Principles and Practice in Windmill 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 of the SPAB 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.

SOME PRINCIPLES AND PRACTICE IN WINDMILL REPAIR

1. WHY PROTECT WINDMILLS?

Windmills and watermills are a part of our heritage and for many reasons have an important place in our lives. Inventions emanating from 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 that 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 mills have already been lost, spoiled by house conversion, or have been gutted for other uses. Today, any windmill with machinery or other valuable features must be fought for. Complete windmills 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 sometimes find good owners, and can be the subject of dedicated repair work. Mill restoration is undertaken by many different people and organisations. The mills chosen may be equally variable in state from complete 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 become 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, a credit to the district, and 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 or other bodies, 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 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': an example would be the provision of a new window or even a new cap for a tower windmill complete with machinery, but lacking winding gear and sails. There would be no intention of replacing winding gear and sails, let alone aiming for working order; the aim would simply be conservation of what was there. 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, maps, sketches, paintings 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 windmill complete with machinery but without sails and fantail is of far greater historical importance and interest than a mill stripped of machinery, but carrying sail frames and skeleton fantail.

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. Suppose a new tower mill cap roof is built on to a cap frame in poor condition, easily strong enough to support the new roof, but not strong enough to turn to wind or support sails. If later it is possible to attempt more ambitious repairs to working order, then the new roof must be removed to allow proper restoration of the curb, cap frame and cap. The cost of these repairs is likely to be five to ten times that of the earlier repair to the cap roof alone, 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 that has 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 and a working mill 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. 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 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. Take a realistic view of your own abilities. Volunteers can do a lot, but some work is best left for the professionals 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 that the 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 or 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 times, expensive new work has sometimes lasted only a few years. This has often been brought about by the use of poor quality or unsuitable materials, poor design detailing, and in some cases bad workmanship. 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 that can be used to prevent decay, are fully understood by everyone concerned with the restoration and maintenance of windmills.

The S.P.A.B 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 mills 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 some windmills *even* today have hideous unweathered ladder-like sails and unsightly caps which are a continuation of the tower. Some windmills have well made new sails and caps that are not copies of the originals, but of a design transplanted from another region, or even from abroad!

In consequence, 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 that reflect their period and region. Where compelling circumstances lead to work being carried out which does not faithfully reproduce the original construction, the new work should be carried out in such a manner that it is reversible without causing 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 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 be as it was when it last worked by wind for trade. In some cases wind 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 windmill which had its wooden wind-shaft and common sails replaced by a cast iron wind-shaft and patent sails in the nineteenth century should be kept in the final phase of development, but any evidence of the earlier technology must be scrupulously preserved.

4.3.2 Original `Mistakes' which were traditional practice

When repairing mills it is tempting to correct `mistakes' made by the original builders. For example, Midland post mills were built without diagonal bracing, and during restoration it could be argued that this bracing should be added for strength. 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 `badly built' mills worked well for a hundred years or more. Any shortcomings in strength can be overcome by the addition of well-designed steelwork – an obvious later addition.

4.3.3 Old miller's and millwright's `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 covering materials and with timbers which were not quite 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 below-standard repairs may 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 components

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 more original structure and gear will have to be replaced. The old material may be strong enough to exist but could disintegrate under load. In a few cases, such as when very early wooden machinery is completely infested with beetle it may be better not to work it so that it can be preserved in situ.

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 re-facing, or by consolidation and the building up of decayed timbers with epoxy resins and dry timber insertions. 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 5.18 below).

4.3.5 Project Design

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

It is important to choose advisers wisely. Often, highly-qualified professionals have little knowledge of windmills, and may not be able to adapt their thinking to these unique buildings. Seek advice from enthusiasts, other mill owners and millwrights, using your judgement to decide who is giving the best advice

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 that may arise from time to time are resolved quickly. Failure to manage the project properly will most likely lead to escalating costs. Where the owner is unable to act as manager, this role may need to be delegated to a suitably competent person. Once again, great care needs to be taken in the choice of such a person.

5. PRACTICAL DETAILS OF REPAIR

5.1 Brickwork

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, sand and aggregate but this can take a long time to cure. Mill mortars are often hard, and a bagged hydraulic lime can provide the necessary strength mixed 1:3 with sharp sand. 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. The towers of windmills with their batter and inclined mortar joints often let water through. Cutting in new bricks and re-pointing may be the cure, but joints must be raked out properly about 25mm deep beforehand. With a tarred tower it is important that repairs are done before applying a new coat of tar. Some towers are rendered and this can be replaced, but if a tower has not previously been tarred or rendered these coatings should only be used as a last resort, as they will alter the appearance and character of the mill.

