Космічні і геоінформаційні технології, засновані на плані розташування ProVI

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У зв'язку зі зростанням складності сучасних проектів, динамічним характером будівельних майданчиків і розташуванням більшості об'єктів на великій відстані від конструкторських і інженерних бюро, обов'язковим елементом управління проектом, зокрема, для проектів з чітко визначеним часовим плануванням, є реалістичне планування. Якщо виконане воно належним чином, то значно допоможе ідентифікувати можливі джерела економії витрат та забезпечить мінімізацію відставання у часі окремих стадіїв будівництва. Після розробки проекту автомобільної або залізничної дороги проектувальники завжди страждають через те, що у більшості випадків проект, виконаний в офісі не становить оптимальний варіант для виконання на будмайданчику чи, навіть, не може застосовуватися. Тому дуже великою перевагою було б забезпечення проектувальників багатовимірною картиною, яка б представляла місцевість зведення будівлі.

Ознайомлення з проектувальною зоною допомагає інженеру уникнути розташування об'єктів у невідповідних місцях, може також запобігати розташуванні проектів на територіях, що охороняються. Застосування методу реалістичного планування гарантує використання оптимальних рішень на кожному етапі проектування. Цей метод полягає у зображенні на 3D моделі стану будівельного майданчику, що може допомогти визначити найкраще розташування плану проекту. Одним з основних викликів для планувальників повинна бути спроба встановлення зв'язку між Базою даних планування і Супутниковим образом. Головним завданням є розробка кращої комбінації взаємодії растрових і векторних даних у такий спосіб, щоб усе моделювання відбувалося в реальному часі;

У цій роботі описано, як космічна технологія, супутникові образи з різними колірними / тепловими каналами, інтегрованими в інформаційну систему, забезпечують корисною інформацією віддалені проектувальні бюро, точно візуалізуючи місцевість і об'єкт проектування. Внаслідок проведених досліджень встановлено наступну залежність: чим коротший час обробки зображень, тим більш актуальна соціоекономічна інформація.

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Space Technology and GIS in ProVI based Alignment Planning

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With the increased complexity of today's projects, and the dynamic nature of the construction sites, giving a glance over the planning area helps cost savings and minimizing delays. For this purpose a linked 3D overview which moves simultaneously with planning can simulate the construction site and define the best location for the project plane. Attempting to establish a connection between Planning Database and the Satellite Imagery which can give the best combination for raster and vector data interaction; all online in a real time cyberspace as an information system provides the most helpful information of the project site for the remote office and feeds the 3D information of the terrain for an accurate visualisation. Performing an immage processing in shortest time would give one the most up to data spatio temporal information.

Keywords – GIS, CIS, Space Technology, Cyberspace, Alignment Planing, Spatio Temporal.

I. Introduction

With the increased complexity of today's projects, construction and time management are indispensable element of the project management. When properly executed, it will identify cost savings and minimize delays during construction [1].

Using the computer programs Intelligent Road and Railway Design attempts to establish a connection between two Points of Interest through an economical path. For this purpose it considers different Design Models, among them the cost models and the alignment optimization models. In his book (Intelligent Road Design, 2006) have discussed Jha et al the impact of different optimization methods, specially the revolutionary role of GIS solutions in road design models. As construction of roads or railways is great interference into the environment. Therefore, spatial data are very important in separate phases of the process [2].

The commonly used method in economic infrastructure design procedure is to minimize total cost or to maximize the total net benefit associated with the alternatives as well as to

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minimize the planning time, to avoid of double work and parallel planning and as result to prevent corrections and re-planning. To achieve this aim, it is important to increase in reliability of the comprehensive fundamental data fed into the design model. In this regard and to encourage independent, cost-effective, aesthetically pleasing, and environmentally sensitive road and railway design, the most proper methodology is to establish uniform design practice manual which includes the design guidelines and standards for geometric features, section elements, special structures, safety terms and erosion control (Road Design Manual published by Design Standards Unit).

