Exchange Parametric Bridge Models from Inventor to SOFiSTiK

Software Lab Project 2012 : Exchange Parametric Bridge Models using XML format

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Abstract

On this poster the main steps used in order to design our software which is able export a parametric bridge cross section from the CAD software Inventor into the CAE software SOFiSTiK by maintaining the parametric features are presented.

Motivation
From Inventor to SOFiSTiK

SOFiSTiK is one of the most used CAE software for civil engineering applications in Europe, especially in Germany. It allows the users to make stress analysis on different types of buildings, in particular it has a bridge analysis application. The bridge is defined as an extrusion of a *main cross section* along the bridge axis with the possibility of relating the coordinates of the points that define the cross section with some variables defined along the axis with a curvilinear parameter "s". This leads to the definition of different bridge topologies. In this case the definition of constrains has a fundamental role in the *main cross section* definition. By applying some constrains to the *main cross section* lines it is possible to reduce the number of free coordinates that is necessary to control.
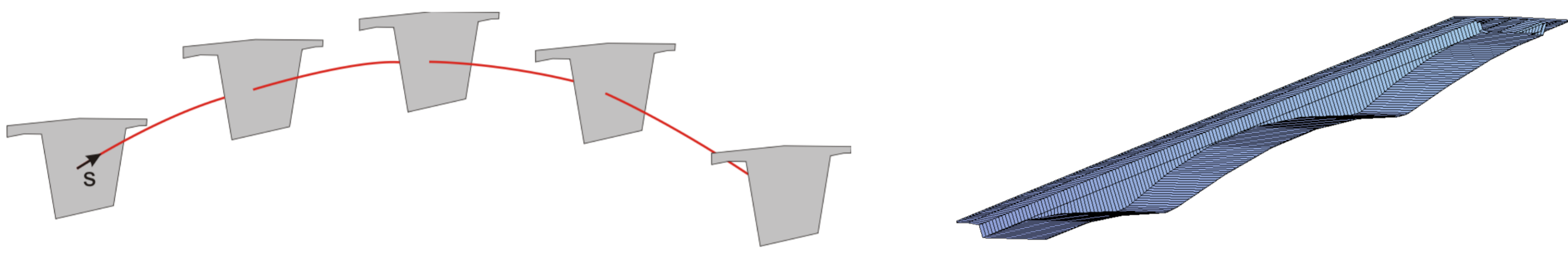

The *main cross section* definition is done in Inventor and all the appropriate constrains are defined there. The aim of the project is to develop a C# console which is able to export the *main cross section*, sketched in Inventor, into a neutral data structure and then from the neutral data structure into a SOFiSTiK input file by maintaining the geometry and most of all the constrain information.
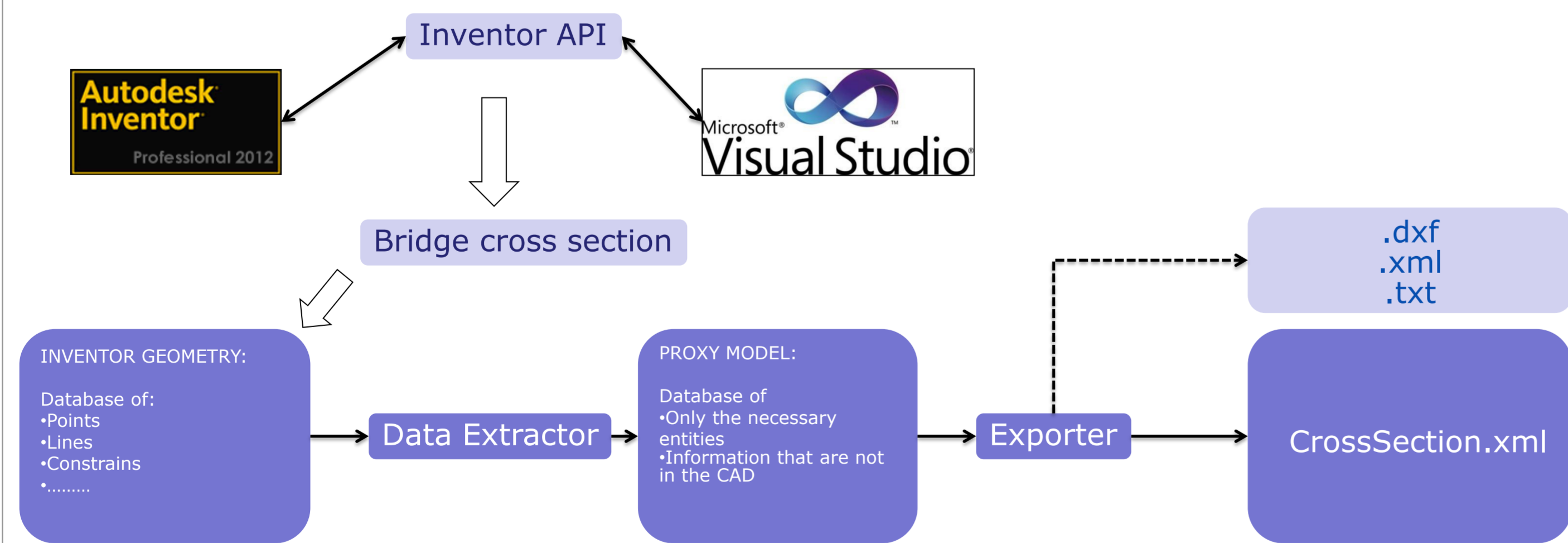

