Such a wheel must be preserved under cover where it can be suitably labelled and its history explained. It would be difficult to preserve some large components and here the best representative section or sections can be cut out and displayed with old photographs, drawings etc. Old tools and equipment relevant to the mill must be carefully preserved. It may be possible to use some of the storage space in the mill for a small museum, but it may be considered better to use a separate building such as a stable or cart shed. It is advisable to keep museum exhibits away from working areas where they would detract from the mill.

7.7 Modern materials

To justify the use of a modern material, it is sometimes said that if these had been available to the old mill builders they would have used them. They would, but the statement is fallacious in that today we are not building anew, but repairing old mills which, when built, represented the latest development in mill technology. This technology continues to develop and is represented today in flour milling by vast

computer controlled mills with hardly a miller in sight, or in large hydro electric power plants. In the old mills we are concerned with a technology which stopped in the mills' last working days, and this is what we seek to preserve. There is no doubt that some modern materials can contribute, but when and how to use them needs experience and good judgement. Often it is proposed to use modern materials, usually steel for structural work, simply because the restorers are ignorant of where to obtain the correct materials and do not have the confidence to work in the traditional way.

It is important that full specifications are obtained for new materials, and if possible, experience with similar uses of the new material thoroughly investigated. PVC `weatherboards' cannot be recommended, as they are different from traditional boards in appearance, are not waterproof and become brittle over the years.

Aluminium and uPVC windows are also not recommended, as they too do not match the appearance of traditionally made ones.

Fibreglass (GRP) has sometimes been used with success, but great care is needed, and the surface must be smooth to prevent the appearance of green algae. Its general use is not recommended.

8. Safety

Advice on safety has been published by the S.P.A.B Mills Section in "Guidelines to Safety in Wind and Watermills". Briefly, all risks should be identified and reasonable precautions taken to protect those working the mill (who may become careless through familiarity) and visitors, who cannot easily and quickly identify the hazards. Simple guards to machinery, handrails, and roping off certain areas to visitors while the mill is working should present no difficulty to the competent owner, miller or manager, who should treat safety conscientiously but calmly. The Building Regulations now require adequate safety guards on permanent ladders as well as staircases. Much as on a railway or road, nothing can be done to stop the person who ignores a safety barrier and is determined to have an accident. You should of course hold adequate insurance, but that does not remove your responsibility to minimise the risks.

Anyone proposing to operate a mill must consult the relevant legislation.

9. Millers and millwrights

9.1 Millwrights and supervision

It could be argued that a good millwright should not need supervision. He should know about survival value and realise that his reputation and order book will suffer if his work does not last. However, it must be remembered that millwrights have a living to make, and business is business. In the old days, if a miller or owner was not fully conversant with his mill, the millwright could `overlook' something to ensure a return visit, or `discover' a defect part way through a job, which would mean additional expenditure. Now, as then, it is worthwhile having an independent adviser who has a thorough knowledge of mills, and is fully conversant with the process of decay and how survival value can be built into new work. It is difficult to say who should do this, as no profession covers the subject adequately. It is no part of a modern architect's training to understand mills and their problems. Mechanical and structural engineers, while understanding well the machinery and stresses involved, will be unlikely to be aware of the survival value of materials used, or be able to assess a job as restoration rather than a renewal. It is the depth of mill knowledge and understanding of survival value that is important. A detailed knowledge of architecture or engineering is easily obtained by consulting the relevant professions. Ideally any mill restoration project should be able to call on a wide range of specialist knowledge from architects, engineers and builders, but this should support decisions taken on the basis of mill knowledge.

9.2 The training of millers and millwrights

If our watermills are to survive, knowledge and skill have to be passed on from one generation to the next. Many of the old skills and methods have already been lost through the demise of the old-time millwrights and the break in the chain of apprenticeship which has occurred. Today, young people interested in millwrighting and milling should be encouraged to help with volunteer weekend and holiday restoration projects and with working mills. If the interest is deep, some may wish to follow their interest full time. This can be difficult, as millwrights are few and often operate alone or with a single partner, but from time to time there are opportunities. It would be a great advantage to train in carpentry, and also to have some skill in metalwork and general engineering, giving a sound base of skill.

