



# AutoCAD Civil 3D Corridors for Railroads: Vault as a Component of BIM—Actual Experience

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## CV5762-R-P

This round-table discussion will elaborate on how to create corridors for railroad projects in AutoCAD Civil 3D software. The speaker will introduce the potential of applying premade railroad structures (Microsoft Visual Basic .NET) in designs consisting of 2, 3, or more tracks. He will share the experience of organizing teamwork in big projects between several engineers and/or other project members. The speaker will also share practical experience regarding why working with Vault software is superior to working with a server that uses civil-data shortcuts. The discussion will include the analysis of a work model (AutoCAD Civil 3D software plus Vault software) that enables an engineer to create a digital 3D model and a manager to monitor and control the progress of the project without specific knowledge of the software.

## Learning Objectives

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

- Find out how you can effectively use AutoCAD Civil 3D software custom subassemblies to create railroad corridors
- Receive practical experience on creating corridors for railways consisting of 2, 3, or more tracks
- Gain practical guidance on organizing big railroad projects and discover the advantages of Vault software over Data Shortcuts
- Find out how AutoCAD Civil 3D software and Vault software better ensure smooth cooperation between a BIM expert and a manager who has no specific knowledge

## About the Speaker

*Darius Simkunas is the chief programmer at JSC Kelprojektas, the biggest infrastructure engineering company in Lithuania and the Baltic countries. He is responsible for the strategy, development, and adaptation of Building Information Modelling (BIM) and engineering software. Darius has over 10 years of experience with Autodesk, Inc., products, consulting and instructing the company's employees. He was an Autodesk University speaker in 2013. He has been working with AutoCAD Civil 3D software since 2005 and has a portfolio of functionalities for specific regional and company needs. He is an AutoCAD Civil 3D Certified Professional, he has been an Autodesk Developer Network (ADN) member since 2008, and he has been working on infrastructure projects using new technology and methodology. Since 2012 he has been responsible for the implementation of Vault software in Kelprojektas. As the project manager he directly participates in the stages of implementation, strategic and technical issues resolution, and product functionality enhancement according to the company's needs.*

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## Introduction

JSC Kelprojektas has been designing infrastructure objects since 1956, but railways were picked up only in 2009 when the demand for such projects increased dramatically. Currently, Lithuania has been engaged in intense modernization of the existing network of 1767 km (around 1000 miles) and the construction of a new railway of different gauge that will cross the entire country. We are also preparing the designs for the track that will span Estonia (220 km or 130 miles).

During the past five years, Kelprojektas alone has prepared designs for over 300 km (180 miles) of railways. These include not only reconstructions of the existing tracks and additions of new ones, but also the construction of a different gauge railway.

This crucial period required software enabling fast, efficient and complex solution of tasks at hand. Civil 3D was the tool that allowed us to design railways and the surrounding infrastructure in a fast and efficient way.

I would like to use this session to share my experience, to discuss the potential of Civil 3D in designing railways, and to show why this particular software package was the most suitable for us. I will also tell how SDK (VB.NET) enables us to expand the functionality of the software and easily create railway models for two, three or more tracks. I will provide argument, why teamwork in Vault is more efficient as compared to Data Shortcuts, and how Vault enhances the cooperation between a BIM expert and a Project Manager without the specific knowledge.

## About JSC Kelprojektas

JSC Kelprojektas is currently the largest group of transport infrastructure engineering companies in Lithuanian that designs transport communications, public use buildings, engineering systems, and performs territorial planning works, etc.

The company was set up in 1956.

The main headquarters of Kelprojektas has always been located in Kaunas with later additions of regional subdivisions in Vilnius, Klaipėda, Šiauliai, as well as Tallinn.

JSC Kelprojektas currently has more than 220 employees.

Almost 6 thousand projects in various scope and complexity; ten thousands of kilometers of roads, streets, and railways built and renovated; bridge projects, territorial planning projects that have received great appreciation and highest ratings – all of this is just a fraction of Kelprojektas group's contribution to the modernization of the national transport infrastructure.

The objective of the company is continuous progress. In order to ensure premium services, Kelprojektas continually invests into advanced solutions, innovations, and up-to-date engineering technologies, improves work processes as well as personnel skills.

