interiors

RAILWAY INTERIORS INTERNATIONAL **2016**

Elizabeth line
A hybrid train has been created to carry 200 million passengers per year on an over- and underground route through London

Brightline
A new approach to US intercity express rail service is soon to launch in Florida

Crowd pleasers

Ideas for carrying more passengers in comfort

Saint-Étienne tram ▮ Testing and simulation ▮ Security measures ▮ InnoTrans preview

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WELCOME

If you were to ask me to recall my least pleasant rail experiences, my mind would invariably linger on those times when I have been forced to stand for long portions of an hour-long commuter service, and when the metro has been so busy that the staff have had to prevent more people from entering the station. For the feature on page 30, we investigate various proposals to improve the situation – including standing seats and an interior layout intended to offer greater flexibility to adapt to the varying demands of service.

The designers of the new train destined for London's upcoming Elizabeth line have also had to consider capacity in great detail – after all, it is estimated that the line will carry 200 million passengers a year. The train is twice as long as current London Underground trains, and great care has been taken to create a calming environment for everyone. One new development is a handhold designed to provide greater lateral support to standing passengers. The unique underground/overground train is detailed in the feature starting on page 10.

Meanwhile, Andreas Vogler Studio and the German Aerospace Center (DLR) have tackled the capacity issue by looking at the structure of the train itself. They teamed up to create the AeroLiner 3000 concept featured on page 58. This design, a finalist in the Tomorrow's Train Design Today competition, imports the idea of a double-decked train to the UK. The train's height has been limited to ensure compatibility with the GB network. This is enabled by separating the two levels with a ceiling/floor of varying height, so the aisle of each is placed where the height is greatest on that level (to one side on the upper level).

Of course, capacity isn't the only factor affecting the industry today, and so in this issue you will find in-depth features on the role of simulation in testing (page 22) and developments in security (page 44). And don't miss the opportunity to learn more about Brightline (page 36) – thought to be the USA's first privately owned and operated intercity express service. The project team has used its experience in the hospitality sector to create a train they hope will lure people away from their cars, partly on the basis of its comfort and convenience – so passengers are assured a seat.

Izzy Kington, editor

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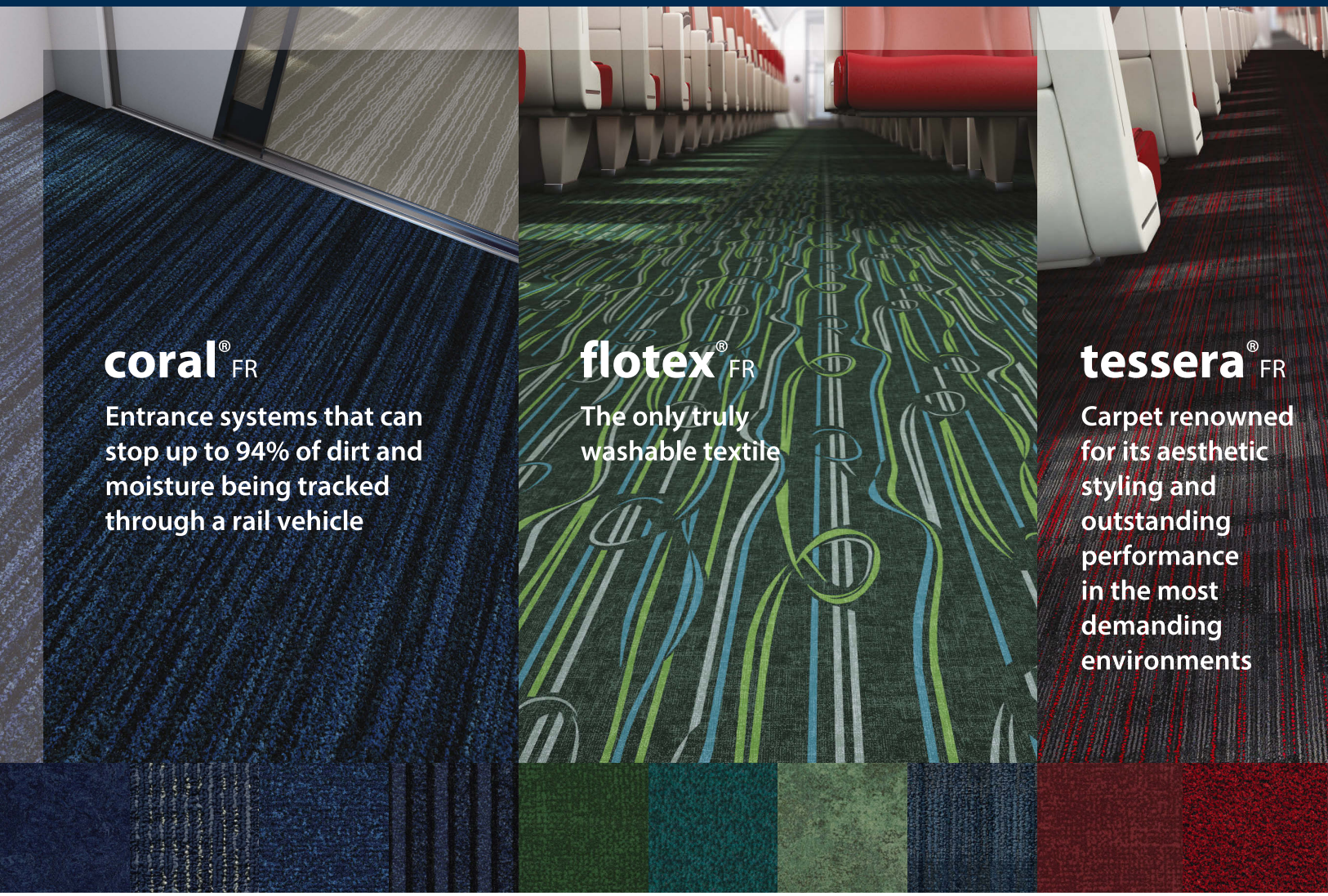

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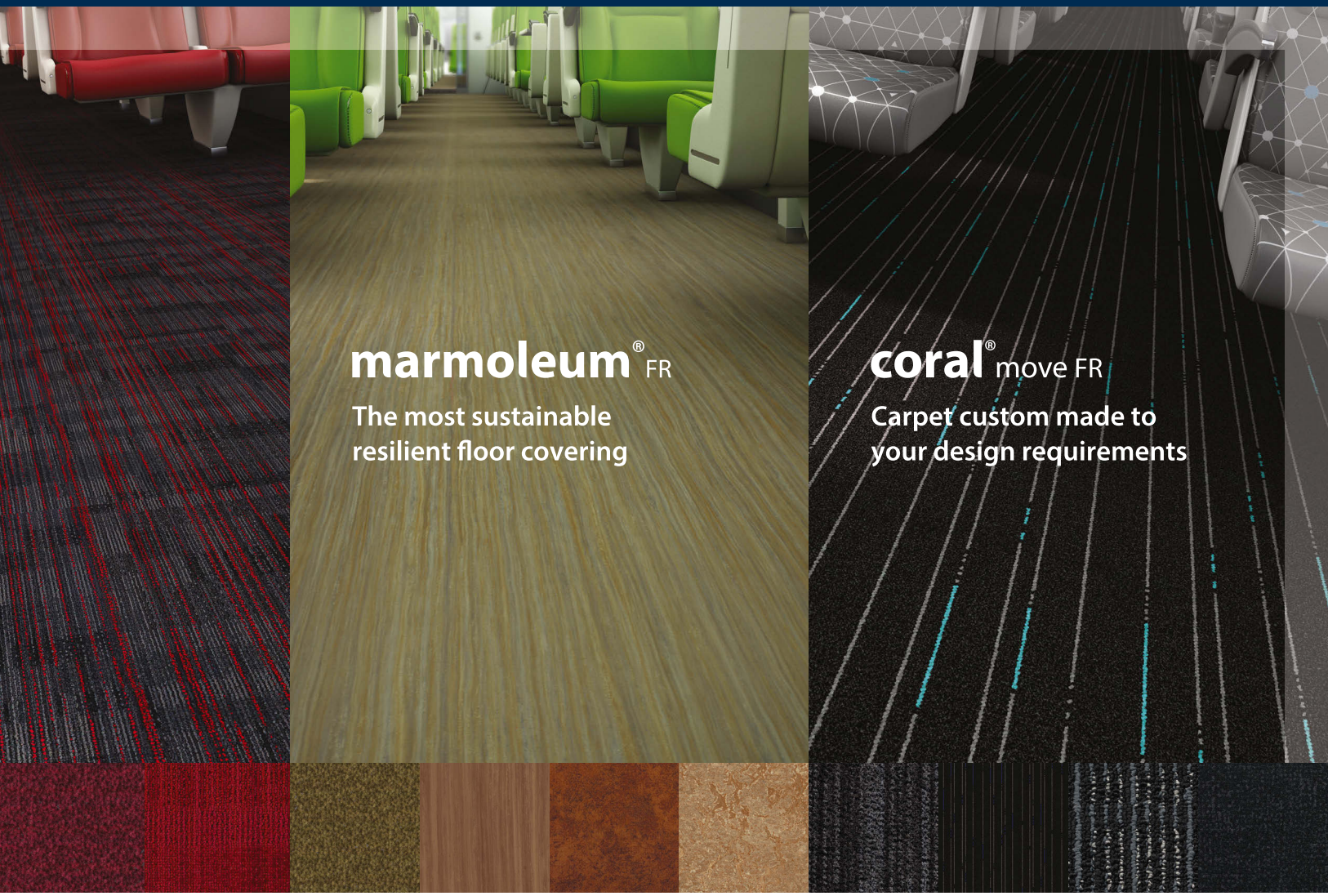

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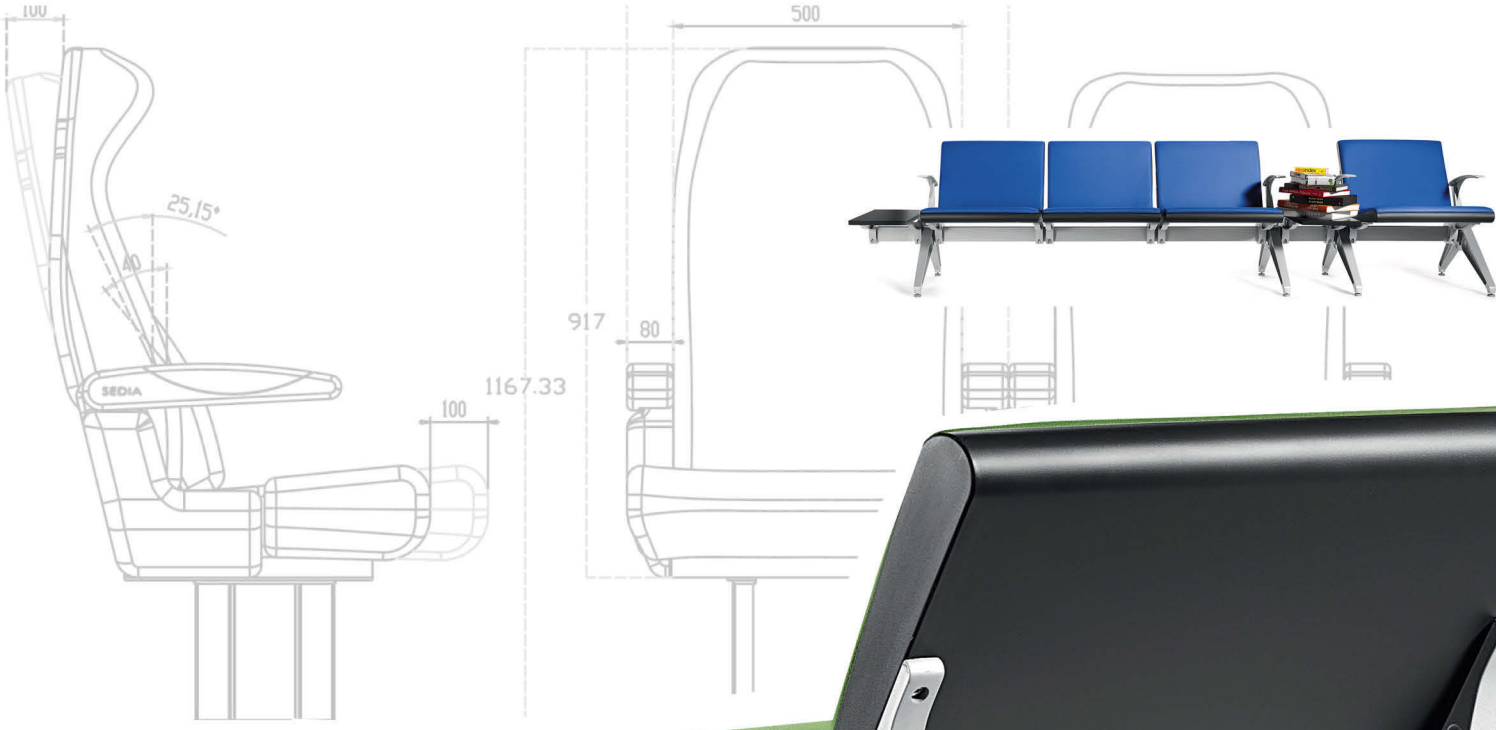

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London bridge

Destined to link towns on opposite sides of London with a route that is partly above and partly below ground, and to be used by 200 million people a year, the new Elizabeth line train offered a unique design challenge


ELIZABETH LINE

London's newest trains are set to enter service in May 2017. Eventually the line will be around 136km long, going right through London and linking Reading and Shenfield, towns to the city's west and east respectively. It will also serve Heathrow Airport, and have a southeastern branch connecting Canary Wharf and Abbey Wood. A quarter of the route (the central section through London) will be underground, the rest will be above ground. When the central section opens in December 2018 the whole route will be named the Elizabeth line, in honor of the Queen. It is estimated the service will enable 1.5 million more people to reach central London within 45 minutes and increase rail capacity in central London by 10%.

"With the relentless growth of London and the continued demand on our transport network, we know we need to increase capacity wherever we can," says Jon Hunter, head of design at Transport for London (TfL).

The Elizabeth line is thought to be Europe's largest current infrastructure project. As well as the construction of 42km of new tunnels, the £14.8bn (US$19.4bn) project includes the building of 10 stations and upgrades to 30 more, and the introduction of 66 new Bombardier trains, designated Class 345.

The first trains will have seven carriages, and be just over 160m long, but later trains will be almost 205m long, almost twice the length of current London Underground trains. These nine-car trains will each have 454 seats and four dedicated wheelchair spaces, with capacity for 1,500 passengers.

Because the train build was such a large contract, it went to European tender. TfL created a reference design to demonstrate its aspirations. "We ensure that all design requirements are fully baked in from the very beginning, so bidders have a very clear idea of what we want," says Hunter. "For example, we wanted materials that would wear in and not wear out, to ensure the whole-life cost was quite reasonable, so we didn't want lots of powder coating. We also stipulated longitudinal seats, to maximize capacity within the trains."

RIGHT: The unusual black front end is intended to make the train stand out at busy, multiple-operator stations such as Reading

BELOW RIGHT: London Underground's iconic roundel sign for the Elizabeth line

We ensure that all design requirements are fully baked in from the very beginning

Jon Hunter, head of design, TfL

Once Bombardier was appointed, another tender was launched to find a design consultant, to advise on the finer aesthetic details. The winner of that tender was Barber & Osgerby. The design process began in earnest in 2014.

The trains are based on Bombardier's Aventra platform. "About 95% of the interior was redesigned," says Hunter. "The hand of design touched almost everything, from the ceiling ducting for the HVAC, to the color and grooves

TIMELINE

Project approved by Royal Assent	Shortlist of five train OEMs announced	Bombardier awarded contract to build the trains and a depot for maintenance	MTR Corp announced as operator for the franchise from 2015 to 2023	Train design revealed publicly	First seven-car train scheduled to enter service	First service scheduled for the central section
July 2008	**March 2011**	**February 2014**	**July 2014**	**November 2015**	**May 2017**	**December 2018**

SIMULATING PASSENGER FLOW

In the bid phase, TfL issued bidders with a passenger flow model in a software package called Legion, along with instructions on how to modify the model to represent their product offering. "Give five manufacturers the same specification and you're going to get five completely different vehicle proposals," says Simon Cran of Bombardier. "I assume the benefit is that they got an apples-for-apples comparison."

TfL provided all the input data for the model – a traffic pattern for a certain time period for two stations. "We had to run the simulation and show that with our interior configuration – including the door positions, door widths, scene arrangements, car length, overall capacity – the train could achieve the required dwell time," says Cran.

Cran says Bombardier uses this type of software regularly, because quite subtle changes to the layout can make a big difference to dwell time.

on the floor, the castings and the moquette seat covers. We made the windows and doors as large as possible to maximize the feeling of space within the vehicle, ensuring the transverse seats aligned with the windows. Instead of powder-coated surfaces, there are large expanses of stainless steel, giving a glittering, jewel-like effect. It is quite a radical departure from our rolling stock of late. We want customers to realize that we care about them."

It is anticipated that the trains will be busy, carrying 200 million people each year. To reduce boarding times, each car has three double doors on each side. The train has walk-through carriages to encourage an even flow of passengers and make them feel more secure. "The actual gangways aren't that long, so it was quite easy to provide adequate handholds to support you as you're moving through," says Simon Cran, head of industrial design and human factors at Bombardier Transportation UK. "We've already delivered wide-open gangways on the Class 378 for LOROL and the S-Stock trains in London."

First nine-car train scheduled to enter service	Line scheduled to be fully operational, with all seven-car trains converted to nine-car ones
May 2019	**December 2019**

ELIZABETH LINE

Access all areas

The trains are designed in line with the latest European standards for people with reduced mobility (PRM). Announcements will be made visually and audibly. Priority seats will be clearly demarcated. There will be 10 multi-use areas throughout the train, and four wheelchair spaces in the middle car, providing a consistent location for boarding. "It also means we have a consistent place to store wheelchair ramps in stations where they are needed, and we can provide information help points, seating for companions and shelters in the same area of the station," says Hunter.

The transverse seats are based on a tried-and-tested product, with modifications to the shape of the back, and the sculpting and density of the foam. The longitudinal seats were custom-designed to match the transverse ones. Then

LENGTHY TESTING

As part of a £20m (US$26.6m) investment by Bombardier in support of the Elizabeth line project, the company recently opened a new testing and commissioning facility in Derby, UK. "It's a new building that is 250m long, and one of the reasons for that is to enable us to accommodate a complete Elizabeth line train," says James Rollin, head of PR and marketing for Bombardier in the UK. "The train is around 205m long. None of the existing buildings at the site were big enough to accommodate it."

The site will be used for static testing and systems integration among other things. "Obviously we'll use the test facility for subsequent projects, but this is its first use," says Rollin.

there are tip-up seats that Hunter describes as an evolution of those on the S-Stock. "There are a lot of demands on the hydraulics on those, so we needed to make sure they are reliable," he notes.

Care has been taken to make all the seats the same height and similarly comfortable. A stepped armrest has been introduced on the longitudinal seats. "One customer has the front part, and the one next to them has the one that steps back slightly lower," says Hunter. "We've reinvented a design from the annals of history."

