W.A.DOUBLEDAY, BE, MAdmin, MIEAust CPEng., Director, Tourist Railway and Museum Engineers and Management Consultants Pty. Ltd.
Not only the Hardware, but the Software too!

Sixth National Conference on Engineering Heritage 1992
Hobart, 5 - 7 October 1992

Not only the Hardware, but the Software too!

W.A. DOUBLEDAY
B.E., M.Admin., M.I.E.Aust., C.P.Eng., Director, Tourist Railway and Museum Engineers and Management Consultants Pty. Ltd.

1. INTRODUCTION

The purpose of this paper is to examine the long term operational preservation of one facet of our engineering heritage: railways. There are over 20 primarily volunteer operated preserved railway or main line locomotive/rolling stock groups in Australia today. They have restored to running condition at least 50 steam locomotives and many carriages with which to operate their trains. Their responsibility extends to many kilometres of track, numerous structures including wooden, steel and concrete bridges. The paper concentrates primarily on the more visible item, the rolling stock, but the infrastructure necessary to demonstrate our heritage in an operational mode, is just as important.

To maintain all this hardware in a safe operable condition, requires a lot of manual work and knowledge on how to do it. This knowledge element is what I have called the software component. Without the preservation of this software, the hardware will not survive in an operating condition for future generations. I believe it only can be properly represented and interpreted when it is in its fully operational status.

From a heritage viewpoint, the hardware aspect of our railways has been well record- ed, but the software not so well. The methods of maintenance have often been lost with the passage of time. Some organisations have built up libraries of drawings, manuals, practice cards etc. Others have not, relying on the knowledge of others, a few old drawings or a general knowledge of how to do the job.

We are seeing other examples of engineering heritage being preserved in an operable condition. My comments apply equally to these examples.

The passing on of knowledge from the old retired hands to the new young enthusiasts is often inadequate. The enthusiast himself can range from a professional or an experienced tradesman from another field, to a person with little or no technical training. This transfer of knowledge requires a shared willingness between both parties. Otherwise it means research of old documentation, or find someone who may know about the job.

Technical and safety requirements are constantly changing. The introduction of new laws or standards often leads to conflict with traditional standards or operating practices. This places pressure on the railway preservationist to find different solutions to enable of railway operation to continue without greatly changing the heritage environment. New methods of construction and materials on the other hand allow for work that could not easily be done in the past.

2. SOME OF THE PROBLEMS

The types of problems that can be found and their solutions vary widely. They vary from poor practices or shortcuts in the past to a virtual complete loss of the method for doing the work. Solutions adopted are dependent upon the physical working conditions, abilities, and the operational requirements of the particular railway. The physical achievement of the restoration of the hardware so far carried out is an indication of the dedication of the workers. They are mostly volunteers, who learn or apply their skills in new fields. Often this work is done in the open. If the workers are lucky enough to be able to work undercover, it is seldom within a formal workshop environment. The restoration of D^{3} 639, *Spirit of Ballarat*, in 1984 is an example of such a restoration.

Towards the last days of steam locomotive working, poor maintenance practices or shortcuts became the norm. The object was to get the locomotive back into service. Anyway, it only had a few more months to go before it was to be withdrawn and cut up.

Steamrail, who operate main line trains out of Melbourne have come across many of these. An example is the fire box stress corrosion resulting from a speedy overhaul in 1964 of locomotive R761 for a bumper wheat season. This was the last time many such locomotives saw regular service. R761 entered service again in 1985, after having run as preserved engine from 1970 to 1974. The lack of experience and ability to check or limit such corrosion, has now resulted in the lower section of the fire box needing major repairs(1).

In the old days, the boiler would have been taken off the frames. Steamrail do

not yet have the facilities to do this, and the work will be carried out in situ, thus increasing the difficulty of the job. In the past few years, the group has developed the techniques to do such repairs. Just to determine the size of the job and prepare the locomotive for this work has taken over 600 hours.

Today's irregular operations cause problems too. When in regular service, locomotives were generally hot or at least warm almost continuously. Now when they are steamed only every so often, the cyclic heating and cooling results in a different range of problems, requiring detailed maintenance and frequent inspection.