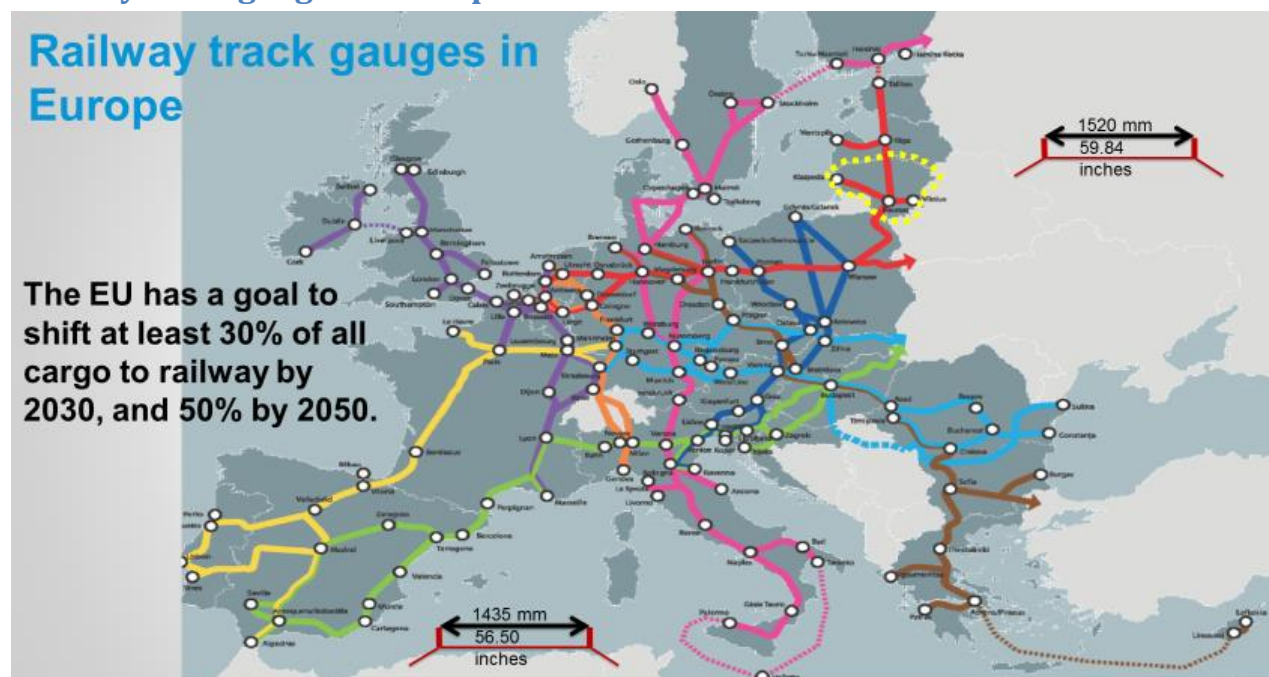
Specialists of JSC Kelprojektas work with various software:

- Autodesk: AutoCAD, AutoCAD LT, AutoCAD Electrical, AutoCAD Architecture, Robot Structural Analysis, AutoCAD Map, 3ds Max Design, AutoCAD Civil 3D;
- Bentley: Microstation, STAAD;
- SoFisTik, ANSYS/Structuraland etc.

Autodesk products make up about 80% of company engineering software portfolio.

The main software is AutoCAD Civil 3D.

### Railway track gauges in Europe.



There are two major railway gauges in Europe:

- 1520 mm (59.84 inch) Russian gauge;
- 1435 mm (56.50 inch) Standard gauge (same as in the US and China).

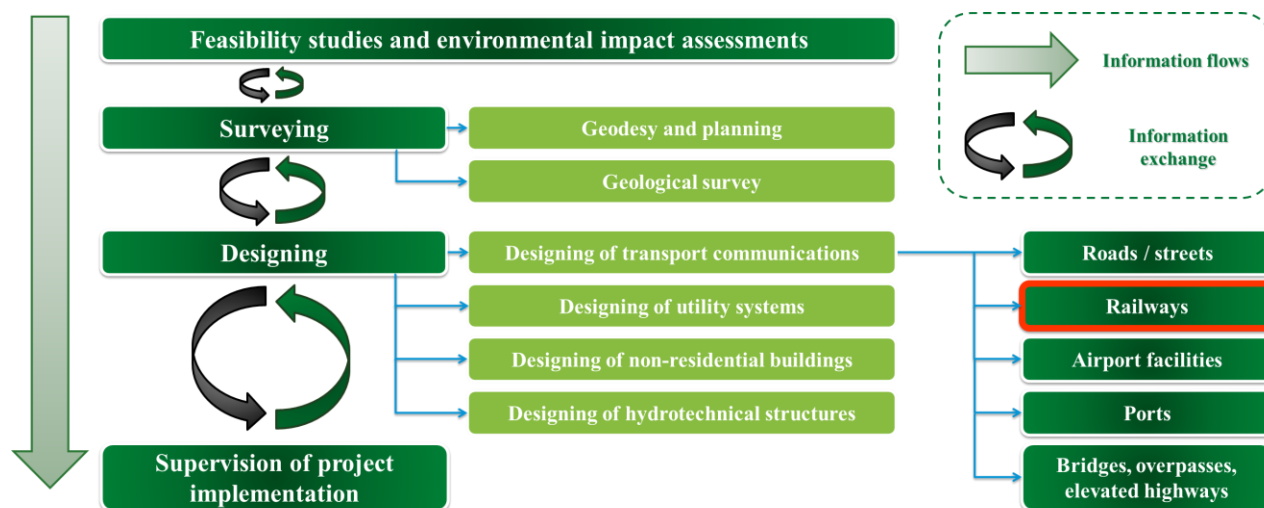
Lithuania has about 1600 km (1000 miles) of Russian gauge railways. Currently, the system of Lithuanian railways is undergoing integration into the common EU system with the construction of 150 km (around 100 mile) of Standard gauge tracks. The final goal of the project is to construct a Standard gauge railway spanning Lithuania, Latvia and Estonia to connect the Northern European countries with the South.

The EU has a goal to cut the number of freight vehicles travelling the roads and to shift some of the cargo to railways – a cheaper, more environment-friendly and safer alternative. Up to 30% of all freight should be carried by rail by 2030, and 50% by 2050.

### Why has Civil 3D been chosen for railway designing?

Railway (re)construction involves replacement/modernization of the entire surrounding reconstruction – bridges, roads and pipelines.

JSC Kelprojektas provides a wide range of services (Fig. 1).