Dark tones have been used on the floor and sidewalls and light ones on the ceiling, to maximize the perception of space. Hunter says the graphite gray on the floor will actually look good as it gets dirty: "This is something we learned from working on the new bus for London: things have to look very good right to the end of the day." Grab poles are an unexpectedly dark color. "It's really important that the grab poles provide a lot of contrast, but that doesn't mandate a bright color," says Hunter. "We do color contrast and reflectivity tests, and sometimes even yellow isn't that good a contrasting color if the combination isn't right. We thought that by using a more muted color, we could provide a calmer environment, while still providing the contrast needed."

We minimized spaces where undesirable devices could be sequestered, or made them easy to check

Simon Cran, head of industrial design and human factors, Bombardier Transportation UK

Lateral thinking

To reduce the number of poles, a new strap hanger has been designed. Hunter says it provides a degree of lateral support, not tightening as it is pulled. It is hinged so that if a tall customer walks into one, it offers no resistance.

Security measures include CCTV, the challenges being to ensure adequate coverage and evidence-grade quality. "Our team of CCTV engineers spent all of the design phase finessing camera angles and positions," says Cran. "My team was involved in the integration of the cameras, to be as unobtrusive as possible. Also in terms of security, we minimized spaces where

Each train will have four spaces for wheelchairs, always in the middle car for consistency

BELOW: All the stations will be step-free from the platform to the street, and some even from the train

SIMON CRAN

The majority of Simon Cran's career has been devoted to designing rolling stock at Bombardier. He joined the company in 1991, with a background in product design. After spells as an industrial designer and studio manager, he became head of industrial design for Western Europe, the Middle East and Africa. Standout projects he had a hand in include metros for China, Electrostar EMU and Turbostar DMU trains for the UK, as well as Victoria Line and S-Stock trains for the London Underground.

Cran says he loves designing rolling stock because of the broad scope the team is given – covering both the exterior and the interior – and because he feels it is such a "worthwhile" form of transport that "enables the movement of large numbers of people safely and efficiently".

One of the big changes Cran has witnessed over the course of his career is the growing reliance on digital product definition. "It has empowered us to maintain the integrity of our designs all the way through to realization," he says. "We can now generate models that are used to develop the product with our engineering colleagues, customers and supply base. We maintain those models as the styling reference for the product."

However, he says his team still produces hand sketches, as "it's the most efficient means by which to draw stakeholders into the decision-making process." Likewise, designs are recreated in scale model form using CNC machines and rapid prototyping technologies. "Those things are brilliant," comments Cran. "We also do full-size mock-ups and little cardboard mock-ups, and we're increasingly using virtual reality for customer design reviews, creating a full-size projection of the interior to give a sense of immersion. Ultimately it's about picking the right combination of methods and tools to meet our commitments to our customers and stakeholders."

Cran says low-fidelity mock-ups are particularly useful in the early stages when a design is highly novel, to give people a quick understanding of the space. Sometimes they're also used to highlight general challenges. "For example, it's sometimes useful to take stakeholders into quite a crude mock-up of a cab interior, just to help them understand the constraints we're facing in terms of providing a workspace that we hope someone is going to occupy for 30 years."

The most important thing for industrial designers in this industry to remember, says Cran, is that the train will be used. "It's about keeping in mind that – as well as meeting all the standards and meeting the customers' needs – the design has to be used safely and comfortably by a range of users, including passengers, drivers, maintenance staff and cleaners, for a long time," he says.

Cran's team includes eight industrial designers, including five on staff, as well as seven human factor specialists. "Those specialists take a key role in the product development, both with my team and supporting the rest of engineering throughout the full product lifecycle," he says.

undesirable devices could be sequestered, or made them easy to check by authorized personnel. Some customers also need to be able to see what's in luggage racks, for example using cameras, but there are no racks on this train."

Hunter says there are no luggage stacks for two reasons. "Firstly, it's a potential massing of combustible materials, and as the train is going through a tunnel, we need to distribute the loading as much as possible," he says. "Also, we have generous multi-use areas in every car. We felt it would be easier for customers to use the closest available space to where they board."

There are also no bike racks, although as on other TfL trains, passengers can bring a folded bike on board at any time.

The trains were designed in line with the UK's GMRT 2100 crashworthiness standard. "When designing a train interior, we look at its passive crashworthiness, working to minimize potential risks to occupants in normal service and also

some other scenarios," says Cran. "Most of that is to do with corner radii on fixings and fittings, things you're likely to bump into or bang your head against. We also look at the availability of handholds, some of which are mandated by standards such as TSI PRM. For example, that requires us to fit grab holds in doorways, as close as possible to door thresholds. We have internal methods to judge if we've provided enough handholds for small users in the right places."

Bombardier also uses standards from other domains. "For example, there's lots of talk about finger traps in various documents in the railway environment, but nobody actually defines what a finger trap is or what the pass/fail criteria are," says Cran. "In this case we use a BS EN standard for playground equipment, which defines how wide and deep a gap can be before it presents a hazard for small people. So we use an amalgamation of native railway standards and bits and pieces from other credible sources to build up our safety architecture."

Material matters

Hunter says the Elizabeth line train is the lightest in its class, despite the limiting factor of fire regulations and durability needs. "We have minimized weight wherever possible, but we couldn't look at carbon-fiber castings or anything like that," he says. "Magnesium, titanium and some of the newer composites would have been

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HONEST DESIGN

One of Jon Hunter's favorite details is the casting that runs above the double-width draft screen. "It ensures that the bracing is in place, but it's also a very beautiful-looking piece of naturally finished stainless steel," he says. "It catches the lights very well and is just a really honest piece of design. Previously, designers might have powder-coated metal to disguise it. We've used it as a feature throughout. We haven't gone for this 'boiled sweet' blobby design, where you drape metal over the components. We've used an angular design language as much as possible, while maintaining optimal regard to the customer safety."

Hunter also reveals the design is influenced by trends in consumer smartphones. "Many phones have big slabs of glass on the front and steel or aluminum on the back, and have lots of very nice design details," he says. "We've replicated that on the train to meet the rising expectations of our customers."

That also informed the provision of real-time information. "We're used to being able to access things instantly through smartphones," he says. "The bar is always rising."

Queen Elizabeth II visits works being done on the line named in her honor

Bombardier looked very hard at how it is casting materials, re-profiling to save as much weight as possible

Jon Hunter, head of design, TfL

really nice to use, but we have fire testing to get through. Bombardier looked very hard at how it is casting materials, re-profiling to save as much weight as possible, but ultimately, these things need to be very robust."

TfL opted for a lot of stainless-steel castings, partly because the trains could be in service for as long as 40 years, with a refurbishment after 15-20 years. "I'm under no doubt that after the full 30 or 40 years, the castings will look as good as they did on day one," says Hunter. "It's very difficult to damage or to even scratch these components."

LEDs have been used throughout, which Hunter says should have a life of at least 10,000 hours. This is the first time that Bombardier has implemented a fully LED system in a UK train. "LED strips run on either side of the center ceiling," says Cran. "Those are supplemented by discrete spotlights the length of each car. The spotlights are integrated in a unit that also contains the speakers."

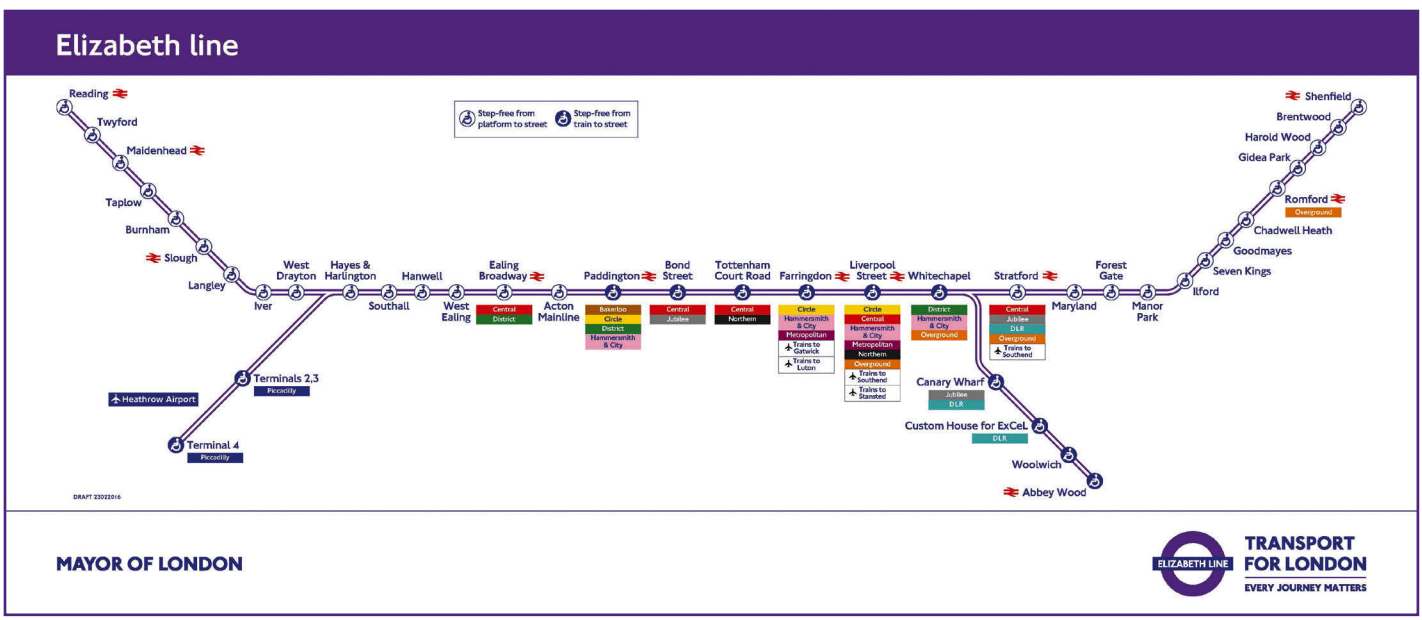
The lighting adjusts in response to ambient natural light changes. "It saves energy and extends the life of the LED," says Cran.

Air-conditioning

The train also has air-conditioning, an evolved version of the system used on the sub-surface S-Stock. "We would have air cooling in all of our vehicles if we could," says Hunter. "There's a trade-off in energy consumption, but we're using a closed system for efficiency."

Cran says a lot of work went into defining the shape and size of the grilles, and even the angle and shape of the fins, to meet aesthetic aspirations in a way that could be manufactured, and to ensure ease of cleaning. "It's just a fact of life that you get a build-up of dust," says Cran. "Also we had to ensure maintenance locks and release mechanisms are unobtrusive to prevent unauthorized use and so as not to disrupt the interior appearance."

Two double-sided full-color TFT information screens will be mounted in each car, providing



ROCKET SCIENCE

Jon Hunter of TfL describes the front end of the train as looking so futuristic that it would look at home in space. “It looks strikingly different from anything in the UK market at the moment,” he says. “We’re going through some shared, big stations, so we need to make the train distinctive, so customers know they’re getting on the right one.”

Key to this distinctiveness is the coloring of the front end. “Traditionally you’d have a yellow front end, but the plan is to go for a black front end, with high-intensity lighting to ensure visibility.”

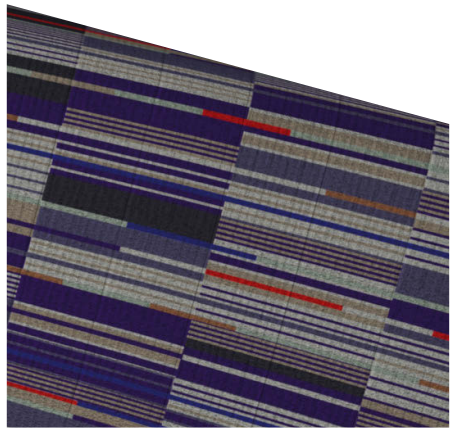
real-time information including the time to the next station, connections and any disruptions. Bombardier actually raised the ceiling in the areas where the displays would be integrated, to make it less likely that people would hit their heads on them. Other challenges included ensuring there was no glare on the screen and that they could be seen by as many people as possible. “A lot of time was spent on the housing and the center ceiling treatment to ensure that it all works visually and can be accessed for maintenance,” adds Cran.

Normally things do get slightly diluted, but on this project, the design vision has been maintained and the train looks exactly like the renderings

Jon Hunter, head of design, TfL

IN NUMBERS

- **66** trains
- **9** cars (seven in the initial stages)
- **205m** length (160m length for seven-car train)
- **454** seats in the nine-car train
- **1,500** capacity in the nine-car train
- **3** seating types
- **4** wheelchair spaces
- **10** multi-use areas in the nine-car train
- **3** double doors on each side of each car
- **2** double-sided TFT screens in each car
- **250m**-long facility built to enable testing
- **136km**-long route



RIGHT: The seats are covered in moquette

BELOW: The train has a continuous design with no barriers between cars

Connectivity

The plan is to make 4G and wi-fi available in Elizabeth line tunnels and platforms from December 2018. It is also planned that wi-fi will be available from Liverpool Street to Shenfield before then, but a launch date has not yet been set. Cran says wi-fi hardware usually consists of a black box and various aerials. “There are material constraints in terms of what can go in front of those aerials to ensure that the signals propagate properly within the vehicle,” he says. Power and data from the train control system also have to be considered.

Overall, Hunter is really happy with the outcome. “Seeing the train in the test facility was quite a pleasant shock to me, because normally things do get slightly diluted, but on this project, the design vision has been maintained and the train looks exactly like the renderings,” he says. “We’ve worked really closely with Bombardier, and they’ve done nothing but impress us. Without them, we wouldn’t have been able to realize the design intent we wanted.”

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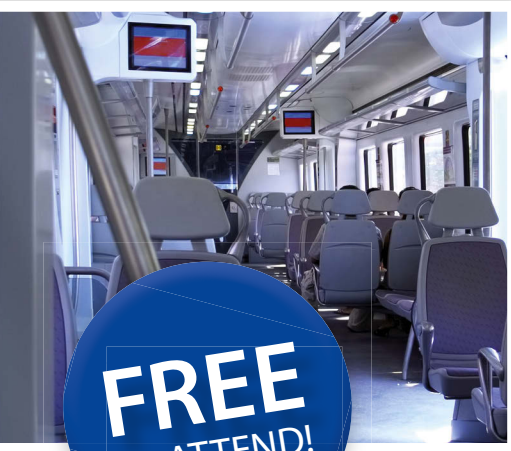

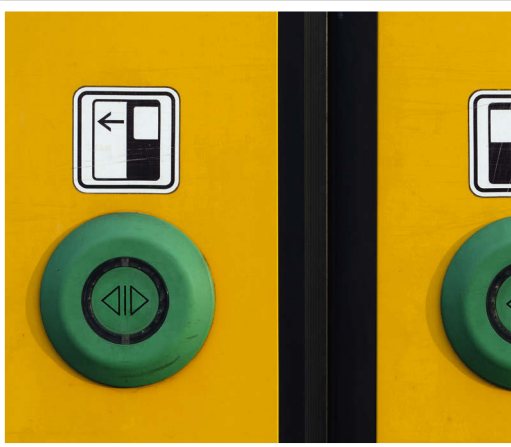

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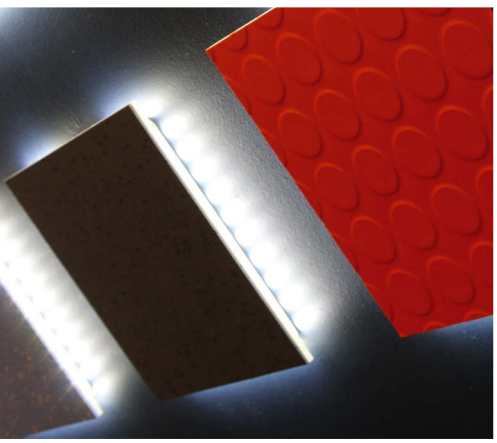

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Reality check

Simulation has revolutionized railcar design. Does it have the potential to sideline real-world testing?

Illustration: Magdeburg

Around 25 years ago, a quiet revolution took place, unnoticed by the world at large but of far-reaching importance for engineers everywhere. Graphical modeling tools were beginning to replace text-based simulation programs, paving the way for model-based design to become the industry standard. A generation later, programs are generating their own code and the latest graphical processing units (using chips with hundreds of cores) are lending today's simulation software unprecedented power. How do these capabilities affect the development of railcars and where does real-world testing fit in?

Prof. Filippo Ugolini, lecturer in biomechanics at La Sapienza University in Rome, Italy, says two clear trends will dominate future railcar interior design. "The main challenges are weight reduction and comfort," he comments. "In terms of the latter there are four basic aspects to address: acoustics, thermal control (containment and distribution), vibration and perceived light. Hence we may see test centers dedicated exclusively to passenger comfort. These should be equipped with instruments derived from biomechanics and medicine as well as appropriate simulation equipment."

We may see test centers dedicated exclusively to passenger comfort

Filippo Ugolini, lecturer in biomechanics, La Sapienza University

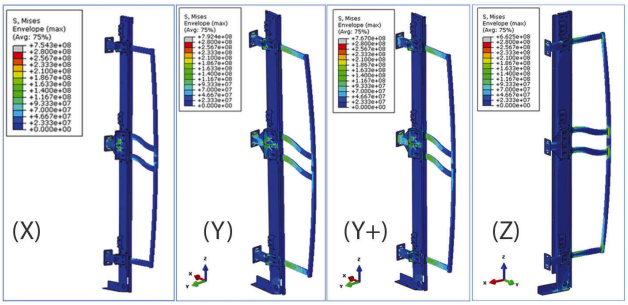
ABOVE: A mock-up of a CAF tram for the city of Besançon, France, by Integral Design and Development

LEFT: Integral says simulation is useful but not a replacement for traditional design processes and fully trimmed mock-ups such as this one, created during the development of SRO trains by CAF

Aviation influence

Ugolini believes railcar interior designers are likely to translate innovations from the aviation world in the future. "We could see non-conventional seat configurations, seat geometries designed to yield maximum comfort from the smallest possible space, greater differentiation between business and economy classes, and more classes," he contends. "More radical changes could include the introduction of bio-friendly ambient lighting, entertainment systems, intelligent window systems, and seats that can adapt to support office or entertainment use as required. But to enable these kind of changes, the industry will need new virtual simulation and testing devices, for example 3D goggles and hologram-simulated ambient interiors."

Other developers also note a trend toward virtual reality. "Visualization and simulation are reaching levels of incredible authenticity," says Fernando Tellechea, head of design and innovation at Integral Design and Development. "I've visited cave automatic virtual environments, and used other virtual reality systems; they are extremely realistic and within minutes you certainly believe what you're seeing."



ABOVE: Stress simulations conducted by Integral for Metrovagonmash in the course of developing a handrail for the Moscow Metro

LEFT: A mock-up created by Integral for CAF as part of development work on the Oaris platform

Physical certainty

But Tellechea says no technology can beat the usefulness of physical mock-ups. "Mock-ups enable you to understand size and proportion properly," he says. "The day our clients walk into the full-scale model is the day the design is approved or rejected. They can go inside, touch the materials and understand the layout."

Mock-ups can also be used in combination with more technological aids. "While working with our mock-ups, we've found augmented reality extremely useful," says Tellechea. "It provides the client with lots of extra information on specific issues, and lets us give alternatives to what is shown in the physical setup."

