GS4402 - BIM is the Key to Success:  
Combining BIM and GIS Data to manage a steel factory plan  
Frank Markus – Man and Machine Inc

HKM (Huettenwerk Krupp Mannesmann) is specialized in the input material production of steel with all necessary process steps—from pig iron production, including the coking plant and sintering plant—up to production of steel, steel slabs, and round steel bars in the continuous casting process.

Today, HKM is a steel enterprise which is setting new, worldwide standards within production and environmental protection. And HKM is setting standards in the IT, too - by implementing a true intelligent model of the whole plant. HKM is number one in the industry, having a complete 3D model of their factory site, including inside and outside equipment.

This class describes best practice workflows using AutoCAD® Plant 3D, Autodesk® Revit® Structure, Autodesk® Inventor®, and AutoCAD® Map 3D software for creating a database-driven 3D model in Autodesk® Infrastructure Modeler software.

Learning Objectives
At the end of this class, you will be able to:

• Learning objective 1: Understand the benefit the Infrastructure Design Suite offers for typical BIM for Infrastructure workflows
• Learning objective 2: Use AutoCAD Map 3D for electric network planning, design, analysis and maintenance
• Learning objective 3: Play through, how the different solutions within the Infrastructure Design Suite work together
• Learning objective 4: Produce high-quality 3D visualizations with Autodesk Infrastructure Modeler for faster decision making
About the Speaker

- degreed engineer for Geography (core area: GIS)
- ’90-97 Man and Machine, BU Manager AEC, Business Development
- ’97-99 Smallworld (today GE Inc.)
- ’97-05 c-plan Inc, Managing Director Germany
- ’05-09 Autodesk Inc., Sales Manager and Business Development CE
- ’09-today: Man and Machine, Managing Director (Infrastructure)

- married, Hobby: making music

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To throw everything into one pot, is usually not such a good idea. The steel factory Huettenwerk Krupp Mannesmann, short HKM, it was the key for a successful data management: 1 single Database for all infrastructure information on the 2 ½ square-kilometer factory site - based on AutoCAD Map 3D and Oracle DB.

The HKM Staff Magazine “We at HKM” takes Superman as a reference: With his X-ray eyes he could have easily vision all buildings and plants, can look at the site and knew right away what is where. The information system which is now under construction at HKM, this analogy is very close. But first things first.
HKM in Duisburg-Huckingen, north-west Germany is one of the leading steel producers in Europe. The company supplies raw material of slab and continuous cast round to the shareholders of ThyssenKrupp Steel Europe AG, Salzgitter Mannesmann GmbH and Vallourec & Mannesmann Tubes S.A. On the site are buildings with offices, manufacturing facilities and warehouses, roads, railways, storage areas and above and underground supply lines of all types. How many kilometers through the whole site is - so far - unknown.

Some facts:
- Integrated Steel factory with 2 furnace, coking plant and basic oxygen steel plant
- 3300 employees
- Production capacity: 5.3 Mill. Tons Steel
- more than 1000 steel grades
- 12% share of all German steel production

Wide scattered large knowledge
A lot of information, coupled with the associated knowledge, possessed far mostly only by employees, who are directly relevant to the System. The digital data are widely spread: in SAP R3® Plant Maintenance system, all kind of databases, thematic maps, spreadsheets and text files – and of course in about ½ million drawings. When investment decisions are pending, however, conversions and upgrades are necessary. In extreme cases – e.g. an accident, it was yet hardly able to collect and analyze all relevant data in a short timeframe.

BIM for Infrastructure - one database for all, one SI for all
Against this background, the company authorities decided in May 2010 to create a system bundled with the existing knowledge of the engineers, which should be available on the corporate network. In principle, this is a so called “Building Information Modeling” System, short BIM. But the buildings are just one type of many different objects...

The new system should regard all relevant information for a certain business process. According to the study about “Digital Factory” of the Fraunhofer Institute for Manufacturing Engineering and Automation IPA in Stuttgart, HKM developed their own model of a digital factory.
To remain competitive, companies like HKM must run their factories and production operations at the limit of their technical, logistical and organizational capabilities. Constant innovation and adaptability are the key to sustainable success.