We needed not only to find suitable software for railway designing, but also to integrate it with the systems already in use. We also had to ensure smooth BIM modelling. Thus, good software is key to success in such critical periods.

|                                            | AutoCAD Civil 3D | USA software provider „B...“ | Russia software provider „C...“ | Slovenia software provider | German software provider |
|--------------------------------------------|------------------|------------------------------|---------------------------------|----------------------------|--------------------------|
| Trasų projektavimas/<br>Best fit Alignment | +/-              | +/+                          | + -/+                           | - +/+                      | + -/+                    |
| Profilių projektavimas                     | +                | +                            | +                               | +                          | +                        |
| Iešmų projektavimas                        | -                | -+                           | -                               | -                          | +                        |
| Konstrukcijų modeliavimas                  | +                | + -                          | -+                              | -+                         | -+                       |
| Komandinis darbas                          | +                | + -                          | -+                              | -+                         | -+                       |
| Integracija su turimomis sistemomis        | +                | + -                          | -                               | -                          | -                        |
| Žinomas darbuotojams                       | +                | -                            | -                               | -                          | -                        |

The analysis of software packages showed that none of the products met our requirements 100%.

But Civil 3D had functionality crucial to our needs, while SDK enabled the creation of missing tools.

Kelprojehtas has been using Civil 3D since 2005. Our employees are highly experience in using it as well as creating additional applications. Civil 3D enables teamwork in railway designing – we use a single digital BIM model and engage all participants of the project (surveyors, geologists, road engineers, pipeline designers, etc.).

### **Civil 3D can accomplish more than it seems at first sight. SDK and VB.NET open a wide range of possibilities**

Civil 3D may not have all the functions required by each engineer, but its functionality is not limited to the list of commands. I would like to show how railway corridors can be modelled and all the required information obtained using VB.NET structures.

More detailed introduction to structure modelling can be found at [http://docs.autodesk.com/CIV3D/2014/ENU/Developers\\_Guide/index.html](http://docs.autodesk.com/CIV3D/2014/ENU/Developers_Guide/index.html)

The source codes of all structure elements created by Autodesk are uploaded during the installation of AutoCAD Civil 3D. You can copy and customize them according to your needs. They offer great material for learning using real examples. (Usually the source codes can be found in C:\Program Files\Autodesk\AutoCAD 2015\C3D\Sample\Civil 3D P\IC3DStockSubAssemblies).

## Creating railway structures using Civil 3D custom subassemblies. VB.NET

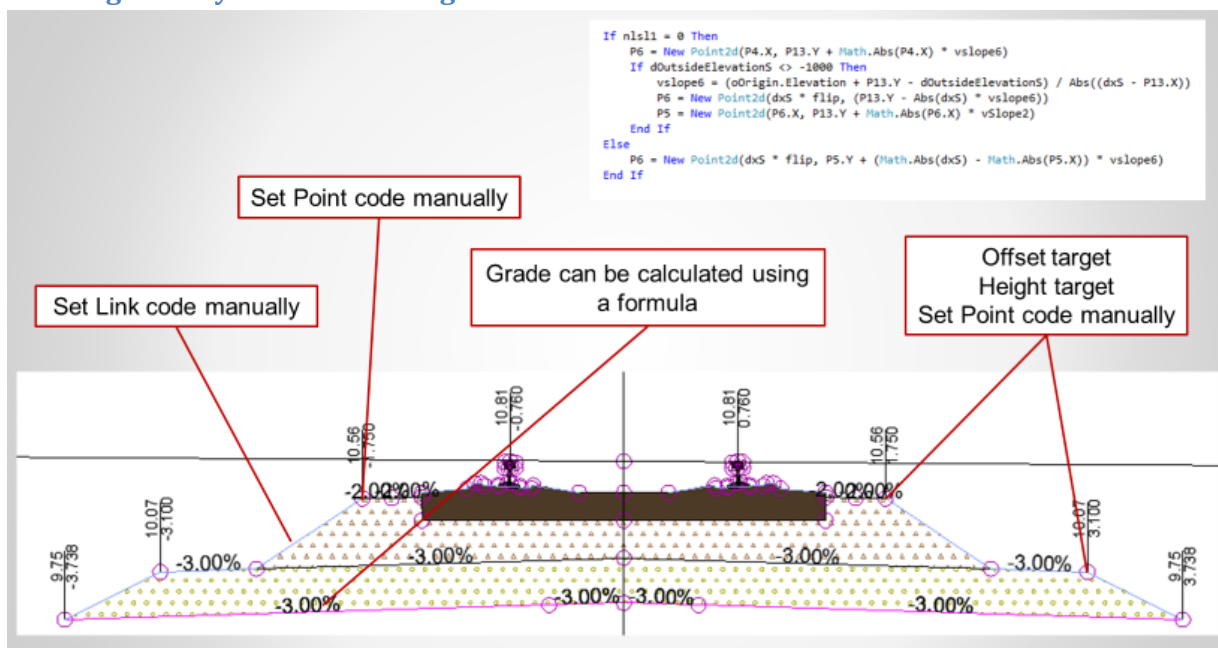
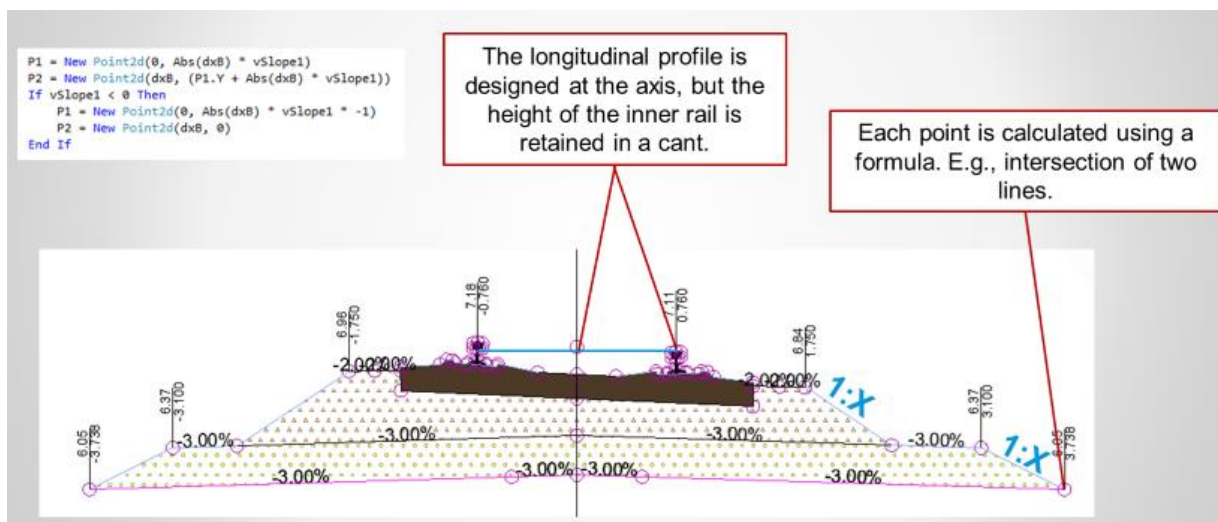