At the engineering end of railcar development, simulation has long proven to be an invaluable tool. But even though mathematical models save huge amounts of time and resources at the prototype and testing stages, running complex software on supercomputers can in itself be a costly affair. This is why NewRail, a rail research unit at Newcastle University in the UK, is investigating ways to streamline the process. "Some crashworthiness simulations can take up to a week of continuous processing," says Conor O'Neill, rail vehicles group manager at NewRail. "Our intention is to simplify the larger models by streamlining the analysis needed, then gaining confidence at a lower level, for example with material properties, before inputting these results into the final model."

Crashworthiness simulations can take up to a week of continuous processing

Conor O'Neill, rail vehicles group manager, NewRail

ABOVE: The driver's cab on a Siemens train undergoing testing

TEST TRACK

With a combined 30km of standard and meter gauge track, Siemens' test and validation center in Wegberg-Wildenrath, Germany, is thought to be one of the largest physical testing grounds for trains in Europe. It can be used to test electric and diesel trains.

The center has multiple test tracks. It can be used to measure wheel support and guidance forces. It is also possible to assess a vehicle's safety in terms of derailment, under DIN EN 14363:2005. Traveling through curves, over hills and across dips can be simulated at standstill. Both standard and meter gauge vehicles can be tested on a turn-tilt table.

Corresponding tipping equipment is available for measuring rolling characteristics. The effect of transverse accelerations including centrifugal forces or side winds can be simulated on a testbed through tipping. The center can also be used for noise tests. Vehicles can be subjected to a simulated speed of up to 160km/h on an acoustic measuring rig, under TSI noise and DIN EN ISO 3095:2005 norms.

Eight weighing elements are provided on a 52m leveled standard gauge track. The load-bearing capacity per wheelset is 30 tons, with a measuring range per wheel of between 1-180kN with a resolution of 50N.

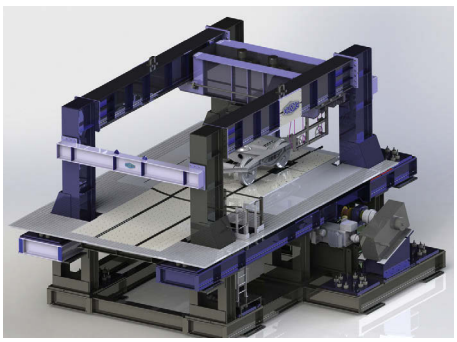
RIGHT: NewRail created this mock-up to demonstrate new fire-resistant furan resins

CENTRE FOR INNOVATION IN RAIL

The Institute of Railway Research (IRR) at the University of Huddersfield in the UK will open a £22m (US$29m) Centre for Innovation in Rail (CIR) on October 12, 2016. The facility will include a £4.5m (US$6m) laboratory with advanced test equipment that will support both the CIR and the wider railway research activities of the IRR.

The venture is co-funded by the UK's Regional Growth Fund, and advised and supported by an industry-led steering group comprising project partners Unipart Rail, Omnicom Engineering and the National Skills Academy for Rail, as well as current stakeholder representation from Network Rail and the Railway Industry Association.

"With a mission to link innovative SMEs and larger industrial partners with academia, the CIR will offer many services, including industrial research, product testing and trialling," says Dr Paul Allen, assistant director of the IRR. "The center's services and facilities aim to develop into a one-stop shop for railway innovators and technology providers."

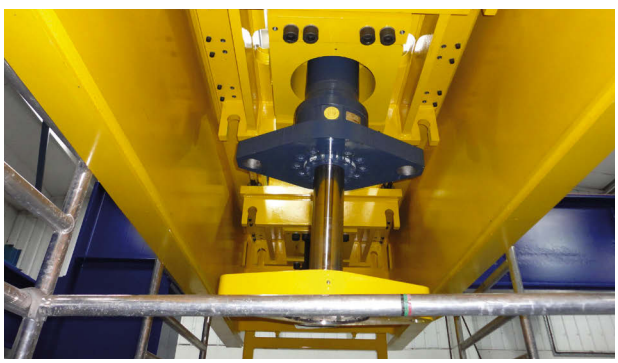


A real-time simulation enables us to see how changing each parameter might affect the result

Conor O'Neill, rail vehicles group manager, NewRail

NewRail is investigating simulations that produce approximations in real time or near-real time. These would speed up the design process early on, when evaluating a wide range of design options is often more important than absolute precision. "We're looking to use gaming engines that can be run locally or based in the cloud," says O'Neill. "We want to harness some of that hardcore gaming processing power. But there is a compromise here: the materials information isn't going to be as detailed as for a major finite element analysis. However, it will give a significant degree of confidence that the design, structure and materials are likely to succeed."

O'Neill says another advantage of a real-time simulation is that you can change properties as it's running. "It enables us to see how changing each parameter might affect the result," he explains. "This will speed up the process of finding the best design for the vehicle. Once you've got that confidence, you can run the big process-intensive simulations with a greater chance of success."



LEFT AND ABOVE LEFT: Equipment at the Centre for Innovation in Rail includes these vertical actuators, used to simulate vehicle body dynamics for the bogie under test

Fire testing

Even sophisticated mathematical models have their limits. One area where simulation currently has limited application is fire protection; because of its complexities, real-world testing is still the main method used.

NewRail's latest project in this area is Fire-Resist, which involved 17 European partners, including Bombardier. NewRail coordinated the testing of a new lightweight composite material – a cork-furan/glass fiber sandwich panel – to

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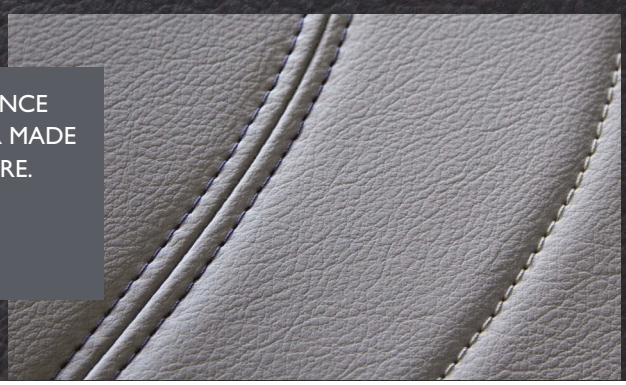

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LEFT: A driver's cab mock-up made from composites by NewRail to demonstrate the possibilities of the material

RIGHT: A mock-up of a CAF commuter train for Mexico

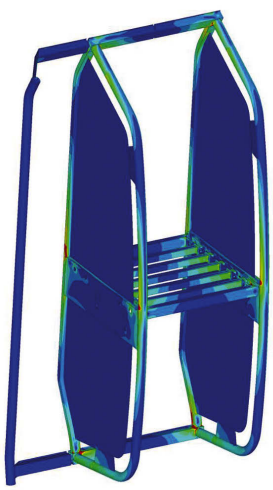
COMPOSITE CAR BODIES

While composites and light metallic alloys have been used for train parts, they are not currently used for structural applications, says Conor O'Neill of NewRail. The research organization's recently concluded Refresco project examined the existing regulatory framework to understand what changes would be necessary to pave the way for this. The hope is to enable the construction of lighter rolling stock that would consume less energy and make fewer emissions.

NewRail worked with 18 partner organizations to analyze certification procedures, identify gaps and develop test and assessment methodologies for isotropic and orthotropic materials.

There are no longer any full-scale crash tests for rail vehicles

Burkhard Arras, head of mechanical system engineering at Siemens



RIGHT: A simulation conducted by Siemens to test a baggage rack

see if it would meet the recently introduced EN 45545 standard. "It's a material for semi-structural components, and is designed to withstand the rigors of interior use in rail vehicles," says O'Neill. "We've proved it can achieve fire compliance, but there are issues around longevity and durability, not from a fire point of view, but from a usability and aesthetics perspective. But the materials look incredibly promising. The industry now needs to make them more affordable and change some of the assembly processes. We're looking at 5 to 10 years before we find composites like these in a primary structural role, but we're likely to see them in interiors before then."

Crash course

Despite the prevalence of real-world tests in areas like fire certification, simulation is now complementing most testing and validation procedures. Developers at Siemens argue for an ever-tighter integration of the two disciplines. "There are no longer any full-scale crash tests for rail vehicles," says Burkhard Arras, head of mechanical system engineering at Siemens. "These days, proving crashworthiness compliance is done mathematically. But this only works because previous physical examples have shown that the calculations mirror results in the real world with enough accuracy.

"Simulation is useful because it allows access to physical quantities and states difficult to find through tests. For instance, it's almost impossible to measure mechanical stress across an entire unit. Through calculations, however, you can easily find critical points, which can then be tested. This shows that testing and simulation work best when used in conjunction. You try to understand certain points in simulation first and then carry out targeted validation. A further point is that we want to reduce the integration levels of tests. Integration levels range from the entire train as a system, across single vehicles down to component level. After analyzing a component through testing, you can use the results to inform a simulation that looks at the entire vehicle. Combining the two methods in this way can cut costs dramatically."

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Space exploration

How are academics and researchers reconciling the needs for both greater passenger capacity and uncompromised comfort?

WHY IS IT IMPORTANT TO ADDRESS CAPACITY?

Selby Coxon, director of the Mobility Design Lab at Monash University, Australia

"Research shows that higher passenger densities, particularly during peak times of the day, have negative implications for train punctuality, crowding, accessibility and passenger comfort. It can be seen that various external stimuli, including population growth, the centralization of employment and petrol price volatility, can contribute to increased commuter patronage. The dispersal and movements of high passenger loads extend the length of time the train is located at the station, thus delaying the service and inflating the problem further down the line. The contributions of lateness and cancellations to overcrowding can be severe, with trains following a canceled service usually the most severely overcrowded. Surveys reveal that passengers value punctuality highly."

Conor O'Neill, rail vehicles group manager at NewRail, Newcastle University, UK

"Overcrowding on commuter trains is a growing problem, with coach capacities often reaching 180% load factor. Improved services and faster trains are drawing more passengers to rail as a preferred transport mode, which can lead to severe overcrowding on rush-hour trains."

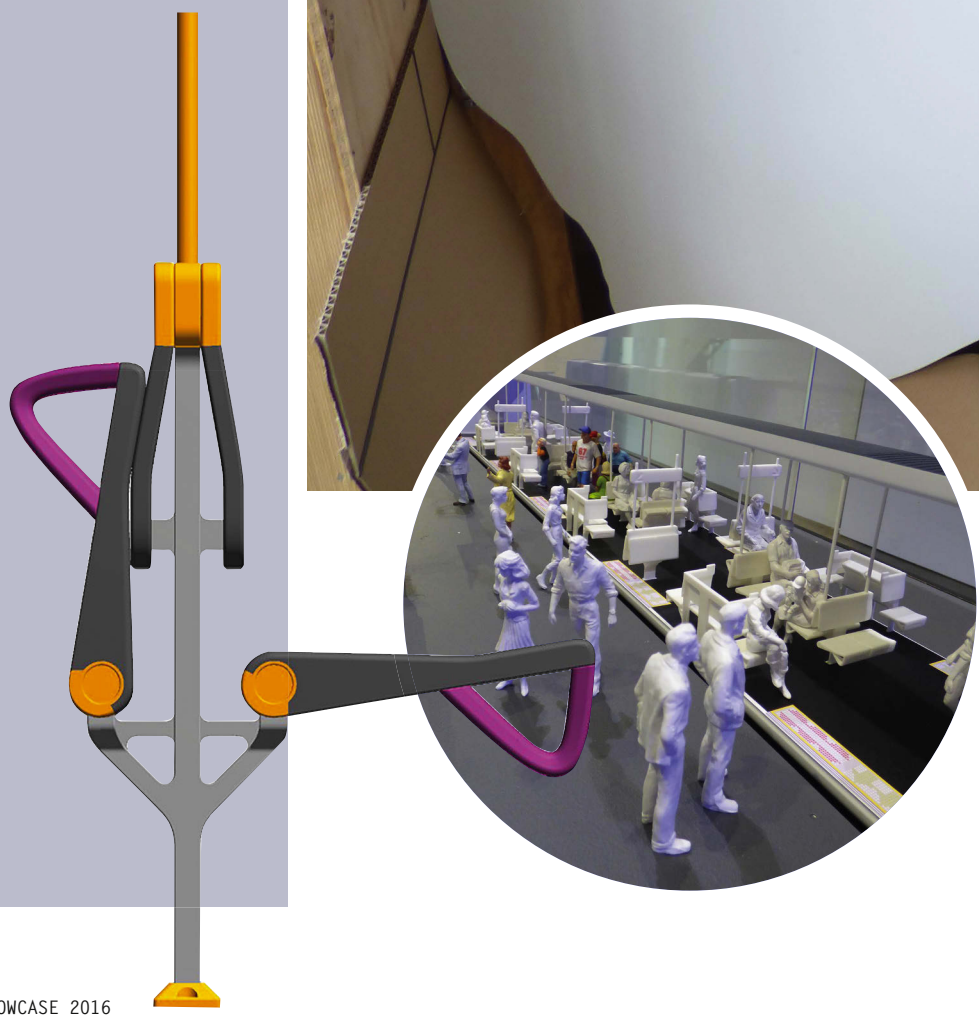
Photo: rtákyd – Shutterstock

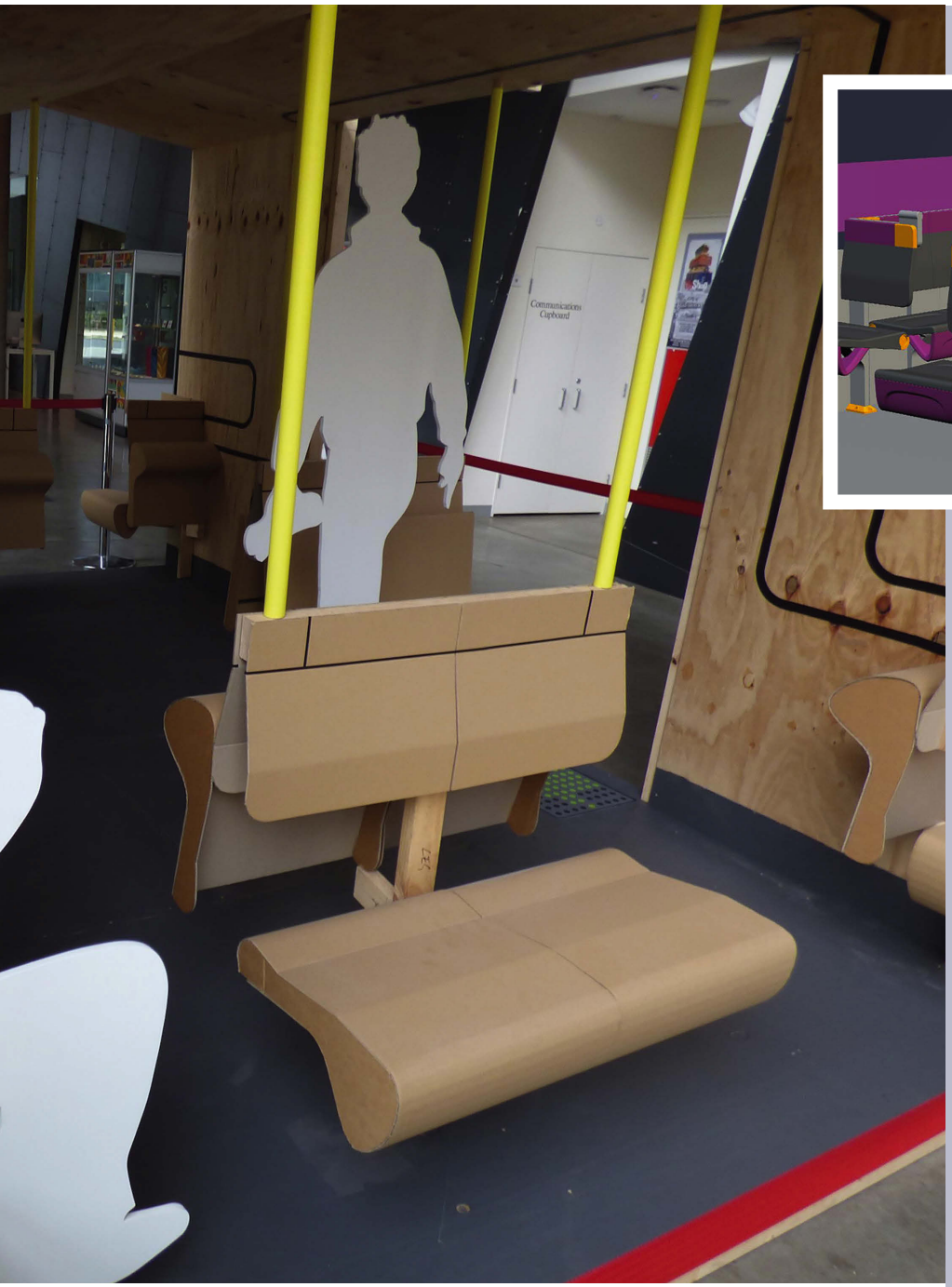
THE IDEA

The Mobility Design Lab at Monash University in Melbourne, Australia, developed this new rolling stock concept to mitigate crowding on commuter trains at peak times. Four main changes are proposed. Firstly, the seat arrangement is reimagined, with rows of forward- and backward-facing seat clusters located along the middle of the carriage, bordered by longitudinal seating with backs to the windows. This creates two aisles rather than the traditional single aisle. A select group of seats, marked by their orange color, are reserved for people with reduced mobility. All other seats are foldable. When stowed they form perch seating and increase the amount of standing space.

The second departure is the peak door idea. “Melbourne’s rolling stock has either two or three doors per side,” says Selby Coxon, director at the Mobility Design Lab. “This concept has two extra doors that are only used during peak periods. Generally, extra doors mean fewer seats, but in this design, seats can be located by the peak doors and locked in a stowed position during peak periods.”

Simultaneous boarding and alighting is facilitated at each door with graphic symbols (a green arrow and a red and white ‘no entry’ sign) indicating the correct side to use.





CHALLENGES

Coxon says the seating and door changes could be implemented through contemporary control systems, operated by a driver or conductor, and that the greatest challenge is actually the operating protocol and passenger acceptance. “Our literature review revealed that passengers attach a high level of importance to being able to take a seat on a train,” he says. “During peak-time services, very limited seating would be available, with most passengers obliged to stand or perch on the folded-up seats. Having an onboard guard or driver reconfigure the train’s interior to suit prevailing conditions is a challenging proposition to current practice. The success of the concept would be dictated by how far cultural norms can be modified and encoded in passenger behavior, but the variation of networks around the world would indicate that it is not an unreasonable idea.”

