A well-planned operation

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Abstract: *Just as the physical nature of most large technology objects is composite – a whole emerging from the physical connection of many parts – so the functional nature of these objects is also composite – a whole generated by the interaction of many smaller functions. Conservators and curators routinely make decisions about which parts of an object to prioritise for conservation, but they also need to make clear decisions about which functions they wish to conserve and why. This paper discusses the factors that can make the difference between the well-planned operation of a functional object and a money-guzzling, low-return headache.*

Introduction

Large technology objects are, by definition, big. Most of them are big because they are composed of many smaller components, each with its own distinct function. These smaller functions interact to create higher level functions – the ability of a gasket to function as an effective seal for instance is vital to the correct functioning of an hydraulic system.

Large technology objects are, however, often described on display as if each one were an indivisible whole. "It is of period A, it represents technology B, it is in condition C, it fulfils function D". A simplified description like this is appropriate to many displays, presenting a clear picture to the public in relatively few words. When it comes to actually working on a large technology object however, as any good mechanic knows, it is a collection of small objects. How those objects are put together is vital – the whole is more than the sum of the parts – but it can still be broken down into the parts, and usually has been at regular intervals during its operating life.

This reducible quality means that over an object's lifetime the various different parts acquire distinct life histories. By the time an object enters a museum collection its different components are of different ages and stages of wear, different sources and manufacturers and different materials. The history of each of these determines its degree of historical significance and its relevance to the purpose of the collection.

The same can be said of the object's functions. Most large technology objects have a range of different functions – provision of motive power, ability to move around, ability to perform a specific work task such as lifting or weaving, ability to stop, ability to send signals or register information. Through the object's working life these functions are adapted, updated, replaced, disused and discarded, along with the components that make them happen. Each of these functions may have a different level of historic authenticity or relevance to the purpose of the collection, and may present different opportunities and difficulties for display.

In particular, functional objects present the opportunity - perhaps the obligation - to maintain their functions. The concept of responsibility to preserve intangible heritage is growing rapidly (Galloway, 2004 and Wain, 2004) and includes aspects such as the sensory experience of large technology and the skills associated with its care and operation. To decide whether it is appropriate to maintain a particular function however, it is important to consider the level of cultural significance of that function and determine whether maintaining it will be informative, useful and relevant - or just an expensive white elephant.

Which functions are worth keeping?

Making large technology functions "go" is much more popular – indeed expected – than the operation of small technological objects. In fact, while it is seen as a worthy aim in itself to collect small objects and place them on static display, to collect large objects and put them on static display is often seen as something to be ashamed of. How often have you heard the heartfelt lament "It's such a pity you can't have them all working..."?

But when people talk about a large technology object working they often just mean getting the engine going and having the main movable bits move. For large objects built before the middle of the twentieth century these are pretty much all the functions they had to offer and even these were somewhat experimental in nature. So to provide an insight into the technology and "feel" of these early machines, motive power and basic movement works well and is not too difficult to achieve. However maintaining these functions is still a resource hungry commitment and before making that commitment the question should be asked - how many engines do the public want to hear? At what point do the costs of maintaining and demonstrating even these limited functions outweigh the return in public interest?

Functional complexity begins to explode after the Second World War, with features such as hydraulics, feedback systems, communications, fire suppression systems and many more. And yet "operating" these objects still tends to mean turning the engines on and having the main movable bits move. This is still impressive (these are, after all, big machines), but perhaps this is an area where a wider range of functions could be explored, combining the public's appreciation for operating objects with a greater variety of experiences. Some of the alternative functions may in fact be safer and cheaper to manage than running an engine, and more suited to use inside interior spaces such as galleries. For example, large technology objects in the Memorial's collection with functions which run independently of the objects' engines are the Sea Fury aircraft (folding wings) and the M113A armoured personnel carriers (openable rear access ramps).

