Creating a modular storage system for large technology objects at the Australian War Memorial

Bill Lang
Kay Jefferies Management Services

Abstract: *The development of a modular, largely generic set of handling equipment for large technology objects has substantially reduced the time and costs involved in large technology movement and handling. This paper outlines the basic units of such a system and the principles underlying its application.*

I have been involved with the design and construction of storage systems for large technology items since 1987, when I undertook work for the Australian War Memorial for the storage and transport of a biplane aircraft and other items. This was followed by work for the National Museum of Australia on the storage of further major aircraft sections including a fuselage, wings and engines.

By 1990 I realised that there was a great need for a co-ordinated, overall approach to the handling and storage of relics, based on the use of a "Meccano set" of generic, modular units which could be combined in a number of different ways to resolve a variety of different problems. Creating a giant "Meccano set" has the following advantages:

- it progressively reduces the cost of storage and handling equipment across a collection, as units from previous projects can be reused for new items;
- it reduces the need to store bulky handling equipment for collection items which are on display, often for years at a time (the equipment can be reused on other projects in the meantime);
- it reduces the need for costly and time consuming tailoring of equipment to objects – tailoring may be reduced to a couple of object specific profiles, with the rest of the equipment being generic).

As each situation presented itself I sought to solve it as far as possible by developing generic units. Tailoring, or specific tooling, was restricted to the interfaces between the handling equipment and the object.

Development of this storage and handling system has been underpinned by the following principles:

1. The object is kept as neutral as possible. The priority during fitting, storage, handling and transport is that **no** damage to the object is incurred at any stage.
2. All storage and handling equipment maintains the maximum possible access to the object for inspection and conservation. For example, an aircraft fuselage will retain access to engine hatches, wing root areas, cockpit, etc.

3. Transport and storage issues (i.e. height, length, depth, weight centres and structural considerations) are fully accounted for in the design of the equipment (including any changes resulting from full or partial dismantling of the object such as changed dimensions, weight centres, handling behaviour, etc).
4. Equipment items not currently required must be able to be dismantled into generic units and returned to the pool for re use. Their specifics (dimensions, load capacities, identifying number) are recorded in an inventory for tracking and future use.
5. OH&S issues are fully considered in the design of the equipment.
6. Manual handling options are provided where possible. For example removable poles are placed at each corner of a trolley to avoid the object being used for traction and to give staff the option of fine position adjustments by manpower.

As a result of this policy, the Memorial now has an extensive and flexible pool of equipment. This includes the following generic units:

- Artillery trolleys – so named for having been designed to carry artillery pieces with a small footprint and very high load. Several of these trolleys can be integrated using rigid steel tubes. This allows them to form a single, large, load bearing trolley capable of carrying a tank, small boat, locomotive, etc.
- Large trolleys up to 8 metres long. Some are purely skeletal structures, others are clad in plywood. These can be used as the base wheeled unit for transporting an enormous range of items.
- Support stands. These can be combined into supports for wing or fuselage sections, gun barrels, rocket tubes, or a humble workbench.
- Connecting tubes. These can be used with all the other generic equipment to create new configurations and dimensions. They are drilled with holes to provide large increment movement, as well as large diameter threads for fine adjustment.
- Lifting beams. These can be used as support bridging beams, spreader beams and main lifting structures.
- Mast hoists. These were loosely based on a design used in the late 1930's to assemble Wellington, Avro Lancaster and other large aircraft. They were initially designed to use with the disassembly of the Lancaster due to the size and load weight restrictions on its former display floor area. Built into their design were considerations relevant to their storage, component handling and extra mast height for future use. Since coming into service they have been used in dozens of situations, assisting with assembly, dismantling, movement in restricted areas and fine position adjustment. They can be used with all the other generic items and often remove the need to hire cranes and other expensive and space consuming equipment. Their use is only governed by the operators' imagination and skill.

This system has been built up over the past 15 years in close consultation with Memorial staff. I have provided creative design solutions, shop drawings, manufacture, and detailed fit up to specific objects, as well as engineering certification for loads, tolerances and functionality. Consultation with Memorial staff has enabled me to establish detailed requirements for each project, including safety, object integrity, time and budget constraints, and to advise where appropriate on simpler or more cost effective ways to achieve the desired results. In many cases the answer is to use what is available in the pool with only a minor specific item to be designed and manufactured. This approach has resulted in considerable savings in cost and storage capacity for the Memorial.

The large technology staff at the Memorial are now confident in assembling this large “Meccano” resource into some surprising arrangements. With appropriate training in rigging, crane use and forklifts, they are now able to safely move and assemble very large, rare and delicate objects. Planning for object movement can now be done so precisely that detailed and accurate schedules for large technology installations are able to be mapped out months in advance.

The following images show the process of installation of the Messerschmitt Bf109 aircraft into ANZAC Hall and illustrate the use of some of the elements of the modular system described above, along with minimal items specifically tailored to the object. Note that a trial of the entire installation layout and procedure was conducted before installation in the gallery, to enable the process to be optimised and checked. This ensured that the process would work correctly, safely and to schedule on the day of installation. As part of this trial, the support column was also fitted to the aircraft – the armature connecting the aircraft with the support was specifically designed to be intimately integrated with the structure of the aircraft and to be almost invisible outside the skin of the aircraft.

Figure 1. Assembly of the lifting frame underneath the aircraft fuselage. The aircraft is in its display orientation. The frame incorporates standard lifting beams of various sizes bolted together with fish plates, as well as tailored wing spar supports, prop spindle support and tail support.

Figure 2. Wide shot showing the layout before site positioning. Note tail support which uses the standard lifting position on the fuselage.

Figure 3. Frontal shot of aircraft in correct position on floor ready for raising. The display support pole is being lifted in with a crane to a position close to the final support site. Note crane exhaust extraction system.

Figure 4. Site cleared of miscellaneous items ready for lift. Note mast hoists at each major beam end – these are the lifting mechanisms for the aircraft. The crane does not give a sufficient level of control and precision to ensure the safety of the object, staff and exhibition infrastructure so is not used for this purpose.

Figure 5. Aircraft halfway up. Staff checking measurements and levels to confirm correct orientation before proceeding further.

Figure 6. Aircraft at correct height for display, waiting for support column to be rolled into position. The aircraft was then lowered onto the column for final fixing.

Figure 7. Aircraft installed on support column in final position. Frame has been lowered to the ground for dismantling. Note: the tail support was removed later using a knuckleboom for access.