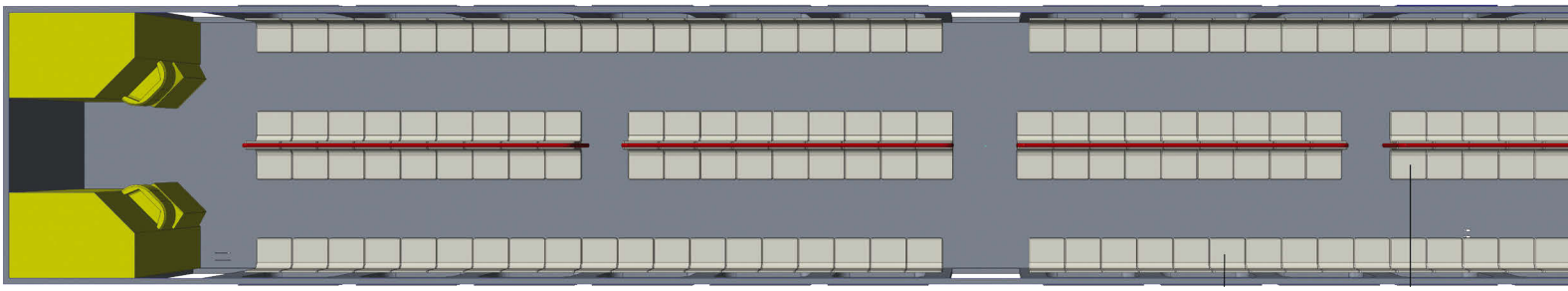
ADVANTAGES

The efficacy of the design has been tested through computational modeling. “The results are encouraging in that they show an improvement in passenger flow,” reports Coxon. “Station dwell time was reduced by 15%-40%, depending on the number of passengers boarding. The greatest improvements were seen during the busiest periods. The work demonstrates that it is possible to explore the design of carriage interiors to improve network performance as an alternative to current costly operating strategies.”

TOMORROW’S TRAIN DESIGN TODAY

Several designers have addressed the issue of capacity as part of the Tomorrow’s Train Design Today competition, run by the UK’s Department for Transport, FutureRailway and the Royal Institute of British Architects, with funding from the UK’s Rail Safety and Standards Board and Network Rail. The brief was to improve the passenger experience on the UK’s rail network.

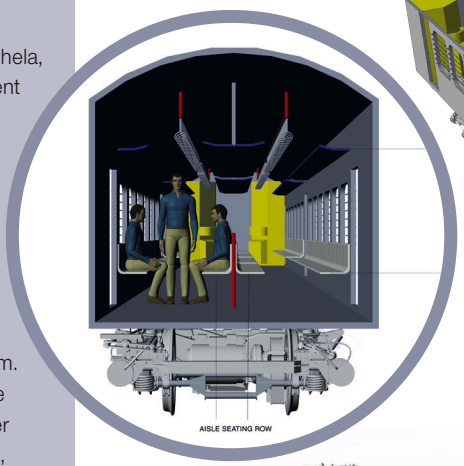
From 48 entries, 10 designs were chosen for further development. Three finalists were then picked – 42 Technology with its Adaptable Carriage; Andreas Vogler and the German Aerospace Center (DLR) with the Aeroliner 3000; and PriestmanGoode with its Horizon design. For full details on the Aeroliner 3000, turn to page 58. PriestmanGoode commented that its design would be revealed at InnoTrans 2016, to be held in Berlin, Germany, on September 20-23.

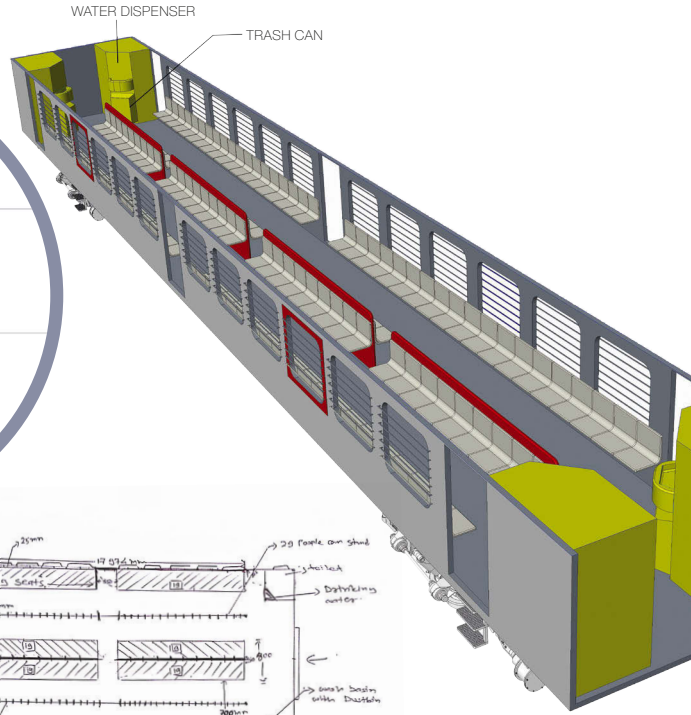


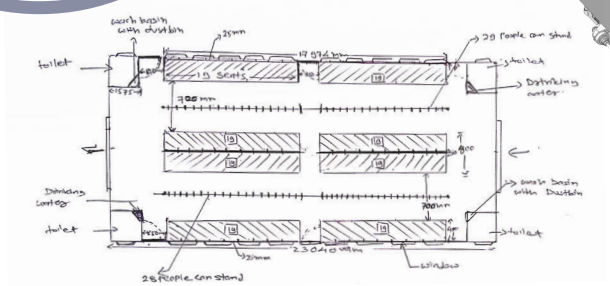
THE IDEA

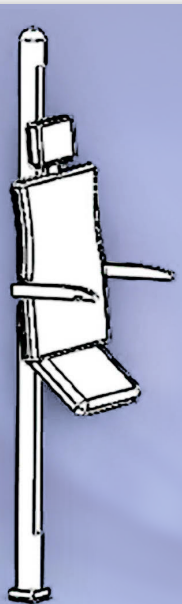
This concept was created by Samarjitsinh Waghela, a transportation and automobile design student at the National Institute of Design in India. “In India, huge numbers of people who only want to travel short distances are forced to travel on local and express trains that are designed for sleeper service,” says Waghela. He has based his design on the dimensions of existing sleeper coaches, with a new seating arrangement inspired by Delhi’s metro trains. Waghela says the layout is optimized for daily commutes of around 100-200km.

As well as increasing the number of seats in the coach, Waghela has increased the number of water dispensers from two to four; added four trash cans, which he says are currently not available in most trains of this kind; and added four lavatories. There are four emergency windows and six doors for entry and exit. Waghela would also like to integrate air-conditioning in the train. “In short, I have tried not to compromise on the safety and comfort aspects of the current coach design,” he says.









THE IDEA

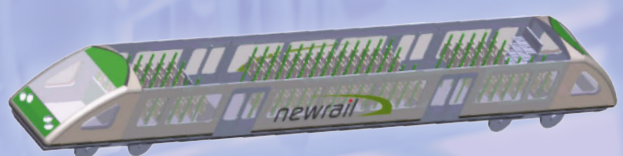
NewRail at Newcastle University in the UK has been investigating the potential of standing seats to maximize the passenger-carrying capacity of coaches while retaining an element of personal space for commuters. “Standing seats are currently being assessed as potential solutions for automotive and aerospace capacity issues, and with capacity already a concern in the rail industry they could form a viable solution to our current and future passenger demands,” says Conor O’Neill, rail vehicles group manager at NewRail.

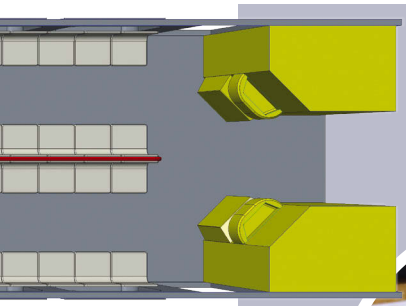
He envisages the standing seats replacing normal ones on commuter train journeys ranging from 30 minutes up to one hour. They would be set a minimum of 530mm apart. The back cushion would be angled by 5°, and the bottom cushion would be 500mm wide. The seat could be adjusted on its pole so that the distance from the base of the cushion to the ground varies between 600mm and 850mm. O’Neill says customers would be charged less to use this kind of seat.

CHALLENGES

The initiative involves building upon early conceptual designs to develop a rail vehicle and interior that can accommodate standing seats without compromising safety or comfort. Part of the work is to optimize accessibility and define the surrounding environment.

“The primary and secondary structure of the vehicle shall incorporate innovative composite materials to strengthen the sub-structure to accommodate the new loading dynamics from the seats,” says O’Neill. “The standing seats shall undergo detailed design, incorporating ergonomic requirements and human-factor considerations to develop a versatile, adaptable and user-friendly solution to fit within the vehicle design envelope.”

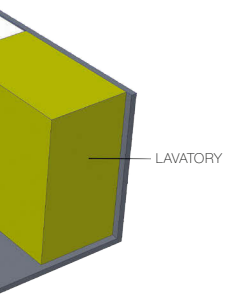




BELOW: Samarjitsinh Waghela, student at the National Institute of Design in India

CHALLENGES

Waghela says that the ideal solution would involve changing the dimensions of current coaches. “In addition, windows need to be rethought so as not to compromise the view for passengers,” he says.



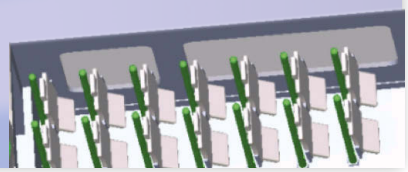
ADVANTAGES

Compared with the sleeper coaches the design takes as its starting point, Waghela says his layout increases passenger capacity by 30%-40%. “If we designed a new coach with new dimensions then capacity could be increased by 50%,” he adds.

ADVANTAGES

Early indicators show that a capacity increase of 30% could be achieved using this design, according to O’Neill. “Comfort has been addressed by sculpting the seats and making them adjustable. In addition, despite standing, each passenger has a defined area, giving the impression and feeling of personal space, which cannot be achieved through standing in existing vehicles. Safety would also be improved because passengers would no longer need to stand in aisles or between carriages.”

O’Neill also says the use of lightweight materials would reduce the operator’s CO_2 footprint and energy costs. “Improved customer satisfaction with the daily commute will draw more passengers to the network and increase route revenue,” he contends.



Bright ideas

The first privately owned intercity express train service in the USA is aiming to revolutionize the passenger experience to compete with automobiles

The Smart car on the upcoming Brightline train features 66 seats that are each 19in wide

Travelers in Florida will have another transport option from mid 2017: Brightline, thought to be the USA's first privately owned and operated intercity train service. The route will eventually extend from Miami to Orlando, stopping in Fort Lauderdale and West Palm Beach on the way, and making the journey in three hours.

"There has been a conversation in Florida about this kind of intercity passenger rail service quite literally for decades," says Michael Reininger, president of Brightline. The company became involved in 2007, but the idea was put on hold while global economic conditions settled. In 2012, efforts began in earnest to build a team and bring the idea to life. The first stage was to undertake extensive global research.

"Intercity passenger rail is still pretty limited in the USA, and always governmentally subsidized," says Reininger. "In many other places around the world there are more intercity passenger rail services and many of them are privately run, for profit. We concluded that we should glean best practices from the rest of the world and combine those with new ideas, along with lessons from other industries, to create a new kind of product."

The company appointed the Rockwell Group, an architecture and design firm, to research the needs of potential customers and develop the brand. Reininger had first worked with David Rockwell, the group's principal, when working for The Walt Disney Company.

Having established the brand, Rockwell's contract was extended to include the design of multiple parts of the ambitious project – including

ABOVE: Each of the five trains has a livery featuring the brand yellow and another very bright color

RIGHT: The Select seats are 21in wide

FAR RIGHT: The Select car is aimed at those who want more space

We concluded that we should glean best practices from the rest of the world and combine those with new ideas, along with lessons from other industries, to create a new kind of product

Michael Reininger, president, Brightline

MICHAEL REININGER

As president of Brightline, Michael Reininger has overall responsibility for the whole project, including the development of rail infrastructure, stations, trains and real-estate developments, as well as operations.

Luckily, Reininger has handled some high-profile developments in his time. He spent 12 years at The Walt Disney Company, where he managed the creation of the Disney Vacation Club, the resort component of Disneyland Paris and Disney Cruise Line. While at the Union Station Neighborhood Company in Denver, Colorado, he led the redevelopment of Denver's Union Station, integrating multiple forms of public transit with new multi-use real-estate. He holds qualifications in architecture, resort and hotel master planning, financial engineering and business management, from institutions including Harvard Business School.

"I've been fortunate to be involved in a number of really interesting and groundbreaking development projects, including hotels, resorts, cruise ships, commercial and residential real-estate and a transit hub, but never before were all of those various pieces called upon for a single initiative," he says. "All these experiences have contributed to the creation of these two new businesses – the transportation system and the urban transit hub development."

station interiors and the exteriors and interiors of the trains.

New eyes

Neither Brightline nor the Rockwell Group has rail experience, but this was felt to be an opportunity to bring a fresh perspective, particularly because the aim was to create an experience more akin to hospitality than transportation. "Many of us have experience in the cruise, hotel and restaurant industries," says Reininger. "The team has a wealth of understanding about what makes great customer service. We've been able to piece together lots of things in a way that has not been done before. We set out to reimagine what it means to travel by train in the USA. We concluded that to do that effectively, we had to look at the travel experience from end to end. It's a branded consumer service; it's not just about the experience on the train, it's also about the environment at the station and beyond, and the way we communicate with our customers through web portals and mobile apps."

The company will also work with third parties to offer integrated packages including other connecting services, parking and hotel rooms.

The target market was identified as being comprised of one third business travelers, one third leisure travelers and one third locals traveling for personal reasons. "There's no other train on

this route," says Danny Taft, a designer at the Lab at Rockwell (see *Rockwell's first train,* below). "People fly between Miami and Orlando but really the biggest thing to overcome is that people are comfortable in their cars."

Reininger says drivers and flyers will be won over partly by Brightline's journey time and cost: "We're able to get you between these major population centers in less time than it would take you to drive, at about the same cost, and in about the same amount of time as flying, at less cost."

The first phase of the project will connect Miami to West Palm Beach via Fort Lauderdale. The route will be served by five integrated train sets made by Siemens in California. Each train will seat 240 people, with four passenger coaches sandwiched between two locomotives.

Productivity and entertainment is of central importance to customers; this is another reason people will choose to get out of their cars

Michael Reininger, president, Brightline

ROCKWELL'S FIRST TRAIN

The Rockwell Group is primarily known for its hospitality work in hotels and restaurants, with customers including Disney. Non-traditional projects such as Brightline are handled by the company's Lab.

Danny Taft of the Lab at Rockwell was surprised by the number of regulations the rail industry is subject to. "I was surprised at how many boxes there were to check, but we were also really surprised at how effectively we were able to all work together and check those boxes," he says. "It was a tremendous amount of work to realize a design that could be built and that passed all the federal regulations – covering everything from accessibility to Buy America. The key was that everyone knew that was all really important."

There are two styles of carriage, Smart and Select, mainly distinguished by the number and width of the seats. Each Select car has 50 seats in a 2+1 layout, while each Smart car has 66 seats (apart from the Baggage Smart car, which has 62) in a 2+2 configuration. The Select seats are 21in wide, while the Smart seats are 19in wide.

Seat options

Smart and Select are not differentiated in terms of quality, says Taft. All the seats have the same underlying design and are finished in full-grain leather. All the seats have integrated magazine holders, cup holders and hidden power and USB outlets. Each car has six club-four arrangements set around tables with slide-out trays. The other seats have fold-down tray tables.

One of the key aims was to create a sense of personal space for each passenger, which Taft says influenced everything from the colors to the lighting, and the choice of high-back seats.

Each car has two vestibules – a small entrance/exit area at one end, and at the other end, a larger vestibule that also accommodates a restroom. There are automatic doors separating the vestibules from the seating areas, but not between the cars. "When you're in your seat, you feel separate from the restrooms and the people getting off and on the train, but it's very easy for passengers to get between cars," says Taft.

Accessibility was a very high priority, and Brightline says the train exceeds the requirements of the Americans with Disabilities Act. "The 32in aisle width is about twice that on a typical aircraft and much wider than on any other train in the USA," says Reininger. "Someone in a wheelchair could go from one end of the train to the other unimpeded. The train also offers level boarding, and even the gap between the platform and the train will be closed by an automated platform. As the doors open, a platform extends from the train and overlaps onto the platform with a lip less than 0.5in. Whether you're in a wheelchair, pushing a stroller or dragging a bag, we mind the gap so you don't have to."

There are grab rails on every seat, designed for easy access from any angle, so people of all heights are never far away from a safe hand hold.

BELOW: Mirrors in the restrooms have integrated lighting

IN NUMBERS

4 passenger cars in the first phase, up to 10 in the second phase

240 seats in the first phase and 500 in the second phase

2 carriage types

21in wide seats in the Select cabin

32in aisle width

3hr journey from Miami to Orlando

9 US suppliers for major interior components

4 displays in each car

ABOVE: Every restroom offers a baby-changing table

All the restrooms are wheelchair-accessible. "Designing for passengers with wheelchairs is great for everybody," says Taft. "In the restroom, not only can you move a wheelchair around very comfortably, but families can use the baby-changing table with ease, and it prevents anyone feeling cramped."

Restrooms reimagined

Reininger says the restrooms offered a big chance for differentiation from roadside and aircraft experiences. The aim was to offer something akin to that offered in a luxury hotel. "The experience will set a new standard," he says.

All the controls – including for the door, flush and combined Dyson faucet/hand drier – are touchless. There is a mirror that Taft says is "as close to a full-height mirror as you can get in a train", with integrated lighting. A custom wall finish was designed by Rockwell and developed in cooperation with Siemens and the laminate manufacturer Wilsonart. "Most people expect the restrooms to be the low bar for a brand, but we've really elevated it," says Taft.

Work and play

Free wi-fi will be available in the trains and the stations. "Productivity and entertainment is of central importance to customers," says Reininger. "This is another reason people will choose to get out of their cars."

Journey information will be provided through four signs in each car. "We worked very closely with Siemens to ensure their providers supply surrounds that match our aesthetics," Taft says.

Overhead luggage racks run the length of the cars and are 22in deep. The underside is a composite material while the vertical retaining

TIMELINE

Project begins, the Rockwell Group hired	Siemens USA selected as train manufacturer	Brightline introduced as the name of the train service	Scheduled delivery of first train set	Scheduled launch of phase one, connecting Miami, Fort Lauderdale and West Palm Beach	Scheduled launch of phase two, extending the route to Orlando
2012	**September 2014**	**November 2015**	**2016**	**Mid-2017**	**2018**

ABOVE AND RIGHT: The vestibules are separated from seating areas by automatic doors

BRIGHT LINES

One very important part of the brief was that the trains live up to the 'bright' part of the brand. "Bright trains feel more spacious, safer, comforting and welcoming," says Danny Taft of the Lab at Rockwell.

A key part of this was the lighting. "The trains feature a great LED lighting system from Siemens that gives really uniform light throughout the cars," says Taft. "There are also individual reading lights, controlled with an illuminated button that is really clear to see, even at night."

After an exhaustive search, a bright yellow was chosen as the main branding color, the team feeling it represented the Sunshine State perfectly. Inside the trains, it is used as an accent to a more neutral but still warm backdrop. For example the Smart seats have several white stripes and one yellow one. The color is also used on the exterior, in concert with other bright colors – red, orange, green, blue and pink – one for each of the five train sets.

The food and retail car is unlike anything seen on a train before

Michael Reininger, president, Brightline

surface is glass, to give a feeling of spaciousness. There are also luggage racks near the vestibule in most of the cars, which can also be converted to store three bikes. Passengers can also drop off and pick up checked luggage in the stations – this is stored in a secured portion of one car.

