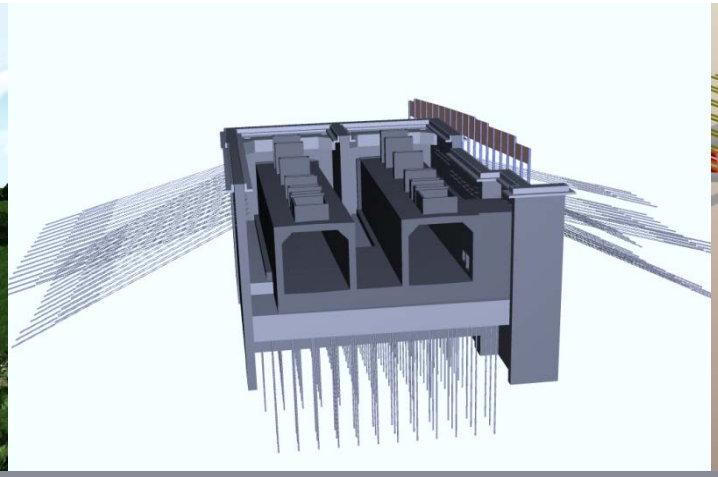
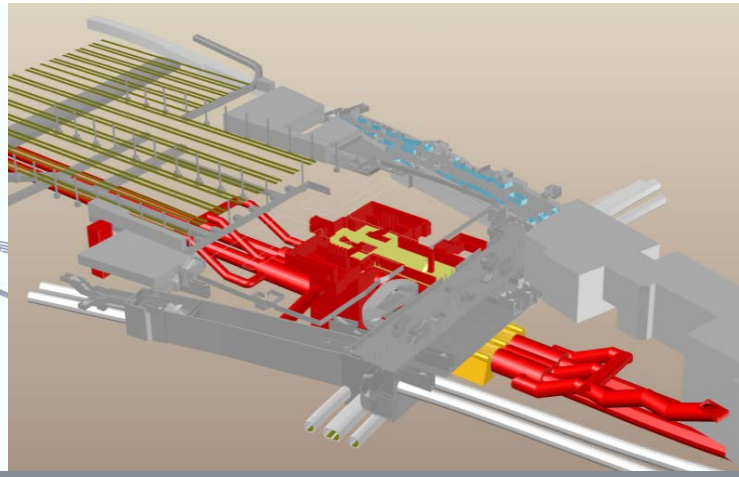




Building Information Modeling
Lake Constance 5D-Conference

DB Netz AG | Heinz Ehrbar | Major Projects Management | Konstanz | 25./26.10.2016

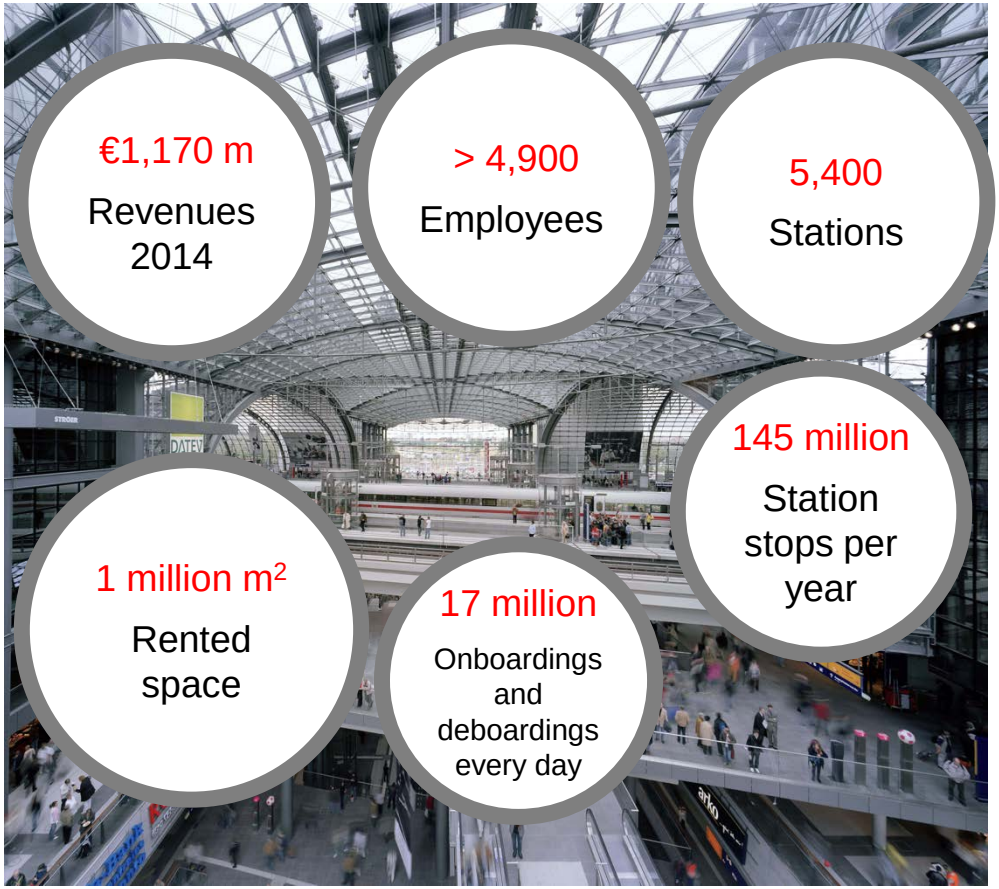
Deutsche Bahn operates and is expanding the rail infrastructure in Germany – a major challenge

DB Netze Track

We build and manage the rail infrastructure!

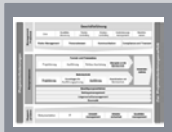
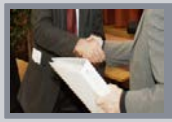
DB Station & Service

We build and manage the stations!