Figure 1.

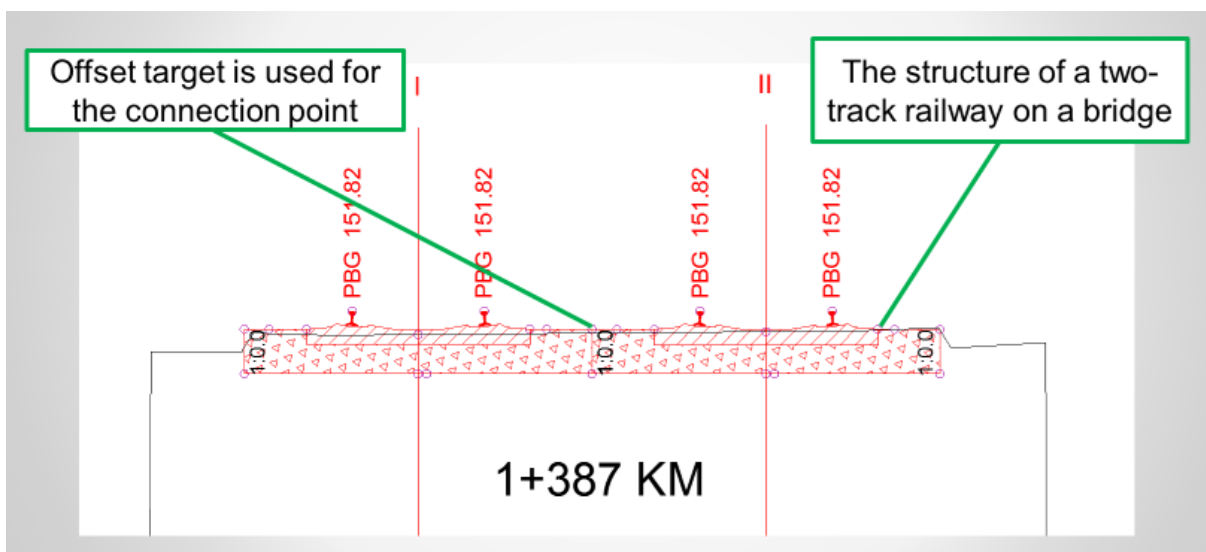
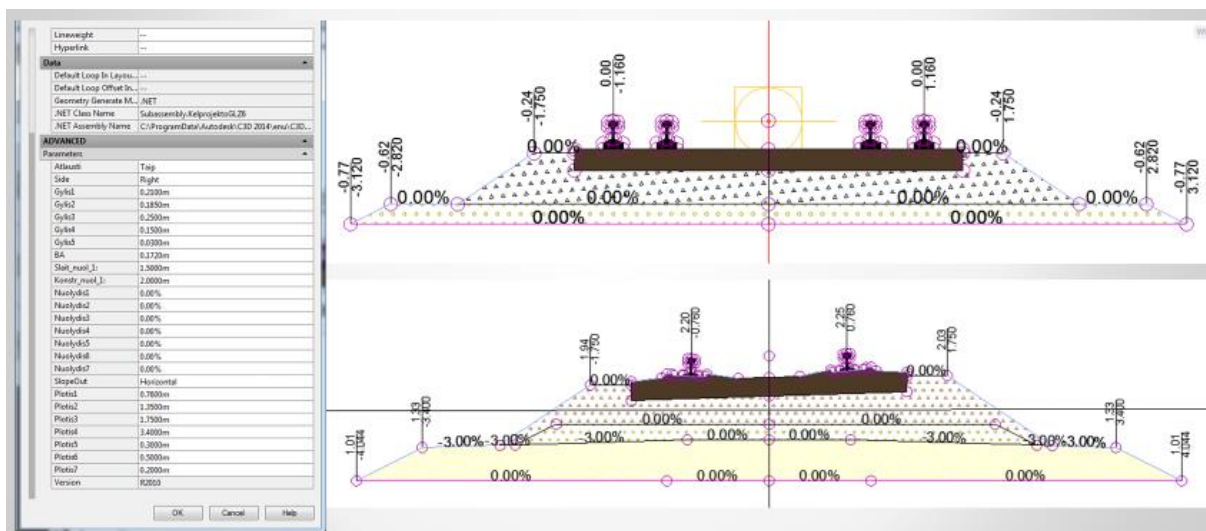
VB.NET enables the creation of structures of required geometry. The geometry of a structure is not static, but we can define as many parameters as necessary. We can define standard point and link codes and allow the user to modify or supplement them. We can define offset and height targets for required points. It is important to understand that the view we see is just a visual representation of a mathematical formula.