Air-conditioning was essential given Florida's climate, and the tinted windows will reduce solar transmission by 75% without impacting visibility.

It was also necessary to adhere to the USA's Buy America policy. "There was a huge push to use US suppliers," says Taft. For example, the vestibules and restrooms feature rubber flooring from Milwaukee Composites, while the seating areas have carpet from Mohawk.

Phase two of the project will see the line extend from West Palm Beach to Orlando, and in light of the extended travel time, the trains will be lengthened. "These train sets can operate with as many as 10 passenger cars and a capacity of just over 500 people," says Reininger.

Food and retail car

In the first phase there will be two attended beverage stations per train. A custom food and retail car will be added to the middle of the train in the second phase. "It's unlike anything seen on a train before," says Reininger. There will be several self-service facilities, enabling passengers to buy Brightline-branded products and essentials such as sunscreen. There will be an automated beer dispenser and a soda machine. A staffed kiosk will sell hot drinks and warm up food items, and assist passengers when required.

"The retail system was developed with a fabricator that does a lot of brick and mortar retail work," says Taft. "It's a modular system and we've worked with them to design shelves that will keep everything stable and accessible. It's about giving people access to the things they want, very easily."

Overall, Reininger believes attention to design can make a big impression on customers. "We've certainly invested plenty of time, attention and resources to achieve that outcome," he says.

Once the system is up and running in Florida, Reininger believes the line could be expanded with additional stops, and that the model could be replicated in other locales. "We have this point of view about where intercity passenger trains can work profitably, based on the distance between major population centers (which should be about 250 miles) and how much time a train would save compared with traveling by car. There are a number of other places in the USA that fit those criteria, but we have not really pursued those opportunities yet. However, as the awareness of our activities becomes more broadly known, we're entertaining more inbound conversations from people in other markets that are interested in doing something similar."

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There are many technological and operational measures available to protect passengers from security threats

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Marcus Ewers, Deutsche Bahn


Bartłomiej Banaszak, Deutsche Bahn

ABOVE: A video camera in a Deutsche Bahn ET 430 train

Security concerns impact train design in many ways. The UK's new Crossrail train is a good example of an open 'walkthrough' layout without barriers between carriages, designed to ensure passengers don't feel isolated, especially in off-peak periods. "You can see through to the next carriage, and be seen," says Simon Cran, head of industrial design and human factors at Bombardier Transportation UK. See page 10 for more details.

Other common measures used by various operators include the deployment of guards and CCTV, both on board and at stations.

In France, security gates and luggage checks were implemented at Gare du Nord in Paris and Gare de Lille Europe in December 2015. Security gates are also being tested at some regional stations. In March 2016, a new law was passed by the French parliament to allow the introduction of more security measures aimed at preventing violence including terrorist attacks and sexual harassment, as well as any trouble caused by drunk soccer fans.

For example, the law enables the deployment of armed plainclothes police train marshals in addition to the already permitted armed uniformed police. It also enables the use of passenger identity checks, profilers to analyze suspicious behavior, luggage checks (if given permission by the traveler) and sniffer dogs. In addition, the SNCF and RATP can check that potential employees are not 'fichée S' – recorded by the state as a security risk.

You can see through to the next carriage, and be seen

Simon Cran, head of industrial design and human factors, Bombardier Transportation UK

During the Euro 2016 soccer tournament, held in the country in June and July 2016, more security guards were deployed, certain Métro stations near fan zones were closed, and Eurostar prohibited alcohol on its trains and in its stations at selected times.

The SNCF deploys 2,800 security agents to deal with onboard risks ranging from hostility to terrorism and it also works with local authorities. Some 40,000 CCTV cameras are installed in stations and on trains. The technology is seen as a tool for the agents, a reassurance to law-abiding passengers, and a deterrent to terrorists and other criminals. IP cameras with fiber-optic transmission are used to enable real-time, remote surveillance. They have a huge recording capacity.

Camera advances

Other technologies now available to operators include video analysis programs that can recognize faces or silhouettes, sound recording and cameras that operate in extremely low or bright light conditions, when subjected to a lot of vibrations or in low-bandwidth environments.

More integrated software packages are also now available. For example, the surveillance of tracks, stations and trains can be integrated with fleet coordination and maintenance functions.

ABOVE: Security personnel checking tickets on a Deutsche Bahn train

RIGHT: A pictogram used by Deutsche Bahn to notify people to the use of CCTV at a station

Hartmut Reiche, Deutsche Bahn

LEFT AND BELOW: A train security surveillance system in Sofia, Bulgaria

Photos: Cylonphoto – Shutterstock.com

Likewise, for driverless trains, surveillance systems can be packaged with speed control systems.

Thales's integrated system projects include the Bergen light railway in Norway. The system incorporates: rail signaling; telecoms; video surveillance; voice communication between driver, passengers and the control center; passenger information; and traffic control. It is already in operation on 10km of line, and could be extended to another 10km in the future.

Integrated security

Jean-Yves Plu, head of critical infrastructure protection for Thales's Secure Communications and Information Systems division, believes the best security solutions involve a mix of both onboard mobile security and fixed security in stations, but there must be a connection between the two. "There has been a rise in integrated security since 2010, whereby different operators interact," he says. "A third-generation security approach has been developing since 2015, which involves the detection of abnormalities such as open doors, abandoned objects or the presence of people in an unauthorized space."

There has been a rise in integrated security since 2010, whereby operators interact

Jean-Yves Plu, head of critical infrastructure protection for Thales's Secure Communications and Information Systems division

Watch this space

Plu points to an ambitious project for Mexico City: "We have created a central supervision center to enable around 20 different agencies in the city to collaborate to manage security incidents in the most effective way."

The company is also working on the 6W4U (Watch For You) intelligent watch concept. Created in cooperation with operational police officers, the 6W4U is designed to be an officer's sixth sense, alerting them discreetly to any potential risks. The 6W4U will enable officers to maintain a secure connection between each other and the command center. Clearly there are a lot of developments on which to keep a close eye.

FACIAL RECOGNITION IN DALLAS

In 2015, a change.org online petition by customers of Dallas Area Rapid Transit (DART) in Dallas, Texas, called for the introduction of security cameras – already used on buses in the area – on trains, after a passenger was stabbed at a Dallas station. DART acquiesced but also proposed to go a step further, to introduce cameras integrated with facial recognition software. These would enable the operator to monitor capacity, especially during major events, identify fare avoiders, and alert law enforcement forces when suspects are spotted on a train.

Privacy issues related to the implementation of this kind of system include what data will be stored and for how long. DART says it will not use external legal suspect data, but only the pictures it keeps on its own databases. However, it is very early days for the project. "We're still evaluating the technology," says Morgan Lyons, communications director at DART. "We've not identified the equipment or vendor."

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AEROSPACE THINKING HITS THE TRACKS

ANDREAS VOGLER STUDIO




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Urban revival

LEFT: Saint-Étienne's new tram, based on CAF's Urbos platform

IN NUMBERS

- 16 new trams
- 5 carriages per tram
- 33m total length
- 1m rail gauge
- 2.15m carriage width
- 100% flat floor
- 238 capacity
- 34 seats
- 6 doors on each side
- 2 wheelchair zones per tram
- 30-40 years of expected service
- 70km/h maximum operating speed

France's oldest tram network will have a resolutely 21st century image when its new trams enter service in late 2016

Saint-Étienne in eastern central France has enjoyed a design renaissance of late. Having suffered the decline of its historic textile, arms and bicycle industries, the city has remarketed itself as a center for design. Emblematic of this was the establishment of the Cité du Design – Higher School of Art and Design in the city's former arms factory, and the Saint-Étienne International Design Biennial. In 2010 Saint-Étienne became the first French city to be classified as a UNESCO City of Design, and is a member of the UNESCO Creative Cities network.

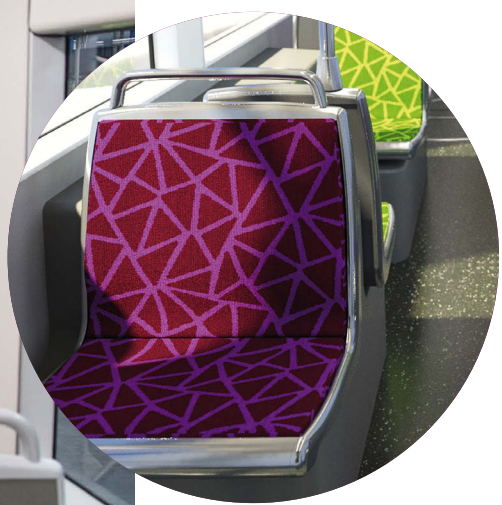
The city's transport system forms an integral part of this image, centered around the idea of design as an agent of urban transformation. A new city-wide visual identity was created for STAS – which operates trams, trolley buses and buses in the area – by Eric Rhinn of Avant Premiere. The design agency was brought in as early as 2009. The visual identity covers all aspects of the transport network, from bus livery to ticket machines bus stops and park-and-ride parking lots.

History lessons

Trams count for around half of the city's public transport today. Founded in 1881, Saint-Étienne's tramway is the oldest in France, and one of the rare few to have remained in continuous operation ever since its creation. Most of France's tram systems were closed by the 1950s and have only recently been reintroduced.

LEFT: The first of the 16 new trams, delivered on July 1, 2016

BELOW: The widest seats are upholstered in prune



APPY DAYS

In keeping with Saint-Étienne's modern image, operator Transdev has developed an Apple Watch app for STAS to help users plan their trips. The app uses geolocation to show the nearest stops, tram times, interest points and local services. In addition, STAS launched its Moovizy app in June 2016, which provides traffic information and enables customers to purchase tickets on their smartphones.

LEFT: The stripes are a reference to the city's ribbon-making heritage

It's a body that facilitates circulation

Francis Nakache, chief executive officer, CAF France

Saint-Étienne first relied on steam-powered trams, which gave way to electric trams from the late 19th century. In 2019, 16 new trams will be launched on Line Three, which is set to be extended northeast of the city center. The cars are being made by CAF France at Bagnères-de-Bigorre in the French Pyrenees.

STAS called upon Avant Premiere again for the design. The city's new branding is certainly evident in the tram's exterior livery, where the bright green body is topped by a dynamic row of colored stripes reminiscent of a barcode. Rhinn says the stripes are a nod to the Saint-Étienne tradition of ribbon-making, which employed some 40,000 people in the 19th century. The tram is also characterized by large windows that allow in light and enable passengers to make the most of the view, a sloping pointed nose and a chrome trim that encircles the tram.

ABOVE AND BELOW: Avant Premiere worked on a complete visual identity for the network, including tickets and ticket machines

Modular design

Saint-Étienne's five-car, 33m-long tram is an adaptation of CAF's modular Urbos range. Elements that can be adapted on the Urbos tram include the size and position of doors and the number and length of carriages. Urbos trams range from the three-car version in Besançon, France, to the nine-car, 56m-long version in Budapest, Hungary.

The tram has a low-level flat floor, even over the bogies, with no internal steps and level access from the platform. This was enabled by mounting equipment on the roof and using energy-efficient, reduced-size IGBT motors. The floor is designed to ease entrance and exit, and enable a capacity of up to 238 people (34 seated) – a big increase on the 133 of earlier trams in the city. "It's a body that facilitates circulation," says Francis Nakache, chief executive officer at CAF France, whose in-house designers adapted Avant Premiere's 3D renderings.

Narrow it down

The principal design challenge for Saint-Étienne was to create a tram that not only runs on narrow-gauge rails – it is one of only three tramways in

LOWER-COST TRAM

Could the next generation of trams be quite different? Alongside its Urbos range, CAF is developing a low-cost tram in association with the Vinci Group, intended as a viable alternative to buses for smaller cities. It was first presented in 2013. "We want to show we can do trams that are much less expensive if we do them differently, pushing the Besançon experience much further," says Francis Nakache of CAF.

If one of the key characteristics of the Urbos is its virtually made-to-measure quality, the NexTram could almost be viewed as the opposite, says Nakache. "We hope to succeed in changing the concept of the French tramway, which is considered sophisticated, very expensive and luxurious, and to return to the primary function of a tram, which is transporting people, showing we can offer two systems in parallel," he says.

The partnership with Vinci enables CAF to provide a complete package that incorporates the design and construction of the trams and rail structure, finance, operation and maintenance. By offering this complete operating package, as well as a more standardized and simplified tram design, Nakache thinks costs could be reduced by 30-40%.

Low-height rails would be laid less deep, the aim being to make track construction simpler and quicker. The trams themselves would be unidirectional, with just one driver's cab and doors along only one side.

France with rails 1m apart – but also that has 2.15m-wide carriages. Urbos trams are usually 2.40m or 2.65m wide. CAF kept the existing bogies, but created totally new modules to suit Saint-Étienne's narrow main street.

Whereas the old trams were unidirectional, the new ones are bidirectional, with six doors down either side – four double doors plus single doors near each end. The interior has a 1-1 layout with a spacious central aisle.

Wheelchair accessibility was a priority, and Saint-Étienne's tram goes beyond the minimum requirements. There are two wheelchair zones in each tram, situated close to double doors for easy boarding and to give sufficient space to turn and affix wheelchairs. There are also accessible stop buttons, plus a row of fold-down seats for when the area is not needed by wheelchair users.

All the seats are manufactured by Saira. The standard model is upholstered in the Saint-Étienne green, while a custom wider jumbo seat is finished in a prune color. The seat upholstery features a light graphic pattern that is echoed on the ceiling panel.

Audio/visual equipment

The policy of accessibility extends to audio/visual notices, resulting in the inclusion of strong visual contrasts, automatic audio station announcements and several overhead TFT displays. Other features include air-conditioning, underfloor heating, CCTV, a passenger counting system, free wi-fi and exterior LED indicators.

The driver's cabin was designed by CAF France to align with the French STRMTG safety guidelines introduced in 2012 and which Nakache believes could become the model for future Urbos trams. The cabin glazing has been made larger to improve the driver's exterior visual field, notably to try to help them see pedestrians. Saint-Étienne's Line Three runs along the narrow, largely pedestrianized Grande Rue, a series of streets that make up the historic thoroughfare through the city center. CAF has also worked to improve ergonomics. It has implemented a tilting seat back devised to suit drivers of various sizes; tried to improve upward visibility through an angled windscreen; and attempted to make controls easier to use, with clearly separate functions.

Nakache forecasts a 30-40-year lifespan for the trams, with a renovation in around 20 years. Testing was conducted at CAF's workshop in May and June 2016. The first tram was delivered to Saint-Étienne on July 1, 2016, and others are scheduled for delivery over the next few months. Service entry is planned for the end of 2016.

ABOVE: The tram has a flat floor throughout and offers platform-level boarding

BELOW RIGHT: Bus stops in the city also follow the visual identity created by Avant Premiere

URBOS IN LUXEMBOURG

In a further collaboration between CAF and Avant Premiere, 21 trams for Luxembourg are being manufactured in Zaragoza, Spain. A full-scale mock-up was put on public display in Luxembourg in December 2015, line construction began in February 2016, and the first trams are due to be delivered in early 2017.

A 45m-long adaptation of the Urbos range, the Luxembourg tram can carry as many as 450 passengers. It will feature large windows and programmed LED lighting sequences designed by lighting specialist Isabelle Corten. The glazed door panels are covered with colorful vinyl in a design by Michel Léonardi. The seats are from Compin's SB10 range. LEDs are incorporated in the plastic headrests, while the seat structure is made from aluminum, resulting in a weight of 9kg for each chair. Other features include a USB socket on each seat and wi-fi.

The Greentech ACR system stores energy generated during braking in accumulators on the roof and also recharges at each station, enabling the tram to run for 3.6km through the historic city center without overhead cateners.

Exhibitors give a taste of the innovations they are set to showcase at **InnoTrans 2016**, which will be held in Berlin, Germany, from September 20-23

Show and tell

MOROCCAN MODELS

Examples of new railway cars for passenger and freight use will be exhibited by **SCIF** of Morocco. These have been developed and manufactured specifically for customers in Africa and Europe. They include passenger cars for Morocco, special freight cars for Tunisia, electric locomotives and different types of bogies.

SCIF was founded in 1946 and is based in Casablanca, Morocco. It has experience in many sectors of the rail industry, including electric locomotives, and the renovation and manufacture of freight and passenger cars.

Hall 3.2, Stand 306

INNOTRANS 2014 FEATURED **2,761** EXHIBITORS

EXHIBITOR IN FOCUS

Alexandra Bennett, global business manager, E-Leather

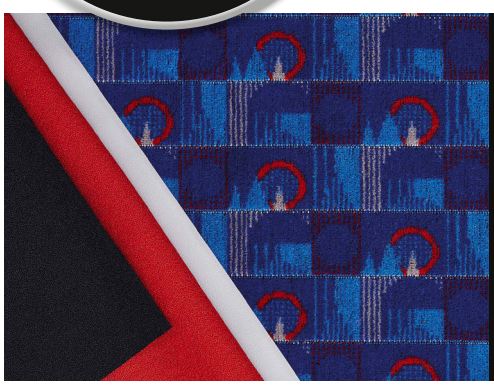
What will be the highlight on your InnoTrans display?
E-Leather will display a new palette of colors for SL2i. This product was launched within the past 12 months and has been popular with bus and coach operators, as well as OEMs. SL7 is compliant with EN 45545-2:2013 HL3 and can be custom-colored to meet rail operators' design requirements. Each of these products maintains the high standards of durability, hygiene, compliance and eco-credentials that our customers have come to expect from E-Leather.

Can you detail a recent application?
For the past 10 years, luxury transport provider Dublin Coach has been revolutionizing the commuter travel experience. Core to this is its fleet of 10 new Mercedes Tourismo 'Cityscape' coaches, created to the specification of John O'Sullivan, CEO of Dublin Coach, and introduced in early 2015. The cream and brown E-Leather upholstery complements the unique green exterior livery and helps create a stylish interior that Dublin Coach hopes will enhance passengers' journeys, while proving hard-wearing, hygienic and easy to maintain in service.

How do you meet customer requirements?
The greatest challenge is identifying truly what the customers' needs are, capturing the requirements in a measurable and tangible way so that we can steer product development to deliver the end goal in a timely manner. However, by spending time in direct contact with all stakeholders within the market, a comprehensive picture is established and regular reviews – within E-Leather and with our customers – enable us to stay on track.

What trends have you noticed in terms of demand and application?
Design trends are being translated across the mass transportation industries. Many countries have similar passenger routes serviced by aircraft, train and coach, so there is increased competition for a comfortable, on-time and cost-effective service. Several operators may operate multimodal services, where a consistent brand is needed to give passengers a sense of safety and well-being. By delivering a modern, hard-wearing upholstery material, we enable our customers to embrace this dynamic trend.

Meet the E-Leather team in Hall 1.1, Stand 206



SOFT FURNISHINGS

Camira will display moquette and flat-woven fabrics, leather and coordinating trims. The company will reference Transport for London's current exhibition, Transported by Design, along with its work with the London Underground. Camira will also explore the development of fabrics over the years, and how the past influences future designs.

The retrospective view examines how design has changed in transport over the past century. Camira's cooperation with the museum illustrates the progression of transport fabrics, and includes a display of a series of moquette fabrics used on the London Underground.