Aspiring `traditional' millers should gain experience working a windmill or watermill as a hobby, not only to learn the craft of stone milling, but to decide if this is really what they want to do, should an opportunity for a full time milling job arise. Once a young person decides to go `full time' as a miller or millwright, it could be argued that he can only be as good as whoever teaches him. While this may apply to some trades, a miller or millwright is likely to be highly motivated, and to be a mill enthusiast, following his interest in his spare time. A millwright will soon become aware of bad practice and strive to do his best, with the final judge being the survival value of his work. He must learn by example, by observation and by doing the job himself.

Most of the old millers and millwrights were little known, solitary people, whose work was taken for granted and who had no working contact with the general public. Today, millwrighting is of great interest and the modern millwright must readily accept this, especially bearing in mind that most mills are aided by public money. As well as milling, the modern watermiller must be prepared to demonstrate his mill to visitors with safety, accuracy and friendliness, and accept this as part of his job.

In the past, dangerous and very expensive mistakes have been made which could have been avoided by a little more knowledge and experience gained from others. In Holland, the Guild of Voluntary Millers not only trains volunteers to operate mills in their spare time, but also ensures that they are proficient at maintenance and making running repairs. On completion of a course, examinations are taken, and if passed a certificate is issued.

It is strongly recommended that any person who proposes to operate mill machinery should study the correct techniques to use, and the protective measures which should be taken to ensure the safety of both man and machine. The SPAB Mills Section may be able to assist with procuring such information.

A particular problem can arise for an owner if one or more `friends of the mill' seek to operate it. Experience has shown that a firm control of such operators is needed, and it is strongly recommended that only persons (whether paid or voluntary) who have had sufficient training and who have demonstrated their skill, should be permitted to operate without supervision. The issue of a `certificate' to such persons states exactly what they are permitted to do. As well as being a means of control, such a certificate acts as an incentive to aspire to good working practice.

10. House conversion

It is unfortunate that the conversion of mills to houses ever became fashionable, and even today many people think of conversion as restoration. In the two decades following World War Two, many mills were standing complete, but detailed knowledge of them was restricted to a handful of people. It is therefore not surprising that so much misguided work was carried out in the name of restoration. Today, with few complete mills left, there is usually little excuse for conversion. People are generally better educated

about their heritage and more aware of their surroundings. In addition there are a number of good books on mills, several millwrights still practice the old crafts and grants may be available to the sincere restorer.

An important part of the beauty of a mill and house is the division of use, one a working building and the other for living in. It is a contrast and harmony which comes from their original function, and is lost when both become houses. Compared with the solid unity of many old dwellings, converted mills look awkward. They have lost their plain dignity and power as working buildings, and never look right as large houses. If there is no mill house, or the original house has been sold separately, it is hoped that local authorities will be flexible enough in their interpretation of planning policies to encourage a new mill house to be built, conditional upon restoration of the mill.

Proposals to house-convert complete mills, or those with the potential to work again, must be opposed through local authorities, and, hopefully, by winning over the owners by demonstrating working mills to them. However, there are compromises. An example is where a watermill has already been completely gutted and its water supply lost. The conversion of such a mill building will ensure that it is kept in good repair. An incomplete watermill with a large amount of storage space can be part converted by using the storage space for residential use. If the waterwheel or turbine remains, then this should be carefully protected in situ and kept in good repair, as should waterways, sluices and their control gear. In any proposal for the re use of a mill building, as much of the surviving working parts and fittings as possible should be retained in situ and treated sympathetically. Exactly what this entails will, of course, vary from one mill to another, but this aspect of conversion needs to be considered at an early stage, and not as an afterthought.

The ill effects of conversion can be minimised if the aim is to return the mill's exterior features to its working appearance as far as possible. In particular, the temptation to alter the size, location and style of windows should be resisted.