5.2 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, supplemented by wood preservatives. If softwoods 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 a medium or high hazard specification. Spraying or brushing on of preservative is barely adequate, but soaking in a bath of preservative overnight or for several days is good. Ready-treated timber may be used, but when joints have been cut, the cut ends, joints or mortises should be soaked overnight in a tank of preservative. Care should be exercised with the use of preservatives as spillage can lead to the pollution of waterways. (See the advice given by the Environment Agency in APPENDIX II).

2. Where water or dampness may be present, all joints and holes should be painted as well as preservative treated. 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.

5.3 Structural timber-work

The main danger to mill timber-work, apart from rot, is infestation by wood-boring beetles. 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 extent of the damage can be assessed visually, and may be further examined by the use of a special decay-detecting drill. This equipment makes only a tiny hole, but yields a paper read-out that indicates the density of the timber, and any voids within.

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.

The structural timber-work of mills often needs major repair 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 wet conditions. They should be used with great care, and specialist advice should be sought.

In certain cases, weak timbers may be reinforced in the traditional manner by fastening new timbers above or alongside. The use of steel girders (RSJ's) to reinforce existing timbers should be avoided except in temporary work. In cases where lack of space prevents use of timber and cost prevents replacement of the original timber, a flitch plate may be inserted into a slot, or bolted alongside.

When a timber is beyond reasonable repair it should be replaced by a new one of the same species as the original. Such timber ought to be well seasoned (air-dried) and treated where appropriate. Timber used `green', or fresh-sawn may twist or shrink in some applications as it dries out. This may not be important, but must be taken into consideration. Timber 6" (150mm) thick or less can usually be obtained air-dried, but larger sizes may have to be fresh-sawn.

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. Timbers that are very large or of difficult shape were probably cut from a tree that had grown to that shape. If 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. Often, traditional boat-builders can give advice on obtaining naturally curved timbers to replace components in windmills.

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, as it bends and buckles when red-hot.

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 may encourage demolition of other historic buildings. Steel tie rods or flats may be inserted in appropriate places to prevent sagging or spreading (`sag irons' in the body of a post mill were a traditional feature), although in most cases it is better to find and remedy the cause of the problem. 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.

5.4 Windows

It must be remembered that windmills are more vulnerable structures than houses. They are unheated and there are no gutters and downpipes. 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.

Do not replace windows with new unless the originals are beyond repair. Most failures to windows can be repaired with new timber let in, or by strengthening plates. Any new work should, in general, follow details present when the mill last worked. Many mills were provided with sashes that could be quickly and easily lifted out, particularly useful in maintenance.

5.5 Cladding

5.5.1 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 or sanded. 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. Boards should have few knots, and those should be sound and not rotten. 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 topcoat. 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, but on the sloping sides of a smock mill, 30% or more is required. As the angle of the boards becomes more shallow (for example on a boarded cap roof), greater overlap is needed to be proof against wind blown rain. There is also regional variation in overlap - for example Kentish smock mills were usually boarded with a large overlap. 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. Nails were usually placed 1" (25mm) up from the bottom edge of each board, one to each structural timber. 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.

On a post mill body or a Kentish or Norfolk boarded cap, the head boards over-sail the side boards and the sideboards over-sail the tailboards, by about 3" (75mm). This over-sailing is traditional and very important to the mill's authentic appearance. If the mill is turning to wind, this over-sailing protects the vulnerable join. If not turning to wind, it forms a bad water trap, but this can be sealed by installing metal "soakers" fitted behind each board when boarding. On no account should the over-sailing be dispensed with and corner fillets fitted instead.

At smock mill corners, boards were often mitred, or were lapped alternately one way and the other. These joints are very vulnerable, and sheet metal `soakers' can be fitted behind the junctions of each row of boarding. The careful use of soakers and the application of lead flashings around windows and other vulnerable leakage points will also help to exclude water.

Aluminium sheet is a suitable material for making soakers but it is important to secure them with aluminium nails to avoid electrolytic corrosion. Aluminium may be painted, but the correct `etching primer' must be used. Lead can also be used, fastened with copper tacks. Code 3 is thin enough not to separate the boards too much.

Some mills were latterly covered with sheet iron or zinc over the weather-boards. Today it is best to replace this with aluminium sheet of half-hard type that has good corrosion resistance and reasonable bending qualities. Where a softer material is required, rolls of high-purity aluminium flashing can be obtained.

