Mat4Rail a Project of the S2R JU Newsletter 02 | December 2018

The driver's desk of the future will be modular and flexible!

Mat4Rail proposes a user-centred concept development as an innovative solution

Traditionally, a train driver's working place consists of a broad dashboard with screens, gages, several controls and switches and foot pedals. From this position, the driver operates and controls the train. Due to the digitisation and automation in the field of rail mobility, the classic set-up of the driver's desk will undergo enormous changes, offering new options for the train driver and passengers alike.

In order to meet the requirements for the driver e.g. ergonomics, comfort, functionality, usability, concentration, safety..., Spirit Design conducted interviews and observations on several train types with connoisseurs of the rail industry (Human-Machine-Interface (HMI) expert and train driver and operators of the Austrian federal railways), to fully understand the driving processes and associated activities in the cockpit while operating a train.

This was followed by an extensive research phase where developments in comparable mobility industries as well as future technological trends were analysed. Based on the user-centred interview and observation results, combined with the research, a multidisciplinary ideation session was held between Spirit Design and INDAT to develop innovative ideas on how to meet present and future demands. As a result, the ideas were combined and visualised to promising concepts by Spirit Design. The resulting concepts were subjected to a thorough technological analysis. In addition, feedback from the project partners was obtained to select concepts and to refine them in further steps. Consequently, two concepts (Driver/Passenger Cabin and Compact Storable Cabin) have been favoured.

The first concept "Driver/Passenger Cabin" is designed as a premium class room with two premium seats. The seats are mounted on floor rails which allow multiple positions (in drive direction, head to head, standing, seating and sleeping). They can either be used as a driver's seat and a jump seat for training purposes, or as premium passenger seats with great views. The ecological and economic value added by this concept is that existing premium seats - manufactured in higher quantities - can be used as a basis for the driver's seat and adapted to new needs in a modular way. It is a sustainable way of reducing resources at the stages of sourcing and production.

The second concept "Storable cabin" keeps the driver's desk and the driver's seat as simple and flexible as possible. All the Human-Machine-Interfaces and panels are mounted on the seat or on a highly flexible sideboard. The entire cabin can be stowed in a hinged compartment if required, leaving the room without any remaining component during the semi-autonomous stages. When the train will become totally autonomous, the compartment can be removed completely. As a result, a free space is created, which can be used in different scenarios ranging from conferences to leisure, gym, merchandising...

After the final decision on the concept is made, a virtual prototype will be developed collaboratively by Mat4Rail participants INDAT and Spirit Design.

Figure 1 Concept 1: Driver/Passenger Cabin Premium

Figure 2 Concept 2: Storable Cabin

Further opportunities in railway structures through innovations in materials and processes

Application to innovative door leaves

Nowadays, the materials used in the serial production of train door leaves and sub-systems are mainly metals like standard steel or aluminium grades. These doors are usually made using a sandwich structure, with assembly of other components and sub-systems by standard joining procedures (fastening, welding...).

At the same time the effort of using composite or multi material solutions for structural applications in different industries has increased lately offering exceptional performance and light weight compared to traditional metallic materials. Nevertheless, in this aspect the railway sector is still underdeveloped in comparison to the automotive or aerospace industries, which widely use composite materials as structural parts that increase the efficiency of the crafts by significantly reducing their weight without compromising their mechanical performances. The limitations for usage in general production for railway structures are well-known by the major companies. However, work is in progress at these companies to mitigate these limitations.

Mat4Rail will pursue an innovative approach based on the search for optimised multi-material solutions through the utilisation of different robust design and analysis methods integrated in a systematic innovation strategy.