Data structure

In order to transfer all the data from the Inventor sketch into SOFiSTiK, it is necessary to define a neutral data structure to save the necessary information. Inventor, during the sketching of a cross section, saves an huge amount of data like points, constrains, workplane, into an internal datamodel. Having defined our own data structure it is possible to extract only the information needed. In order to do this, a Cross Section object has been created with the following structure:
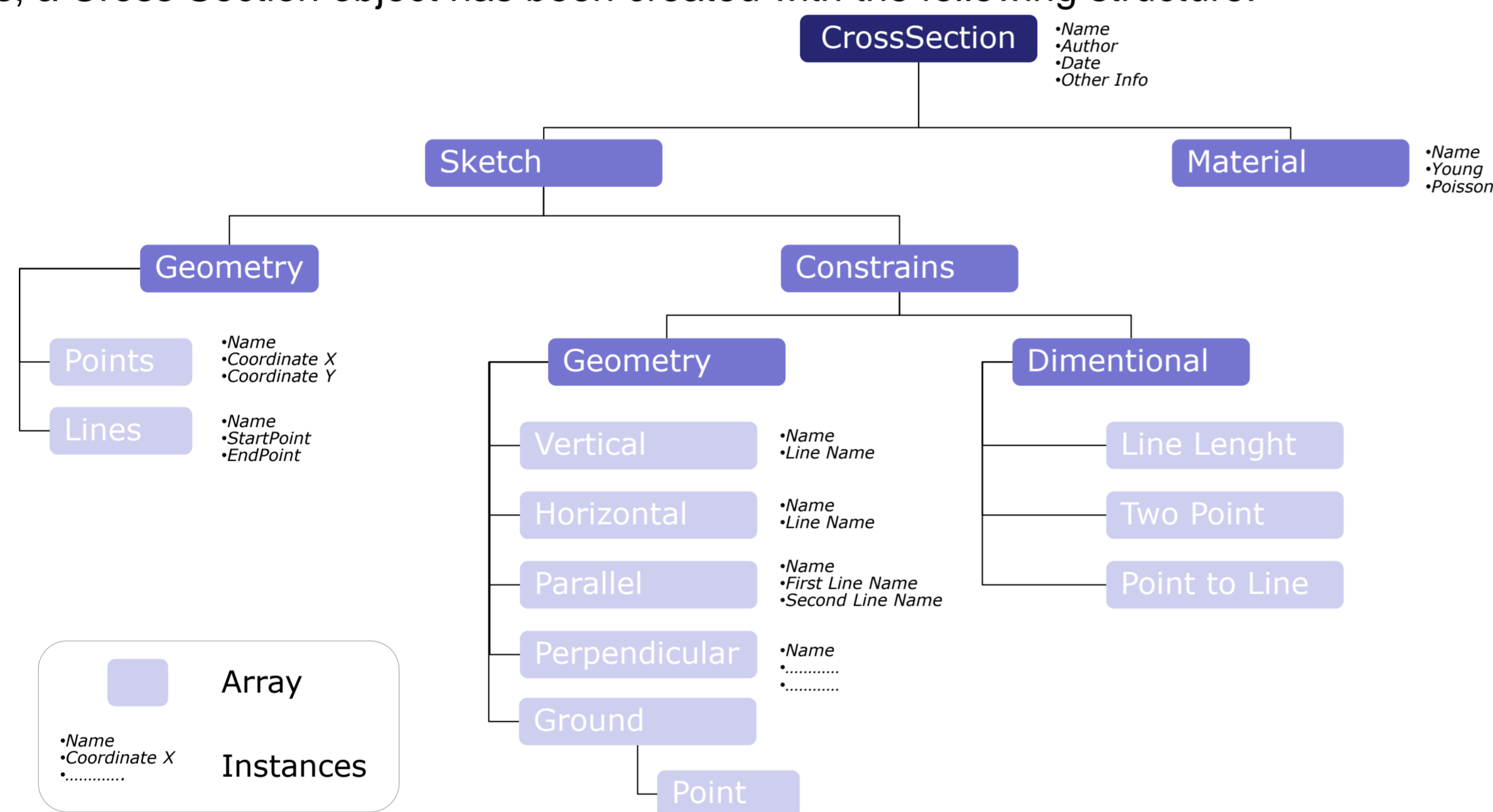