Some large technology functions may be difficult to manage in their original configuration, but be relatively easily adapted for museum use. Most aircraft hydraulic systems, for example, are normally powered by a pump driven by the running engine (or an electric backup pump) and operate at high pressure to overcome the aerodynamic forces on the flight surfaces during flight. A pinhole leak in such a high pressure system could result in the escape of a stream of hydraulic fluid. However an alternative low pressure, hydro- electric system could be manufactured to replace or run alongside the existing hydraulic system, and be operated by a simple electronic program. This could perhaps even be made to respond to visitor operated controls and used to demonstrate the effect of changing the shape of flight surfaces on the aircraft's performance (Croker, 2004).

In the early twenty-first century many functions in large technology objects are being designed to be run by separate layer of functional systems – automated computer systems (Graham-Rowe, 2003, issue 2420). For these objects just running the engine and moving the main movable bits is not an option. Most of the movable bits are not directly connected to the control mechanisms used by the operator – they are activated by the electronic systems in response to a combination of operator delivered instructions and factory set instructions about the best way to safely run the machine. To even run the engine and move the main movable bits in these objects it is necessary to maintain the functional electronic operating systems to manage them.

This brings new challenges which I do not believe the museum world has yet grappled with. One of these is that a mechanic can no longer maintain these systems without expensive specialist training and diagnostic equipment – dedicated training and equipment which is produced by, and specific to, particular vehicles or products. The Memorial's Bushmaster infantry mobility vehicle, for instance, requires separate equipment and training to maintain its CAT engine and its Allison gear box. Commercial and (in the Memorial's case) military secrecy may become an increasing barrier to functional maintenance of historic objects, either passively as a result of training and equipment costs, or actively, particularly with objects which are still sold commercially or used on active military service (Schroeder, 2004). The use of computerised systems in large technology also brings in all the problems currently faced by other users of digital technology in the heritage industry, including rapid obsolescence of hardware and software (particularly specialised proprietary products), bugs, viruses, data corruption and incompatibility with earlier systems.

The future may hold a number of other ethical and practical challenges which have not yet landed on the workbench of the unsuspecting conservation mechanic. For example components of modern large technology objects are increasingly being made to be replaced when damaged – it is often not possible to repair them (Graham-Rowe, 2003, issue 2377). The day is also fast approaching when many components will not be built but "grown" using genetic algorithms – not even their manufacturers will know quite how they work, or quite how they could go wrong (Davidson, 1997). A malfunctioning electronic security system could lock down a whole vehicle and send a ear-splitting screech through the galleries. Still want to run the engine…?

Running the engine and making the main movable bits move for objects from this era is in any case pretty clearly not the main point of the technology. The point of these objects is not just that they can move, but how well they can do it – how safe they can be in dangerous situations, how fast, how precise. The old large technology experiences of sound, smell and movement may even be largely irrelevant – many twenty-first century machines are engineered to minimise noise and emissions and to move with the minimum of energy-wasting fuss and excitement (with the exception of Harleys which have forged a whole brand out of energy-wasting fuss and excitement).

Along with many other aspects of large technology use and care, selection of functions for display purposes has often been driven by ideas and assumptions that perhaps have more to do with machines from before the Second World War than technology from the last fifty years. Undertaking a more explicit evaluation of the significance of different functions for collection development and display may deliver a variety of advantages, including a wider range of experiences for the public, more options for exhibition developers and opportunities to preserve a wider range of functions and maintenance skills.

What other factors should be considered?

As well as the cultural significance of functions, a number of other factors must be considered when deciding whether maintaining an object in an operational condition is a viable proposition. The following list covers the factors that our experience at the Memorial has suggested are most critical (a number of these factors are also noted in Paine, 1994).