It is most important to use aluminium screws/nails to prevent electrolytic corrosion, and to seal the joints effectively by welting or the use of mastic on overlaps. Aluminium may be painted white but the correct `etching primer' must be used.

5.5.2 Tower and smock mill caps

If a cap is to be weather-boarded great care must be taken to build in survival value. Horizontal boards must be prepared and fitted as described in the preceding section and vertical joints sealed with soakers. Boards used on vertically boarded caps must be primed and undercoated on all contacting surfaces, and allowed to dry before being fitted to the frame. Battens to cover joints should be similarly treated, and bedded on mastic.

In the past, painted canvas was sometimes used to cover boarded caps. This was not a very long-term option, and is not recommended today. A modern product "Belzona Molecular Membrane" has been used with success, and may be considered along with its special primers and paints.

In recent years aluminium has been used successfully as a cap covering for holding repairs, or as a substitute for other materials. It has been applied direct on to the ribs, but this is not recommended. A more pleasing appearance inside

and can be achieved by boarding the cap before attaching the aluminium. In a year or two the cap will weather to a matt grey, but painting the sheeting outside gives a more authentic appearance. Soft, fully annealed sheet can be used over boards with a layer of felt between, and welted seams can be formed. The stronger half-hard sheets have to be overlapped by at least 3" (75mm). Vertical joints should overlap away from the head (or wind direction), and mastic should be used in each joint. Aluminium screws or nails should always be used when fixing aluminium cladding.

5.6 Provision for water run-off

Good provision for water run-off is essential if work is to survive. Obvious vulnerable points include where sheers project at the back of a cap, and where fan posts are joined to sheers or fan carriage. Here run-off water will concentrate at a weak point and rot will quickly take hold unless a simple aluminium channel is provided to lead the water away. Another vulnerable point often neglected is where the wind-shaft passes through the cladding, but it is easy to provide a channel or an inverted 'V' guide above the shaft to direct water around and down. If water runs down inside the striking rod hole of a wind-shaft, a small container and pipe can be installed to act as a gutter to direct the drips to the outside of the mill to prevent rot. Alternatively - and better - the method in section 5.8 may be used.

5.7 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. This particularly applies to later auxiliary machinery (including engines) which is important as it illustrates the development of the mill over time. 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. A further disadvantage of removing millstones and heavy components, especially from a post mill, is that its ability to withstand high winds is impaired and the mill may be blown over.

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 with determining the history of the mill. Call in a mill historian for advice.

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.

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

Cast iron parts that are beyond repair by plating, welding or stitching 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, welds must be ground smooth and edges and corners bevelled. A hot-dip galvanised finish is required outside.

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 waxed or lightly oiled.

Today's nuts and bolts are in metric sizes, and have hexagonal nuts. It is permissible to use these if the originals cannot be salvaged and repaired, but they should be hot-dip galvanised, being of rust-prone mild steel. Some grant donors insist on stainless fastenings etc., but this is expensive, and rather excessive. Threaded studding should never be used for bolt making except in low cost `holding' work. It has low survival value and will cut into the wood, allowing loosening and water penetration.

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). A variety of head shapes were used in the past, and may be matched today. The decision to use traditionally-shaped fastenings may be discouraged by cost. Aesthetic considerations may restrict their use to high-profile parts of the mill.

Any missing machinery or small parts it is intended to replace should be studied carefully in similar mills and good copies made. The design of milling machinery 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 anyone with experience of working that or other mills.

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.

5.8 Sails

The sails of a windmill are its crowning glory, and it is sad that so many are badly designed, badly made, could never turn in the wind and need regular replacement. New sails must be copied from the mill's last working sails (except where an obvious `bodge' was made), taking care to accurately reproduce all dimensions and weathering angles. Regional variations in their design and construction must be maintained and standardisation or transplanting the practice of one region to another must be opposed.

Sail stocks are difficult to make traditionally today because timber of the correct length and durability is very costly or unobtainable. In the past, baulks of English oak, Baltic or Scandinavian redwood, Canadian Oregon pine and American pitch pine were used, but today's timber cannot match the old.

Alternatives must be of the same dimensions, be durable and of acceptable appearance. Steel box sections are extremely strong, but tend to be heavier than timber and can overload an old mill structure. With the same dimensions and appearance they can provide an alternative, provided proper allowances for working stress are made in the design. The work needs to be of high quality,

otherwise cracks may occur and propagate, with ensuing sudden catastrophic failure.

