T Division

Digitalisation and technology – two sides of the same coin

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There is nothing new or unusual about a technology division at Deutsche Bahn. What is new, however, is the combination of digitalisation and technology – a combination that is crucial in the search for answers to the most pressing questions concerning the future.

The railway was once a driving force behind societal transformation – the "startup" of the first industrial revolution, as it were. Some 180 years later, we are now in the middle of the fourth industrial revolution, which – with the help of sensor and communication technology – will be driven largely by artificial intelligence (AI).

There is a good chance that the railway will once again play a leading role in a networked Mobility 4.0 landscape. The railway is the most energy-efficient and environmentally friendly means of transport available and the cornerstone around which many new mobility forms and services are already aligning – in many cases, used by the same passengers. This generates huge potential for us at Deutsche Bahn.

We want to develop integrated, intelligent mobility solutions that make our customers' lives easier by making it easier for them to organise their day-to-day travel. To do this, we need to act. And we need to act quickly. We need to address questions concerning our technological and digitalisation expertise in the DB Group as well as the role of the T Division (Digitalisation and Technology Division). We need to combine the unique expertise we have gained from 180 years of railway experience with the new technologies. We are more than just a mobility provider and logistics specialist: we are also a technology company that needs to be in complete control of its technology. To put it another way: we do not have to build or own trains, but we should be able to. The same applies to autonomous buses, networked heavy goods vehicles and customer platforms.

Few markets are as dynamic as the mobility market. We need to be able to develop new skills in areas such as artificial intelligence, robotics and data science. Technological and digital innovations are ten a penny. We must be able to assess these innovations with regard to their relevance for our business, develop the appropriate skills and come up with new products and business models.

The T Division will do more than simply bring together and develop the necessary functional competency. It will also establish the network that allows all areas of the company to reap the benefits of technological advances. The road to technological leadership in the mobility sector leads through innovation networks both within and outside the DB Group. Internal networks must be interdisciplinary, technically sound and agile and must extend throughout the whole company. External networks will involve partners from the worlds of business and science. This expertise will form the basis of viable applications that will ultimately create new customer experiences. This is the only way to make our core business – the railway – more attractive in the long term while also developing new business processes and services.

In recent years, digitalisation at DB has continued to pick up pace. Projects have been launched, new units have been established and innovative solutions have been brought to the track and road. The examples are numerous, and include Germany's first self-driving public bus, the world's first practical application of lorry platoons, and the use of multicopter flights to inspect railway tracks, bridges and station buildings, as well as the growing use of sensor technology at switches and crossings, on escalators and in lifts as a basis for predictive maintenance. In addition, new "condition based maintenance" models and artificial neuronal networks for railway energy management are reinforcing operational procedures. Neuronal networks replicate – in highly simplified form – the complex

A better view from above: vegetation management using a drone

Photo credit: DB AG/Finkbeiner

Photo credit: DB AG/MAN/Jan Hoza

Deutsche Bahn brings innovations to the street, such as the world's first lorry platoon on the A9

structures of biological neural systems. They allow us to emulate functions of the human brain using algorithms and acquire knowledge by analysing large data volumes.

Digital development is proceeding at incredible speed across the board. Many developments, such as AI and robotics, still feel like the stuff of science fiction. However, we need to be clear that these technologies are neither exalted nor fanciful – they are already being used to tackle pressing tasks in our core business. New technologies play a pivotal role when it comes to tackling the roots of punctuality problems and quality deficits. They also have a key role in increasing capacity, putting more traffic on the tracks and facilitating new mobility services that meaningfully complement existing railway services.