The images show examples how one or another point is calculated.



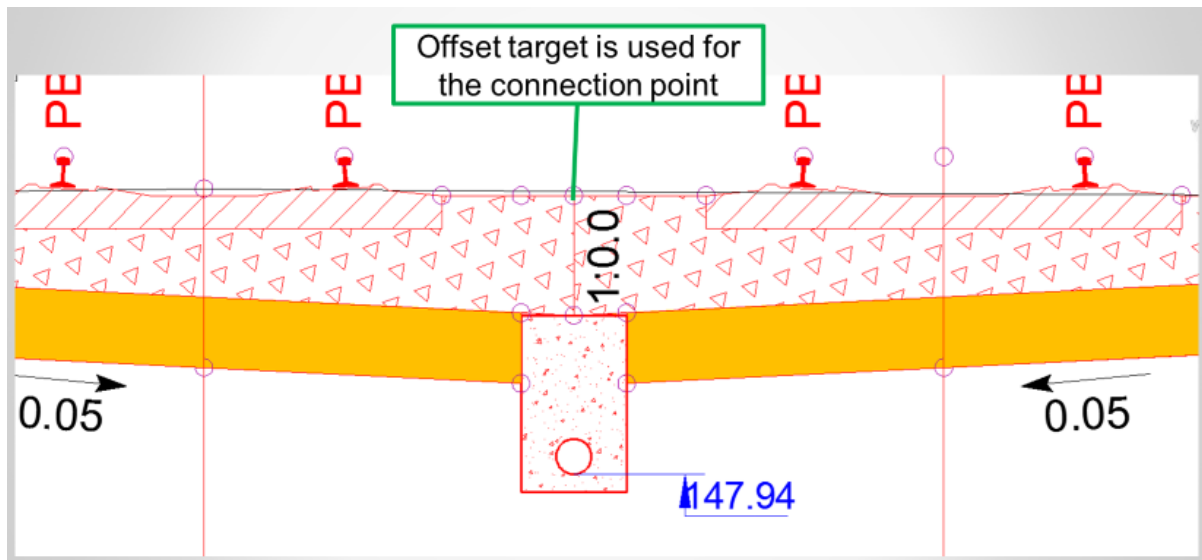
Railway structure consists of two parts – left and right. Unlike road structure, it pivots along the inner rail instead of the axis in a cant. The longitudinal profile is designed at the centre of the track, but in case of a cant the subassembly retains the design height for the inner rail, while the outer rail is raised according to the designed cant. The point at the axis is raised accordingly.

The formula can be applied to each point with regard to the situation at hand as well as the values of other points, grade, etc. E.g., the outside point is calculated as the intersection of two lines.



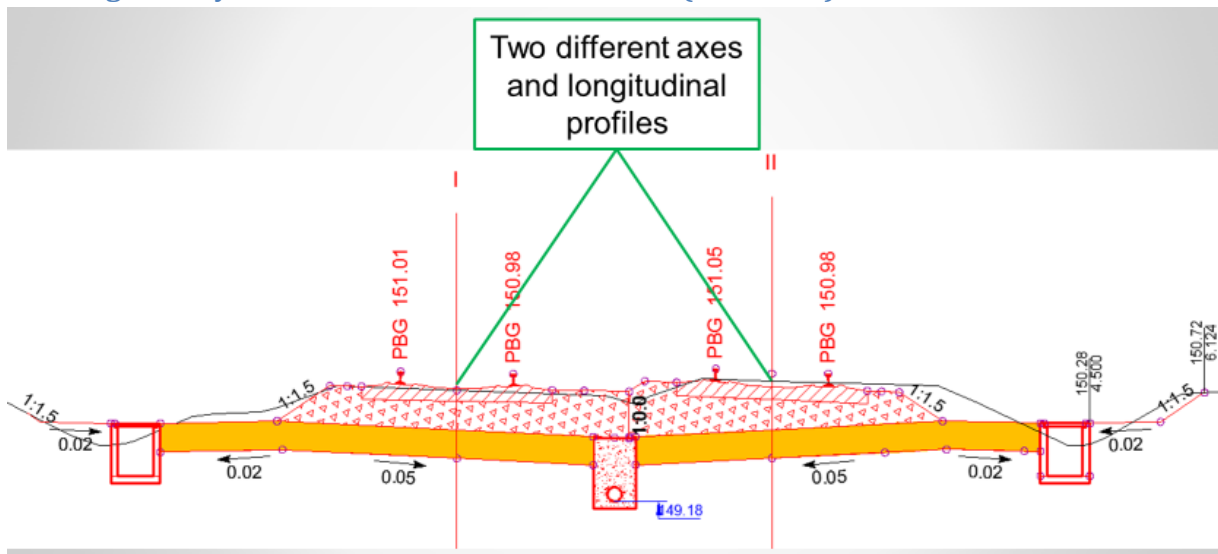
Here you can see the cross-section of a double track on a bridge. This is not a newly created structure, but the parameters have been modified.