In road construction, a roadway is traditionally designed using 2D views of the horizontal and vertical alignment coupled with a series of cross-sections along the road axis. This approach allows the civil engineer involved in the road design to concentrate on the major design tasks, like the radius of curvature and gradient and contributes towards reducing the complexity of the design work. Another requirement is information on the adjacent terrain [3].

Born around 30 years ago, CAD systems can provide rapid evaluation of alternative alignments, optimization techniques for road project planers, and powerful search tools for large number of alternative alignments in short spans of time. Therefore most of the alignment software packages if not all, are CAD based. Besides the ability to analyze, recognize and link local, national, or international road design standards, CAD processes are quiet suitable for the criteria-standard based modeling task of road design project. The models aims at designing a path with minimum total road costs, while conforming to design specifications, environmental requirements, and driver safety. GIS with its spatio-temporal analysis tools can still be a very helpful solution in very early steps of alignment planning.

Therefore Infrastructure Design is a suitable area of help for GIS design applications, as Road and Railway Design starts with satellite technique and image processing methods. The general design task for the layout of a road or railway is to find the technically feasible alternative road layouts between two points and to select the best for further assessment. Given are the design parameters of the road (design speed, minimal radius of curves, maximum slope) and information about the terrain (land cover, elevation, geology). The alignment problem is sufficiently complex to pose substantial research questions, but simple enough to be tractable [4]. This is a permanent inevitable procedure of data transaction which is performed unnoticeably manually in today's common design processes and ends to a long feedback operation which can be speeded up if modeled and embedded in the alignment planning package. This is highlighted in the Fig 1.

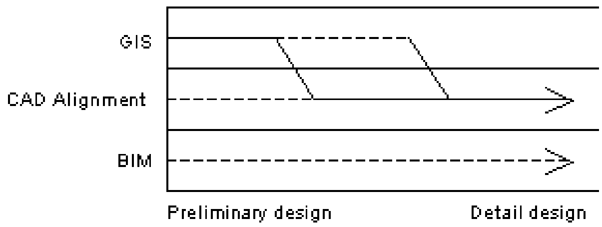

Fig.1 GIS, CAD, and BIM interaction in alignment planning(source: author)

II. GIS for Alignment Planing

Database connectivity, features system, navigation, query, render options, special effects, hierarchical and multi-resolution database representation of GIS with its 3D graphics and efficient new algorithms for terrain visualization gives the techniques which can be combined with fast handling methods for large amounts of data to make integrated GIS visualization systems. Virtual GIS can be used almost in any field of planning process. Planners for new road and railway facilities can see full 3D views from their prospective sites or can see the view from nearby existing landmarks with the planned facility in place. The Fifth Dimension of GIS "spatially enabling business and analytic intelligence", extends existing concepts of enterprise, interoperability, and integration and creates new value for planers by leveraging the power of place and analytics in support of fact-based decision making, planning, and operation. Notwithstanding its universality of purpose and function, there has been little deep integration of GIS with the Road and Railway Data Models used by planers even though many Design Programs rely on the same or very similar data models. Traditionally, the principal driver for data sharing, integration, and interoperability has been the cost of data acquisition and maintenance.

However this is changing. Increasingly, design model integration; Web/data/application services; simplified system administration; and operations, asset, financial, and human resource management are the driving forces. Very adequate methods of simulating time and cost data and integrating them with planning data is one of the advantages of GIS. Besides GIS' possibility of Data Interoperability enables one to easily use and distribute data in many formats. Take advantage of the spatial extract, transform, and load (ETL) capabilities to eliminate barriers to data sharing and provide accurate spatial data to your users. GIS data interoperability's direct read option makes the direct read and use of supported formats among them LandXML, IFC, CAD, and BIM data for visualization, mapping and analysis purposes possible [5].

III. Alignment Planing in ProVI©

With its proprietary data model, ProVI© [6] is a CAD complaint graphic interactive program system based on

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AutoCAD for the transport and infrastructure planning in the fields of road, rail and drainage. ProVI builds directly on AutoCAD, which means that all graphical elements created through the program are AutoCAD elements and thus all functions of this system are already available to the user in the design stage. Currently AutoCAD versions 2007 to 2011 and the desktop solution Civil 3D are supported. The clear, modular structure, the context-related online help and the windows-oriented design of the user interface enable economical, effective application of ProVI after just a short familiarization.

