First-class carriages on the DD-VIRM feature a change to predominantly coach-style seating, with new seat-back tables

DEVELOPMENT RACE

Developed in just a few months, the pace at which the new seats on NS's DD-VIRM double-deck trains were developed is a triumph for both effective co-operation and modern development tools such as CAD

THE DUTCH DD-VIRM is an Intercity train that consists of one or more combinations of four or six double-deck coaches. The first series of these trains, known as the DD-IRM, was introduced in the 1990s and comprised just three- and four-car trains but, over the course of the past few years, extra cars have been added, resulting in the DD-VIRM. Three-car trains were transformed to four-car sets and four-car trains to six-car versions. Later, more of these series were ordered in four- and six-car versions, so that there are currently more than 300 in operation in The Netherlands.

The brief for the DD-VIRM rail-cars specified that the interior and exterior design had to be based on – and be compatible with – the original IRM series. This revealed a few problems however – one of which was the seat. The IRM first-class seat was originally produced by Compin Benelux while the second-class seat was supplied by EMSTA Seating Breda. When both companies discontinued their relationship, the moulds were subsequently unavailable for the VIRM project. Other commercially available seats, meanwhile, did not fit in with the VIRM interior as a result of the specific (exterior) shape.

Bombardier Transportation and NS were therefore forced to develop a new seat in a period of just a few months and the contract for the engineering and the construction of the seats was awarded to Schlegel Swiss Standard (SSS).

But as the Dutch footballer Johan Cruyff put it, 'every disadvantage has its advantage' and this provided the team with the opportunity to tweak and enhance any weaknesses that existed in the previous models.

Improvements

To assist in this process, NS contracted Richard van der Weide, an ergonomist with extensive experience in public transport affairs. The design was executed by Jos Pelzer, design consultant of Bombardier Talbot/Aachen and Niels Greif, advisor, Industrial Design of Bureau Spoorbouwmeester. NS also brought in NedTrain Consulting for commercial and engineering expertise. Based on previous customer surveys and the opinions of the assembled expert team, several seat improvements were proposed, including:

- Altering the layout from solely vis-à-vis to mainly coach – a topic that Bas Leermakers discussed in detail in the December 2005 issue of *Railway Interiors International*. This revised layout would allow the integration of a folding table in the back of the first-class seat.
- The wall-mounted wastepaper basket would not be used in the potential coach layout as a result of its inaccessibility to those passengers in the aisle seats.
- The existing seat was too curved, resulting in body pressure points and, in particular, passengers' shoulders being pushed forward by the headrest – a problem that was exacerbated with taller travellers.
- The sitting depth was also found to be too small and, in combination with the curved shape, caused uneven pressure distribution on the upper leg and buttocks, thereby resulting in a feeling of discomfort. This was once more problematic for taller passengers;
- Although the same basic colour scheme was to be retained, the fabrics used for the second-class seats were altered from vinyl to velour, while the pattern was also changed. The first-class seats were already supplied with velour so this pattern remained the same.

Some key design characteristics of the original seat were not to be changed however. These included:

- The overall basic shape, due to old and new cars being combined in one VIRM train set. Therefore, the transition from one rail-car to another should be fluent.
- The base colour schemes for first and second class so as to preserve the visual clue in differentiating between first- and second-class compartments.
- The closed, circular shape of the armrests to avoid the risk of getting stuck in emergency situations, and at the same time minimising the risk of minor injuries during normal traffic through the aisles.
- Only one frame is used for all seats, regardless of their class and position in the cars.
- The total seat height was not to be raised so that conductors could be provided with a clear overview of the entire rail-car. The new coach layout already overcomes this oversight when compared to a vis-à-vis layout.

> "The Dutch population is the tallest in the world and – possibly as a result of immigration – the differences between the tallest and the smallest is also increasing. This presents a major challenge"

Concurrent engineering

With the goals of the project in place, how was a solution developed in such a constrained timeframe? Primarily, it was achieved through recognising and accepting the differing roles and expertise of the participants involved.