### Creating railway corridors for two or three tracks

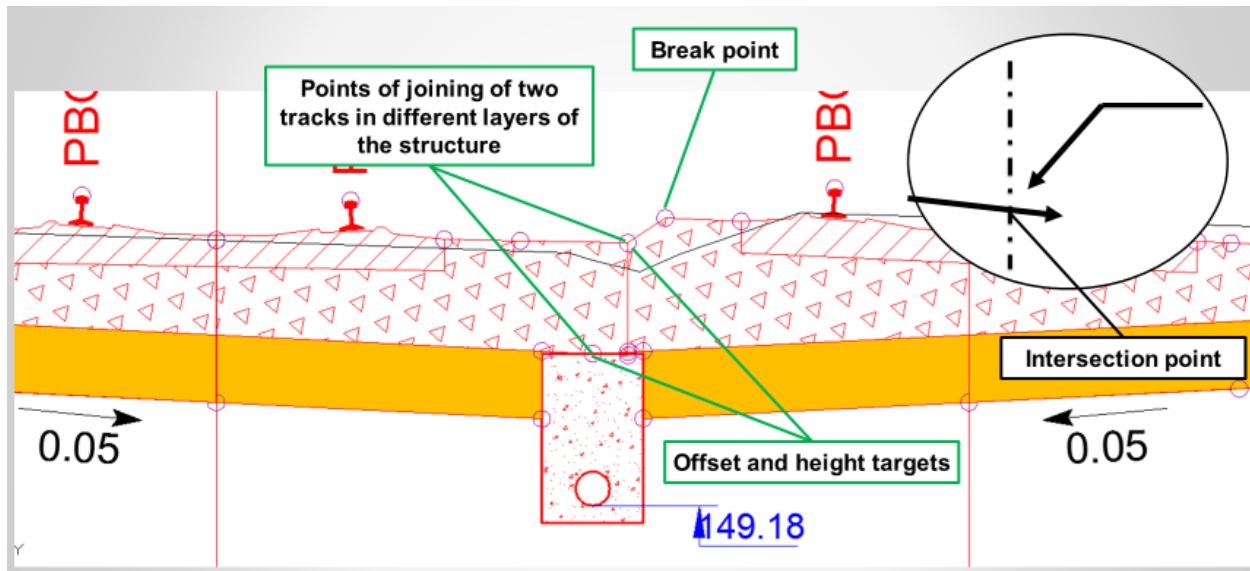


The designing of a two track railway often requires to change the distance between the tracks. Static structure elements cannot be applied in such situations. The points along the edge of the structure can change distance according to the defined offset target. This ensures smooth joining of the tracks.

### Creating railway corridors for two or three tracks (in a curve)

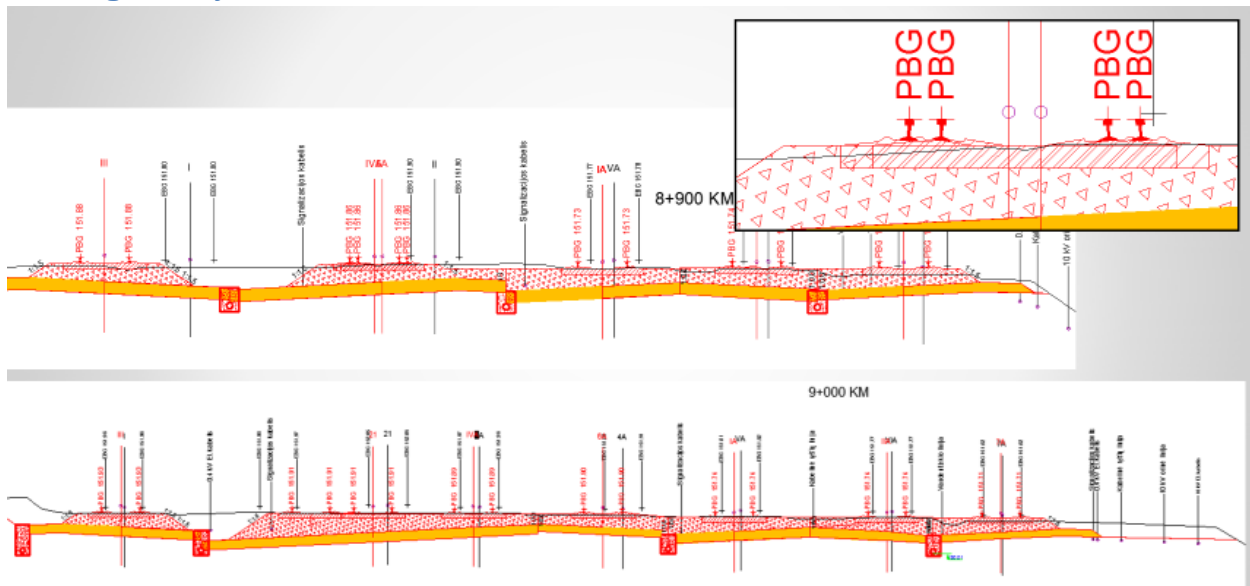


The creation of a corridor model in a curve is exclusive and requires additional attention. Civil 3D can define the cant of a rail in the alignment type.