Successfully implementing large-scale projects means meeting many project requirements

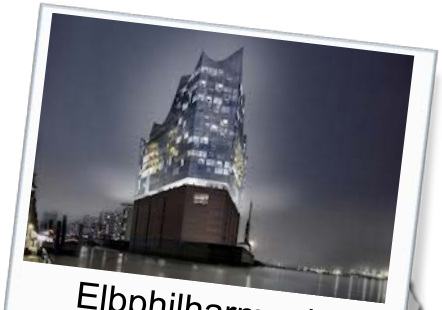
Successful project implementation

 **Quality Functionality**	Implementation of the project in compliance with: ■ The agreed quality/functionality ■ The agreed deadlines ■ The agreed cost budget
 Deadlines	
 **Costs/ financing**	
 Occupational safety	■ Ensuring the health of all project staff
 Environmental requirements	Protection of: ■ Flora and fauna, atmosphere, hydrosphere, lithosphere ■ Rights and property rights of third parties (vibration/noise control)
 Processes/ organisation	Ensuring: ■ Unambiguous and quick decision-making procedures ■ Unambiguous assignment of tasks and responsibilities
 Market	■ Finding the most suitable partners for order processing (planners, companies)
 Public opinion	■ Elaboration of majority-capable solutions with a high level of public acceptance

Various large-scale projects in Germany are experiencing problems with fulfilling the project requirements

The accumulation of cases has become a danger to the German construction industry

Rail project Stuttgart 21



Elbphilharmonie Concert Hall Hamburg

BER Airport Berlin/Brandenburg

Structural shortcomings?

End of 2012:

Creation of a Construction of **Major Projects Reform Commission** by Mr Ramsauer, the German Minister of Transport

Elaboration of **specific recommendations** for action in order to:

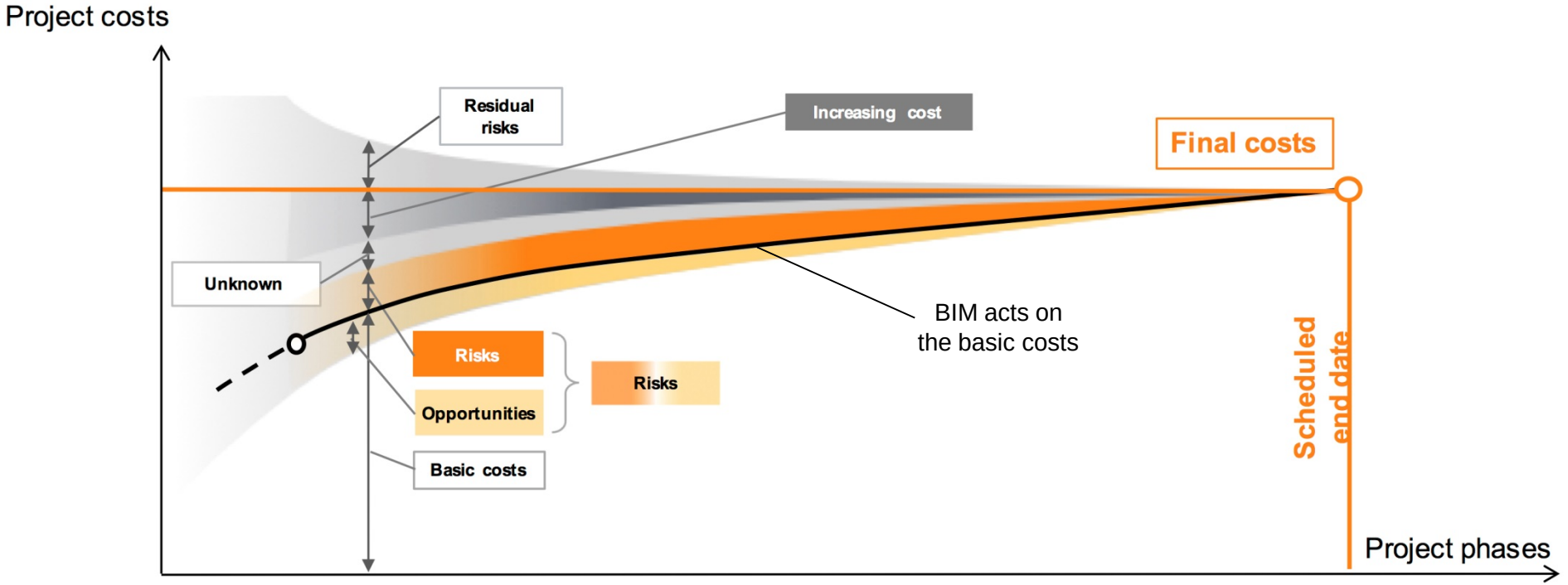
- Be able to deliver large-scale projects with the agreed quality, on time and within budget in future
- Avert damage to the reputation of Germany's economy

The Construction of Major Projects Reform Commission issued recommendations in 10 areas in 2015

Key recommendations of the Reform Commission

- Cooperative planning in teams
- Plan first, then build
- Binding economic feasibility analysis
- Clear-cut processes and responsibilities/competence centres
- Greater transparency and control
- Risk management and analysis of risks in the budget
- Awarding to the most economical, not the cheapest
- Collaborative cooperation on the project
- Resolution of disputes out of court
- **Use of digital media – Building Information Modeling**

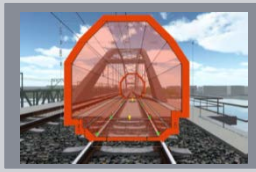
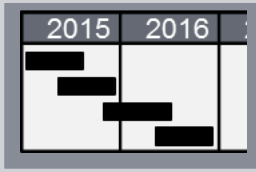
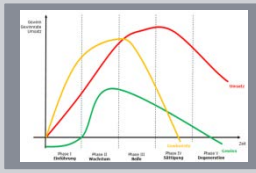
BIM acts on the basic costs and is a risk-reducing measure, but never a replacement for risk management