Hall 1.1, Stand 324

MOCK-UP DEBUT

INCREASED CAPACITY

A full-scale model will be used to demonstrate the Aeroliner3000 concept from **Andreas Vogler Studio** and the **German Aerospace Center (DLR)**, at the DLR's stand. Funded by the RSSB, the concept is designed to enhance the capacity of existing lines in Great Britain at dramatically reduced costs and environmental impact. The double-decked high-speed train concept was designed in line with the HS2 Classic Compatible Train Specifications 2012 for a maximum speed of 400km/h. Designed in line with the GB PG1 gauge, it is compatible with existing infrastructure on the majority of the rail network in Great Britain. Preliminary studies have also been conducted for possible application in high-frequency commuter service.

The mock-up, built by GETA Wangen, is being displayed to show the concept's feasibility, ergonomics and aesthetics. Components include electronically dimmable windows by Vision Systems, lighting by OLEDWorks, a new passenger seat by RICA, carpet by Forbo, leather by Lantal and fabric by Kvadrat.

Hall 2.2, Stand 405

133,595
TRADE VISITORS ATTENDED INNOTRANS 2014

NEW LAUNCH!

TRAM PREMIERE

The new ForCity Plus tram from **Škoda Transportation** has a capacity of 345 (including 69 seats). The fully air-conditioned vehicles are equipped with a visual information system, which also includes devices to enable visually impaired passengers to communicate with the driver. A tilting platform facilitates entry and exit for passengers with restricted mobility. A system with six internal and six external cameras is installed to ensure passenger safety. The vehicles have a gauge of 1,000mm and comprise five sections. The first and last bogies are fully pivoting.

Škoda Transportation will also debut its new double-decked multiple unit for push-pull operation by DB Regio on the Nuremberg – Ingolstadt – Munich route in Germany.

Hall 9, Stand 302

CUSTOM LEATHER

Its ability to create custom leather solutions will be the main focus at **Boxmark**'s stand. The company says it can offer an almost unlimited variety of styles for both prototypes and serial products. Design options include perforation, embossment, printing, laser engraving and contrasting or decorative stitching.

Boxmark's Emotions structural embossments are available for many colors in various leather collections – there are more than 3,000 options. Unique effects can be produced on embossed surfaces through additional processing using special dyes and gloss techniques.

The company has an in-house sewing room and saddlery. Its skilled staff can produce everything from functional seams to ornamental and custom ones. The company also works to ensure an ergonomic design and precise fitting, aiming to optimize comfort and ambience.

Hall 3.1, Stand 214

Fast forward

Andreas Vogler Studio and the German Aerospace Center (DLR) took up the challenge of developing a double-decked high-speed train concept for the tight British loading gauge, to enhance the capacity of existing lines at a dramatically reduced cost and environmental impact

LEFT: The upper deck features a split-level floor that could be modified to enable the integration of seats of different sizes

BELOW: The 200m double-decked train is compatible with the GB PG1 gauge

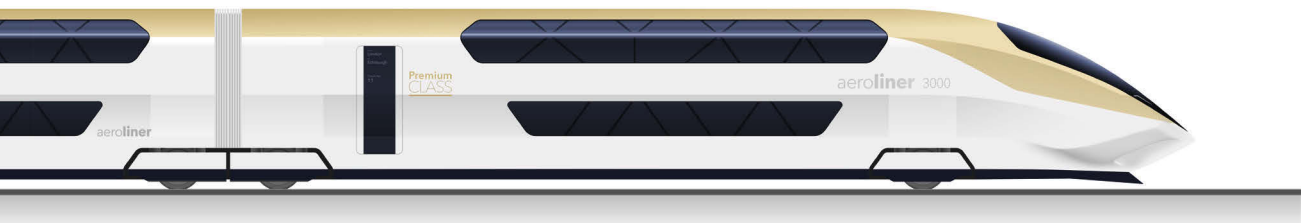
In 2014, the RSSB, a British rail industry body, launched a competition titled Tomorrow's Train Design Today, calling for passenger rolling stock designs that would provide "a glimpse of the future" and showcase the capability of the rolling stock supply chain to deliver key elements of the design. The competition was very open, with one main restriction: not to touch the infrastructure. The brief revolves around four 'C's: capacity, low-carbon, comfort and cost-sensitive innovation.

Andreas Vogler Studio teamed up with the German Aerospace Center (DLR) to propose a high-capacity double-decked high-speed train that would be capable of traveling at 400km/h on the new HS2 line from London to Birmingham, UK, and continuing on existing lines as far as Edinburgh.

Aerospace thinking

"Great Britain's very successful railway system is caught in the straitjacket of its historical infrastructure," says Andreas Vogler, founder of Andreas Vogler Studio. "Seat pitch is already as low as it can go, train length and line capacity are already maximized and it is very difficult to build new lines next to existing ones in dense urban areas. The only way to increase capacity is introduce double-decked trains with each deck having a lower ceiling than existing single-deck trains."

Therefore Andreas Vogler Studio created a split-level design. On the upper level the gangway is to one side, where the floor is lower. The gangway on the lower level is placed in the middle, where the ceiling is higher. The prime design driver was to bring aerospace thinking into the train world, both in terms of engineering and design. The AeroLiner3000 double-decked high-speed train design conforms with the HS2 Classic Compatible Train Specifications 2012 for a 400km/h maximum speed. Andreas Vogler Studio says the design could increase line capacity by more than 30% without any change to existing infrastructure, while enabling short station dwell times.



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MAIN: There are two toilets per car, on the lower level

BELOW: A cross-section showing the stepped-height floor/ceiling between the lower and upper levels

The studio also reports that very promising preliminary studies have also been conducted regarding the train's possible use for high-frequency commuter service in and out of London with a maximum line speed of 160km/h. Fitting into the GB PG1 gauge, the double-decked train could operate on most of the rail network in Great Britain, and it is fully compatible with existing tunnels, bridges and platforms.

The 200m trainset comprises 20m end cars and 17m coaches. Each has four individually powered and controlled wheels at the very end, forming a virtual Jacobs bogie. The train has a maximum axis load of 17 tons. However, the individually controlled active wheels are designed to minimize wear on the tracks and wheels.

Light reading

Vogler says lightweight construction techniques can reduce the weight of the car body by 16%, while optimized aerodynamics would reduce operating and maintenance costs while also limiting carbon dioxide and noise emissions. "Using lightweight construction principles we can create a double-decked car for the GB PG1 gauge that also saves space, enabling us to meet TSI-PRM requirements."

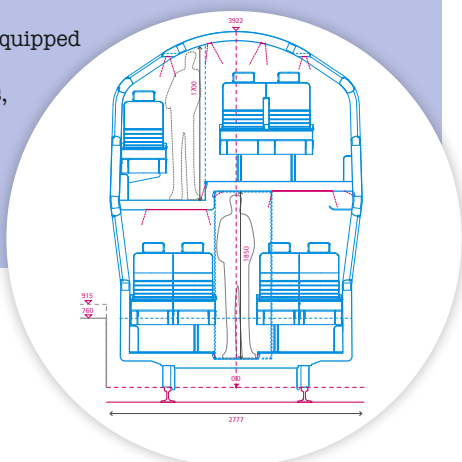
The lightweight coach structure would consist of curved steel tubes that are laser-welded together. The design includes large windows with very slim diagonal posts. Each coach would have two small airline-style toilets and six priority seats on the lower deck.

FULL-SCALE DEMONSTRATOR

In the space of two years the AeroLiner3000 train has made it through a feasibility study and now a 1:1 demonstrator is being built by GETA Wangen. The demonstrator will be shown at InnoTrans 2016 in Berlin, Germany on September 20-23.

In addition to allowing the industry to preview the interior design and ergonomics, the demonstrator will also be used to test passenger flow, maintenance and at-seat service. Both the upper and lower level will be accessible.

The demonstrator will be equipped with electronically dimmable windows from Vision Systems, illumination by OLEDWorks, a newly developed seat from Rica Seats, and various materials from Forbo, Lantal and Kvadrat.



ABOVE: The lower deck features 39 standard-class seats, with six priority seats per car

Many comfortable and even luxurious means of travel don't offer full standing height – for example small private jets, some yachts, cars and helicopters – but they are still elegant

Andreas Vogler, founder, Andreas Vogler Studio

Flexible interior

The AeroLiner 3000 coach has been designed to enable maximum flexibility. For example, the split-level floor could be modified to accommodate seats of various sizes. The central coach is envisaged with a multifunctional interior that would give flexibility to the operator. It would feature platform-level wheelchair access and a toilet on the lower deck. The upper deck could be used for an automated container-based luggage transportation system, currently in the early conceptual stage. The 200m trainset could accommodate 627-700 seats.

"Passenger comfort would be achieved at 830mm seat pitch using thin aluminum seats made by Finnish manufacturer Rica Seats," says Vogler. "Comfort would be further increased by minimizing noise, vibrations and pressure variations, improving air-conditioning and including interactive smartphone-based passenger information and control."

The windows would feature electronically dimmable glass, which could control the amount of sunlight entering the cabin, subtly preparing passengers for upcoming tunnels while also supporting the HVAC system in all seasons.

Although the main objective was to demonstrate the viability and configuration of a double-decked train for Great Britain's infrastructure, the designers also made a considerable effort to create a feeling of elegance that would enhance passengers' experience of the space and the large windows.

"The stylishness of train travel in the Victorian era has mostly been sacrificed to vandalism-proof functionalism," says Vogler. "Trains also often lack the elegance found in airline cabins."

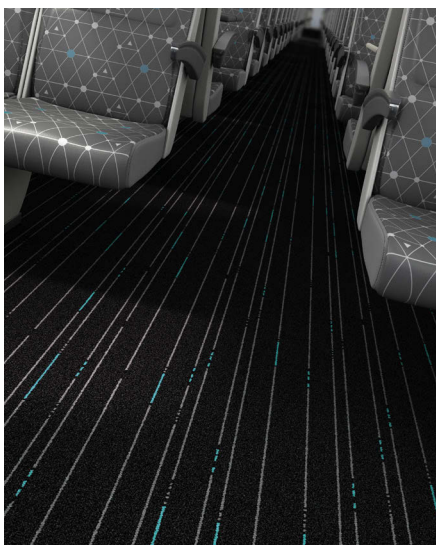
Andreas Vogler Studio is home to architects and industrial designers with experience in space-travel and airline design, who are familiar with designing small spaces, while DLR has long-standing experience in high-speed double-decked train design, with its ongoing NGT research project. "Many comfortable and even luxurious means of travel don't offer full standing height – for example small private jets, some yachts, cars and helicopters – but they are still elegant," points out Vogler.

RIGHT: Coral Move FR, a tufted carpet that complies with EN 45545-2 HL2

BELOW: The new carpet uses an Econyl nylon yarn from Aquafil, which is made from 100% recycled material

Magic carpet

Coral Move FR, the latest carpet from Forbo Flooring, has been designed to offer clients vast customization opportunities



The latest addition to Forbo Flooring's large portfolio of floor coverings for the rail sector is Coral Move FR, a tufted carpet that is compliant with EN 45545-2 HL2 and offers extensive custom design and color possibilities. The product is an adaptation of Coral FR, the company's entrance matting system, which is already widely used in vestibules. Other varieties of Coral FR include Duo, Brush and Classic.

The creation of Coral Move FR came about during the development of a product for a different segment, says Raymond Koomen Bonnier, a senior designer who has been with Forbo Flooring for 18 years. "Some key customers in the transport industry were asking for a product without the scraper yarn used in our Coral FR Entrance System," says Koomen Bonnier. "At that time I was developing a product for hotel corridors and showed those customers some of the prototypes. The feedback was very positive."

Tom Kuijper, business director for Coral and Nuway, Forbo Flooring's Entrance Flooring Systems division, led the team during the creation of Coral Move FR. "We wanted to offer our customers a great floor covering from both a functional and design perspective," he says. "This means that the product complies with all the rail industry's legal requirements around safety, fire retardancy, smoke and wear, and our customers can use the platform to configure their own special product, with our support."

LEFT: Coral Move FR is not a range, but a platform that operators can customize

Special yarn

Forbo Flooring says many of the product's advantages are down to the Econyl nylon yarn used. "This yarn gives Coral Move FR great dimensional stability, ensuring easy and effective cleaning for rail operators while maintaining visual appearance for longer than wool carpets," says Jacco Vlaar, head of key account management for transportation at the company. "With daily vacuuming and periodical spray extraction cleaning, Coral Move FR can withstand heavy traffic and still provide underfoot comfort and an attractive aesthetic."

The Econyl yarn, produced by Aquafil, is 100% regenerated from pre- and post-consumer waste material, for example old fishing nets, carpets and plastic components. This waste material, which might otherwise be dumped in a landfill, is recovered by Aquafil from all over the world and transformed through the Econyl Regeneration system into top-quality nylon yarn. The use of this yarn enables Forbo Flooring to reduce waste and manufacturing-related pollution, and minimize consumption of natural resources and energy. The launch of Coral Move FR contributes toward Forbo Flooring's extensive efforts to reduce environmental impact. The company announced earlier in 2016 that it has reduced its environmental footprint by 23% over the past five years.

Design freedom

Koomen Bonnier says that what really sets Coral Move FR apart is the freedom customers have to tailor the design to meet their requirements. "It's not a pre-designed product range, it's simply a product construction," he explains. "In essence we're providing a platform for designers, giving them a tried-and-tested product and the freedom to choose from 132 colors, resulting in thousands of design and color combinations."

Forbo Flooring believes the solution is well timed as it has noticed a growing trend of rail operators using interior fabrics and surfaces as a way to make their brand stand out. Operators can create unique carpet designs that align with their branding, both in terms of color and pattern. "Coral Move FR's customization capabilities do not stop at color and design," adds Vlaar. "We can offer custom roll sizes or cut-to-shape pieces, delivered where and when our customers need it."

Coral Move FR was officially launched at Railway Interiors Expo 2015, which was held in Prague, Czech Republic, on November 4-5, 2015. Forbo Flooring reports that the new product was very well received by visitors. New to the company's product portfolio just seven months ago, this new tufted saloon carpet already has a proven track record. The custom carpet is currently being fitted on 30 TGV Atlantic trains, two TGV Ouigo trains and 26 Thalys trains in France, Belgium and the Netherlands.

Forbo Flooring's other products for the rail industry include linoleum flooring, broadloom carpets, flocked floor coverings and entrance systems.

Trend watch

Synergy, durability, weight saving and environmental responsibility are just some of the requirements seat cover manufacturer Autostop Europe is working to meet

Customers are increasingly demanding to be able to purchase multiple parts from one supplier, says Autostop Europe, which manufactures seat covers for the automotive, rail and aviation interior industries in Europe. The company has teamed up with Global Interior Systems, an experienced manufacturer of seat frames and foams, to provide this kind of integrated solution for those in the railway industry who are seeking seating.

"The demand for integrated solutions is seen across all industries, but especially in the railway and automotive markets," says Panayiotis Pitsikos, president of Autostop Europe. "This has to do with economies of scale, increased buying power, reduced costs, technology transfer and simplicity. Customers are putting more pressure onto each supplier to deliver better, cheaper and one-stop-shop solutions. This is the reason why Autostop Europe and Global Interior Systems joined forces."

The companies have complementary expertise. Autostop Europe is highly experienced in the manufacture of seat covers using various materials, and Global Interior Systems in the production of seat frames and foams. "We can now offer a complete seating solution, with shared technologies and experience that will ultimately benefit each customer," says Pitsikos.

Autostop Europe is based in London, UK, and has manufacturing plants in Serbia and Greece. Its in-house design and development team can create unique designs using various types of materials. Leather, vinyl and fabric have been at the core of its business offering for many years, and can be used singly or in combination.

Tough stuff

Durability is a key focus. "Our products are made of strong materials and are manufactured to last for a long time," says Pitsikos. "We put them through rigorous tests in conjunction with our suppliers, to

MAIN AND INSET: Autostop Europe's manufacturing facility

ABOVE: Various versions of Autostop Europe's AC and NK seat cover ranges

LEFT: A Thesis seat, for use in train stations and airports

ensure their durability over time. Our customers have always been happy with the materials we deliver."

Pitsikos says leather is the most traditionally popular seat upholstery material. Embossed, perforated, smooth and printed offerings are available. "Leather is commonly used for first or second class coaches, as it offers lots of design opportunities and is easy to maintain," says Pitsikos. "Fabrics have only evolved in the past few years to be more durable and maintainable."

The team works closely with each client to understand the complexities of the project and provide solutions that are unique and at the same time production-friendly, often in a short timeframe. "Our manufacturing processes have always been set up to be able to produce multiple types of products at the same time," says Pitsikos. "There is increasing demand for customized solutions at lower volumes, but we welcome these projects because we have managed to minimize our setup and tooling costs."

Simple pleasures

According to Pitsikos, one of the biggest trends the company has witnessed in the past few years is demand for products – especially seat covers – that not only have a nice design and are comfortable, but that are simple enough for quick assembly and maintenance. "With more than 25 years of experience in the automotive industry, we have been able to transfer this knowledge to the railway industry," he adds.

There is also a growing market for environmentally friendly solutions, Pitsikos says: "We believe that green solutions will be a requirement in the future, either because they are requested by customers and/or end users, or because they are mandated by law. We are working closely with all our material suppliers to ensure that they also invest in research and development into new materials and can keep up with the trends."

Light and low

Another trend is for lightweight solutions. "Demand for lightweight seating is on the rise, especially for new trains, but not so much for renovation projects," says Pitsikos. "Our research and development department has been testing various lightweight frames, foams and covers and presenting them to customers to review. The biggest target in this work has been to keep costs as low as for conventional materials, and we are achieving that."

The company is currently working on various seat prototypes for first and second class coaches for both the European and Asian markets. It also recently introduced the Thesis range of seats for waiting areas in train stations and airports. It has been installed in Dubai International Airport in the UAE. The seats can be implemented in many combinations to suit the space available.