In a curve, the joining of two tracks becomes complicated as the surface of the top layer has to break. In order to achieve a smooth joining we create two temporary layers in order to obtain a joining point. At the place of intersection, we create a feature line that will be used as an offset and height target. The lower layer of the structure is joined with regard to the central line of the axes. We can also add a drainage pipe to the lower layer if necessary.

### Creating railway corridors for two, three or more tracks



The upper cross-section shows an example with 8 tracks, and a section of a double track with one Standard gauge track and one Russian gauge track.

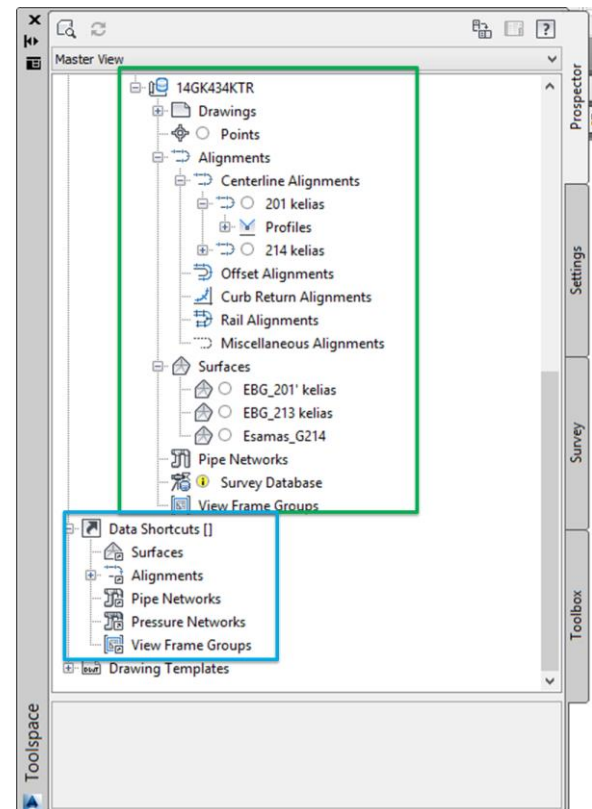
## Managing big railway projects.

***Divide et impera!*** Divide and rule! The maxim favoured by Ancient Roman conquerors

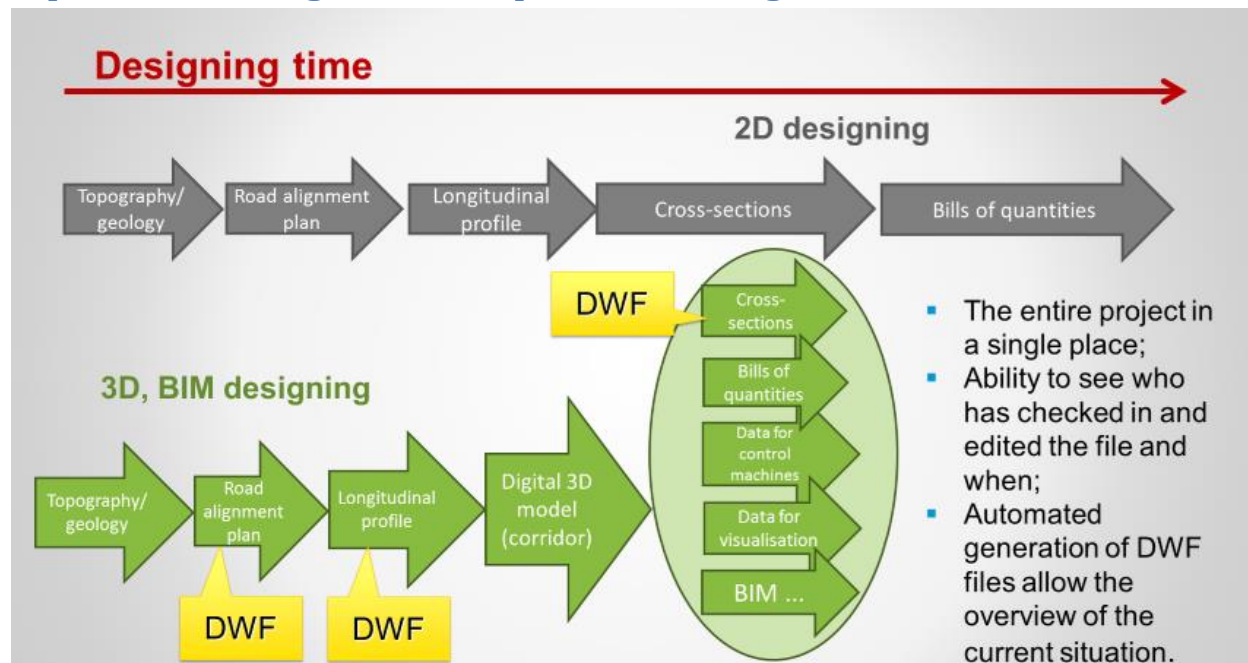
- Create separate files for different track axes and longitudinal profiles.
- Create separate files for different railway corridors. Optimal work involves 5–10 km (3–6 miles).
- Create separate cross-section files for each corridor file.
- Civil 3D Data Shortcuts technology enables everyone to see each other's information and work efficiently in a team.