It may possible to make stocks from fibreglass or aluminium alloy. However experience with fibreglass has shown it to have a short life when used for this purpose. Where aluminium alloy is proposed, it is important that detailed specifications are obtained for the materials used, calculations for stress are carried out, and if possible experience in the use of the material at another mill taken into account. However, aluminium is prone to the risk of severe hidden electrolytic corrosion in the long term. These materials are not recommended.

A better, and increasingly popular alternative to single-piece stocks is to laminate them from planks of selected durable or pressure-impregnated timber. This gives the stocks their traditional weight and character with enhanced strength and durability. The technology has been proven in the long term, and many firms offer reliable "Glulam" beams made to your drawings. Durable timber such as Siberian larch may be used, and preservatives can be employed that are compatible with the glues used. These must be applied after all shaping and boring.

For long survival it is essential that sail-frames be constructed from as good quality timber as the stocks. All the components should be vacuum impregnated with preservative after jointing and before assembly. If a sail whip is too long for treatment, the sail bar mortises and bolt holes can be treated by fitting bungs and filling the cavities with preservative. Alternatively it is easy to improvise a tight fitting trough from thick polythene to allow treatment by soaking.

All joints must be painted, especially the sail bar mortises in the whips. Any mild steel bolts must be galvanised, painted and assembled with grease or paint. The striking rod hole can allow water to penetrate to the centre of a wooden stock, and must be well treated and painted. Never attempt to exclude water from the canister by sealing, as movement makes this impossible. The aim must be to ensure that any water getting in can drain out again easily.

Stocks must be properly wedged with folding wedges at front or back, and not battened all round either side of the canister as has often been done in recent years- a skimped method that will ensure rapid rot in the stock centre. On patent sails the striking gear should always be put back, and ideally a full set of cleats (thimbles) should be provided, even if all or most are empty. This avoids the all too familiar `dead' look of many sails and demonstrates the former presence of shutters. The number of shutters replaced will depend on whether the mill is turning to wind, and if there is a local guardian. A working mill will have a full set, an occasional worker with operative fantail about half a set, and a non-worker perhaps one shutter per bay, or just enough to support the shutter bars.

5.9 Curbs, fantails and winding gear

If the cap of a tower or smock mill is to turn to wind it is essential that the curb is perfectly circular and level, as well as strong. In recent years several restorations have been spoiled by failure to appreciate this. Although non-traditional curbs have been constructed, all the materials for traditional curb construction are still available today.

Ideally a fantail should perform its task of keeping the sails facing into the wind, but this will depend on the condition of the mill and the presence of a local guardian to lubricate and look after the mechanism. If the fan cannot operate it must be fastened securely or its area reduced. Many mills have a strong fan-stage and fan posts and there is less of a problem, but some (e.g. Kentish) fan-stages are of relatively frail construction, and it may be advisable to reduce wind resistance by leaving out the middle boards of each blade. If new gearing is made it must be traditional in design, with gearwheels of the correct pattern and number of teeth. If these are not available, patterns should be made and castings obtained. Brackets should normally be of cast iron; but if parts are fabricated from mild steel, these must be simple heavy sections, and they must be galvanised or painted, or rusting will be rapid.

As with sails, attention to detail is vital to the survival value of winding gear. Timbers, including those of the blades, must be treated, joints painted and assembled with paint. Drippers may be provided to protect vulnerable points from run-off water. Fan blades are better constructed from plain boards, but if tongued and grooved boards are used, the tongues and grooves must be painted before assembly. Plywood should not be used.

The general need for quality of construction and effective maintenance of any winding system cannot be stressed highly enough; if the winding gear on a fully shuttered mill fails and the mill is tail winded the consequences could well be disastrous.

5.10 Foundations and floors

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 under-pinning is attempted.

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 eliminate trapping meal, which can become mite infested and difficult to eradicate.

Boards, 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 joined with metal tongues are used, the tongues should be of 1" x 1/16" (approx. 25 x 1.5 mm) galvanised steel, to allow for seasonal movements without gaps appearing. As with all flooring, floorboard cramps are essential for a good tight fit, and the

correct cut flooring nails (not round wire nails) must be used. A preference should be given for boards of a full 1 ¼" (32 mm) thick, planed to finish at 1" (26mm) rather than for 1" (25 mm) which will be too thin after planing. Mill floorboards were usually wide, and this should be matched in the new work.