Using the API provided by the Inventor Application, it is possible to access to the points and lines information stored in the Inventor database. Only the needed information is stored into a *PROXY MODEL*, that includes the sketch information and some more additional data that the designer can enter, such as the material properties or some sketch comments. This is the goal of the *Data Extractor*.

In order to make the sketch information accessible to other programs it is decided to store this information into a neutral data structure called as the xml format. This work is done by the *Exporter* that serializes the information stored in the CrossSection object and creates the xml file. The idea is to give an high flexibility to the software for the future purpose, for that reason two exporters were designed. This will ensure the opportunity to get information from another CAD software, changing only the *Data Extractor* and export the cross section data also into other data formats, by changing only the *Exporter*.

Constrains

The constrains in the CAD modeling are entities that relates lines and point to each other in order to reduce the design time if some changes on the sketch are needed. The constrains exported in this project are basically the horizontal, vertical, parallel, perpendicular, and fixed constrains, plus the dimensional constrains.
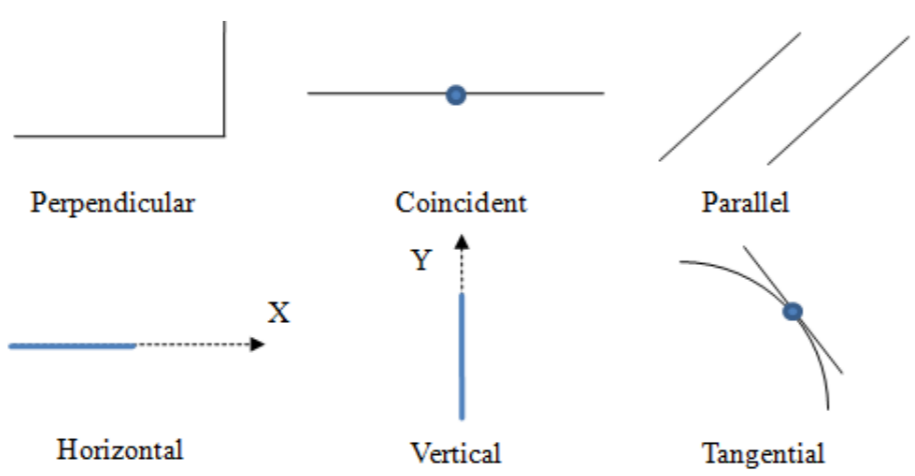
The bridge cross section