## Advantages of Vault as compared to Data Shortcuts

- The entire project in a single place;
- Ability to work effectively in a team with remote subdivisions;
- Open files are stored on local disks making the work with files faster than on the network;
- Ability to work with files off-line;
- Ability to go back several versions;
- Ability to see where the file is used and by whom.



## The potential of Vault for ensuring efficient cooperation between a BIM model expert and a manager without specific knowledge in the field



There has been a "revolution" going on in the designing field during the past several years – the classic 2D/3D designing has been gradually replaced by BIM designing. BIM designing does not include 2D drawings. Instead, a parametric 3D BIM model is created and used as a source to generate all the necessary information (detailed drawings, bills of quantities, data for machine operation, etc.). A shift to BIM modelling has no effect on the duration or queue of designing stages. However a new stage – creation of a digital parametric 3D model – has appeared in the designing workflow. It may seem that this new stage consumes additional time, which could be used to simply generate 2D drawings and filling in the bills of quantities.

But this time pays off. The created model allows to generate all the necessary information and even more. Modern-day requirements have changed, the production process has been upgraded and the information of the model is required during the construction process (machine control), while presentations often use 3D visualisations.

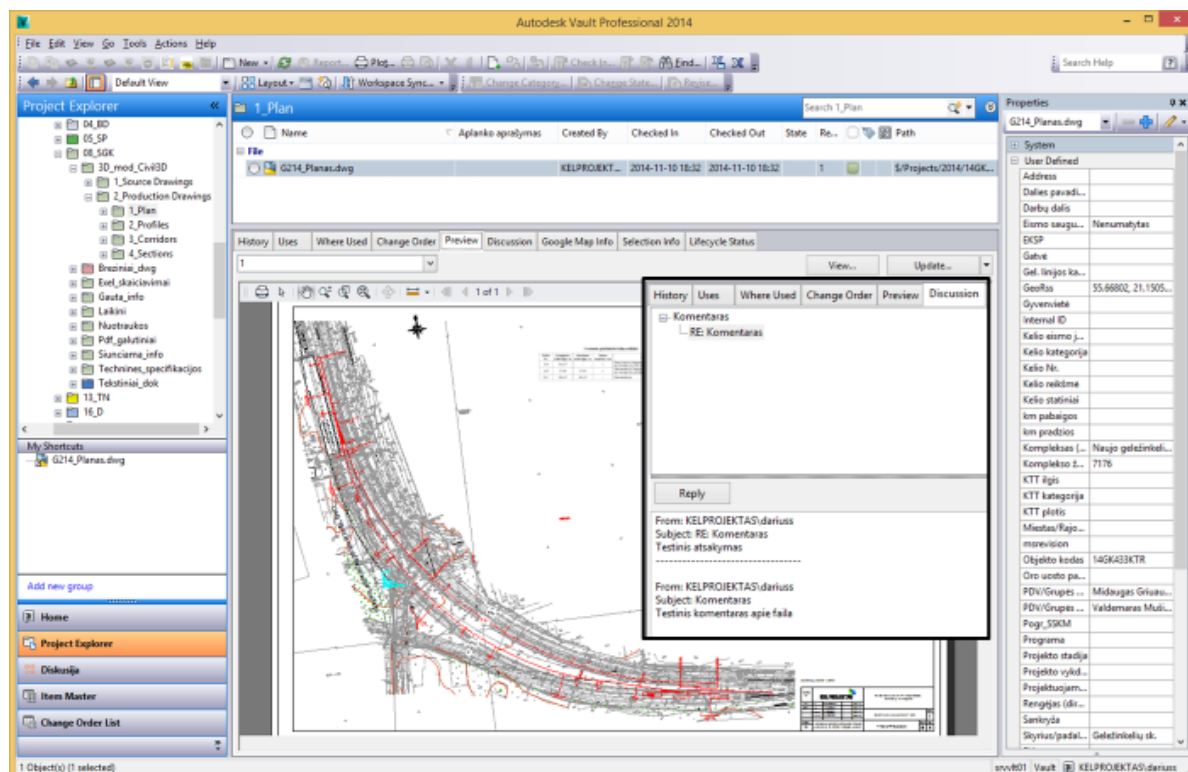
The search for optimal solutions often requires modifications to the design, and the digital model allows the extraction of necessary information here and now. Modifications of 2D models would take a lot of time and resources.

When a digital model is being created, Project Managers have to solve the problem of tracking and recording the completeness of the project. Everything was clear with 2D designing: if 100 cross-sections are needed and only 10 have been created, then the project is at 10%. With a BIM model, cross-sections are not created one by one. Instead, they are generated from a model. The creation of a model is a complicated process requiring specific knowledge of the

software. How can the Project Manager know the level of completeness of the model, and whether the model is moving in the right direction? This is where we decided to make use of Vault and its functionality.

Civil 3D enables the creation of digital model output data – cross-sections and longitudinal profiles – in separate files, while Vault allows the generation of review files in DWF format.

The DWF files let the Project Manager view the status of the digital model and the design solutions. DWF files can be generated in a JOB server and do not consume the resources of the employee's computer.



All participants of the project work in a single space. It can be clearly seen who has uploaded the file and when. Modifications can be described in a short commentary at the version of the file.

Additional functionality allows to start discussions on relevant files. These include comments on the file and the design solutions.

It is possible for an employee to record the percentage of completeness in Vault attributes, while the Project Manager can generate reports.