11. Conclusion

Our old mills are some of the finest in the world, and today's millwrights and millers, both professional and amateur, are their true trustees. We must cherish our mills and care for them in a practical way by ensuring that all repair and maintenance work is of lasting value and worthy of the name of craftsmanship.

APPENDIX I - The use of lead paint

Restrictions cover the use of lead carbonate (white lead) [2PbCO3.Pb(OH)2] and lead sulphate (basic sulphate of lead) [2PbO.SO3], but not lead oxide (red lead) [Pb3O4].

The regulations came into effect on 28th February 1992, and do not apply to paint supplied or manufactured before that date. They ban the sale or use of lead carbonate and sulphate for any purpose except for the restoration or maintenance of Grade I or Grade II* (in Scotland, category A) Listed Buildings, Scheduled Ancient Monuments or Works of Art, and then only to restore or maintain historic textures and finishes. Anyone intending to supply or use lead paint must complete a Declaration Form on supply or use, and send it to the appropriate "competent authority" at least three weeks in advance.

The form is in two parts. Part 1 has to be completed by the person intending to use the paint, who then sends the form to the person intending to supply the paint, who then completes Part 2. The form is then sent to the "competent authority", namely:

English Heritage
23 Saville Row
London W1S 2ET
Tel: 020 7973 3000
www.english-heritage.org.uk

Historic Scotland
Historic Scotland Conservation Bureau
TCRE
Historic Scotland
Longmore House
Salisbury Place
Edinburgh EH9 1SH
Tel: 0131 668 8683
www.historic-scotland.gov.uk

Cadw Plas Carew
Unit 5/7 Cefn Coed
Parc Nantgarw
Cardiff
CF15 7QQ
Tel: 01443 33 6000
Fax: 01443 33 6001
E-mail: Cadw@Wales.gsi.gov.uk

Copies of the form, which has explanatory notes, may be obtained from:

Department for Culture Media & Sport
2-4 Cockspur Street
London
SW1Y 5DH
Tel: 020 7211 6200
enquiries@culture.gov.uk

Open 10:00am to 12:00pm and 2:30pm to 4:30pm, Monday to Friday
The paint supplier may also stock the form.

Anybody not following the regulations could be prosecuted and imprisoned.

APPENDIX II - The application and use of wood preservatives

We are advised by the Environment Agency that they are carrying out research into the environmental effects of different wood preservatives. Future advice will embody the results of this research, but in the interim, they offer the following guidelines which they consider to be the "Best Practice", and which should help to reduce the risk of pollution from wood preservatives.

1. Treatment should not be carried out in or near watercourses. Timber requiring treatment should, if possible, be taken to a suitable location, where all timber treatment products can be contained.

2. Treated timber should be air dried and subsequently immersed in water in tank conditions to remove any surplus product. Disposal of tank washings should be via a Waste Disposal contractor.

Because of commercial implications, the Environment Agency does not recommend specific wood preservative products. However, generally they consider copper, chrome and borate products are less likely to cause environmental damage.

APPENDIX III - Useful addresses and telephone numbers

SPAB Mills Section
37 Spital Square London E1 6DY
020 7456 0909
millsinfo@spab.org.uk
www.spab.org.uk/mills

Environment Agency
Ring for local offices
08708 506506
enquiries@environment-agency.gov.uk
www.environment-agency.co.uk

English Heritage
PO Box 569 Swindon SN2 2YP
0870 333 1181
customers@english-heritage.org.uk
www.english-heritage.org.uk

Historic Scotland
Longmore House Salisbury Place Edinburgh EH9 1SH
0131 668 8683
hs.conservation.bureau@scotland.gsi.gov.uk
www.historic-scotland.gov.uk

CADW Plas Carew
Unit 5/7 Cefn Coed Parc
01443 33 6000
cadw@Wales.gsi.gov.uk
cadw@Wales.gsi.gov.uk

Department Culture Media and Sport
2-4 Cockspur Street London, SW1Y 5DH 020 7211 6200
info@culture.gsi.gov.uk
www.culture.gov.uk _environment

£5.00