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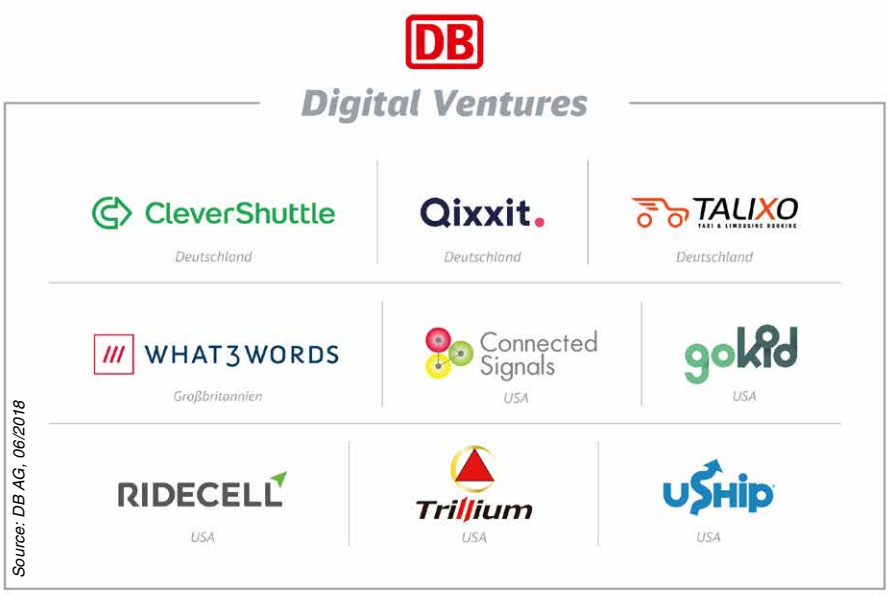
Key areas in digitalisation: data harmonisation

Data is the raw material of the digital age. And indeed, data harbours significant potential. In the case of Deutsche Bahn, it can help us to improve processes and thereby achieve greater quality in our core business. It can also help us to develop new services for our customers all along the travel chain. For historical reasons, data at the DB Group is stored at different locations and collected using different criteria. Even some of our current customer information systems receive data from different sources, with the result that passengers often receive contradictory information. This shows how urgently we need a uniform database.

But this is not just a technical issue. It is also a cultural issue. Because we are no longer able to structure the growing data volumes manually, it is vital that all operational data is transparent and usable in all divisions. Only when taken as a whole, our data is a tremendous wealth from which we all can benefit – above all, our customers.

Trains with brains: AI in the railway industry

Artificial intelligence is already helping us to solve everyday problems at Deutsche Bahn. Imagine a situation where a tree falls on to the track during a gale. Why not have the track report that there is something lying on it that should not be there (with the help of weight sensor technology, for example)? And why not have the track or tree alert the control room or approaching trains directly? And AI can be used to do even more than simply distribute information. It can also trigger specific processes and actions. In this example, it could activate the gradual braking mechanism in an approaching train even before the obstruction is visible from the train. AI could also be used to ensure that a chainsaw operator turns up to clear away the fallen tree.



Source: DB AG, 06/2018

Key technologies for tomorrow's mobility and logistics sector: Deutsche Bahn gets involved with promising startups through Deutsche Bahn Digital Ventures GmbH

In future, trains will communicate digitally with other trains and with signal boxes and switches. Everybody will know where everybody else is. Although we are not quite there yet, we are working hard to make this future vision a reality, e.g. with our "Digital Rail for Germany" programme. This will bring us to a completely new level of system transparency. At this point, scheduled maintenance will be replaced – initially by predictive maintenance and eventually by need-based maintenance.

Room to innovate

By now, almost every business unit in the Group is coming up with innovations. The T Division is home to the central digitalisation workshops, in which solutions are developed for all divisions. We have really given our employees the space and freedom they need to innovate. An example of this is Skydeck, the think tank of our internal IT service provider DB Systel. In the Skydeck, everything revolves around innovative IT solutions for our core business – the railway.

Employees who want to try their hand at introducing other mobility forms apart from trains and stations or developing disruptive business models can bring their visions to life in our new intrapreneurship programme. The first team to successfully complete the programme was "weColli". weColli developed a platform for logistics companies that provides emission-free delivery of goods over the last mile using cargo bicycles.

We are just as interested in inspiration and innovations that originate outside the DB Group. DB mindbox in Berlin is the central location for promoting startups with a focus on rail operations. Through Deutsche Bahn Digital Ventures GmbH, we also get involved with promising startups whose solutions could potentially become key technologies for the mobility and logistics market in five to ten years' time.