5.11 Paintwork

By contrast with many mills on the Continent, most English mills were restrained in their use of colour externally. Except in a few cases, woodwork was painted white or tarred, and some ironwork painted black. Other colours should not be used unless there is evidence that the mill was so painted in its working life.

Old photographs can sometimes reveal forms of decoration; e.g. the black stripe on the head of some Essex post mills, or red stripes on the fan blades of some Norfolk tower mills. 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 use is now restricted to Grade I and II* Listed Buildings. Permission to use it must be obtained in advance see APPENDIX 1 for details. It is a soft paint that gradually powders away rather than peeling, covers nail heads well (vital in the protection of weather-boarding) and soon weathers to a light grey. Modern microporous paints may have the problem of not covering metal well. Titanium based `brilliant white' paints give mills a garish look, contrasting with the soft white or light grey of their working days. Modern paints, despite their sales pitch cannot be recommended for mills, and often promote decay and early failure

Traditional paints based on a linseed oil medium are considered best. They can be obtained from sellers of conservation materials, and although expensive they offer the best chance of protecting the exterior of mills. A variety of pigments can be used to create the appearance of lead paint without the toxicity. It is often a good idea to apply raw linseed oil to the bare wood before priming. This ensures that the subsequent coats of paint adhere well, particularly if the wood has become degraded and porous. Sometimes a second coat of oil is beneficial.

In certain areas, windmills were coated with a mixture of pitch and tar applied hot. This was an excellent finish, but the genuine materials are very difficult to obtain today, as the gasworks that used to supply them have closed down. Creosote (not a suitable finish anyway) has been banned, and tars may soon follow, although some firms will still supply coal tar pitch. Some success has been obtained using bitumen products such as those used for road repairs, but more research needs to be done.

For interior surfaces a traditional finish is lime-wash, 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.

5.12 Lightning conductors

In the interests of survival it is prudent to fit lightning conductors to windmills, as a powerful strike could result in total destruction, while lesser strikes can cause damage which may be very expensive to repair. A conductor system should be as unobtrusive as possible, and be designed to the specifications of the current British Standard Codes of Practice.

There are, problems with applying conductors to windmills, as it can be difficult to obtain straight or nearly straight runs for the conductors from top to bottom of the mill. Sharp changes in conductor direction are liable to cause the `strike' to leave the conductor and find an alternative path to earth, with the likelihood of consequential damage.

Conductors are commonly made from plastic sheathed 1" x 1/8" (approx. 25 x 3 mm) aluminium strip. Copper may alternatively be used. As a guide for tower and smock mills, it is suggested that a conductor should run from the tip of each sail to the canister, being attached to it by small, approx. ¼" (6 mm) diameter) stainless steel set screws. The neck brass should be similarly connected to the brackets of several truck wheels. The cast iron track segments around the curb must be connected together, with one or more strips connecting between the track to earth rods at the base of the mill.

It is best to employ a well-established firm of lightning conductor engineers to advise and to install a suitable lightning conductor system to a mill. They have the experience and testing equipment to ensure that the system is truly effective against lightning.

5.13 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 that 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.

5.14 Mills in trade

Today, with the increasing popularity of whole-foods 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 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 will require

adequate levels of safety (including escape from fire), heating and lighting. Proper guards to moving machinery should be provided in all cases (see Section 5.20 below). In a mill which works full time, both original structure and machinery can be further threatened by original 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.

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. 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.

Windmills rarely have much room for new machinery. The question of millers and their training is considered in Section 6.2.

5.15 Maintenance

Maintenance must be aimed at maximum survival and should not be just cosmetic. Windmills are often shrouded in scaffolding, yet the work done at great cost is frequently ineffective. Painting mill sails in the usual way may shorten their life. In summer when timbers dry out and joints shrink, sails should be treated with clear organic solvent preservative, flooded around and into the joints, followed by painting all round the joints, forcing paint in and thus sealing them. Only when this has been done should the sails be painted all over, otherwise water merely runs off exposed parts of the sail unlikely to decay and into the joints where decay is rapid. The use of impervious paints can prevent timber from drying out after rain, trapping moisture and promoting rot. Note that as mentioned already, the risk of decay can be much reduced by using good materials in repairs, and painting inside the joints during assembly.

Good ventilation is very important, and on a fine day after a wet spell of 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, as well as generally keeping an eye on it. At the moment few mills receive such care, and only when sails or boards

fall off do those responsible consider maintenance. For a mill in working order, `on the spot' maintenance is really an 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.