In SOFiSTiK the bridge is defined as a sequence of cross sections and each one defined at a certain value of the curvilinear parameter "s" along the axis. The *main cross section* is defined as a polyline that intersect a set of standard points STPs, for that reason it is necessary to provide the STPs as sequence in order to avoid the definition of intersected cross section.
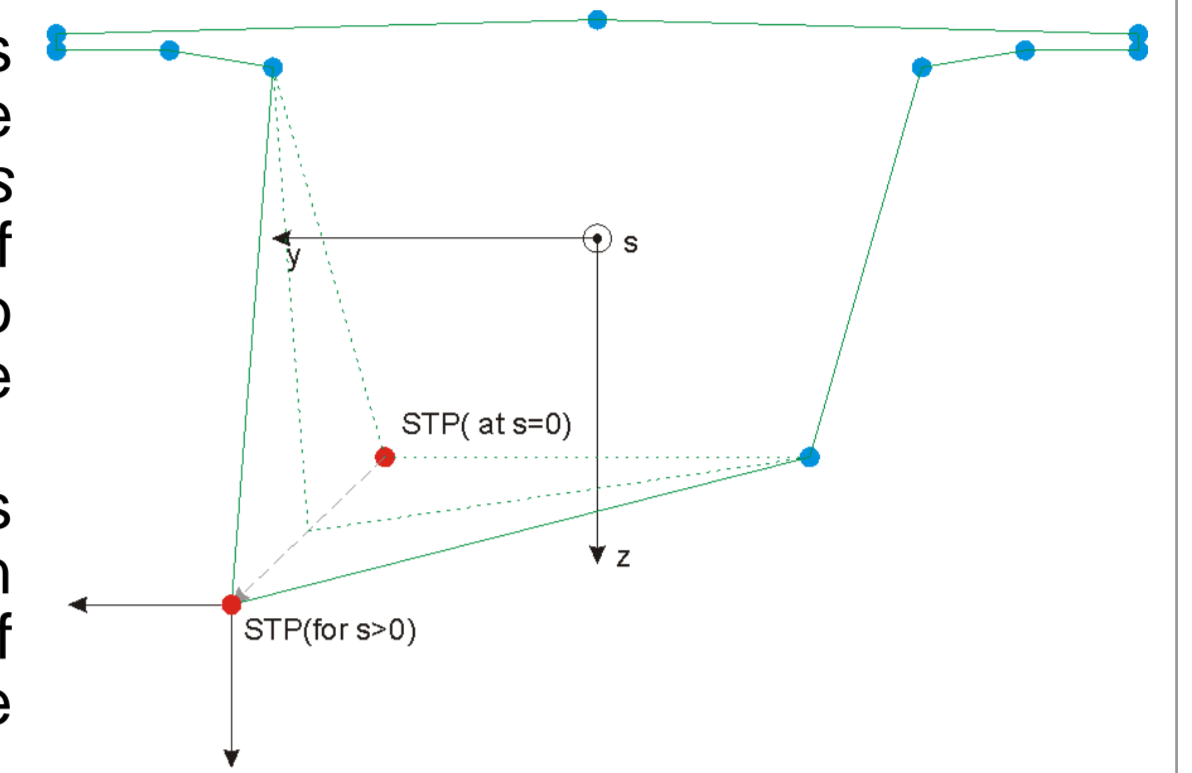
The coordinate system is defined as Y and Z, and the STPs position can be related to some variables whose value can change along the bridge axis. This leads to the change of the polyline shape at different "s" values, hence to the change in the cross section shape.

The application of a constrain to a line reduces the number of degree of freedom that the sketch has in the 2D plane. This leads to a reduction of the number of coordinates variable that is necessary to control in order to change the cross section topology along the axis.