Concerning the technologies, the project partners will take advantage of the latest developments in new materials (resins, foams/cores, composites, new metallic alloys etc.), manufacturing processes (out-of-autoclave, one-shot processes) and joining/integration techniques (adhesives, welding processes, mechanical fasteners etc.) taking into account the production costs, the manufacturing aspects and the railway constraints applicable specifically to the door systems. To this end,

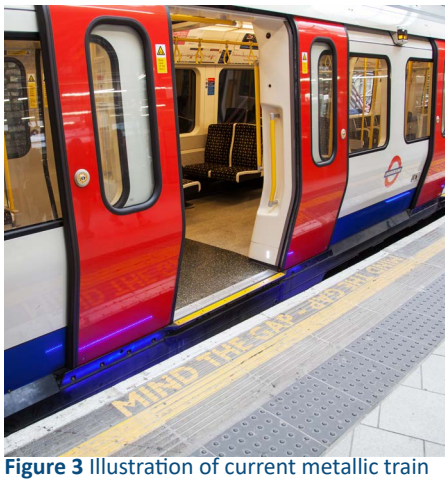

Figure 3 Illustration of current metallic train door leaves

Mat4Rail brings together partners from the composite (Coexpair) and aluminium (ASAŞ) processing technologies, as well as specialised research partners (ITAINNOVA and University of Bremen). For example, regarding advances in metallic alloys, ASAS contributes with new aluminium alloys (EN AW 6005 and 6082) that not only present ease of fabrication, good weldability and corrosion resistance, but also with higher mechanical strength than commonly used 6060. As a result light and thin section train material/doors can be designed and produced permitting profile's wallthickness with less than 1 mm, allowing novel configurations.

Additionally, since Coexpair is a supplier of most advanced solutions for production of composite parts in the aeronautics sector, their experience is also expected to help develop new door concepts and compare them to the current designs.

The benchmark shows that previous R&D projects successfully demonstrated the capabilities to design and to manufacture lightweight doors that can meet technical and safety requirements, including fire, smoke and toxicity regulations. But major companies still have to mitigate other limitations such as lowering costs for economic viability. This economical limitation is taken into account by partners and efforts are focused on developing low-cost novelties based on multi-material and hybrid solutions.

Composite processes present some concrete advantages. Among others, only one-shot injection of the full door part is needed instead of several operations (as cutting of metal sheet and section, surface preparation, assembly by adhesive bonding or using rivets and fasteners, intermediate controls etc.) lowering in this way the cost / performance.

Based on Coexpair's previous experience in the IMS&CPS project (EU-funded FP7 project, including an economic analysis of a composite wagon composite panel), it is known that a low-cost target can be achieved for a composite railway structure with a repeatable Resin Transfer Moulding (RTM) process.

The improvement of manufacturing processes will also be evaluated as a means to reach the target cost. This will include an automation evaluation of the different steps of the manufacturing of composite parts.

Over time the innovative door development will contribute to sustainable transportation by allowing a reduced energy usage through lightweight approaches for transport. This will allow future transport to consume less energy than is currently the case. Through increasing capacity using new lightweight materials, transport systems will carrying more passengers or freight with greater efficiency.

Figure 4 Airbus A320 frontward door manufactured (one-shot injection) by Coexpair

Material-independent design loads for car-bodies

A new algorithm for the generation of synthetic operational load sequences

From the beginning of railway transportation until today, most components of railway vehicles were made of steel and aluminium. For this reason, design and construction is focused on metallic material. An evident example is the development of the design loads for car-bodies of railway vehicles.

Figure 5 Bad rail causes high loads on vehicles

These design loads for trains were derived from old load assumptions made for steel bridges in the 1930s. They have been complemented by expected accelerations during the operation of the vehicles over the last centuries and are the state of the art still today. As it is, railway vehicles are designed as moving steel bridges.

The actual design load cases are confirmed by many years of experience with the production and operation of railway vehicles. The structural parts of these vehicles were made of metallic material and with a common basic design. The experience of the last decades has shown that these old design loads are not sufficient for new constructions, e.g. low-floor trams. The old design loads are also not sufficient for new construction material such as composite material and non-metallic joints.