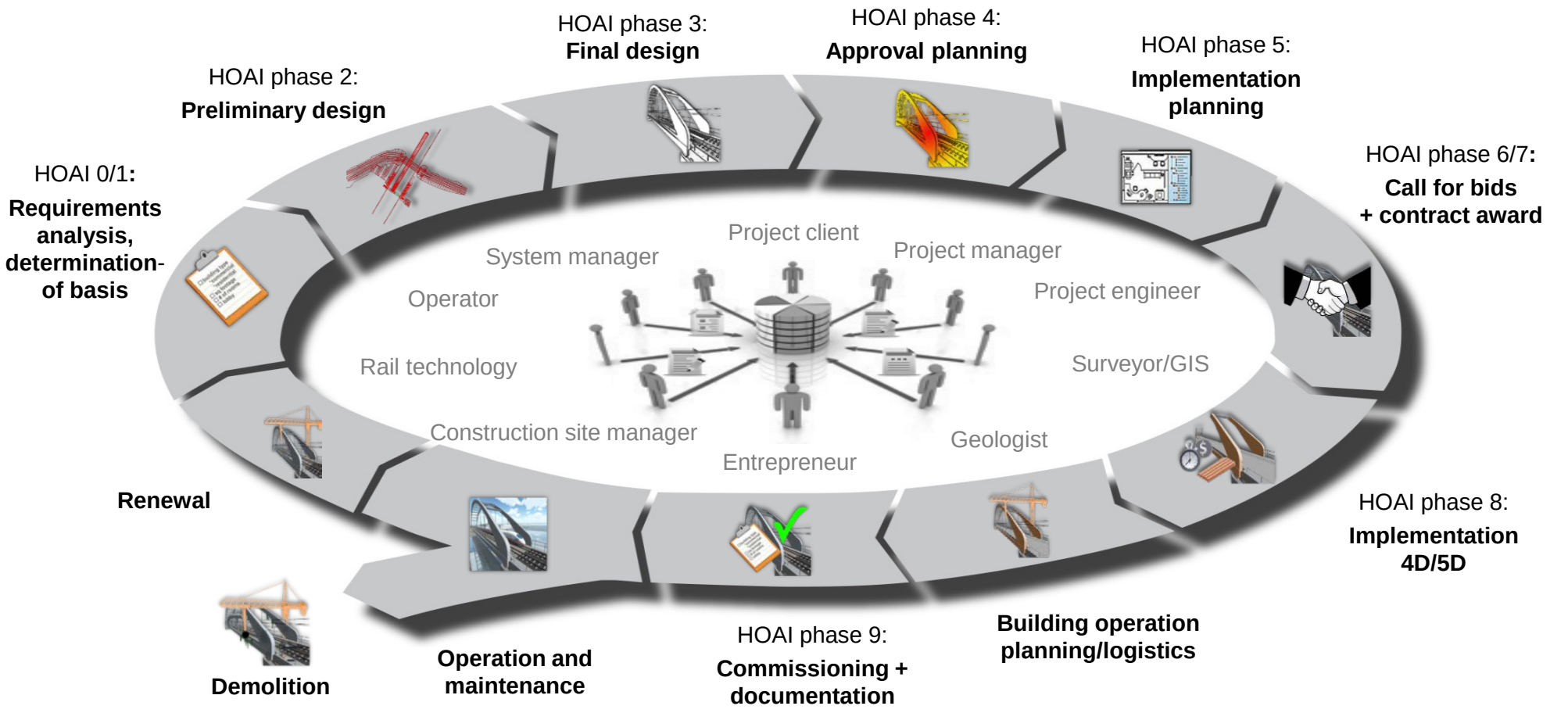
Project phase (HOAI)	Project preparation			Planning		Preparation of implementation		Implementation
	Service phase 0: Requirements planning	**HOAI phase 1:** Basic evaluation	**HOAI phase 2:** Preliminary design	**HOAI phase 3:** Final design	**HOAI phase 4:** Planning for building permit application	**HOAI phase 5:** Construction drawings	**HOAI phases 6+7:** Prep. of tender docs + contract award	**HOAI phase 8:** Construction site management
Cost phases as per DIN 276	Cost framework		Estimation of costs	Costing		Quotation		Cost finding
Project expertise	Not consolidated		Pre-consolidated in planning	Consolidated in planning		Consolidated in planning/contractually		

Nevertheless BIM makes a significant contribution towards achieving the project goals in a better way?

Advantages of BIM

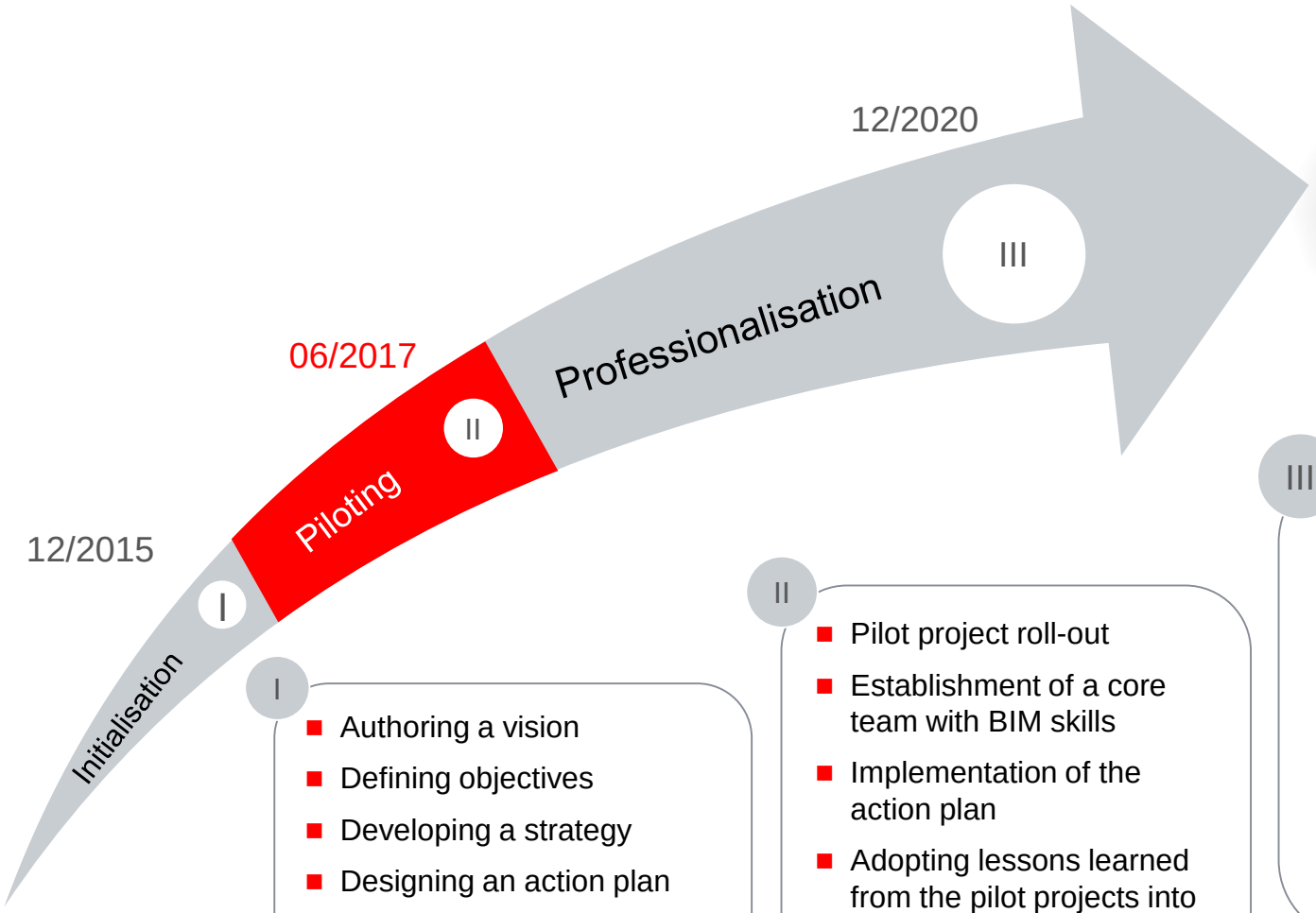
	Improved planning quality	■ Collision checks, i.e. automatically checking for contradictions between the maintenance groups ■ Variant and production analyses prior to start of construction
	Improved adherence to deadlines	■ Building sequence models in coordinated, integrated schedule models; including early inclusion of implementation expertise ■ Minimising "forgotten services" in schedules
	Greater cost assurance/efficiency improvements	■ More precise, complete quantity/cost data already available in the early planning phases ■ Transparent updating of coordinated cost models
	Improved acceptance of major infrastructure projects	■ Visualisation of complex overall coherencies of a structure ■ High-quality consideration of variants in large numbers
	Better life cycle observations	■ Early energy and CO2 balance-sheet analysis and simulated operations prior to start of construction ■ Early handover of the digital construction documentation