5.16 Removal of machinery 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 remove machinery permanently from a Listed mill, and it cannot be condoned to remove parts from a non-Listed mill which is not under threat as 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 machinery removal, and then to sell the mill, and the new owner does not act on the permission but restores the mill instead.

2. Listed Building Consent has been given for removal of machinery, should this be 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 machinery has reluctantly 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 situ' before removal.

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

(c) Secure and weatherproof storage is required.

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

5.17 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 the danger the mill will never be 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 proposed by bona fide museums are better and several have been successfully completed (e.g. the Danzey Green post mill at the Avoncroft Museum at Bromsgrove and the Eastbridge wind pump at the Museum of East Anglian Life at Stowmarket).

5.18 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 brake wheel that is badly worm-eaten and partly rotted will have to be replaced if the mill is to work again. It may show mortises where it was originally fitted with compass arms to an earlier wooden wind-shaft, and may have old wooden cogs sawn off with an iron cog ring bolted on. A decision would be necessary as to whether the cog ring is left on the old wheel or transferred to the replacement. Such a wheel must be preserved under cover where its parts can be labelled and its history explained. It would be difficult to preserve a whole cap frame, curb or long floor beams, and here the best representative sections can be cut out and displayed with old photographs, drawings and so on. Old tools and equipment must be carefully preserved. It may be possible to use some of the storage space for a small museum, but in all but the largest windmills it is best housed in a separate building, such as a stable or cart shed. It is advisable to keep the museum away from working areas, where it would confuse and detract from the mill.

5.19 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 the large unmanned wind turbines, which are appearing in increasing numbers.

In 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. Steel should not be used to replace wood in the structure of a mill, but if used carefully as plates and brackets, can strengthen old timbers and allow them to be retained.

It is important that full specifications are obtained for new materials and if possible experience in the similar use of a material thoroughly investigated. Some modern materials may be used effectively, such as aluminium cladding on tower mill caps and post mill roofs, which can be left self-finished or painted. PVC `weather-boards' 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. However, its general use is not recommended.

5.20 Safety

Advice on safety has been published by the S.P.A.B Wind and Watermill 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 the roping off of 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 should consult the relevant legislation.

6. MILLERS AND MILLWRIGHTS

6.1 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 understand the survival value of materials used and to be able to assess a job as restoration rather than renewal.

It is the depth of mill knowledge and understanding of survival value that is important, not detailed knowledge of architecture or engineering. The latter are 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.

6.2 The training of millers and millwrights

If our windmills 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, 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 many mills are aided by public money. As well as milling, the modern windmiller 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 Wind and Watermill 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 which states exactly what they are permitted to do, acts as both a means of control and to encourage initiative.

7. 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 no excuse for conversion. People generally are better educated and more aware of their surroundings, there are a number of good books on mills, several millwrights still practice the old crafts and grants are 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, yet never look right as large houses. However, these effects can be minimised if the aim is to return the mill's exterior as far as possible to its working appearance. This need not necessarily include the replacement of sails and fantail; but a new roof, for example, should follow the shape of the original cap, and the temptation to alter the size, location and style of windows should be resisted.

If there is no mill house, or the original house has been sold separately, it is hoped that the local authorities will be flexible enough in their interpretation of planning policies to encourage a new mill house to be built, conditional on the restoration of the mill. Proposals to house convert complete mills or those with 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 - for example, where a windmill has been completely gutted, then the conversion of the structure will keep it in good repair. An incomplete mill can be partially converted using those parts devoid of machinery. Any machinery remaining should be carefully protected in situ and the conversion as a whole should be sympathetic to the original structure. As examples of bad practice, the insertion of numerous additional windows of the `picture' type are a quite unsympathetic treatment for a tower mill conversion. Similarly, the renewal of a cap the shape of which bears little resemblance to the cap originally fitted is an anachronism. Exactly what treatment is considered permissible in any particular conversion needs to be considered at an early stage and not as an afterthought.

8. CONCLUSION

Our old mills are some of the finest in the world, and today's millwrights, millers and owners, 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, Fortress House, 23 Savile Row, London W1X 1AB (England).

Historic Scotland, 20 Brandon Street, Edinburgh, EH3 5RA (Scotland)

Cadw, Brunel House, 2 Fitzallen Road, Cardiff CF2 1UY (Wales).

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

D.N.H., Central Stationery stores, South Ruislip, Middx., HA4 0NZ, free of charge.

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 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. Tank washings should be disposed of by a Waste Disposal contractor.

Because of commercial implications, the E.A. 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