A different field is the maintenance and construction of wooden trestle bridges on preserved railways. It may appear to be very simple task to replace a pile. However, neatly fitting a new pile within the cross heads so the shoulders and not just the bolts are taking the load requires a good skill in timber work and experience in just how to do the job. Slipping in a piece of timber about 400 mm in diameter, weighing a couple of tons and onto a prepared foundation into a bridge that may still have to allow for train running, is not a simple task for amateurs.

While equipment such as backhoes can do great things, it still requires a method for doing the job. There are only a few people left in Victoria who can do the job efficiently. Very little has been written down about the actual methods. They have been handed down from worker to worker. Undertaking this work on a high bridge, or working in an excavation today, is very likely to require training in scaffolding or shoring techniques, things unknown or ignored in the past.

The VR maintained good practice cards for locomotive maintenance, but for carriage underframes, these were virtually non-existent. Fortunately some men spent their own time watching and learning underframe maintenance in the final days. This necessary skill could have become a lost art. It is no use having a great locomotive, but no comparable heritage carriages for it to haul. Woodwork and roof maintenance are other areas where one could spend a lot of time examining problems too.
The maintenance of old skills is very important in being able to ensure that these objects that reflect a past engineering heritage continue to operate in the future. One dying skill such as scraping and fitting plain metal bearings is no longer taught to apprentices. Virtually all the bearings on older locomotives and carriages are of this type. Roller bearings only appeared towards the ends of their lives. Fitting a plain bearing for service at speeds of 100 to 120 kph requires skill, and knowledge of the whole running gear assembly. The checks to this assembly to ensure that it is not overstressed because another part is out of adjustment or worn is just another element of the necessary software.

An example of a lost art is one that had to be rediscovered by the Emerald Tourist Railway Board. The ETRB is the operator of Victoria's *Puffing Billy*. Some years ago, the railway had to renew the boilers of some of its locomotives. Renewals were done in steel, instead of the originally built copper. After installation of the new boilers, a problem of leaking fire tubes occurred. This became a major headache. It was because of the excessive stresses the tubes placed on the rear tube plate due to their expansion when in service. This phenomenon did not occur in the copper based boilers. To overcome this problem required extensive research, experimentation, and talking to retired boiler makers. An old technique known as 'prossering' was adopted. The technique is to use an expanding segmented tool to place a ridge in the tube on the water side of the tube plate. The ridge formed around the exterior of the tube acts as a shoulder that bears on the inside edge of the tube plate. This prevents the tube from moving outwards independent of the tube plate(2).

Standards must be maintained to a level required for their operational need. For locomotives and rolling stock operating on a branch line, the quality of the work can be lower than that required for main line, high sustained speed operation.

The problem is to ensure that our railway engineering heritage hardware will be able to continue to operate into the future, and not just for a few more years. It is going to require a lot of work today, to ensure that we preserve as much of the software in its various forms as we can. The men who worked on this equipment have now virtually all retired and unfortunately passing on.

Another type of problem faced by operational preservation is the lack of tooling to do a specific job, for example, boring valve cylinders. In Victoria the machines and tooling for this job were scrapped. To carry this out commercially could be prohibitive in cost. The tolerances over the length of the valve cylinder are very small. Any large inaccuracies, will result in the locomotive not performing. The solution is to make up a bit of tooling for the job. A detailed knowledge of how things can be done, and what tolerances are required, is essential.

On the other hand, old tools never die; they are often used in odd repair jobs. So be careful in what you throw away.

Tooling and machines are all very well to have. The knowledge of how to use or to set them up, and what the requirements are is important. In this way we will ensure that we can maintain tour railway engineering heritage in an operable condition. It cannot be allowed to become just a stationary piece of machinery that can only be interpreted by looking at it and touching it.

3. MODIFICATION OF EQUIPMENT AND ASSOCIATED HERITAGE ISSUES

In operational heritage preservation, the acceptability from a purist point of view of replacing materials, and making improvements or changes to the equipment presents dilemmas. However, better methods of carrying out work are now available. Component replacement or one that was a major job previously can now often be avoided. For example, the improvement in welding technology, has allowed boiler and firebox repairs that could not have been contemplated in the days of regular operation to be undertaken. Some people have used the principle of keyhole surgery to repair a main steam pipe deep within a boiler. Previously its complete removal for repair would have been required.