Mat4Rail is carrying out research work to fill this prospective gap in the definition of design loads for car-bodies of railway vehicles. The research in development of better load assumptions for railway vehicles is the work of the project partners IMA Dresden, RISE and University of Bremen.

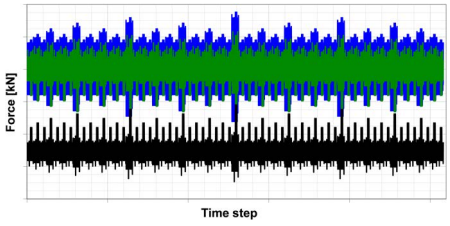

Figure 6 Synthetic operational load sequence

The newly developed load assumptions are based on the accepted normative design load cases. These load cases will be mixed to a representative sequence of synthetic operational loads. In the first step, the number of load cycles during the expected lifetime will be assigned to the design load cases. In the second step, the load cases will be ordered with respect to their percentage. Finally, the amplitudes of the load cases will be scaled by a linear exponential distribution. The result is a sequence of synthetic operational loads.

This synthetic load sequence shall be similar to real operational loads. Therefore, the algorithm for the generation of synthetic operational loads was validated by a comparison with measured operational loads for car-bodies of trams and shall also be validated for car-bodies of other types of railway vehicles, such as regional trains and high-speed trains. Therefore, comprehensive existing measurement data is being analysed by IMA Dresden too.

The similarity between synthetic operational load sequences and real operational loads allows the material-independent strength design of railway car-bodies. The fitness for purpose of this method will also be evaluated during the Mat4Rail project by fatigue strength tests under variable amplitude on a component with bonded joints.

The new algorithm for the generation of synthetic operation loads is an important step for an accepted certification method of components made of new materials such as composites or bonded joints in car-bodies of railway vehicles. IMA Dresden will also raise this topic in the European standardisation group for the applicable European norm EN 12663.

Figure 7 Measurement tram Dresden

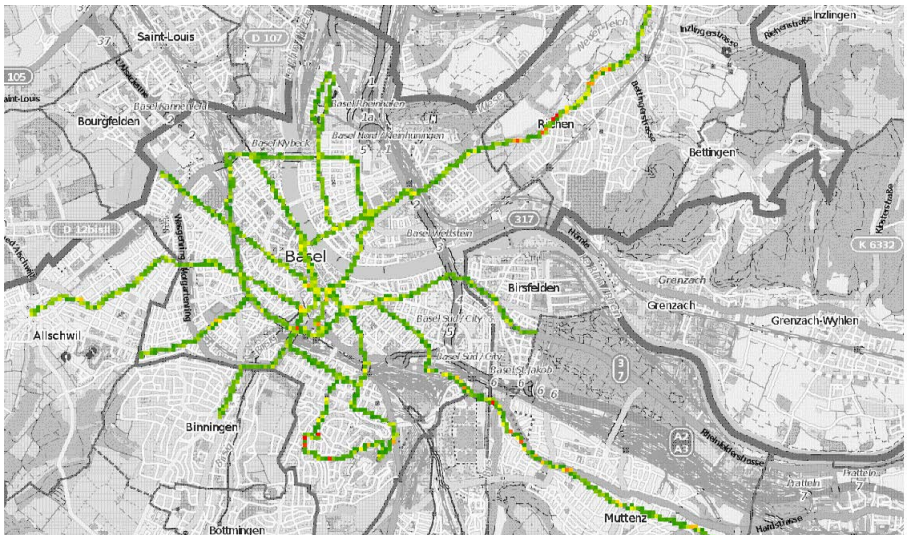

Figure 8 Damage-plot in track-network

Mat4Rail on Tour

Project partners contribute to relevant meetings and events

The Mat4Rail consortium consists of 16 partners bringing together extensive expertise in engineering and materials research, testing and characterisation of materials and mechanical properties as well as experts in industrial and product design and EU funded projects. Our consortium contributes to a number of events and meetings relevant to the railway industry in order to present and promote the key findings from the Mat4Rail project. An overview of the events at which Mat4Rail has been presented can be found below.