New aspects of a sustainable environment came up: The production of steel on the basis of iron ore requires a lot of energy. Only the share of energy costs in the production costs for the raw material slab or round steel is about 40%. Not only from an ecological but also from an economic perspective, the steel industry is therefore always working to reduce the energy consumption. This aspect is one of the most important to be implemented into a new information system. This was the road towards a digital factory model: Missing data - such as detailed Information of the pipe system – must be completed. In addition, all information should be managed centrally in a single database to avoid the mass of redundant data, which exist at that time. It was important for HKM, that the complete solution must be implemented, customized and managed by one contractor. Since then, each topic in the “digital playground” was placed to a different contractor.

Pic. 3: Orig. Sketch of the customer’s idea, Mai 2010
HKM conduct a market analyze and quickly found that Autodesk offers a range of products with which different responsibilities of the factory site can be covered: From cadastral work on civil engineering up to the machine and plant construction, from building maintenance to an information retrieval system. Especially since the HKM engineers already have experience with mechanical engineering products from Autodesk (Inventor), the direction towards Autodesk was twice. But apparently there was no system integrator, which can deliver all applications, could train, install and manage the portfolio. And: Integrate SAP and other existing Enterprise Systems within this new Software Environment.

Finally, the HKM key account manager of Autodesk and the HKM invited Man and Machine Inc, short M+M, as a partner. M+M as a platinum partner of Autodesk is the one and only System Integrator (SI) and Value added Reseller (VAR), who offers the complete Autodesk Portfolio and Services in one company. After numerous preliminary and intensive counseling the “M+M competence center for AEC and IM”, a solution based on established worldwide standard software and a little own programming, are the base for the new BIM of the HKM enterprise. Step by step the steel factory became a “glass factory”, so to speak, a “glass plant.”

“The M+M approach includes both the planning process and optimization of ongoing factory operations. Planning includes the active and cooperative participation of all Stakeholders, and – in the context of the Digital Factory – is transformed into a continuous business process that breaks down the boundaries between planning and operation.”, says Frank Markus, Managing Director of M+M Systemhaus in Stuttgart and in charge of Infrastructure Management at M+M Inc. “In this approach, standardization of software components and system architecture are essential prerequisites for achieving rapid implementation of an efficient management system”.

Planning, Design, Maintenance – 2D GIS Workflows
Besides the existing Autodesk Inventor installation and Autodesk Vault to manage the mass of mechanical drawings, the out of date GI System was replaced first. Here, the 2D data was migrated from the original CAD400 System into an Oracle Database which is the central DB for all data – 2D and 3D graphical plus all numeric, alphanumeric and meta data. Another reason to work with a database instead of the original drawings was, to reduce the different file formats, different releases of a certain design etc.

The decision was made quickly and the choose product was Oracle, for many good reason…although in other parts of the company MS SQL Server was used. But the missing spatial capabilities and the ability to store 3D data in tables of a DB leads to Oracle.
Pic. 4: Complete 2D network and facilities of HKM Duisburg

The HKM Survey Department and M+M set up a pilot to optimize the workflow and system components before rolling it out to all departments: The planning of the new cocking plant – a 120 Mio US$ project – was chosen to test all scenarios: From first sketches to the as-built construction and visualization. This pilot means to bring more than 10 different departments together, collect and optimize their data and present all information with a new information system.

Today, all 2D infrastructure data such as the complete electrical, gas, water, waste water, survey and civil data are available through all departments. Based on AutoCAD Map 3D and the retrieval system any employee with their own permission have access to the data at anytime and anywhere. These 2D data are the base for the 3D Planning and Design processes.
3D Data acquisition by terrestrial laser scanning

The migration and data optimization of the 2D Data + Attributes was a standard procedure for the M+M Consultants. But how to collect and handle all the 3D data of a complex steel plant?

Plans of the existing factory buildings and equipment are often far from adequate – and any plans that do exist tend not to include a three-dimensional representation. Moreover, existing plans are generally not sufficiently up-to-date to be used in factory planning at HKM (and so in other factories)

M+M had good and long-term business experience with SI Engineering, a specialized company of 3D visualization. We are together on the road since 1999 to convince customer in a 3D GI-System. The specialists of SI Engineering recorded with the help of a 3D medium range scanner (Riegl) the above-ground pipe bridges, parts of the existing cocking plant and surrounding plants and buildings – just everything which is needed for the business process “Plan and Design the new cocking plant” besides the existing 2D data and attributes and the very complex mechanical drawings. With the ability to capture existing factory halls in 3D, convert this data into CAD data and ensure simple replanning of the facility by means of participative systems, this new approach finally eliminates these crucial shortfalls in the planning chain of the Digital Factory.