- the current state of the object (which will dramatically affect the cost of making it functional);
- the likely impact of wear on significant parts of the object;
- the need to update the object to meet modern safety standards;
- the restrictions of the museum context, including;
  - ⇒ The requirement to deliberately disable or remove potentially hazardous functions (for example weapons systems);
  - ⇒ The need for special provisions in the exhibit design to facilitate either display operation of the chosen functions or exercise of functional systems for maintenance;
  - ⇒ The cost and availability of certification that will be acceptable legally and to insurers. This includes:
    - Suitable licensing arrangements for machines and their operators (roadworthiness, authorised drivers etc - this can get quite curly when the machines no longer fit the requirements of current codes and when no training courses are available to teach the skills required to operate them);
    - Suitable certification for museum use (certification may only be available if a machine is fit for its original use, whereas the museum use may be substantially less demanding and risky and allow for greater retention of original components);
- the level of benefit to the museum of operating the object. For example operation may be a direct revenue raiser – a number of small museums in particular charge for rides in operating trains and vehicles;
- Non-display reasons for maintaining functionality:

    - ⇒ the preservative effect of operation due to both distribution of wear and preservative compounds and the increased level of care and attention that it demands (Paine, 1994 and Hallam and Courtney, 1995);
    - ⇒ large technology objects may be logistically easier to manage and preserve if some functions are maintained. For example the weight of the Memorial's fifty two tonne Centurion tanks means they are extremely difficult and expensive to move if they are not self-mobile. Equally, to inspect the interior hydraulic and fluid spaces of many First World War guns, it is vital that the breech, recoil, elevation and traverse mechanisms are maintained in a movable condition. Once these systems have seized up through lack of care and exercise, inspection of the internal spaces and maintenance and disassembly of the components are impossible (Pearce, 2004);
- The resources available to maintain functionality in both the short and long term.
    - ⇒ Money and time – the more complex and potentially dangerous the function, the more money and time is required to maintain it successfully. Money and time are primarily expended on:
        - **Getting it going** (and making it compliant with relevant standards);
        - **Keeping it going** – regular exercise, changing lubricants, cleaning etc;
        - **Getting it going again** – when things wear out and accidents happen;
    - ⇒ Facilities for safe and appropriate operation and repair (including both workshop and exercise areas);
    - ⇒ Record keeping – records of what decisions have been made and why, log books, conservation reports, maintenance plan, parts and spares inventories, photographic documentation, results of periodic performance testing etc;
    - ⇒ Skills – developing and maintaining a pool of skilled people to both operate and repair the machinery.

The Plan

To make a success of conserving and operating a functioning object, all this information needs to be brought together in a project or object treatment plan. This does not have to be a huge undertaking, but it should be developed with the involvement of key people. These include the person who knows why the object is significant, the person who knows what the object is made of and how it works, the person who knows how the object will be displayed and the person who knows how the object will be moved and stored. It also includes the person who knows how much money is available (and can maybe get some more) and the person who can meld all these other people and their different ideas into a successful project team.

The project plan prepared by the team must record the following information:

- which functions are to be conserved and why;
- what funding, skills and facilities are to be used;

- what health, safety and legal requirements must be complied with;
- what tasks are required to conserve the identified functions,
- what supply train is required (identification and purchase/stockpiling of suitable spare parts, lubricants, fuels etc)
- whether any mothballing or other work needs to be carried out in parts of the object not selected for functional conservation (such work might be needed to ensure the safety or structural stability of the object, or to conserve the possibility that additional functions might be reactivated in the future).

After the project is complete, the same team must complete a project report which records changes made to the original plan (and their rationale) and the final outcomes (treatments applied, information discovered, project costs – this will help in planning the next project – and actions taken to ensure legal compliance). The team must also ensure that a maintenance plan is designed, written down (and located somewhere other people can find it) and set in train. The maintenance plan must include periodic monitoring to document the ongoing condition, reliability and safety of the object and the effect of operation of the chosen functions on the rest of the object.

She's a little ripper – just what we wanted

The final result should give everyone a warm inner glow. Good decision making up front should result in conservation of a set of functions that closely fit both the intended use of the object in the collection and the money, time and other resources available. People involved in the work should feel satisfied that the job has been done to high standards and management should feel happy that the project has delivered the agreed outcomes on time and on budget. Most importantly, everyone gets the fun of watching, hearing and smelling (and sometimes operating) a real, working object.

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