Short digression: DB's understanding of BIM



BIM is model-based method for digital planning, implementation and management of construction projects throughout the entire operative life cycle = > **Virtual building first, then physical**

The DB strategy envisages the introduction of BIM in three phases by the end of 2020



By the end of 2020, all new standardisation-capable and complex projects will be planned with BIM

I

- Authoring a vision
- Defining objectives
- Developing a strategy
- Designing an action plan
- Establishing an initial pilot project

II

- Pilot project roll-out
- Establishment of a core team with BIM skills
- Implementation of the action plan
- Adopting lessons learned from the pilot projects into all fields of action

III

- Planning all new standardisation-capable and complex projects with BIM
- Transferring the lessons learned from all fields of action to regular operation
- Establishing a continuous improvement process for BIM

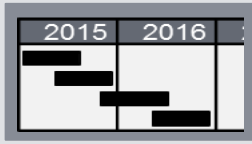
But BIM can only develop these benefits if the right boundary conditions are in place

Benefits

Improvement in the delivery of project objectives in terms of...

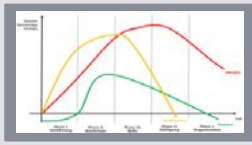
Planning quality

Acceptance of infrastructure projects



Deadline assurance/higher efficiency

Cost assurance



Life cycle considerations

Boundary conditions

creating boundary conditions for leveraging benefits through...

End-to-end BIM application

Definition of new forms of collaboration

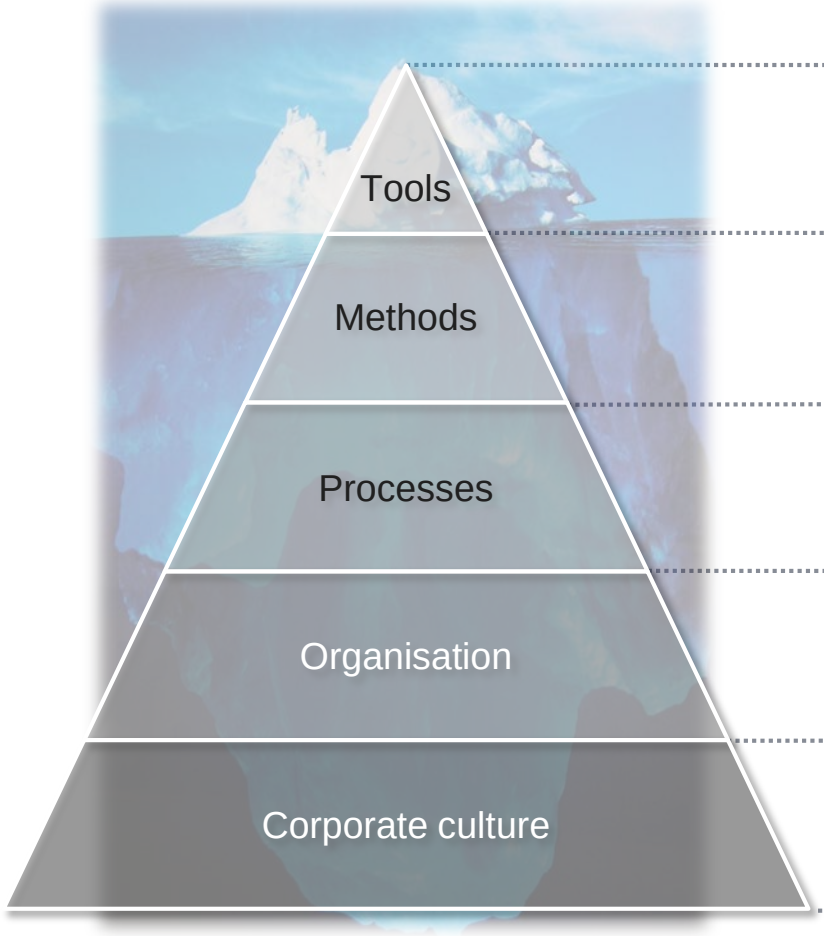
Coordination of processes – organisation – IT

