Better by design

DCA has applied four principles and a user-centric approach to the design of SNCB's double-deck trains

The creative application of design has always been a vital tool for winning market share in the highly competitive global railway arena, especially the commuter sector. This has never been more so than with the current drive for new flagship high-speed rail connections between busy urban conurbations around the world.

Product design and development consultancy DCA has been at the forefront of transport design for more than 40 years, developing solutions for the mass transit and high-speed rail markets. During that time, the company has established four core principles for the delivery of successful transportation design projects.

First, it works with the other key project stakeholders to identify all significant project risks and specifically tailor the programme of design work to tackle and manage these risks. Generally this involves addressing risks as early as possible in the project lifecycle and progressively reducing them to acceptable levels before significant capital investment commitments are made. Computer-based virtual prototyping and simulation tools provide obvious opportunities for such early risk management. These tools include computer-generated interior renderings and walkthroughs, configured to allow users to explore all aspects of a proposed interior space from the same viewpoint as a passenger moving through the actual transport environment.

Similarly, computer-aided engineering software is used extensively at DCA to predict the mechanical or electrical performance of proposed design solutions before investing in the production of physical parts. Examples from recent DCA projects include the application of injection moulding simulation software to explore the manufacturability of glass-filled polycarbonate seat headrests; the use of computational fluid dynamics to optimise ventilation duct geometry in underground vehicles; and the use of finite element analysis to predict the design life of an emergency egress device under fatigue loading.

DCA's design and development work for the seating solution on London Underground's D Stock vehicles provides a further example of the successful application of finite element analysis. In this case, computer predictions of stress and deflection levels under defined abuse loading situations were used iteratively to optimise the design of the one-piece cast armrest to reduce its material usage and weight. All computer simulation work is subsequently validated via practical test programmes either run internally in the company's own workshop and test facilities, or externally using organisations such as MIRA and TRL for load and crash testing and Exova Warringtonfire for fire testing.

The second principle is to integrate these risk management activities within a comprehensive project plan covering all aspects of the design development and clearly identifying the management interfaces with the other programmes of work required to deliver the new rolling stock. The plan will be unique for each project, but will draw upon rigorously managed development processes based on DCA's ISO 9001:2008 approved Quality Management System.

The third principle is total integration of the full range of skills required to deliver complex, multidisciplinary transportation projects. DCA has assembled an in-house team of more than 70 researchers, designers, ergonomists, interaction specialists, mechanical engineers, hardware and software engineers, prototype technicians and project managers. The tight fusion of these skills allows efficient progress in all aspects of a project concurrently.

The firm's approach to the design of passenger environments is evidence based. It draws upon research findings, generated by the in-house team, to develop a detailed picture of the various user groups to determine what each seeks from the travelling environment. The scope of this research ranges from investigating the functional and accessibility requirements, through to exploration of the less tangible features that act as delighters, making a journey enjoyable and memorable – an experience that customers will look forward to repeating.

These research findings act as the foundation for all subsequent design decisions, and avoid the personal preferences and prejudices of individual designers. Project-specific user knowledge is combined with studies of local and global trends, both inside and outside the transportation arena. The challenge here is to achieve a design that is relevant to the local culture without relying on potentially patronising national or regional clichés and that is contemporary without invoking short-term fashion cues that will not stand the test of time.

The strength of this user-centric approach was demonstrated in DCA's design of the M6 double-deck trains developed for SNCB in collaboration with Enthoven Associates. Here, research data provided a deeper understanding of the flaws in the existing rolling stock and insights into the travelling aspirations of the target users. There were many complaints about the open, inter-connected carriage architecture, which did not allow for an effective air-conditioning system, meaning that the interiors were often either oppressively hot or uncomfortably cold. Passengers were unable to establish any feeling of privacy or personal space within this environment, and disliked the sense of permanent connection to the vestibule areas. The seating

ABOVE LEFT: The M6 double-deck trains developed for SNCB
ABOVE: View from vestibule showing curved stairs and doors

“DCA’s seating solution improved passenger flow and gave the interior a greater feeling of openness”

ABOVE: Upper saloon showing staggered seating and window bays
LEFT: Typical seating bay

areas were cramped and this impression was heightened by poor ambient and artificial lighting arrangements that threw some areas of the interior into shadow, making them feel oppressive. In addition, overhead luggage provision was inadequate in the lower saloon and non-existent in the upper saloon. The inevitable result was luggage cluttering the interiors and obstructing the aisles.

With its lower ceiling height, lack of overhead luggage racking and reduced window areas, the journey experience in the upper saloon was considered by passengers to be far inferior to that in the lower saloon. Trains therefore consistently ran with the lower saloon preferentially loaded, to the extent that passengers would actually wait for the next train rather than travel in the upper saloon of a train where all the lower saloon space was occupied.

In response to these research findings, DCA conceived an innovative solution for the seating layout. The seats were arranged in a staggered bay formation that provided a wider central aisle without pinch points between seatbacks. This not only improved passenger flow, it also gave the interior a greater feeling of openness. A second major benefit of this was that passengers could store their luggage securely at floor level between the back-to-back bay seats directly opposite their own seat position, making it highly visible and easily accessible.

In order that each seat bay should align directly with a window, the engineering team at Bombardier, DCA’s manufacturing partner on the contract, used an asymmetrical carriage structure. This resulted in a staggered window arrangement to match the seat layout, giving impressive levels of uniform, natural illumination, and imparting a light and spacious feel to the whole interior.

Access into the saloons on both decks was completely redesigned to include a curved staircase that aided passenger egress and incorporated profiled sliding glass doors that isolated each saloon from the vestibules and allowed SNCB to maintain an optimum internal environment via a sealed air-conditioning system.

The radical design solutions conceived for the M6 project not only won the manufacturing contract for Bombardier, but have proved so successful in service that there have now been four follow-on orders from SNCB, representing approximately 64,000 passenger seats in total. Nothing provides a more positive indictment of DCA’s four transport design principles, and in particular the company’s user-centric approach, than this degree of commercial success.