From XML to CADiNP

SOFiSTiK works using an input data files in CADiNP language. For that reason a *Translator* is designed. Its role is to create the CADiNP file with all the geometric and the constrain information from the xml file. It is developed as C# function and implemented in the GUI. From the xml file all the information is stored in a CrossSection object and from that the CADiNP file is created as .dat file.
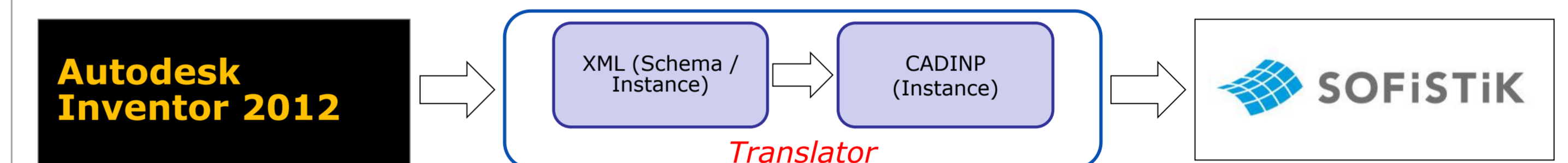
The development of the different type of constrains is done according to the algebraic geometry equations. Each line is defined by a couple points whose coordinates depends can change along the bridge axis $P0(Var1, Var2)$. The constrain act always on the Y or Z variable of the second point that is involved in the constrain.
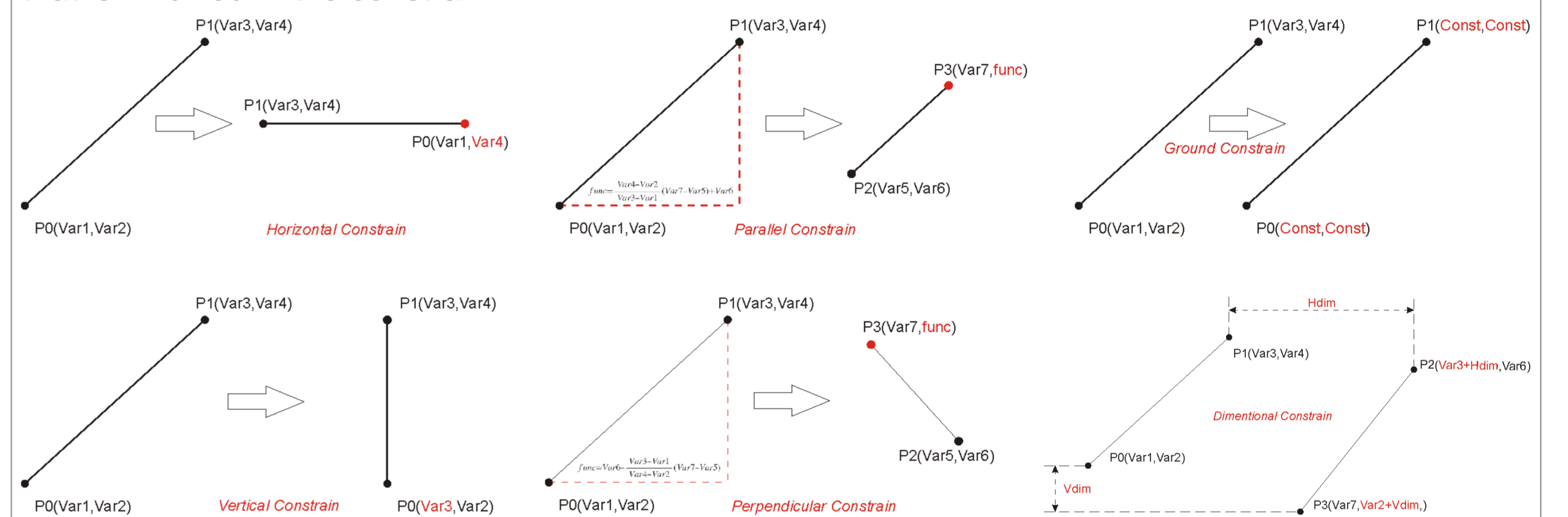

- *Ground Constrain:* the Y and Z variables of the STPs involved in the constrain are set as constant values.
- *Horizontal Constrain:* the variable related to the Z coordinate of the second point of the involved line has always the same value as the first one.
- *Vertical Constrain:* the variable related to the Y coordinate of the second point of the involved line has always the same value as the first one.
- *Parallel Constrain:* the variable related to the Z coordinate of the second point of the second line involved in the constrain fulfills the line equation of the first line.
- *Perpendicular Constrain:* the variable related to the Z coordinate of the second point of the second line involved in the constrain fulfills the perpendicular line equation w.r.t. the first line.
- *Dimensional Constrains:* the variable related to the Z or to the Y coordinate of the second point has an additional offset value w.r.t. the first point coordinate.