Figure 10 Mat4Rail Consortium during the 3rd General Assembly

InnoTrans 2018 – The Future of Mobility

From 18th – 21st September 2018 Innotrans, one of the largest and most influential exhibitions within the rail industry and transport technology, opened its doors in Berlin. The exhibition was sub-divided into the five trade fair segments Railway Technology, Railway Infrastructure, Public Transport, Interiors and Tunnel Construction, InnoTrans occupied all 41 halls available at Berlin Exhibition Grounds.

Within these halls, Shift2Rail together with its members showcased more than 20 cutting-edge solutions for a groundbreaking transformation of railway systems. Mat4Rail is happy to have been able to contribute to Shift2Rail's quick-wins in form of a short video and overall to new innovations and concepts in the rail way sector thanks to the support and funding received from Shift2Rail.

Figure 9 Screenshot of Mat4Rail's Quick-Win video for Shift2Rail

Mat4Rail partners also took part at InnoTrans 2018. The Mat4Rail design partners SPIRIT and NVGTR held a designer's meeting together with the complementary Shift2Rail project, PIVOT. Further, the two Mat4Rail partners IMA Dresden and GRAMMER were on site as exhibitors.

Mat4Rail 3rd General Assembly

From the 26th -27th September 2018, the Mat4Rail consortium travelled to Borås, in Sweden, where our partner RISE is situated, to hold the 3rd General Assembly meeting of the Mat4Rail project.

Over the course of the two day meeting the WP leaders presented their results to date and their plans for the upcoming year. The work streams for materials and for interior design also held smaller meeting to discus their advancements in their fields which supports the outcomes and effectiveness of the project as a whole. The consortium also had the opportunity to have a guided tour through RISE to receive an understanding of their work and activities outside of the Mat4Rail project. The Mat4Rail Ecoexecutive Board also held a face-to-face meeting to discuss overall project progress and potential risks of this ambitious research and innovation action.

Shift2Rail IP1 Steering Committee meetings

The Shift2Rail Joint Undertaking (S2R JU) supports multiple projects structured into five asset-specific Innovation Programmes (IPs) to cover all the different structural (technical) and functional (process) subsystems of the rail system. Mat4Rail is funded under IP1 Cost-efficient and reliable trains, including high-capacity trains and high-speed trains together with eight ongoing projects. To assess the progress of these projects each IP organises online meetings between the project Coordinators and the IP's Steering Committee. Each Coordinator presents their project's technical achievements and any main deviations from the Description of Action (DoA) as well as dissemination measures. Our Coordinator, Elena Jubete from CIDETEC, has been representing Mat4Rail in the three IP1 Steering Committee meetings since the start of the project on 16th January, 27th June and 9th October 2018.

SusChem 2018

Mat4Rail was also present at the SusChem brokerage event held in Brussels on the 23rd of October 2018, where Mat4Rail Coordinator, Dr. Elena Jubete, from CIDETEC Surface Engineering, participated along with 180 attendees, and delivered the fact sheet and shared the main challenges of the project during the networking sessions. SusChem is the European Technology Platform for sustainable chemistry. It is a forum that brings together industry, academia, governmental policy groups and the wider society. It addresses challenges that are specific to Research and Innovation in the European chemical industry in connection with the societal challenges of Horizon 2020.

Mat4Rail-PIVOT Plug and Play Meeting

On the 27th of November Mat4Rail coordinator Elena Jubete from CIDETEC and WP6 leader Christian Jurke from NVIGTR met PIVOT WP7 leader Robert Dumortier from SNCF and core partners from Aaernnova (Xabier Valor, Javier Arrabal and Sergio Maximiano) in a joint workshop in order to work further on Plug and Play strategic requirement planning and on the various design solutions. As a result, general settings have been elaborated and design refinements concluded. Also, a more jointly work relation has been

decided and a plan for action has been decided on the collaboration between the partners in these two projects. Next steps and further results will be available in the first quarter of 2019.