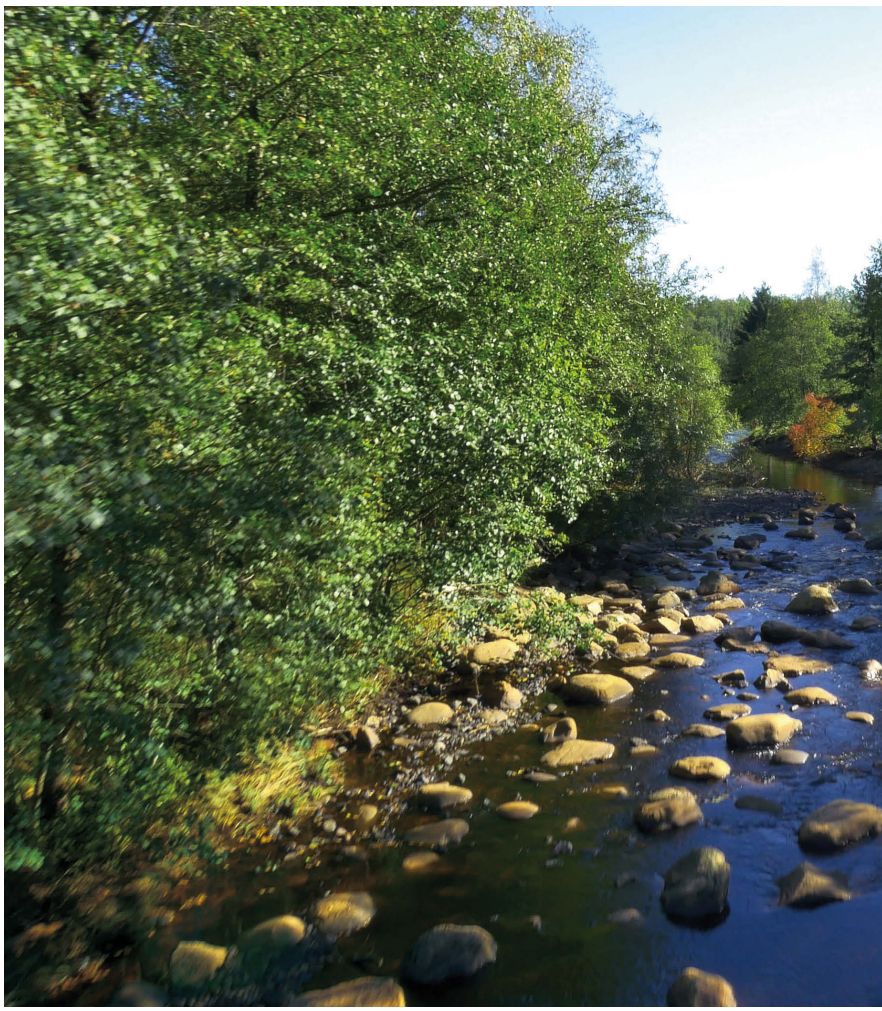
Natural beauty

A leading supplier of leather has taken a great leap to improve its environmental responsibility

The vision at Elmo is to produce leather that is eco-friendly and sustainable, as well as technically and aesthetically impressive. “All our railway leather has the highest technical properties, exceeding international standards in terms of certifications such as EN 45545,” says Jimmy Ahlgren, sales director at Elmo. “Our mission is to evolve our products and processes to stay ahead in a competitive market, yet never fail in our commitment to the planet.”

The company’s tannery on the west coast of Sweden has focused on the environmental aspects of the leather-making process for decades. For many years, Elmo has been searching for an international environment certification, but with no suitable scheme in place, it decided to develop its own environmental benchmark, focusing not only on the product, but also the complete manufacturing process and beyond.

“A commitment to environmentally sound production processes is one of the company’s core values and part of the Elmo success story,” comments Ahlgren. “The road to where we are today has not always been straightforward. A lot of hard work and commitment has gone into making Elmo a leader in terms of environmentally friendly tanneries.”

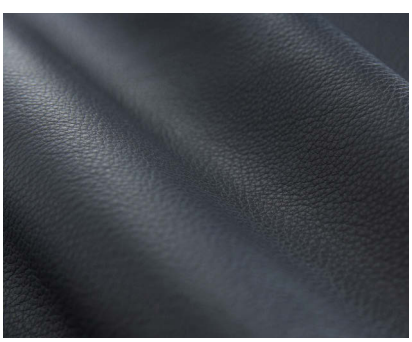


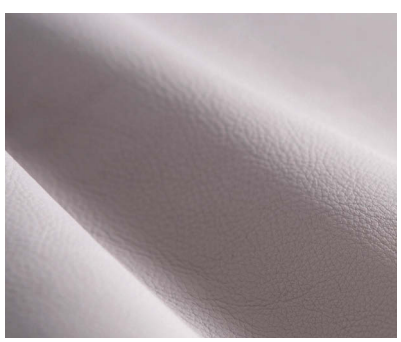
Wastewater

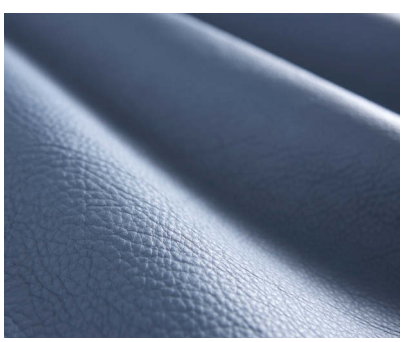
A key part of this has been the company’s approach to the wastewater it produces. “A tannery should not be measured just by the levels of chemicals in the leather, but also by the chemicals in the wastewater,” says Ahlgren.

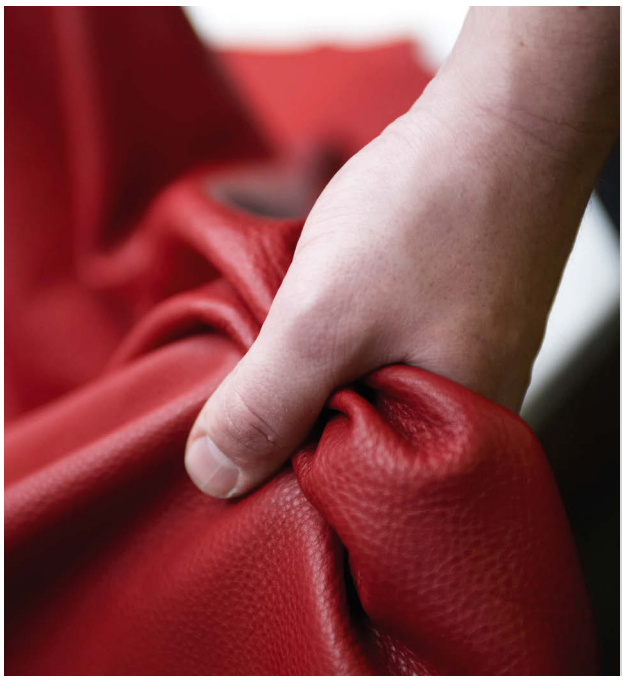
Back in 2000, the situation was far from ideal. The tannery’s wastewater was discharged to the local treatment plant, together with the rest of the municipality’s wastewater. The majority of Elmo’s wastewater was a by-product of its leather production processes and the company says this became an obstacle, preventing any increase in production.

RIGHT: Some of Elmo’s leathers









ABOVE: Elmo operates in about 40 markets globally and employs around 120 people at its facility in Svenljunga, Sweden

LEFT: Wastewater from Elmo's tannery is treated before being returned to the nearby river, and converted into drinking water downstream

RIGHT: Elmo offers real leather that meets EN 45545

LEFT: Elmo's wastewater initiative was recognized as one of the 22 best environmental projects by the EU LIFE Fund

"In addition, the Swedish environmental authorities were putting pressure on us to reduce nitrogen pollution," says Ahlgren. "The reduction of nitrogen discharges to rivers and lakes had been a very high priority in Sweden for several years."

Elmo took on the challenge to introduce a new treatment process. The goals were clear: to achieve a dramatic reduction in nitrogen pollution in wastewater and to become one of the greenest tanneries in the world. In 2004 Elmo invested €5m (US$5.6m) and thorough research into a new cleaning facility. By changing processes and substituting chemicals, Elmo surpassed its reduction targets. Nitrogen levels were reduced by 94% and further reductions were also achieved with other pollutants. For example, chromium levels have dropped by a 99.6%, biological oxygen demand by 99.9% and chemical oxygen demand by 99.1%.

When, in 2005-2006, the EU LIFE Fund identified the 22 best LIFE-Environment projects in Europe, Elmo's wastewater treatment plant was recognized as one of them. "This EU LIFE-supported project has demonstrated that it is possible for the leather industry to reduce its nitrogen discharge by more than 80% in a cost-effective way," says Ahlgren.

Drinking water

The success continues. "Water used in the tanning process is taken from the nearby river and is later returned back to the river, cleaner than before," says Ahlgren. "Downstream, a regional cleaning facility turns the river water into clean and safe drinking water, supplying cities on the west coast of Sweden. Elmo is probably the first tannery to accomplish this. We believe we have achieved our vision of becoming the greenest tannery in the world."

Tread safely

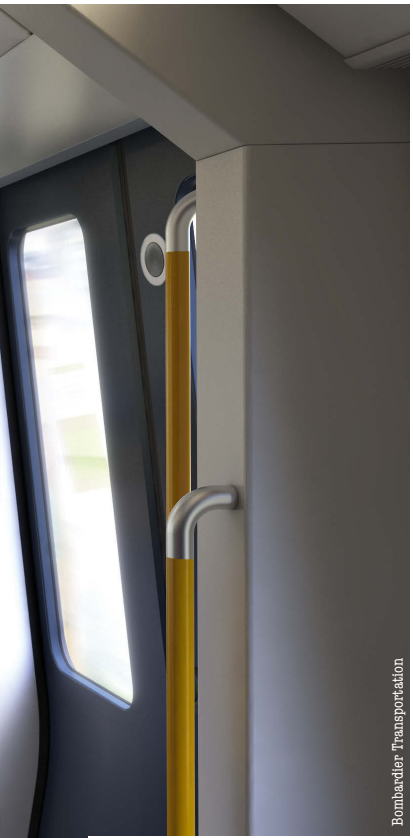
With current high-profile projects in the UK, Sweden and Australia, Treadmaster's flooring solutions are proving popular

London Underground transports approximately 1.3 billion passengers every year and so a heavy-duty floor covering is essential – and it also fulfills a critical safety role. The most recent project undertaken by Treadmaster for London Underground involves the supply of more than 9,000m^2 of its TM7 flooring product for the refurbishment of 36 seven-car metro trains (built in 1972) on the Bakerloo line.

Treadmaster says TM7 is particularly suitable for metro flooring applications because it meets the highest fire rating of BS6853, Cat 1a, and the updated European standard EN45545-2:2013, HL3. The product is also designed to offer high durability, slip resistance and ease of cleaning.

The company worked with both London Underground project engineers and Transport for London's design department, as well as the external designer appointed to the project, Jedco, to provide two color palettes – wine and gray. One is for the main flooring and the other for the vestibule areas.

"With over 40 years of service, the Bakerloo line fleet is the oldest on the Tube network and is inevitably starting to show its age," says Paul Marchant, product design manager at London Underground. "It is one of four lines (along with the Piccadilly, Central and Waterloo & City lines) set for new trains from the mid-2020s. We're implementing a range of operational and maintenance improvements to extend the life of the current Bakerloo line fleet until we introduce the New Tube for London on the line. As part of this program, we are working with Treadmaster to replace the flooring with an improved, contrasting-color design that will make the train interiors more welcoming and more accessible for visually impaired passengers."


Bombardier Transportation

LEFT: The C30 metro for Stockholm, Sweden

RIGHT: One of the refurbished Bakerloo line trains for the London Underground

BELOW LEFT: Customized flooring in the vestibule area of a Bakerloo line train

BELOW: Queensland's New Generation Rolling Stock

Transport for London

BURNING QUESTIONS

Simon Andrews, Treadmaster's new business development manager, is concerned that the new EN45545-2 standard is a dilemma for metro operators who currently adhere to more stringent national standards such as the UK's BS6853 Cat 1a and are now faced with switching to the new EN standard.

"The two standards are not comparable so it could appear to be a downgrade in passenger safety if an operator switches directly from BS6853 to EN45545-2," says Andrews. "I hope that operators will not feel pressured to reduce costs by switching to materials that would not have previously met the relevant national standard but now meet the new EN standard."

Treadmaster's TM7 meets both BS6853 Cat 1a and EN45545-2 HL3, while TM8 meets BS6853 Cat 1b and EN45545-2 HL3.


Image: Bombardier Transportation

Stockholm metro

Treadmaster is also supplying 17,000m^2 of its TM8 product, in a mid-gray color, to Storstockholms Lokaltrafik, Stockholm's public transport body, to be used on the new C30 metro. Bombardier Transportation is building the 96 four-car Movia trains in a contract worth US$771m. The new trains are scheduled to commence operation in early 2017.

The C30 interior features spacious gangways and uses indirect light to create an open and bright environment. The number of designated priority zones in each train has been increased to eight, to ensure there is ample room for people with reduced mobility, as well as providing extra room for those traveling with wheelchairs, baby carriages and extra-large luggage.

Photoluminescence

Treadmaster has also won a major new contract to supply flooring for 75 six-car EMUs destined to help increase commuter capacity for the growing population of southeast Queensland, Australia. Bombardier Transportation is building the trains at its Savli plant in Gujarat, India. The first train is expected to begin service in the second half of 2016.

Treadmaster is supplying 22,000m^2 of TM8 flooring in light and dark gray colors. For the first time in a rail project, the company is supplying its new photoluminescent strips, which are used to provide emergency evacuation markings, both down the aisles and in the vestibules.

LEFT: A fabric created for Queensland Rail

BELOW: Camira uses various flame-retardant treatments and back coatings to comply with international standards

Hot topic

As a fabric supplier, Camira's priority when creating custom solutions is to ensure flammability standards are met

Fabrics for rail interiors are designed to enhance the passenger experience but they don't just need to look good – operators require the highest technical standards in terms of durability and flammability.

At the top of the agenda is flammability performance, which is essential to passenger safety. Flammability tests are used to determine how quickly a fire spreads on a certain material, as well as the temperature increase, and the toxicity and density of smoke produced. No matter which country the test applies to, flammability standards have the same aim: to measure how well a fire can be contained and prevent danger to the traveling public, as well as maintaining passengers' confidence in the safety of the trains they are traveling on.

The BR252 flammability standard, formulated in 1987 on behalf of British Rail, formalized the testing of rail carriage interior fabrics – for both flammability and physical performance parameters such as abrasion and color fastness properties.

Fabrics used throughout the world must be compliant with country-specific standards. Most countries have different methods of testing and their own requirements for fabrics. The UK, for example, has to meet the BS 6853: 1999 standard, a code of practice for fire precautions in the design and construction of passenger-carrying trains. The standard provides varying criteria for every component used in a rail carriage.

RIGHT: Camira uses hundreds of colors of yarn to create its fabrics, and can also create bespoke colors for custom projects

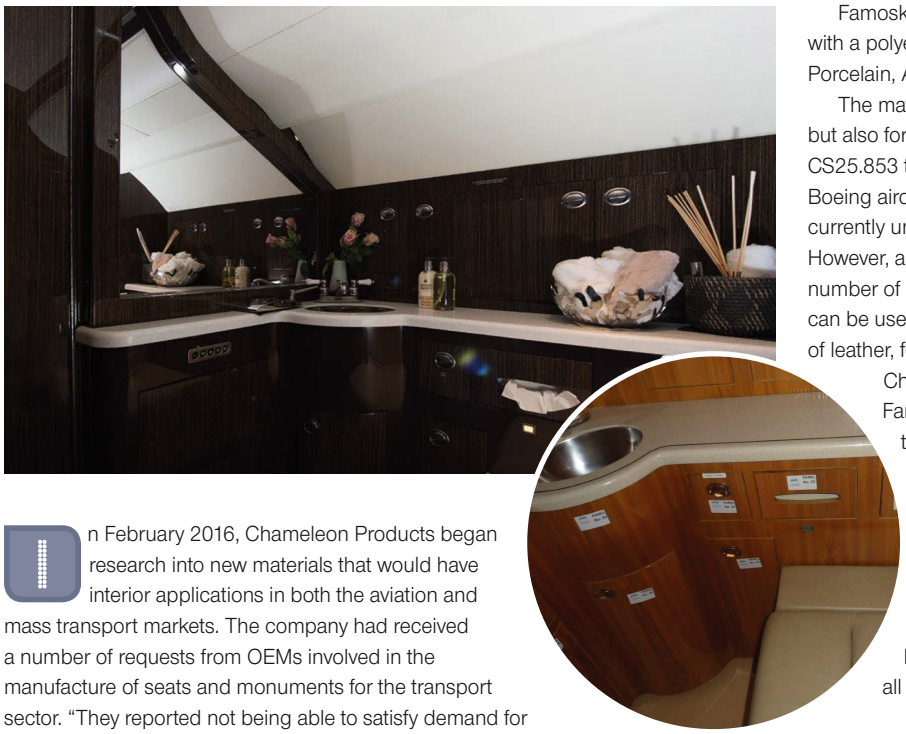
Other country-specific standards include NF F 16-101 in France, DIN 5510 part 2 in Germany and NFPA 130 in North America. The European standard, EN 45545-2, harmonizes various flammability requirements from different European countries and the International Union of Railways.

Achieving the highest safety and flammability standards is central to the development of fabrics at Camira, a textile supplier based in the UK. To comply with international rail standards, different types of flame-retardant treatments and back coatings can be applied. The company says that by using alternative construction capabilities, fabrics can be developed to meet specific technical requirements while maintaining the desired aesthetics.

Working with customers, Camira's in-house design and technical team create custom-made fabrics to meet the necessary standard. The company's successes include the woven pile moquette featured on Auckland Transport in New Zealand, wire-woven moquette used on the London Underground (including the new Elizabeth line train) in the UK, flat-woven fabric for SNCB Belgian Railways and leather for Virgin Trains' East Coast first class carriages in the UK. Other customers include Paris Metro, Swiss Rail, Czech Rail, Israeli Rail, Queensland Rail, Korean Rail and Moscow AeroExpress.

On a roll

A new material from Chameleon Products is designed to offer a soft and comfortable feel in waste-reducing roll form



In February 2016, Chameleon Products began research into new materials that would have interior applications in both the aviation and mass transport markets. The company had received a number of requests from OEMs involved in the manufacture of seats and monuments for the transport sector. "They reported not being able to satisfy demand for products with a more tactile and comfortable feel, requested by their customer base and interior designers," says Trevor Whetter, managing director at Chameleon.

This apparent need propelled Chameleon to research, develop and produce a number of solutions that would not only address this criteria, but would also be cost-efficient and meet the various specifications and certification criteria in the transport market.

Following several months of research and development, a new material was identified, tested and launched as Famoskin. The material had to be a premium product that was extremely soft and supple, while also being hard-wearing and easy to use. "It also had to offer cost advantages over leather," says Whetter. "Leather is generally priced in square meters, but because it is supplied in hides, the purchaser never really knows what the total cost is going to be. They may have to order more than expected because of the irregular shape and size of hides, and because natural marks and scratches will make some areas unusable."

Famoskin is supplied in a 144cm-wide roll. It can be cut to length with scissors, and shapes can also be laser-cut. "This means virtually all of the material can be used, potentially saving money," comments Whetter.

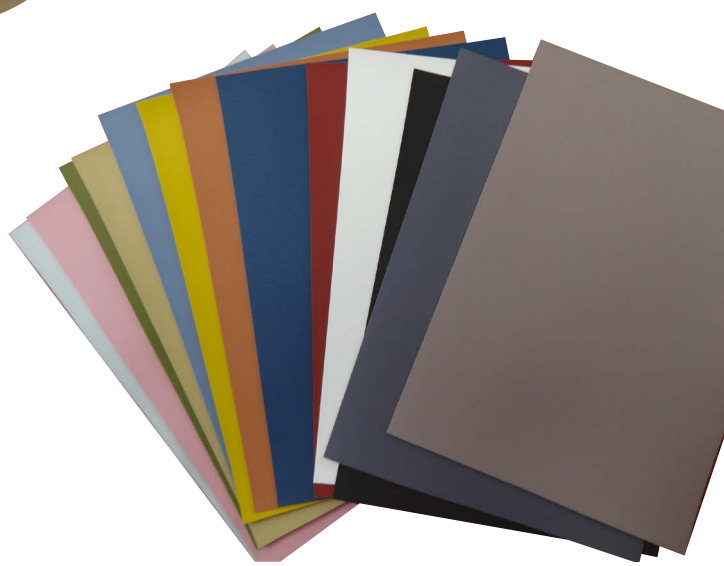
Famoskin is a man-made product combining an elastomer with a polyester jersey backing. It is supplied in 13 colors including Porcelain, Aqualite, Pink Ice, Olive Green and Brick.