Blockchain: the next big thing

Blockchain is one of the most promising technologies of the future. Its triumphant advance began with its role as the technology behind cryptocurrencies such as Bitcoin. However, it could conceivably be used in many other industries. At Deutsche Bahn, we are already working on a range of potential applications. One of the specific projects being run by the blockchain team at DB Systel focuses on the allocation of revenue in regional transport.

More and more people are using local public transportation in Germany. At the same time, there has been a corresponding increase in the number of transport providers. Besides bus and rail operators, these also include car sharing companies, bicycle rental systems and ridesharing services. Passengers want to be able to use public transport as easily as possible, without having to worry about boundaries between transport systems, service providers or fares. Even today, the process of allocating revenues to the correct service provider is already very complicated. Seamless travel chains incorporating increasing numbers of service providers will also make it more difficult to allocate revenues clearly.

As a potential solution to this, we have developed a new blockchain-based platform together with IBM. The application facilitates helps ensure faster and better integration and allocation between different mobility service providers by providing transparent information at all times regarding how many tickets are sold, when, and by whom. We are holding early discussions with public transport partners about testing the prototype in practice.

We are also working on other projects related to trains and infrastructure. With the help of blockchain technology, we could map the entire lifecycle of individual

Photo credit: DB AG

Switching a DB Cargo diesel shunting locomotive BR 294 over to a diesel/battery hybrid drive at the Cottbus depot – installation of the hybrid block

objects (such as switches, rails and trains) and all their components transparently, even when they leave Deutsche Bahn's area of control, e.g. for reprocessing in partner depots. This would ensure that all manufacturing, operational and maintenance details were available at all times. By combining blockchain with other technologies such as sensor technology, artificial intelligence or big data, we could, for example, predict possible wear or damage at a much earlier stage than is possible today. This would lead to shorter repair times and improve safety.

The switch to alternative drive systems

Rail transport is the most environmentally friendly mode of transport available. Deutsche Bahn intends to consolidate its environmental advantage even further by setting a new climate target for 2030: to cut specific CO_2 emissions from global transport operations by half compared to 2006. This would be a very significant step on the way to becoming a climate-neutral Group, which Deutsche Bahn plans to be by 2050. The Group intends to achieve this by modernising its existing fleet and by developing and implementing alternative drive systems.

By using alternative drive technologies, we want to dramatically reduce the CO_2 and NOx emissions currently produced by diesel transport. We are also focusing on reducing noise pollution and saving energy. Today, 90% of all rail transport services in Germany already use environmentally friendly electric traction. As always, the last 10% is the most difficult to achieve.

Deutsche Bahn currently has a fleet of around 2,400 diesel trains in Germany, around half of which are to remain in operation beyond 2025. It is precisely for these trains that the changeover to alternative drive systems is so important. Compared to conventional diesel operation, the changeover means having to consider a whole range of new prerequisites (e.g. operating mode, refuelling and infrastructure). Besides established hybrid approaches such as diesel/battery or overhead line/battery systems, other energy concepts such as hydrogen/fuel cells or synthetic fuels may also be used.

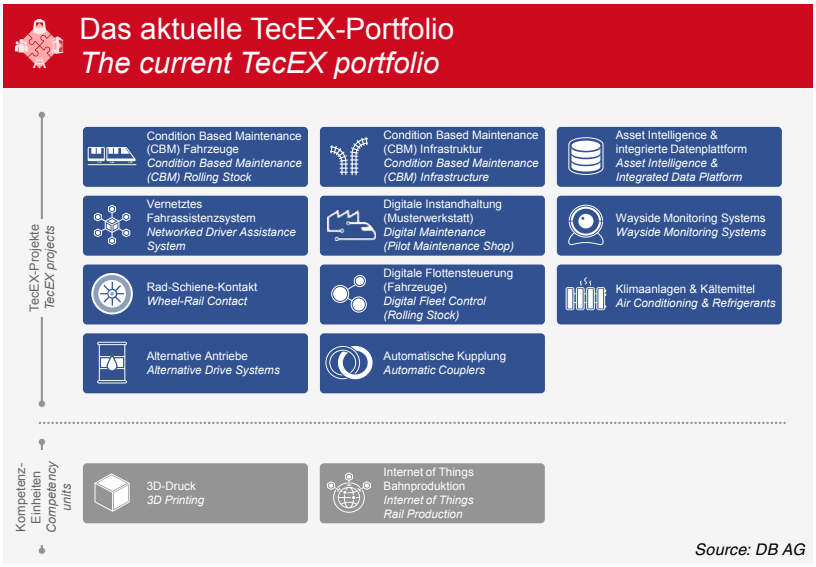
Due to a lack of technically mature industry solutions on the market – in particular solutions for converting existing vehicles – the DB Group is taking the first step toward achieving innovative, viable solutions itself.