Conclusions / Outlook

At the end a GUI included in Inventor sketch environment has been designed. It allows to sketch some prescribed cross sections, to export the xml file or to create the CADiNP file.

The program is also able to handle both the external and the internal cross section, but they need to be defined in two separate sketches. The two cross sections are considered as two separate entities but the software is able to merge them in the same CADiNP file. Because of each constrain is defined trough an equation applied at the Z variable of the second point involved in the constrain, this leads to some limitation when more constrains are applied on the same line. This problem could be solved only by using a different design approach that could be the implementation of a geometry constrain resolver.
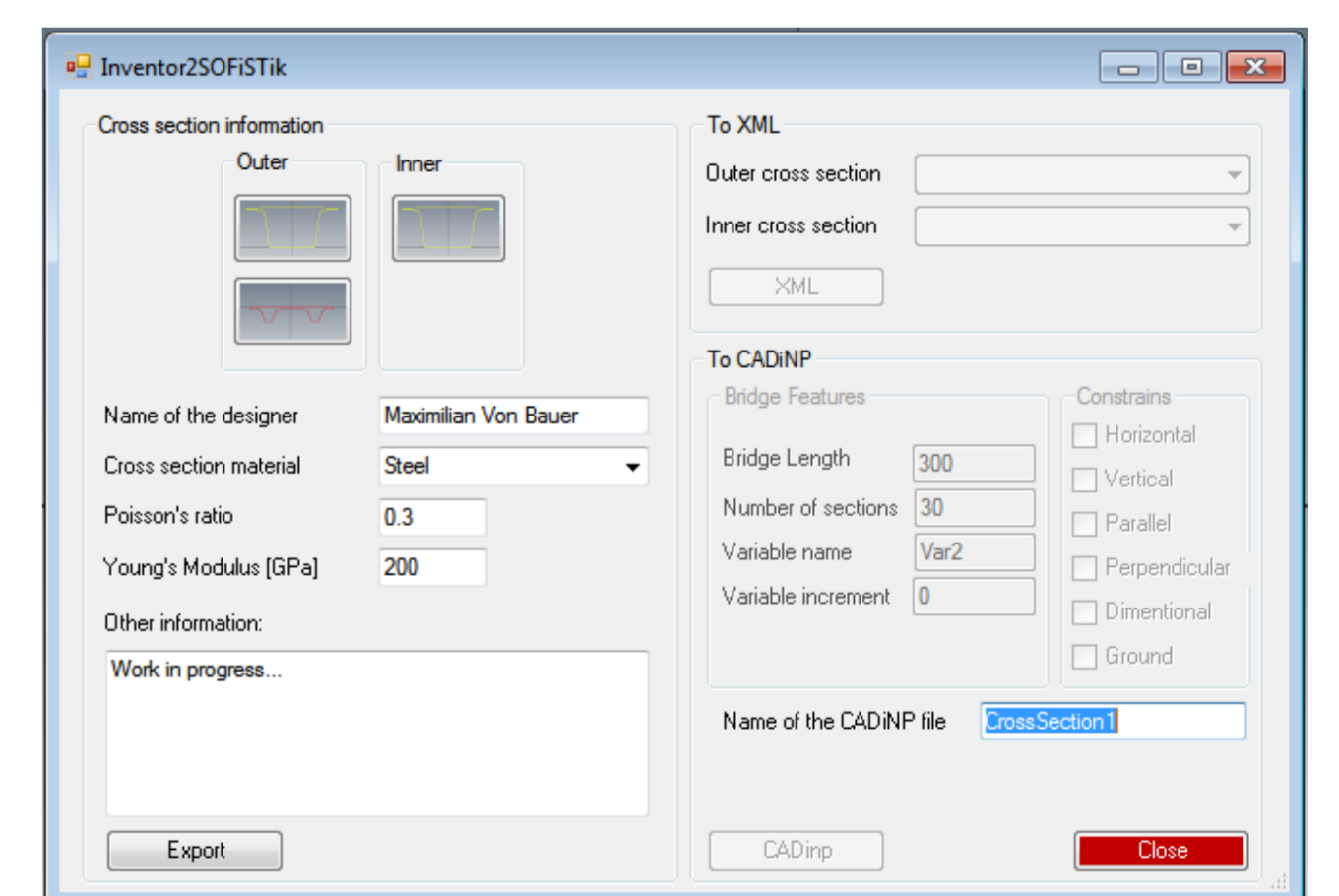
Further works could be done in expansion of:

- *Data Extractor* to get the cross section data from another CAD system like Siemens NX.