The material needed to pass many tests, not only for strength but also for flammability. Chameleon reports it has so far passed CS25.853 tests for vertical burn, smoke and toxicity for Airbus and Boeing aircraft, and the marine IMO MSC 307.88 standard. It is currently undergoing rail testing in accordance with EN 45545-2. However, as different tests are required for various applications, a number of generic tests will be carried out. Whetter says Famoskin can be used on any product that requires a top finish, or in the place of leather, for example seats, monuments, galleys and bulkheads.

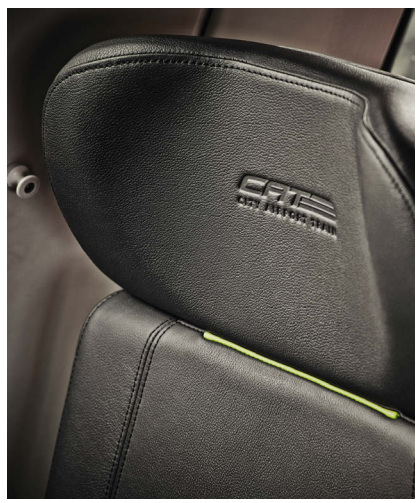
Chameleon has also developed an extension of the Famoskin product by laminating it to a variety of foams and technical materials. The resulting product, Famokush, has passed railway standard BS476 and BS6853.1999 annex B2 when applied to graphite foam. It has also been successfully tested for the aviation sector and is expected to make its aviation debut shortly. Famokush is available in 4mm-thick and 8mm-thick versions, and Whetter says it is particularly useful for head strike areas because it has a "soft and springy" feel. It is available in all the colors currently available for Famoskin.

ABOVE: The bathroom on a Bombardier Challenger before (inset) and after (main) the panels were refurbished using Chameleon's decorative film process

RIGHT: Famoskin is available in 13 colors



LEFT AND BELOW: Boxmark created customized leather seat covers for the City Airport Train in Vienna, Austria



Practical magic

Rail leathers from Boxmark are designed to offer weight and durability advantages

At Boxmark, interior fittings are currently being developed and mass-produced for several railway operators. The company's rail product portfolio includes upholstery leather and ready-made seat covers for train and station seats, as well as leather wrapping for components, wall panels and built-in parts. The company says its railway leathers meet flame-resistant standards throughout the world, and are suitable for use in all types of railway carriages, including trains, subways and trams.

"Railcar interior fittings have to be particularly hard-wearing and comfortable," says Marjan Trobis, managing director of Boxmark Slovenia. "Our products meet these needs while also conforming to international standards and adding a particular charm."

One of the company's most popular products for trains and stations is Xtreme, a leather designed for maximum durability. "This material has certificates that prove excellent resistance to mold, bacteria, disinfectants, dirt, oil, alcohol and water (including chlorinated and salt water)," says Trobis. "It is highly resistant to stretching, tearing, breaking (even at sub-zero temperatures) and abrasions. It is also flame retardant."

Trobis adds that rather than having a surface layer of protection, Xtreme's protective properties are inherent throughout. The leather has been awarded the Certificate of Material Excellence from Material ConneXion.

Another popular product is Xlight, which was designed for a reduced weight (±600g/m^2 when laminated) without a reduced thickness. "This special material reduces the total weight of each train, resulting in fuel and power savings and consequently lower pollutant emissions," says Trobis.

Xlight is available with the Xtreme treatment. "The benefits of Xtreme and Xlight include longer intervals between refurbishment; optimum comfort and cleanliness; and fuel, energy and cost savings," says Trobis.

Boxmark also offers a comprehensive customization service for prototypes and serial products. "Today's interiors not only have to fulfill functional but also design-oriented demands," says Trobis. Leather can be perforated, embossed, embroidered, printed on, laser engraved and provided with contrasting or decorative stitching.

For these custom projects, the company uses the same materials it supplies for the automotive industry. "We use the finest leather and other upholstery materials, as well as the best cotton for embroidery," says Trobis. "The final products meet all international industry standards, so customers receive the best quality."

Brand designs

As well as expanding its SL7 composite leather range to offer rail, coach and bus operators the possibility of consistent branding, E-Leather is growing its presence around the world

Introduced in 2015, E-Leather's SL7 is a composition leather product that consistently meets EN 45545-2:2013 HL3 for rail seat upholstery. Now E-Leather has invested in the development of an increased palette of colors for the range that meets coach and bus requirements. The move is intended to enable multimodal operators to present a consistent brand across a diverse fleet of vehicles.

E-Leather prides itself in its approach to compliance, reporting that most large operators have substantial and strict specifications. The company says that designers and seat manufacturers can be confident in the support they will receive from E-Leather. The company is adding to its team of experts at its headquarters in Peterborough, UK, has increased its local presence across Europe in 2016, and is continuing to expand worldwide.

One recent customer, Indian Railways, turned to E-Leather when looking to modernize a luxury tourist train that includes a stop at the Taj Mahal. The operator wanted to upgrade the train to offer a modern, durable and hygienic environment for passengers. Working closely with Indian Railways's Rail Coach Factory in India to meet all technical requirements, E-Leather supplied a vibrant selection of materials within a tight timescale.

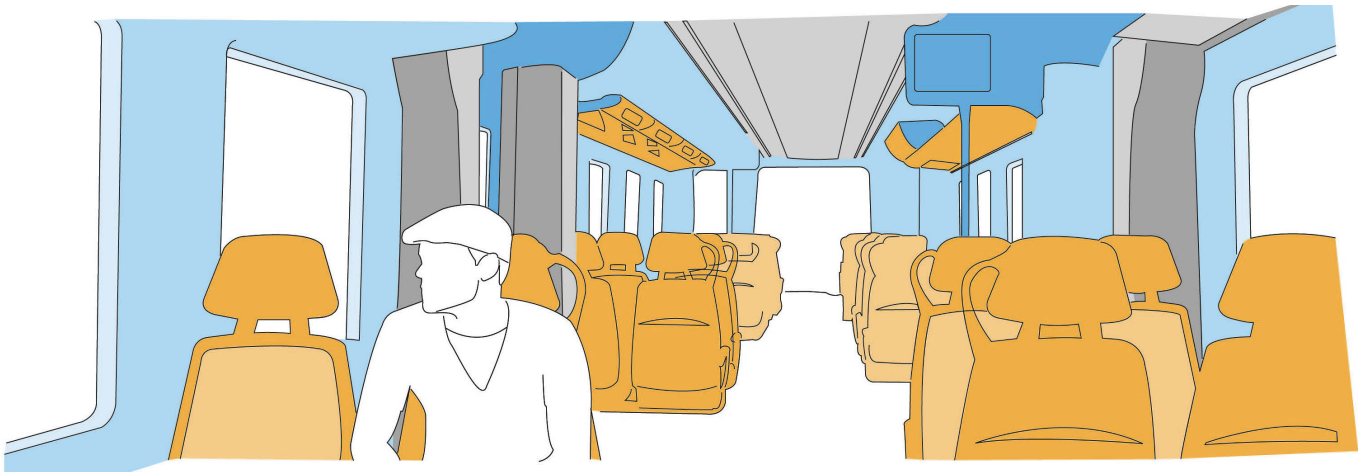
E-Leather has also generated repeat custom. "Operators have been benefiting from the reduced maintenance costs associated with our products for several years, leading to further adoption throughout their fleets," comments Alexandra Bennett, global business manager at E-Leather.

One example is De Lijn Oost-Vlaanderen, a bus and tram operator in Belgium. "The implementation of full E-Leather upholstered seats in our refurbished trams has upgraded the passenger experience while reducing maintenance costs," says Patrick Debeuf, head of materials at De Lijn Oost-Vlaanderen.

The company's other recent successes include being awarded Daimler-approved supplier status. E-Leather was also nominated by Daimler for its supplier innovation award, in a category recognizing the development of materials that excel in weight reduction, durability and ease-of-maintenance.

"E-Leather recognizes the importance of providing a cost-effective and compliant platform that enables designers to challenge the present status quo in railway interior design," says Bennett. "Influenced by the automotive and aviation industries, the rail industry is working hard to make the rail commute a more pleasurable experience."

ABOVE: E-Leather offers numerous options for customization



Material difference

A quiet transformation is taking place in the industry's supply chain, says Sekisui Polymer Innovations

Photo: Brookville Equipment Corporation

ABOVE RIGHT: The Liberty streetcar in Dallas, Texas, features interior panels made with Kydex thermoplastics

As a material supplier for railway interiors, Sekisui Polymer Innovations (Sekisui SPI) collaborates with professionals throughout the industry, from transit authorities and consultants, to railcar builders and interior integrators, to thermoformers and part assemblers. Over the past few years, the company has seen the role of material supplier transform. "As technology changes and regulations become more stringent, material suppliers must go far beyond just taking the order; they must have a broad and in-depth understanding of the industries they serve and the materials used in them," says Rich Cort, business manager at Sekisui SPI.

The company reports increased demand for high-performance materials that meet regulations while delivering a fine degree of finish and color, requiring manufacturers to have special technologies, innovative R&D solutions and exceptional technical support. "The expectations of our customers are simply higher," says Cort. "They have changed as passengers' expectations of the transportation experience have become more refined."

Cort says passengers are more likely now to expect a customized look and finish, resulting in increased demand for thermoplastic materials. "Thermoplastics enable designers to work with thinner gauges, resulting in lighter-weight parts, while allowing for a more detailed, cohesive design," says Cort.

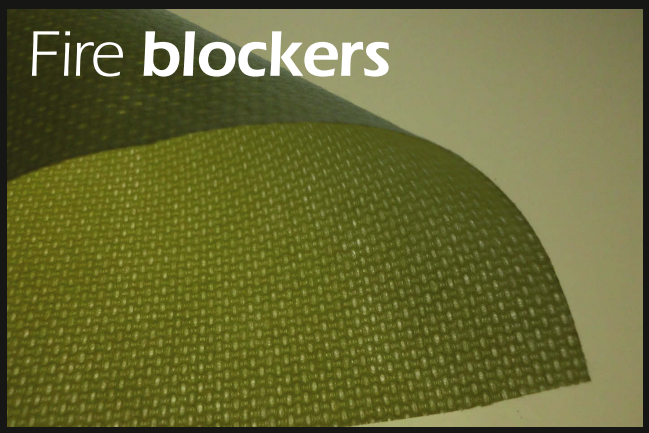
Thermoplastics are made of polymers that are formed into 3D shapes with heat and pressure to make the sheet conform to the shape of a mold or die. When parts made from thermoplastics are replaced or redesigned, they can be recycled directly into the production stream. "Some of the advantages over traditional materials such as fiber glass include integral color, no secondary finishing operations and durability," says Cort.

Coordinating many interior components from different sources into an integrated design can be a difficult task. "Furthermore, the sophistication of a design can suffer if small parts that are important to the aesthetics are abandoned when a high minimum order makes them costly to manufacture," says Cort. "Sourcing materials from one supplier provides more consistent color, texture and gloss. Add low minimum quantities to the mix and the possibilities expand even more. Imagine materials used as side and ceiling panels complete with a seamless, color-coordinated profile molding: all part of a decorative concept reflecting a transit authority's brand."

Providing great technical support is also a priority. At Sekisui SPI this has evolved from a troubleshooting resource for customers to a vital part of product development. "Our team members are engineers and thermoplastics professionals with decades of experience within our company and the industries we serve," says Dennis Kelso, technical services manager at Sekisui SPI. "A single expert is assigned to an industry and is charged with anticipating market needs and collaborating with R&D and customers in product and application development."

In 2014, SPI opened FSTLab, where suppliers, engineers, processors and end users collaborate with the company's R&D, technician and design teams on new fire-resistant technologies and materials. "When suppliers work together, synergy happens, resulting in harmonious design, production efficiencies and increased uptake of high-performance materials," says Cort.

Fire **blockers**



The custom-engineered spun-laced and needle-punched materials offered by Norafin are suitable for use as fire blockers in a range of markets, including public transport. Norafin says these technical non-woven materials' fire blocking and fire retarding capabilities accord with EN 45545-2, FAR/CS25.853a, ABD 0031-F and BSS 7239 standards, and the materials also comply with railway standards regarding the emission of smoke and toxic gases.

The materials range in weight between 70-450g/m^2. They are designed to meet the market's requirements for superior durability (offering resistance to abrasions and Velcro), softness, density and drape characteristics. The range includes material concepts formulated to resist damage from vandalism, for example punctures, and multilayer solutions incorporating scrim. "Norafin answers the market's requirements with a huge variety of fiber blends, a broad weight range and innovative applied technologies," says Francois-Xavier Delatte, business development manager for the company.

DESIGNERS' TOOLBOX

Products and services designed to meet real needs in the rail industry

Elastomer **compounds**

Kraibon elastomer compounds from Gummiwerk Kraiburg can be used to supplement fiber-reinforced composites. "Kraibon is a outstanding choice as it can compensate for the disadvantages of these materials, especially with respect to acoustics, impact and splintering protection," says Rolf Schollmeyer, Gummiwerk Kraiburg's project manager for composite applications in the aircraft and railway industries.

Used in hybrid composite materials, Kraibon acts as a binding agent between the two materials. "It compensates for the differing expansion of metal and carbon in a component, and also maintains excellent adhesion to both materials," explains Schollmeyer. "Another advantage is the insulating property between the two materials, which prevents corrosion."

For use inside rail cars, a special type of Kraibon was developed that fulfills the requirements of EN 45545 R1 HL3. Kraibon is offered as a non-cross-linked foil in thicknesses starting at 0.5mm and is cross-linked together with the matrix resin.

Electric **actuators**

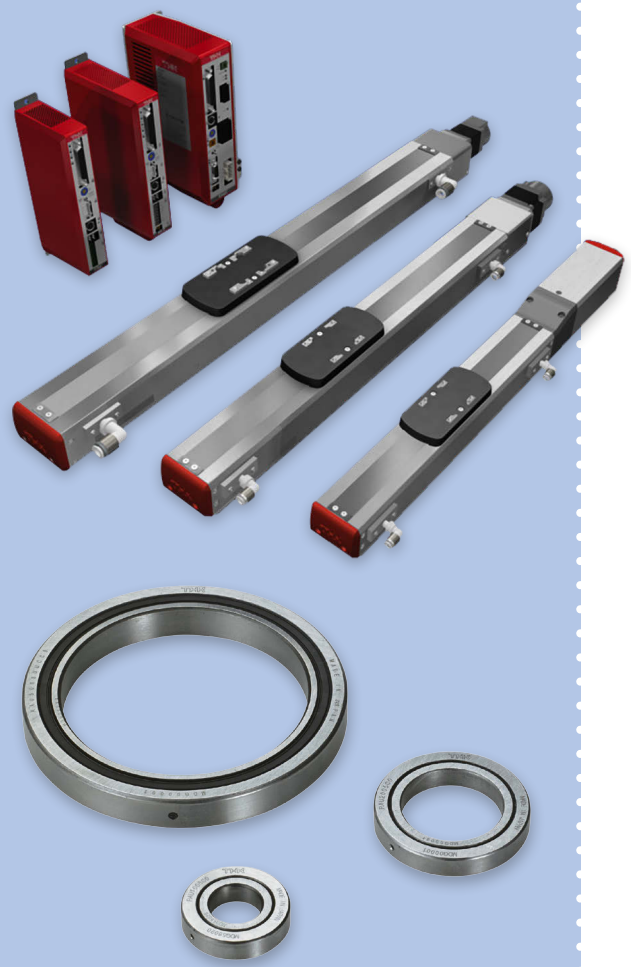
Three new electric-driven actuators have recently been introduced by THK: the compact KRF series, the compact KSF series and the clean CKRF series. Electric actuators from THK are used in train car interiors, as well as in manufacturing processes.

The compact KRF series integrates an outer rail with a U-shaped cross-section for rigidity. The strip seals on the top face and the side covers provide a fully enclosed structure designed to prevent damage from penetration by foreign matter. The strip seals are adhered by magnets on the top face of the rail. Movement in several axes can be enabled easily. The KRF range includes four cross-section sizes (42 x 35mm, 45 x 52mm, 55 x 59mm and 66 x 60mm) with stroke lengths from 50-800mm.

The compact KSF series is built on the base structure of the KRF series, but equipped with a ball screw that has a larger diameter and pitch lead. This enables KSF to be driven with a more powerful motor, providing greater dynamics (a top speed of 1,500mm/s and acceleration up to 2*g*) and longer strokes. Alternatively, KSF can be applied in a smaller and lighter size than KSF while working at the same motor power as KRF. The standardized QZ grease-up system is designed to ensure a long service life and long-term maintenance-free operation. Two cross-section sizes (46 x 45.4mm and 64 x 66.4mm) and two maximum stroke lengths (900mm and 1,300mm) are available for KSF.

The clean CKRF series (pictured top right) is also built on the KRF base design, and was created for use in ISO14644-1 Class 4 clean rooms. It has a fully sealed structure and integrated suctioning adapters. Three cross-sections are available (45 x 52mm, 55 x 59mm and 66 x 60mm), with stroke lengths from 50-800 mm.

THK also recently launched a new cross roller ring, RAU (pictured bottom right), which it says is characterized by its small dimensions and high rigidity. With its 10mm inner diameter, 21mm outer diameter and a weight of 9g, RAU1005 is THK's smallest bearing of this kind. Its load capacity is 1.12kN (dynamic) and 0.809kN (static). The company says rigidity and stable torque are achieved because the inner and outer rings form a single part. The series is available with an inner diameter between 10mm and 100mm as standard products. The product was originally developed for robot joints and miniature electric actuators.



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Deco *dining*

COLOR AND PATTERN

The blue and gold color scheme in 3674 reflects the train's iconic livery, while the upholstery features a pattern inspired by marquetry used on the train.

In March 2016, a new bar car was unveiled for the Venice Simplon-Orient-Express. The 3674 bar car is one of 17 carriages on the train, which has a 1920s/1930s art deco style design. The train can accommodate 185 passengers in single or twin cabins, and there are three dining cars, two bars and two galleys. Prices start from £2,210 (US$2,975) per person sharing a double cabin, and include all meals served on board.

The Venice Simplon-Orient-Express began service in 1982. The 3674 bar car was launched for the beginning of the 2016 season following a refurbishment during the train's off-season, from November 2015 to March 2016.

Operator Belmond says many passengers are on board to celebrate a milestone event in their lives and are looking for a once-in-a-lifetime experience, hence the food is of Michelin standard. The 3674 bar car and the Champagne Bar are the social hub of the train, where passengers can enjoy a pre-dinner drink and in 3674, live piano music.

FOOD AND SERVICE

Staff are trained to manage staggered dinner sitting times, depending on the number of guests traveling at any one time. A new caviar menu has been developed for the 2016 season in collaboration with Petrossian. It includes shots of Alverta Royal caviar, caviar cubes and sandwiches using papierusse, a fine sheet of pressed caviar. There is also a new cocktail menu devised by Walter Nisi, head barman.

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