It is also teaming up with Toshiba to develop a new diesel/battery hybrid switching locomotive. The DB EcoRailSimulator, an in-house IT development, simulates and validates drive designs and potential energy savings. This ensures that only efficient, high-performance hybrid locomotives are put into operation.

Condition-based maintenance: the maintenance of the future

To increase the efficiency of our rolling stock maintenance in the face of growing competition and to ensure more consistent quality, we urgently need to embrace new technologies such as the Internet of Things (IoT), Big Data and AI. Only with the help of digitalisation will we be able to make the leap from scheduled preventive maintenance to predictive maintenance and, ultimately, to need-based maintenance.

This provided the impetus for the Condition Based Maintenance (CBM) project, which aims to implement the potential identified. In the first phase of CBM, condition monitoring is used to provide continuous,



Portfolio of the TecEx Group programme

transparent information on the condition of vehicles. It considers two types of information: internal data (including operating data, data from regulations and diagnostic reporting) and external data (such as weather data and manufacturer specifications regarding threshold values for components).

In the second phase, the data is analysed with a view to exploiting component reserves more effectively and failure models are developed using machine learning. The information obtained is used to optimise rules, maintenance processes and maintenance activities, thereby increasing the availability of traction units. Higher vehicle availability means better quality and greater convenience for our customers. In addition, by limiting the number of scheduled and unscheduled component replacements, we can reduce our material and labour costs.

The following two examples illustrate this. Continuous monitoring of traction motor temperatures helps us to recognise anomalies at an early stage and minimise subsequent damage, which in turn leads to increased locomotive reliability. Condition monitoring and machine learning provide continuous, transparent information on the condition of vehicles. As soon as a threshold value is reached, a digital process generates a specific work order for the maintenance depot.

Joining forces for success: the TecEx Group programme

The TecEx Group programme can be seen as the catalyst for the technology strategy adopted by Deutsche Bahn at the start of the year. This strategy brings together the technological expertise in the Group and illustrates the impact of new technologies on the integrated rail system. Eleven core projects derived from the strategy were moved to the TecEx programme, including projects on the alternative drive systems and condition based maintenance already discussed.

TecEx was adopted jointly by the DB Group CTO (Chief Technology Officer) and the business units. The approach used differs significantly from the strategies used to date. The programme reflects the key technological interests of the business units, which have been thoroughly incorporated into the programme from the start and play an active role in designing it. This degree of involvement has not always been the case in the past. By using this approach, we have achieved widespread acceptance of the content and methods used to implement the TecEx programme within the DB Group. The CTO Board, which consists of the DB Group CTO and the CTOs of the business units, supports the programme.

Furthermore, we have focused very clearly on how the issues in question are to be operationalised and implemented specifically with the business units. The keyword here is “network excellence”, whereby the network refers not only to players within the DB Group, but also to national and European partners and – in another step – even further afield.

The TecEx portfolio reflects the dual role of the board division very accurately. On one side, there are the traditional technical aspects of the railway, focusing on topics related to engines and structures, while on the other side, there are the new digital technologies. We need to bring both together.