Action continuity

Multiplier organisation

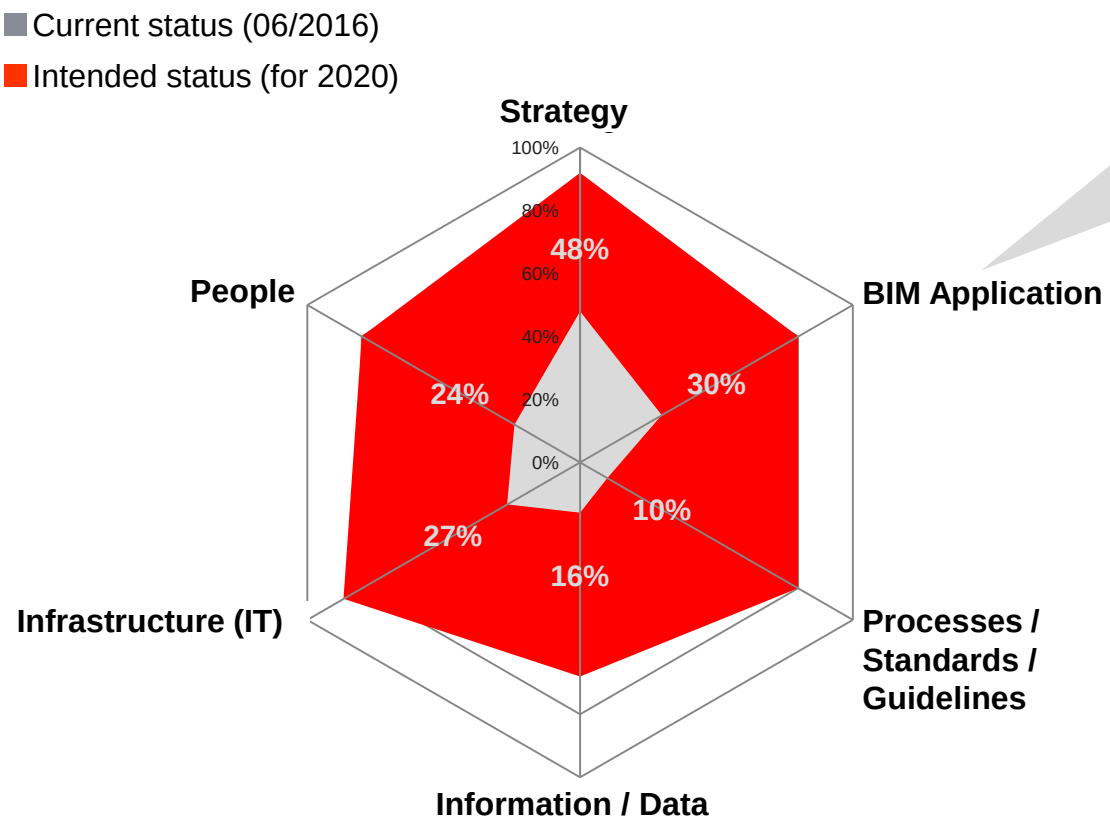
The areas for action primarily relate to "soft" factors; BIM is 20% technology, 80% approaches and processes

Effects of the BIM method



- The shared use of **IT tools** enables more efficient project planning workflows with lower error quotas
- Deployed **approaches are revolutionised**; parallel, team-orientated project processing
- **Processes need to be redefined** to reflect changing circumstances
- Modified processes have **an impact on the organisational structure**
- The prerequisite is working on a shared platform – **open information exchange culture**

The BIM ramp-up at DB Netz AG will be measured against maturity models[1)] for each action area



Example: "BIM application"

Current maturity level (30%)

- Application of BIM in pilot projects,
- Expandable data model for GIS and commercial structures in place

Intended maturity level (80%)

- Standardised use of BIM in the standard process with a limited exchange between the parties
- BIM data integrated pervasively into all software systems

1 Based on the Pennsylvania State University Computer Integrated Construction Research Group

The boundary conditions are created by taking measures in six areas for action

Area for action	Measures
 **Strategy**	■ **Vision, objectives** and **implementation steps** ■ **Partnerships** with **industry** and **universities**
 **BIM application**	■ **BIM use cases** in the **project** and **operations, first in pilot projects,** later generally
 **Processes/ guidelines**	■ **Processes** and **guidelines**, and **organisation** need **to be adapted** ■ **Legal boundary conditions** must be **specified**
 **Information/ data**	■ Object catalogues/attributes **manufacturer-independent interfaces** ■ **Defining the information requirements** of the **ordering party**
 **Infra-structure (IT)**	■ **Software** and **hardware** ■ **Jobs**
 **People**	■ **Basic and advanced training** and **recruiting** ■ **Change management**

Action

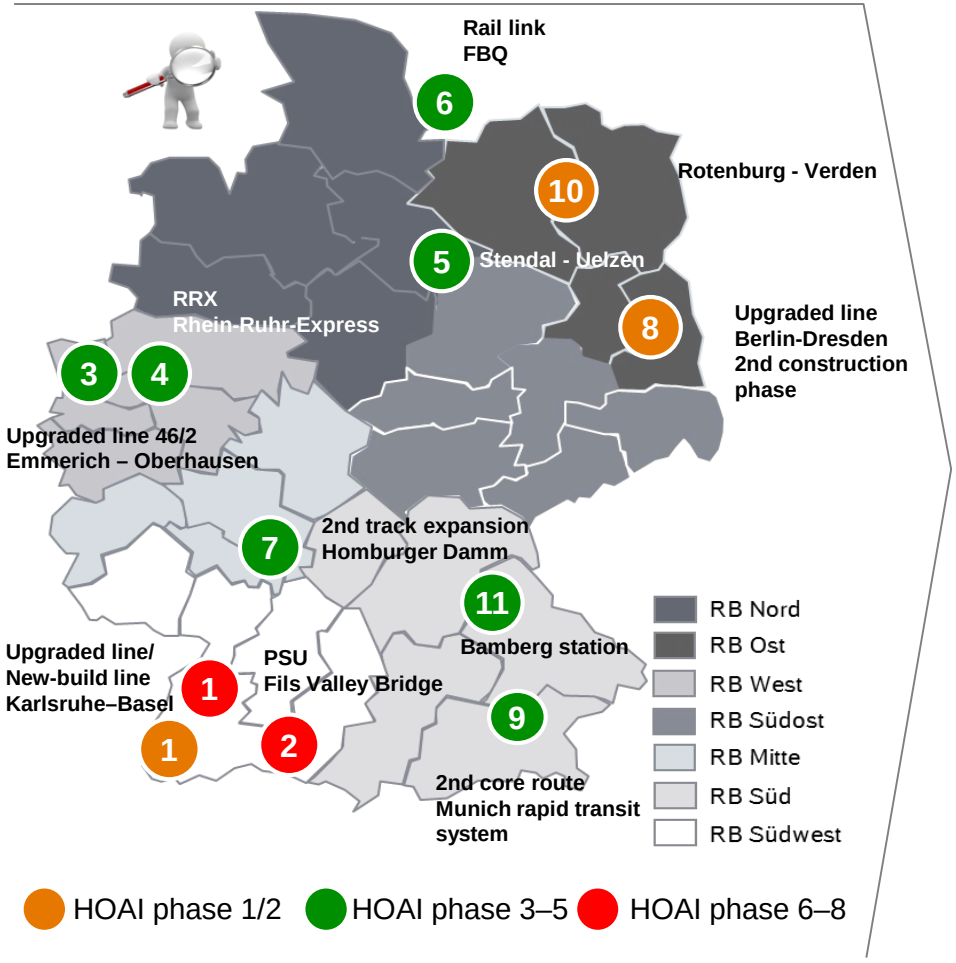
For each area of action, measurable criteria need to be defined.