PIVOT Midterm event

On 18th October 2018, the Midterm event of the PIVOT project, Performance Improvement for Vehicles On Track, was held at the Maison des Associations Internationales in Brussels. This event was organised by PIVOT in intense collaboration with the complementary projects (open calls) Mat4Rail, Run2Rail and Fair stations, to disseminate their results to date. All these projects are funded by the European platform Shift2Rail, within Horizon 2020.

About 50 attendees from the rail sector participated in this event, including representatives from train manufacturers, service providers, railway platforms and technological developers.

The event was structured in five main presentations, one per technological demonstrator (TD) of Shift2Rail, where joint presentations were made between PIVOT and each of the corresponding open calls, as well as five explanatory posters of each technological demonstrator. In particular, the Mat4Rail project coordinated by CIDETEC, collaborated in the presentation of the results in three talks and three posters, for the three technological demonstrators TD 1.3 - The new generation of car body shells, TD 1.6 - Innovative doors (WP6) and TD 1.7 - Train modularity in use.

Figure 11 Participants from Mat4Rail and PIVOT collaborating within T.D 1.3, from left to right: Emmanuel Detaille (Coexpair), Elena Jubete (CIDETEC), Per Blomqvist (RISE), Eduardo de la Guerra (Talgo), Alaitz Rekondo (CIDETEC) and Markus Brede (Fraunhofer IFAM).

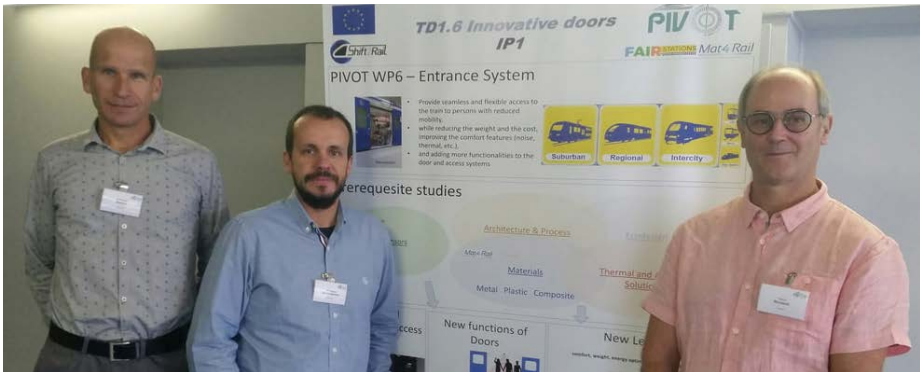

Figure 12 Participants from Mat4Rail and PIVOT collaborating within T.D 1.6, from left to right: Emmanuel Detaille (Coexpair), Jose Manuel Bielsa (ITA), Thierry Montainé (Wabtec).

Figure 13 Participants from Mat4Rail and PIVOT collaborating within T.D 1.7, from left to right: Robert Dumortier (SNCF), Georg Wagner (Spirit Design), Christian Jurke (NVGTR) and Javier Arrabal (Aernnova).

Mat4Rail
a Project of the S2R JU

Designing the railway of the future

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- Instituto Technológico de Aragón, ES
- CENTEXBEL, BE
- RISE Research Institutes of Sweden AB, SE
- AIMPLAS Asociación de Investigación de Materials Plásticos y Conexas, ES
- IMA Materialforschung und Anwendungstechnik GmbH, DE
- Huntsman Advanced Materials GmbH, CH
- Coexpair SA, BE
- ASAŞ Alüminyum Sanayi ve Ticaret A.Ş., TR
- NVGTR Gbr, DE
- Spirit Design – Innovation and Brand GmbH, AT
- ESCATEC Switzerland AG, CH
- Grammer Railway Interior GmbH, DE
- INDAT GmbH, AT
- accelopment AG, CH

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