DEPOTS Design

Rethinking depot design

The introduction of new vehicle designs and ever greater use of condition monitoring systems are driving the evolution of rolling stock maintenance depots.

MICHAEL BORN
Director, Depots & Workshop Design, DB Engineering & Consulting

Regular servicing and maintenance of rolling stock are fundamental to both the safety and operational efficiency of any railway, be it main line, metro or light rail. Over the past two decades, there have been some significant shifts in the way that locomotives and rolling stock are manufactured and deployed, which in turn are impacting on the design and operation of depots and workshops. There are a great many factors that need to be considered when building new maintenance depots or reconfiguring existing facilities.

Depot design embraces a wide range of activities: dimensioning the facilities, planning the buildings and track layout, specifying the technical equipment and project management through to commissioning and handover. An essential part of this is to consider the most appropriate maintenance procedures and the logistics requirements for spare parts and consumables.

DB Engineering & Consulting has been working in this field for more than half a century, managing the construction and remodelling of depots and maintenance facilities for DB, other operators and local transport authorities within Germany, as well as many different railways around the world. Our work ranges from metro depots in Medellin and São Paulo to the Vietnam Railway workshops in Da Nang or DB Fernverkehr's latest ICE high speed train servicing depot in Köln. And where necessary, we can call on experts from across the DB Group to help with specialist tasks such as staff training or optimising the environmental impact.

Changing workload

Most modern vehicles incorporate new materials and production methods which can help to minimise maintenance. They also make much greater use of electronics in train control, condition monitoring and fault diagnostics, which provide valuable data for the depot staff but bring their own specific maintenance requirements. Added to these are stricter regulations around environmental protection and energy use.

Operational and business-related factors should not be underestimated. Pressure to improve availability and maximise the utilisation of expensive trains means that vehicles must be serviced and made ready for operation in the shortest possible time. Ideally, servicing and basic repairs should be undertaken as close as possible to where the vehicles are operated, reducing the need for unproductive positioning moves. In Germany, as in many other countries, there has been a trend away from large central workshops towards having smaller, regionally-structured maintenance hubs and mobile maintenance teams.

At the same time, rising customer expectations and the regular re-tendering of operating contracts mean that rolling stock is being refurbished more frequently, or replaced by new vehicles. This is reducing the average vehicle age, which in turn impacts on maintenance and servicing intervals. Maintenance organisations and facilities need to become more flexible and adaptable. Increasingly, operators and owners are opting to build new depots specifically to service new train fleets, which can sometimes be more cost-effective than adapting and re-equipping older facilities.

Today, the workload of a modern depot can range from basic servicing and inspection during operations through to simple maintenance and the exchange of individual components or minor repairs. In line with the regionalisation trend, more of the routine overhauls are being undertaken locally, including the replacement of entire sub-assemblies. Vehicles are only sent to a major workshop for heavy overhauls, mid-life refits or

accident repairs. Metro and light rail operators with a stand-alone network typically have their own workshops alongside the servicing and stabling facilities.

Design factors

There are quite a few factors which must be considered when planning new or remodelled maintenance facilities. Firstly, is the depot being designed for a stand-alone line, or as part of a network? Will it be maintaining one vehicle type or more, and how large is the fleet to be serviced? How intensively will the trains be operated, in terms of hours or trips per day, and when will they be available for maintenance, cleaning or inspection? Do all vehicles return to the depot each night, or will some be stabled at terminal or junction stations across the network?

Designers must also consider the basic servicing routine. This would typically include the supply of fresh water and disposal of waste, internal and external cleaning, and litter removal. In the case of longer-distance trains, it may even include the filling of vending machines and the replenishing of bistro or catering carriages.

Fig 1. Computer simulation of the warehouse for DB Fahrzeuginstandhaltung's central electronics workshop in München.

Image: Dorothea Schmid

In dimensioning the workshop capability, the operator must decide how much provision needs to be made for accident repairs and/or periodic overhauls. This in turn influences the provision of storage for spare parts and maybe workshop space for the overhaul or manufacture of specific components. Will spares be sourced from the vehicle manufacturer or a centralised logistics supplier, and if so in what quantities?

Local factors to be taken into account might include climatic conditions, with cold countries requiring thawing

CFL's main workshop in Luxembourg has three working levels providing convenient access to underfloor and roof-mounted equipment.

Photo: Walter Liesenfeld

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facilities to de-ice the trains ahead of maintenance. Depots in desert countries might require additional capacities to deal with sand filters or the increased load on air conditioning systems.

The provision of staff accommodation will depend on how many operations staff are to be based at the depot, as well as the servicing, workshop and administration employees.

There are also some specific issues to be considered in relation to the remodelling of depots to maintain new or modernised fleets. A key factor here is the timescale for vehicle replacement, and the degree to which the fixed equipment and other facilities can be used by both old and new trains. This will influence the choice between gradual modernisation of the existing facilities, partial demolition and remodelling, or the construction of a purpose-built facility.

When planning a redesign, it is important to consider how essential tasks can best be accommodated in the existing facilities through the re-organisation of internal workflows. Is it necessary to set up temporary workstations during any reconstruction?