The **ramp-up BIM** measured against a **maturity model**[1]

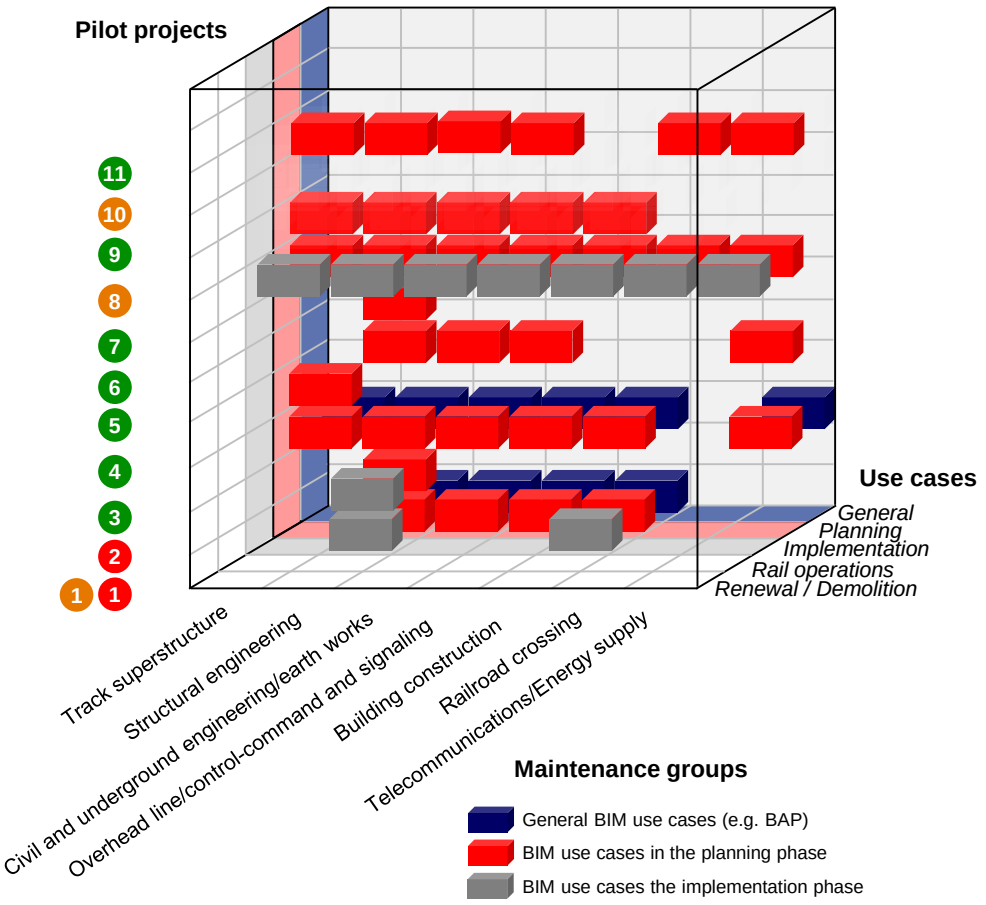
1 Based on the Pennsylvania State University Computer Integrated Construction Research Group

With a portfolio of 11 pilot projects, the intent is, wherever possible, to cover all technical areas and use cases at DB

Pilot projects



Piloted maintenance groups and use cases



"Learning by doing" requires close collaboration between head office and the regional pilot projects

Central services

Planning specifications

- BIM strategy
- BIM – **Customer information requirements**
- BIM – **Property types and property catalogue** (including operator requirements)
- BIM – scopes of services:
  - Surveying
  - Planning
  - Implementation
- BIM – **level of details** (LOD, LOI)
- BIM – qualification concept for contractors
- BIM – quality assurance concept
- BIM – general project implementation process
- BIM – sample organisation
- BIM – professions
- Legal boundary conditions (copyright, liability law)

Communication and training

- Picking up all stakeholders phase by phase
- BIM theme days
- Exchange of knowledge between pilot projects
- Employee-related training

To be provided by the pilot projects

Resources

- Appointing the BIM project team
- Naming BIM coordinators
- Providing a BIM-capable **working environment** (premises, hardware, software)

Deliverables

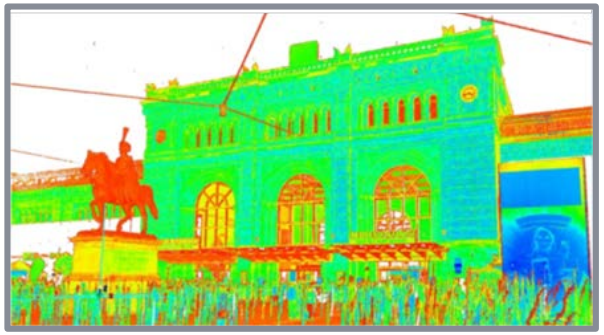
- Defining the scope of the BIM project (in terms of geometry, maintenance groups)
- BIM – **defining use cases**
- Defining and implementing a BIM project handling plan
- Commissioning planners and building contractors with BIM services
- Coordination with regional asset officer

Communication and training

- Monthly update of BIM report
- Participation in training and theme days incl., introducing their own topics
- Integration with platforms for an exchange of knowledge
- Employee-related training

HOAI phase 0/1, requirements analysis and basic evaluation: 3D inventory by means of digital methods (laser scan)

Objective: **3D inventory** with a view to **establishing comprehensive 3D maps of existing networks** and forming the basis for further projects



The input data from the 3D laser scan result in a 3D point cloud

Then the point cloud is imported into an editing program for:

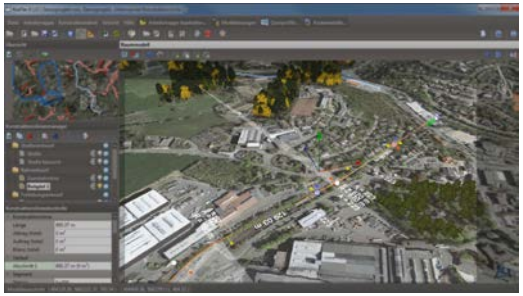
- Identification and geometric delimitation of the decisive construction and system components
- Object classification and storing relevant information

HOAI phase 2, preliminary design: Accelerated formulation of an agreement-capable variant decision with 4D models

Objective: to achieve an agreement-capable **variant decision** with the project stakeholders for downstream planning

- Being able to track train paths and perform other variant comparisons using specifically CAD systems