Making minor modifications to a locomotive is often necessary to overcome design defects that were ignored in the past. An example is a pocket where water sits in the boiler for long periods. The effect of this was not significant in 'the good old days'. Today it is, especially when the locomotive sits idle for a long period of time quietly corroding away.

Changes to the appearance of locomotives vary from making minor additions to the equipment such as additional air lines to run today's modern carriages to changing the colour scheme. One example of the changing the appearance in a minor way is the tender of former New South Wales Government Railways locomotive 3801. The original had deteriorated to the point where it had to be replaced. The sides were originally of riveted construction, but the replacement was welded. This resulted in a smooth exterior surface. The welding on of false lines of riveted heads was considered, but it was decided not to on cost grounds despite requests on heritage grounds(3).

All these can often bring comment of an adverse nature from the purists. The most important thing is to know what changes have been made. One material replacement that brings little adverse comment is that of asbestos used in boiler lagging etc. The work however, causes another set of problems.

Commercial considerations of changes have been taken into account too. Not doing a job can cause an in-service failure, which can be commercially costly. *Puffing Billy* for example has reviewed and modified its lubricating systems to ensure that maintenance costs are kept to a minimum. They are sometimes using plastic surfaces instead of metal to metal(2). Engineering ability with a commercial understanding of the financial position coupled with the knowledge of the heritage issues is necessary. Again the software component is important.

4. HERITAGE POLICIES

Many of the railways lack a formal heritage policy. I would consider that some are still in the playing trains mode. They have not worked out where they stand in terms of heritage and what they are trying to achieve. On the other hand, many have, and 3801 Limited is a good example. It has restored to operating condition several carriages to go with 3801, to which some changes had to be made. Professor John Glastonbury in a paper presented to the Railway Heritage Conference in Sydney, said(3)

> '... a very serious approach was taken to the restoration of these heritage items, this approach was tempered by the needs of present day engineering technologies, railway operating requirements, costs and passenger needs. The restoration project set out to restore this heritage to working order, so that present day passengers can savour the experience of rail travel as it was 50 years ago.'

We have a responsibility today to ensure that we can keep our engineering heritage in an operational condition long into the future. This needs to be done in many ways, one of which is to ensure that there is a pool of interested people in the future. It may be all very well to have the hardware, and the books, drawings etc. to support it. To have no one interested in undertaking it, is just as bad. We must be true to what we believe in for the future. Prepare heritage policies, and include in the documents where the information came from and why, so it forms the basis of future understanding. It all adds to the software component required to enable the hardware to survive.

5. RECORDING THE SOFTWARE

The maintenance of written records, filing systems, documentation, drawings etc. is very important. Today's computer equipment and microfilming allow this to be done much more easily. Don't lose the filing cabinet and make sure backup copies are available. Old textbooks, personal papers or collections often provide important clues on how to do something.

Documentation is not seen as important by many people. 'Let's get the job done now, and then go on to the next one'. Doing paperwork is not an enjoyable task. The lack of time and resources, such as documentation recording and organisation skills particularly in a volunteer organisation, is generally acute. The enthusiastic kids of today are almost without exception willing to learn. When you ask them the question; 'Will todays equipment be operational for your kids?', they start to see the problems and see why recording is needed.

It is important that what is done today in maintenance, restoration and reconstruction is recorded. This will help at some time in the future in finding out what was done. It may offer a solution to a problem that has been encountered unexpectedly, or just give the information on when the component was last replaced or worked on. The records will form another part of the ongoing heritage of that piece of equipment.

6. TRAINING FOR THE FUTURE

Another form of the software needed to operate and maintain our engineering heritage, is the worker himself, whether he is the actual skilled tradesman or a knowledgeable person. He must know how to do the work or to determine how to solve the problem, and understand the heritage of the piece of equipment on which he is working. A willingness to pass on his knowledge is also essential.

Sometimes the old hands are not willing to assist. The job is either too hard, or too dirty. They are often not interested in supervising either. Steamrail had to bring people from the UK in 1982 to provide the supervision skills for retubing their K class locomotive. They learnt from these people how to do the job, and are now training new people.