Based on the responses to these many questions, our usual approach is to draw up a 'requirements profile' for the depot. Based on a detailed simulation of the operations, it is possible to develop an initial layout for the various activities. The next step, which can be no less complex, is to consider how the depot relates to existing railway facilities. The depot must also be integrated into the urban structure, or into the landscape when building on a greenfield site.

A specific consideration for local and urban transport operators may be the degree to which tasks can be combined with those for other modes of transport. For example, we helped to design an inner-city depot complex in Singapore, where metro trains are maintained on one level and the level above accommodates a bus depot with all of its related requirements. In another example, recreation and sports facilities for the community were located on the roof of a subterranean metro depot.

Photo: Ralph Schneider

A new servicing facility has been developed in Köln for VT622 and VT 620 DMUs.

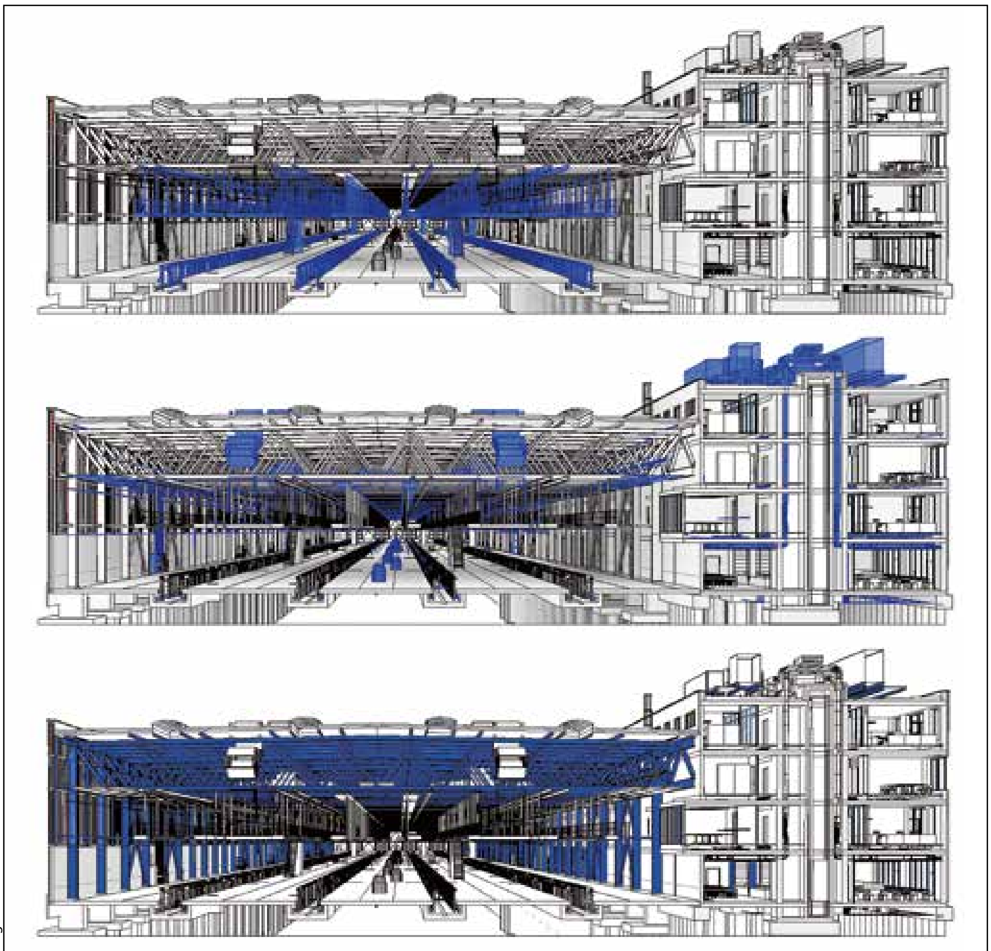

Image: Erik Eifler

Fig 2. BIM drawing for the ICE servicing depot in Köln, showing the machine technology (top), technical building equipment (centre) and structural design (bottom).

Green maintenance

Increased environmental awareness and stricter regulatory requirements have encouraged greater attention to materials recycling and waste water treatment, while rainwater harvesting has become common in new depots. Some facilities make use of roof-mounted photovoltaic cells or wind generators to reduce their carbon footprint, while others have tapped geothermal energy for heating.

Specific environmental measures might include the separation of litter and other waste materials removed from the train during internal cleaning, requiring separate storage and disposal facilities. External cleaning systems and washing plants have to incorporate water treatment, and some traditional cleaning agents are no longer permitted. The use of water-soluble paint is preferred on sustainability grounds, while protective agents are increasingly used to combat graffiti and scratching. Many operators use vinyl overlays for their liveries or as an advertising medium, which have their own specific handling and maintenance requirements.

Optimised servicing and maintenance processes are a key element in ensuring the sustainability of the rail mode, in a continuous chain that starts with design of the vehicles. It is not just a question of better accessibility for maintenance or for the replacement of components or subsystems, but about the environmental impact of the overhaul process, balancing the flexibility of decentralised maintenance against the increased efficiency of a centralised approach, particularly with the greater adoption of standardised vehicle families.