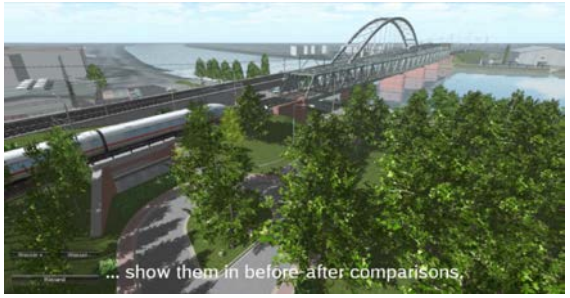
Creating new train paths in the spatial model



© A + S Consult GmbH KorFin

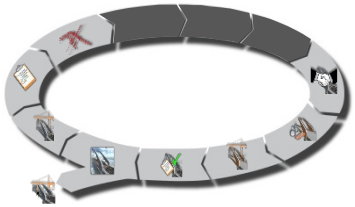
- Public participation through visualisations and models with the aim of improving acceptance

The new track route in Frankfurt Niederrad



© DB Systel WorldInsight

Final design (HOAI phase 3–5), draft, approval, construction drawings: Development of conflict-free 5D planning models appropriate to the current phase

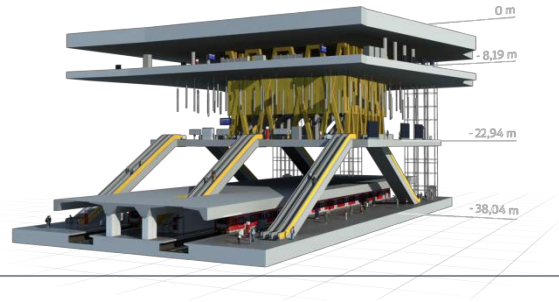


Objective: A **coordinated and conflict-free 5D planning model is required** for the call for bids

Model-orientated 3D planning

2nd Munich rapid transport system core route extension between Laim and Leuchtenbergring

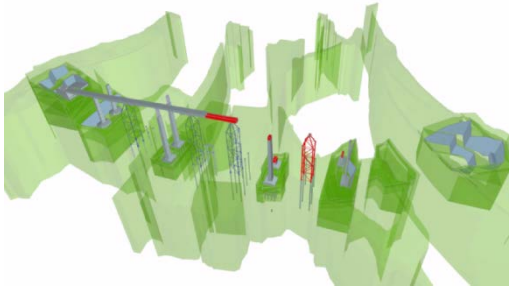
- Track length: 10.1 km
- Maximum speed: 80 km/h
- Underground stations: 3
- Depth of the stations: -41.4 m



Model-orientated 4D planning

Fils Valley Bridge

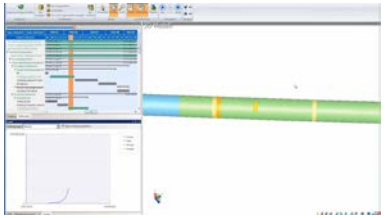
- Total length of bridges: 485 m
- Height: 85 m
- Span (max.): 150 m
- Width of superstructure: 8.4 m
- Number of bridges: 2
- Construction method: semi-integral/launching girder



Model-oriented 5D planning

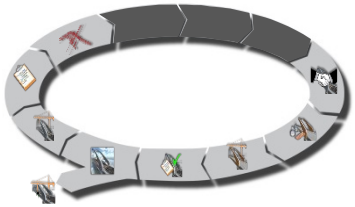
Rastatt tunnel

- Total length of the tunnel: 4.27 km, 2-tube structure up to 20 m below the surface
- Diameter: interior 9.6 m, exterior 10.6 m
- Tunnelling method: 2 tunnel boring machines
- Micro pressure wave constructions: 2 at the tunnel portals (sonic boom effect)
- Tunnel tube construction period: approx. 3 y.