The 3D data were migrated and optimized into Autodesk LandXplorer (today: Autodesk Infrastructure Modeler, AIM), processed and visualized. From here the 3D information goes directly into the Oracle DB. All objects are designed on a specification of the Open Geospatial Consortium (OGC), which are more or less a worldwide standard for spatial data and can be used for any queries, linkages, analysis or for creating thematic maps. SI Engineering developed a small application to work seamlessly between the DB and AIM. Today, AIM is nearly for any “outdoor” data the Graphical User Interface, because all tables from all Application and Media (also the 2D Objects) are in access from this seats.
“Thanks to the laser scanning and processing things it’s possible, which it previously in the software environment Autodesk was not: We can now use the point clouds easier which brings immense synergy effects through all spatial business processes.” says Ernst Loeffler, project manager and head of department of survey at HKM.

In 2011 Autodesk came up with the AutoCAD Infrastructure Suite – for HKM a logical step will be to upgrade the different products into suites. It felt like Autodesk “invented” the suites for this kind of customers, who are working across division, multimedia and interdisciplinary. The biggest challenge was to build up a seamless and integrated information system. This is – today – no part of the suite. So M+M developed several interfaces and implemented batches and routines to

- Integrate AIM as the GUI for 3D Plant data
- Implement Revit/Revit Structure Data into the Retrieval System (Spatial View)
- Combine SAP R3 to the Database
- Use Adobe PDF 3D to handle the huge Autodesk Inventor Data in the same Software Environment.
- Implement True View in WebGIS
Pic. 7: All buildings are reconstructed with Revit and Revit Structure

Pic. 8: Factory floor with Slab flame cutter in Autodesk Navision®
3D visualizations for faster decision making
After presenting the first results of what is possible and how many synergy effects can help the employees to do their work better or faster or both, the roll-out to different departments of the company was just a question of “when”: The presentation to the managers and board of HKM leads was the kick-off to complete a 3D model of the whole factory site. The most impressive thing at that time was the visualization of the complex cocking plant, which was the pilot for both partners:

- HKM to see and fell, if 3D visualization can help to find a better, harmonized and faster decision. By building a 3D digital prototype of the cocking plant extension, the stakeholder had a better platform for their decision. And by the way, it leads the customer into a 4D/5D model, taking the costs and time schedule into the visualization and combining SAP R3 with the model.
- M+M had their first experience with a DB Integration into AIM, which helps to repeat this experience in other, similar projects (Arcelor Mittal, Henkel, Airport Hamburg etc.)
Challenge: Information Retrieval System
Just a little but important component in this Information System is the part of the 3D Viewer. Since starting the project in 2010, an easy-to-use retrieval and viewer system had to be implemented. Due to the fact, that Autodesk has no web-based 3D viewer, which can be combined with the DB, SAP etc. the first decision felt on Google Earth®. In the meantime, Autodesk offers a first release of the AIM Viewer, which could be the bases for the graphical frontend of the Retrieval System.

![Image](https://via.placeholder.com/150)

**Pic. 9: Complete LOD2 buildings and LOD 3 piping of the HKM plant**

Summary: The right way
For HKM employees this new solution offers the access to all technical data across division boundaries. It reduces the redundancy, which came up in the past, when the same data was collected again and again with different aspects. Long term, this means that HKM, thanks to non-contradictory 2D and 3D data, that

- the company can boost their productivity
- reduce lead times in decision making
- optimize inventories and employees working time
- increase the availability of resources

The new system can be used as a knowledge base for newbies and rookies to raise their knowledge of the complex environment called Steel factory.

"So far we are still a long way, however," slows Ernst Loeffler, the euphoria. "Today we reached the goal, which brings all data together in one Database - an important and fortunately successful step. Now we can begin to raise ‘our treasures’ in analyzing and combine the data under different aspects. Anyway, we are on the right track."