DB in 3D

3D printing is continuing to gain momentum in the DB Group. The start was marked by printing a simple coat hanger at the end of 2015. Nowadays, more than 4,500 parts and other products are

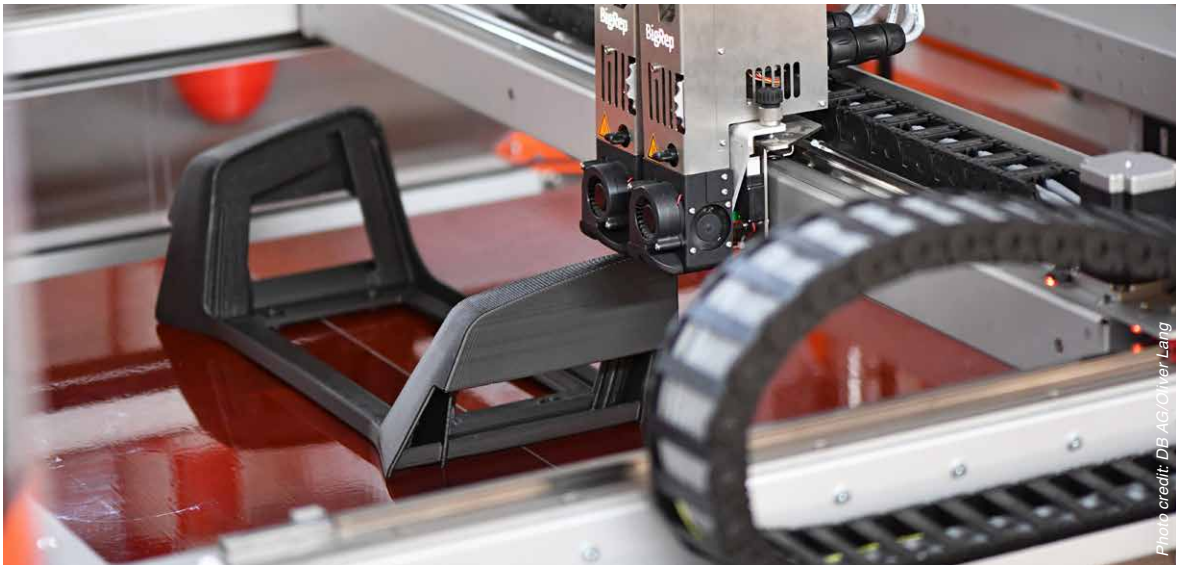


Photo credit: DB AG/Oliver Lang

3D printing: producing a headrest

printed using this technology. With 3D printing, the DB Group can produce replacement parts quickly, avoiding problems associated with long delivery times or parts that are simply not available any more. This allows trains to get back on the track quickly and reduces downtime. The range of applications for 3D printing is wide: anything from ventilation grilles to headrests or horizontal damper brackets.

> *Deutsche Bahn can become a figurehead for Germany as the home of technology*

By using additive manufacturing techniques in 3D printing, i.e. constructing spare parts layer by layer, we can also optimise spare parts in advance at points that are particularly prone to failure. This type of pre-emptive measure minimises the risk of failure and, in turn, increases train availability. While the first replacement parts were printed exclusively out of plastic, we now also use the powder printing technique to print metal components for use in high-speed trains, e.g. the terminal boxes used to protect sensitive cables in ICE engines.

In the medium term, 3D printing can transform entire value chains. It is no longer necessary to store large quantities of spare parts. Instead, parts can be produced on site as required, literally at the push of a button. This provides a tremendous degree of flexibility, since spare parts can be produced quickly and in tiny quantities and it is no longer necessary to maintain large amounts of warehouse space. By testing a range of new materials such as fatigue-resistant elastomers or flame-retardant plastics for use in railway options, we will continue to discover more potential applications for 3D-printed spare parts in the future.

Conclusion

The railway was once a symbol of technological progress and a trailblazer in terms of societal developments that were nothing short of revolutionary. With the invention of the steam engine and the railway, people who lived miles apart were suddenly neighbours and entire industries were made possible thanks to goods transport. Even now, in the era of artificial intelligence, the railway still offers added value that extends far beyond simply getting from A to B. With networked digitalisation and technical expertise and the specific technological competencies of the business units, the DB Group can and should claim technological leadership in the mobility sector. With this motivation and this goal, the DB Group stands an excellent chance of setting new standards in the fight against climate change, emissions and inner city congestion and of becoming a figurehead for Germany as the home of technology and digitalisation. ■

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