One interesting problem for the future is the one resulting from the introduction of metrics. Todays youngsters do not learn imperial measurements. Can they add 7/16" and 25/32" easily, and get the right answer? It is 1 7/32".

It is the detailed knowledge of what can be done today with materials combined with a detailed knowledge of what the problem is and understanding it, that is essential. Today's steam locomotive boiler maker and fitter have to be a multiskilled people. Many steam locomotive organisations have trained their own apprentices in the skills they require, or have taken on apprentices from outside industries to enhance their skills (ETRB). This creates a pool for the future of skill personnel, some of whom will become the inspectors of tomorrow's work to ensure safety requirements are being met.

7. CONCLUSIONS

As you will have seen, the range of problems that operators can encounter is vast. To overcome these, an extensive knowledge of how things were done in the days of regular operation is essential. This knowledge ranges from the physical records, to actual skills in carrying out the various jobs. Without the maintenance of the various forms of the software, we will not be able to maintain our hardware. Training of our future maintainers in both the old and new skills is essential.

In maintaining our hardware, many heritage issues arise. What changes are acceptable, and how should things appear? This requires that the operators have a good knowledge of the cultural and engineering heritage of their hardware and written heritage policies. Another form of the software required.

The future of our operational heritage trains/museums will be dependent not only upon the way today's operators establish a structure to enable operation, preservation and conservation to be carried out. But, on the way they present and maintain their 'exhibits'. Only by understanding the need to preserve the software will they be able to operate their hardware. The maintenance of this knowledge is essential. They will not serve the future public in a proper manner. There may be no tomorrow if this is not done.

8. ACKNOWLEDGMENTS

The assistance of M. Hughes of Steamrail Vic, P. A'Vard of the Emerald Tourist Railway Board and H. van den Berghe in preparing this paper is acknowledged.

9. REFERENCES

1. Swaine, C, 'Locomotives', *Stacktalk*, Vol. 3, Issue 1, January/February 1992, pp. 17-20.

2. Marshall, D, 'What's Happened to our Locomotives?, *Narrow Gauge*, No. 107, December 1987, pp. 5-9.

3. Glastonbury, J, 'Commercial Heritage Train Operation: The Challenge, Railway Heritage Conference, Sydney, October 1991, Aust. ICOMOS.

SUMMARY To preserve engineering heritage equipment in an operational condition requires the preservation of the knowledge that built it and maintained it too. Many problems associated with the maintenance of the operation of heritage railways and railway vehicles are examined, along with heritage, recording and training for the future. If the preservation of this knowledge is not done, then the long term operation of these railways is doubtful.

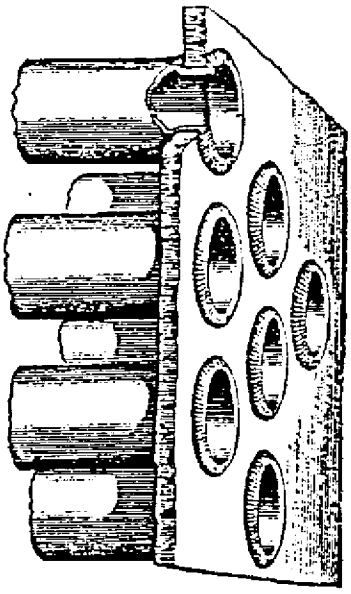

Diagram showing part of the end of the plate and tubes, and how the ends of tube have been beaded.
(Courtesy of Puffing Billy Preservation Society)

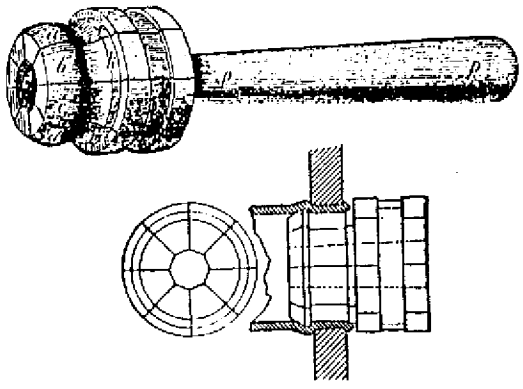

Diagram showing Prosser's tube expander.
(Courtesy of Puffing Billy Preservation Society)