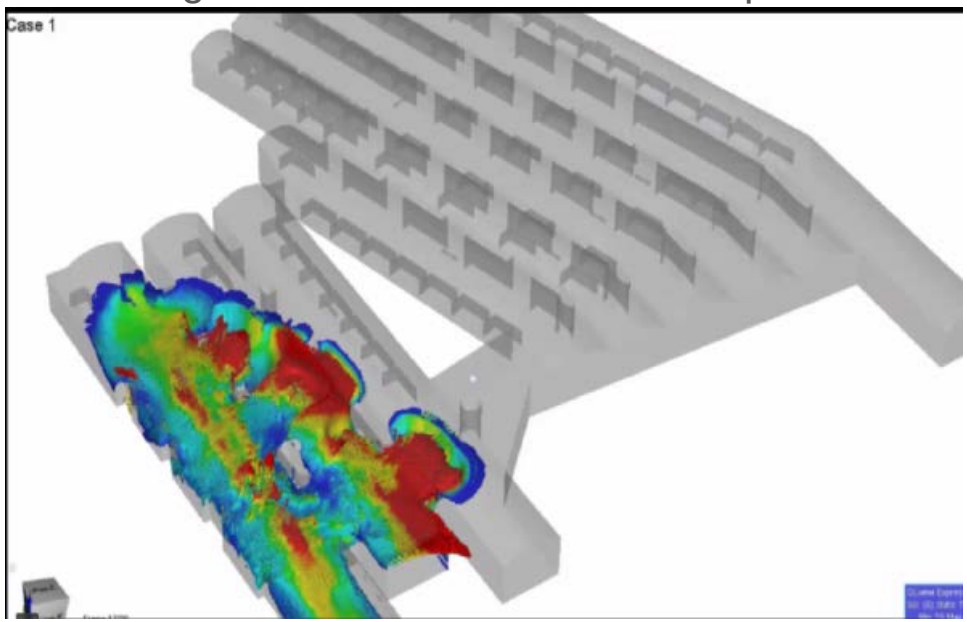


© RIB iTWO 5D

By the way:
Digital 3D models form the basis for many simulations

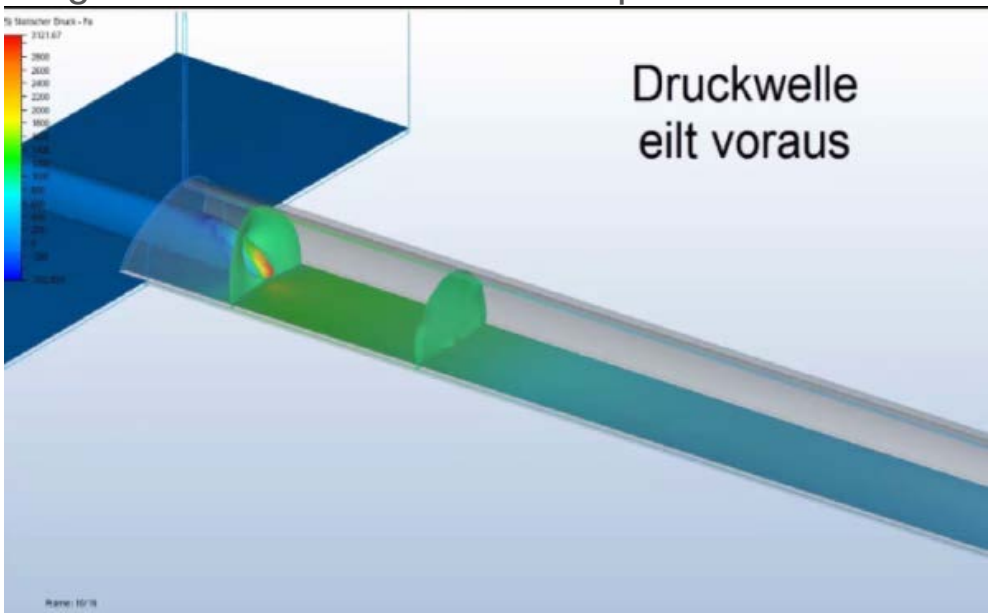


E.g. simulation of smoke development



© autodesk

E.g. simulation of air flows and pressure waves



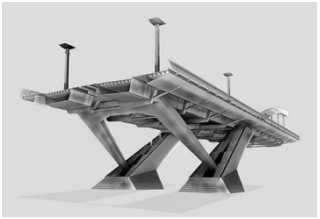
© autodesk

Preparation of tender documents (HOAI phase 6/7)
BIM supports and facilitates the tender and contract award

Objective: Unambiguous tender documents are required as the basis for the implementation

Model-orientated tender

- Semi-automatic authoring of bills of quantities
- Makes it easier to compare bids



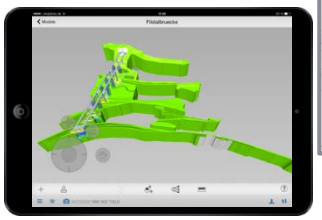
Effect on contracts

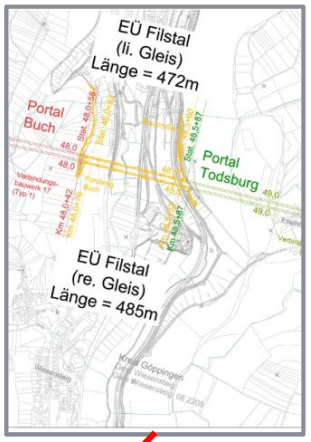
- BIM triggers the ongoing development of new contract models
  - Early consideration of contractor expertise
  - Full transparency of service content in model-based working empowers collaboration

Construction site management (HOAI phase 8) implementation phase: mobile devices for project control, model-based machine control and geo-referenced site documentation

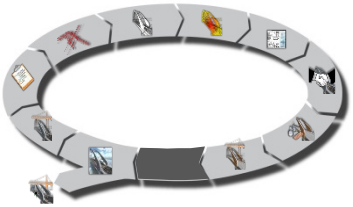
Objective: The use of mobile digital end-user devices allows for **more economical site logistics**, considerably better **project control** and **quality assurance** and more accurate **site documentation**

- Model-based project control and quality assurance
- Model-based machine control
- Geo-referenced site documentation





Acceptance procedure (HOAI phase 9) and documentation: On the day of commissioning, the operator can access the complete build documentation in 3D.



Objective: **To ensure efficient maintenance and continuous inventory data maintenance** for rail operations and follow-up projects

Maintenance planning

- Planning based on model information
- Virtual inspection of the yard

Maintenance and repairs

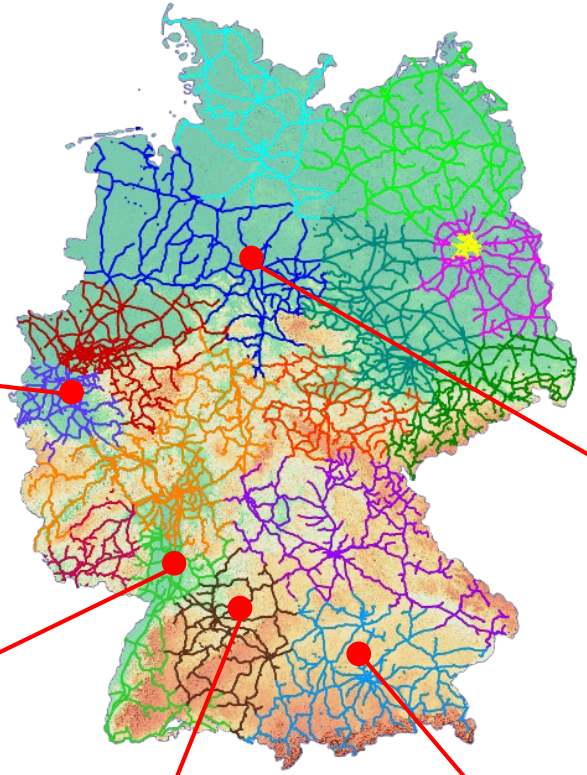
- Updating of the model with maintenance actions

© DB Systel WorldInsight

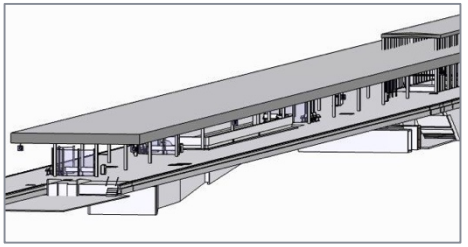
Future vision:
In ? years, the entire infrastructure will have been adopted into the 3D model

Operations and maintenance

Cologne-Nippes ICE depot



Hanover Main Station



Rastatt Tunnel

© DB Systel WorldInsight

2nd main line in Munich

Fils Valley Bridge

More transparency for large-scale infrastructure buildings?
More transparency for large-scale infrastructure buildings!

Transparency requires a change in corporate culture

- BIM stands for **transparency and collaboration** between all project stakeholders:
  - Project client
  - Planner/subject matter expert
  - Contractor
  - Construction supervision
  - Approving authority
- BIM requires a **change in corporate culture**; away from sequential, isolated processes and towards a parallel, team-orientated "open books" approach to work

"LET'S DO IT!"

Thank you for your kind attention.

Heinz Ehrbar

Head of Major Projects Management

DB Netz AG
Kleyerstraße 25
60326 Frankfurt am Main

heinz.ehrbar@deutschebahn.com