- *Exporter* to export the cross section into an IFC-Bridge data model using an EXPRESS language.
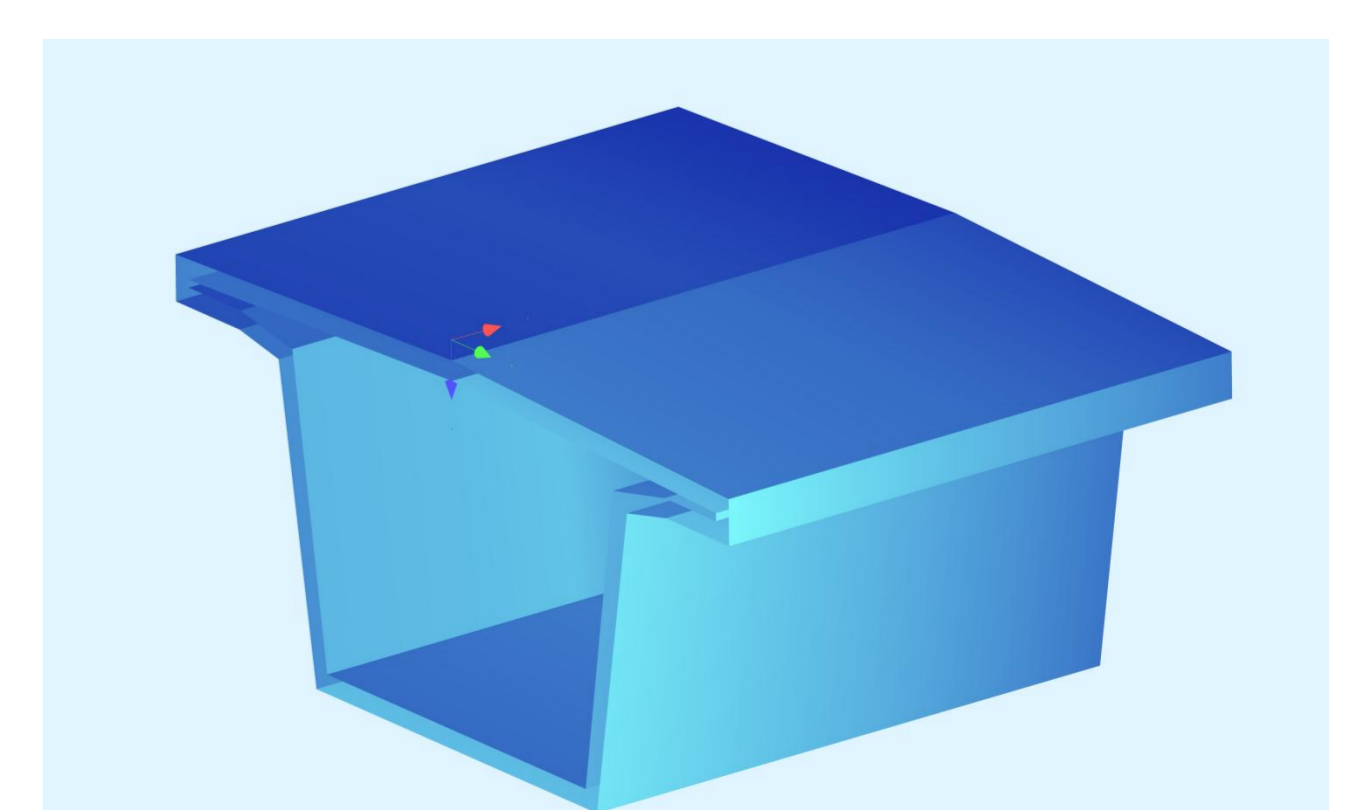
References

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