During only four working meetings at Schlegel's Switzerland facilities, decisions were made on a computer screen based on rapid prototyping and on a hardware model. After each visit, participants elaborated their actions and via the NS project manager were able to provide new input for the prototypes. The use of screen-based

(as opposed to a hardware model) seat design and the use of concurrent (ergonomic, aesthetic and constructional) seat design was also key in this regard.

The basic design of the new seats was made in a three-day session by just two industrial designers, with the NS product manager on standby. In doing this, all of the InterCity product specifications could be integrated immediately.

Another important difference from a traditional design process was that a panel of passengers was not employed. NS usually asks its riders to rate (a selection of) designs for aesthetics and comfort. As a result of the time constraints in this project, this was not conducted and was in fact trusted to the designer and ergonomist respectively.

With no drawbacks having so far been identified from this unusual course of action, the seat has even recently been shortlisted for a Dutch Design Award.

Design

With regard to the seat design, the following factors were considered, and were also crucial in the overall design of the train interior:

- Application of contemporary design, materials and colours;
- A breakaway from the standard train norm (tunnel effect);
- Optimum balance between form, function and technology;
- Design image, environment and comfort;
- Clearly visible difference between first and second class;
- Avoid a technical image;
- Easy cleaning;
- Individual, inviting and comfortable seat;
- Characteristic design;
- Avoid straight lines.

The folding table (first class only) was made vandal resistant. An overload-protection feature was also developed that causes the table to pass a security stop at a load of over 80kg, without damaging the construction. The table can then be placed back in position.

Ergonomics

As a basic design principle, it was decided to develop a seat that fits P5 female to P97.5 male. The reason for this skewed distribution is that rolling stock has a minimum life expectancy of 30 years and with human heights still showing a tendency to increase, the design had to some extent be future-proof. Additionally, the Dutch population is the tallest in the world and – possibly as a result of immigration – the difference between the tallest and the smallest is also increasing. This presents a major challenge.

Some adjustments were made in the design process to account for the dynamics of sitting and the averagely smaller population of certain passengers (taking into account elderly and children) in comparison to the working population.

Most notable of these design changes from an ergonomic standpoint were:

- The backrest has been made less curved in all directions, thereby providing more room for posture changes. As is becoming more evident from the aircraft sector, the risk for thrombosis as a result of a prolonged fixed posture is not to be underestimated. Of course, a well-designed lumbar support and lateral support (R≈1000 in the first class seat) are provided.
- The lower 100mm of the headrest is brought in line with the backrest. This design accommodates the shoulders of taller passengers while still providing passengers with the opportunity to rest their heads.
- The sitting depth (effective seat depth) was increased from 360 to 390mm in second class and from 320-370 to 390-410mm in first class (depending on adjustability). A free space of 64mm minimum (454-390mm) between the front edge of the seat and the back of the lower leg remains for P5 women. This dimension is relevant as some free space must exist to guarantee unobstructed blood flow to and from the lower legs as veins and arteries are close to the surface of the skin at the back of the knee.

For taller passengers, however, increasing the sitting depth results in better comfort as pressure is more evenly distributed.

Limitations

The speed of the design process also presented problems. Foam stiffness is higher than required, causing the seat to feel 'hard' or 'firm'. A lower stiffness, however, could not be guaranteed by the manufacturer to retain its quality for a certain period of time, but there was no time for further exploration in this area.

Another design dilemma existed between the wish for a folding table with a width of about 420mm (the width of two pieces of A4 paper or a laptop computer) and the requirement to use a standard frame for first- and second-class seats. As the folding table in the new design could only be positioned between the two vertical frame parts, this resulted in a folding table with a suboptimal width of 300mm.

From an ergonomic standpoint, the position of the wastepaper basket in the lower part of the back of the seat is suboptimal. Efforts therefore resulted in a concept that was as high in terms of construction as was possible for the location.

Furthermore, an easy-to-use mechanism for its opening and closing was developed in combination with a separate handling motion for emptying by cleaning staff. Still, emptying the dustbin is a physically demanding task, resulting in the posture being bent and twisted.