In the Road Design Module, all computation results can be validated in accordance with the relevant guidelines. In addition to the general features, there are special programs for the calculation of sight distances, tractrix and traffic intersections. ProVI includes a large number of location and level plan building blocks specific to road building as well as traffic signs which can be introduced into the drawings to make the subject matter clear. From concept to the final production of drawings, not only the German (RAA, RASt, RAS, EAHV, RLW, ERA) but also the Austrian (RVS) guidelines can be taken into account. The user can easily integrate further regulations according to the specific requirements of a project. In the Railway Design Module, all new computations can be carried out and validated in accordance with guidelines.

In addition to the DB AG, ÖBB, SBB and TSI regulations, further standards can be implemented without any problem. The guidelines of BOStrab are also supported for all local transport projects. Drawings are laid out according to the relevant drawing standards. In addition to the general features, there are programs for calculating points, the display of point level plans, consideration of ballast-less track and much more. ProVI contains a great number of railway-specific location and level plan building blocks which can be introduced into the drawings to make the subject matter clear. The design of high-speed Maglev systems represents a particular challenge when designing alignments. ProVI offers a special module for this which can cope with all calculations specific to such systems. ProVI designers have been involved in almost all Maglev projects worldwide [7].

Fig.2 CAD complaint ProVI alignment planning (source: author, ProVI)

ProVI Planing through GIS

Proper design requires the blending of safe roadway layout and grade with minimization of impacts on the existing terrain and environment. These standards are further intended to be flexible in consideration of different traffic volumes and terrain conditions. These guidelines describe besides the range of influences, information, data, criteria, and other considerations that may have to be considered in developing a road or railway project. These include appropriate recognition of transport demands, safe and efficient traffic operations and achievement of balanced provision for the needs of all road users and ensures consideration of context sensitive design and the associated concepts of design domain and functional classification of roads.

In accordance to the standards real world data should be acquired which is the first step towards setting up a simulation framework for the design process. The implementation includes also a 3D visualization aspect which will be added to the ProVI environment. As shown in Fig 3 and 4 this enhances the whole entire planning procedure, speeds up the decision making, reduces the planning costs, and consequently optimizes the planning processes.

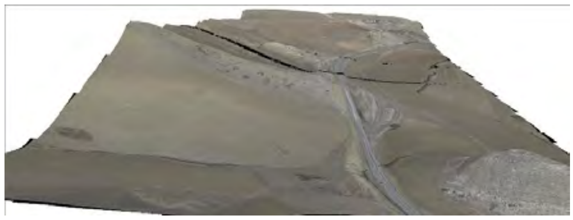

Fig.3 3D View of GIS application in aligment design before spatial analysis of ProVI (source: author, ProVI, GIS)

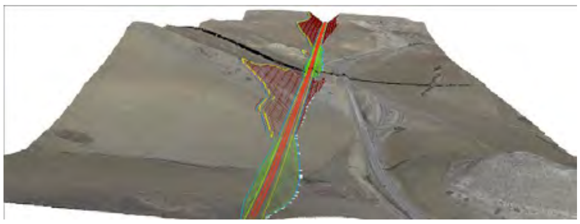

Fig.4 3D View of GIS application in aligment design after spatial analysis of ProVI (source: author, ProVI, GIS).

For this paper a ProVI program sequence and data flow for execution a road or railway task was tested. The result is packed in a visualization movie which will present the Terrain Situation before and after construction, and earth work statistics.

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Conclusion

This paper has presented implemention of a customization method and transformation concept between available graphical environment of ArcGIS® and mathematical environment of CAD based ProVI® The transaction of data in these two environments runs loss less. The implementation can be exploited straightforward by planners to apply an online control model during planning, e.g. for management of time, cost, optimum alternative solution for the best decision making..

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