From time immemorial, the trade-off between preventive and corrective maintenance has been a part of the process orientation. This tries to balance the conflicting priorities of availability, operational safety and cost. Today, there are new technical and organisational options that do not simply report failures, but provide the operator with near-continuous data about the performance of the vehicles. They also report when the limit values for individual parts or components have been reached, which means that the replacement of key components can be combined with minor maintenance to minimise downtime. This means all technical elements are used optimally, and can be properly overhauled, offering further environmental benefits.

Predictive maintenance

In terms of condition-based, or predictive maintenance, there are two main approaches: 'infrastructure monitors train' or 'train monitors train'. As an example of the first case, various parameters relating to the bogie are recorded by electronic sensors and checkpoints along the route and transferred to the operations centre. In the second case, the train monitors itself in a comprehensive manner, and also reports this data to the operations centre so that the dispatchers can react appropriately.

The dispatchers can initiate any necessary testing and rectification work to be undertaken during a standard periodic inspection, arrange an exceptional empty run to return the train to a depot for urgent maintenance, or even take the vehicles out of operation immediately in order to ensure safety.

This reporting chain offers advantages for the depot team, allowing an incoming vehicle to be directed straight to the appropriate track for maintenance or repair if required. All the spare parts and tools required for rapid execution of the work in the available timeframe are on site until the vehicle is put back into operation.

As the manufacturer of the predictive maintenance system used by DB is neutral, all of the railway-related assets of both infrastructure and vehicles can be represented in a overall system.

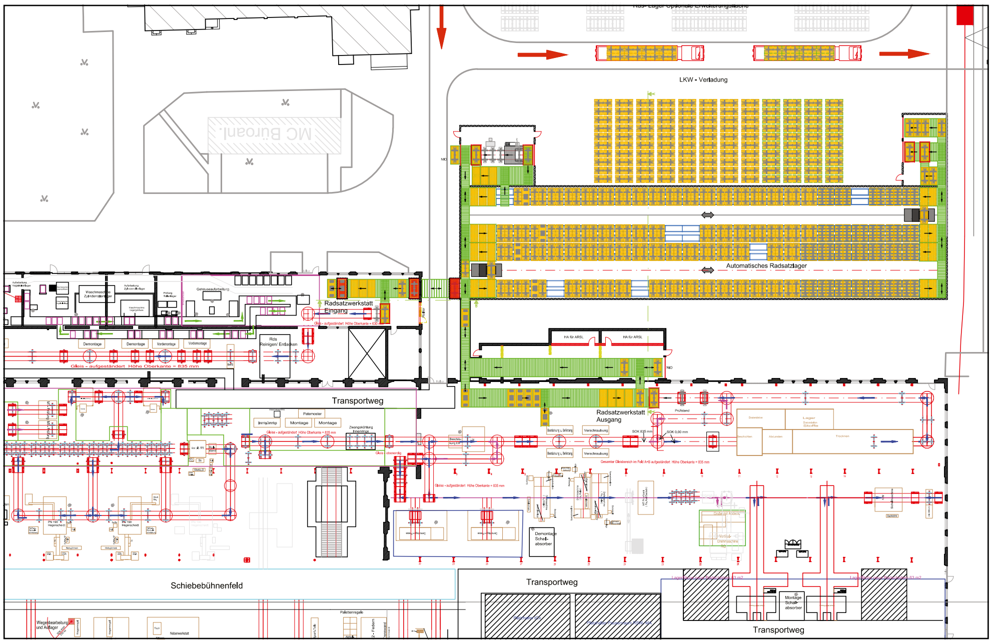

Image: Joachim Fischer

Fig 3. Layout for a wheelset workshop with automatic storage being designed for Deutsche Bahn.

Storage and stockholding

Holding a large quantity of spare parts can represent a significant cost element in the maintenance process, based both on the value of the spares and the space required. However, this has to be traded off against the loss of productivity if vehicles are held out of service awaiting parts. While greater use of condition-based maintenance is providing more information about the life-cycle and usage of individual components, operators need to give thought to these issues when planning their maintenance strategies, as this will affect the layout of depots and workshops.

A fundamental question arises over which components should be overhauled at the local depot to optimise operational performance and where centralised maintenance would be preferable to improve quality or reduce costs. Complicating this process is the fact that product cycles are becoming ever shorter for both vehicle manufacturers and their suppliers, even with the increased adoption of standard train families.

The increasing use of electronics and their ever-shorter development cycles pose big challenges for rail operators used to vehicle life-cycles ranging from 20 years to 40 or more. DB has seen its expenditure on obsolescence management and redesign of electronic components increase steadily for several years.

In 2015, a team of logistics consultants from DB E&C worked on the development of a central electronics workshop for DB Fahrzeuginstandhaltung at the new Triebwerk München site (RG 12.15 p55). This project included the preliminary design and planning of the warehouse equipment, as well as setting the long-term objectives for the tender documents in terms of construction, parts supply and disposals. ■