Critical success factors

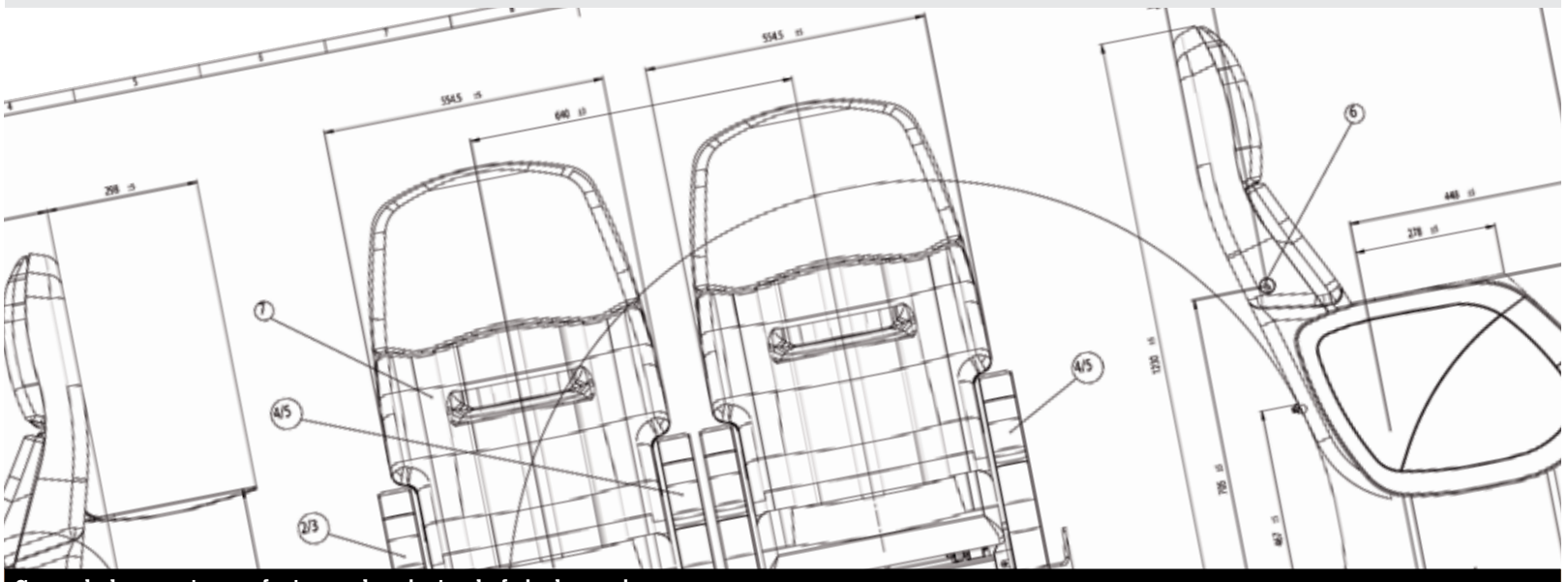
While the speed at which this project was completed proved to be key, there were several other notable reasons for its successful conclusion. First and foremost, the designers deliberately kept those features that had already proved to be successful while redesigning anything that had previously given rise to passenger complaints or was recommended by the experts involved.

While the expertise and roles of the different stakeholders and experts involved were explicitly acknowledged, the emphasis was on computer-aided design as opposed to mock-ups, which were only used to validate the details. And finally, because the experts were trusted to know the needs and characteristics of passengers sufficiently, no customer clinics were needed, which also proved crucial in meeting the sensitive deadline. END

>ABOUT THE AUTHOR

Richard van der Weide M.Sc., Eur.Erg.
Managing director of INTERGO, a consultancy focusing on human factors design in transport
Contact: Intergo, PO Box 19218, NL-3501 DE Utrecht, The Netherlands – Tel: +31 306 778 700, vanderweide@intergo.nl, www.intergo.nl

Niels Greif
Advisor, Industrial Design of Bureau Spoorbouwmeester, the independent consultancy office of Architecture, Industrial and Graphic Design and Art of NS and ProRail
Contact: Bureau Spoorbouwmeester, PO Box 2038/G5, NL-3500 GA Utrecht, Netherlands – Tel: +31 302 353 704, niels.greif@spoorbouwmeester.nl, www.spoorbeeld.nl



Second-class seats now feature velour instead of vinyl coverings