

Article

Optimal Design of Ski Tracks in Construction Projects: Taking the Warm-Up and Training Ski Track of the South Area in the Yanqing Competition Zone of the Beijing 2022 Winter Olympic Games as an Example

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Abstract: Mature civil engineering software and platforms can provide a dynamic correlated situation of the road design, generate a quick and accurate grading design in terrain model making, and, most importantly, improve the design efficiency and calculation accuracy and reduce the workload of designers in the construction project. However, the application of existing platforms in complex site engineering for the design of ski tracks has not been well developed. The design process of ski tracks requires consideration of elaborate requirements in complex environmental conditions. In this study, we aim to simplify digital elevation model (DEM) data, optimize ski track contour lines, and localize the design expression of the ski track designs based on the experience of the construction of the National Alpine Ski Center in the Yanqing Competition Zone for the Beijing 2022 Winter Olympic Games. This study examines the feasibility of the optimal digital approach combining mathematics and computer science based on the case study of the warm-up and training ski track of the south area in the Yanqing Competition Zone. This study will contribute to the optimal design of skiing tracks in construction projects and help to improve designers' workload efficiency for the design and construction of ski tracks in the future.

Keywords: building information modeling (BIM); Beijing 2022 Winter Olympic Games; warm-up and training ski track of the south area in the Yanqing Competition Zone (WTST); digital elevation model (DEM)



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1. Introduction

1.1. The Development of Digital Design in Architecture

Technology follows design demand rather than design adjusting to the availability of new technology [1]. Starting from school, design and architecture students routinely use the best of the new technologies that provide information-rich and fully networked multimedia environments [2]. The tool of digital design is increasingly able to express designs through the rational medium of computing. Due to the efficiency and effectiveness of digital design, the traditional architectural design industry has already been subverted by it, especially in mega-complex construction projects [3,4]. The use of BIM technology could save around 5% in overall costs, and the 3D digital workflow contributes invaluable time savings [5,6]. Consequently, the building information modeling (BIM) process has been progressively implemented worldwide in the architecture, engineering, and construction (AEC) realms [7,8]. At first, the digital modeling process provides the choice of the BIM-oriented software more suitable for the modeling of transport infrastructure. The most used software tools are Civil 3D (developed by Autodesk), OpenRoads (Bentley), Roads (Sierrasoft), and so on, all of which can effectively manage infrastructure design and provide valuable support to project designers [9,10].

Civil 3D has proven to be one of the most effective tools, and it facilitates the integration between the structural/architectural elements, installations, and the infrastructure axis by allowing for the interchange of file formats. Furthermore, Civil 3D offers useful tools for the customization of parameters for every digital object of the model. According to the above, the BIM model was prepared for the development of the subsequent phases of digital modeling by means of the Civil 3D software [6]. New digital technologies, such as BIM, algorithmic modeling, automation methods, and augmented and virtual reality (AR/VR), have the potential to support interdisciplinary industrial construction projects but are not fully exploited yet [11,12]. Furthermore, the application of Civil 3D can only provide a platform for relatively fine calculations, and it requires in-depth design and research for practical implementation.

1.2. Beijing 2022 Winter Olympic Games

Beijing is the first city to have ever hosted both the Summer and Winter Olympic Games. The Chinese people's perception of the Olympic Games changed from trying to have the most challenging and best one to having the most sustainable one. Instead of being number one for gold medals during the Games, the aims of hosting the Games have been developed to create a positive environmental impact with new development for the northern region of the country, promote winter sports, and improve the health and well-being of the Chinese people. Consequently, at least 300 million citizens were motivated to be involved in winter sports as an outcome of hosting the Winter Olympic Games. Meanwhile, the Beijing 2022 Winter Olympic Games not only promoted winter sports events, but also provided a stage for the demonstration of the most advanced technology.

Yanqing Olympic Zone is a snow-related construction project with the shortest construction period, the highest difficulty, and the highest construction standards in China [13]. One of the competition venues—the National Alpine Ski Center—is the highest-level alpine skiing track in China and the first alpine skiing track in China that meets the Olympic standards. Even though existing ski resorts in China (see Figure 1) provide invaluable experiences, the National Alpine Ski Center is the first venue to meet the Winter Olympic Games requirements, and it promotes the development of the ski resort industry in China.

The design consortium (see Figure 2) for the Beijing 2022 Winter Olympic Games in the Yanqing Competition Zone includes the China Architecture Design and Research Group (overall lead organization), Beijing General Municipal Engineering Design and Research Institute Co., Ltd. (for municipal transport) (Beijing, China), Ecosign Mountain Resort Planners Ltd. (for alpine skiing tracks) (Whistler, BC, Canada), and PlanungsbüroDeyle GmbH (for sliding center track and its cooling system) (Stuttgart, Germany) [13].

For all of the racing and technical events in the Winter Olympic Games, the competitions raised a challenge for the construction parameters of their tracks, which lead to a complex design of the ski tracks. The tracks hosted all the alpine skiing events of the Beijing 2022 Winter Olympics and Winter Paralympics, including downhill, slalom, giant slalom, super-g, combined events, and team events. The National Alpine Skiing Center is located at the southern foot of Xiaohaituo Mountain in the north of the core area of the Yanqing Competition Area with about 960 m of elevation difference and an average gradient slope of above 40%. The National Alpine Ski Center has three competition tracks, four training tracks, other contacts, and technical tracks. The total length of all tracks is about 23.1 km, and the maximum vertical drop is about 925 m [14].

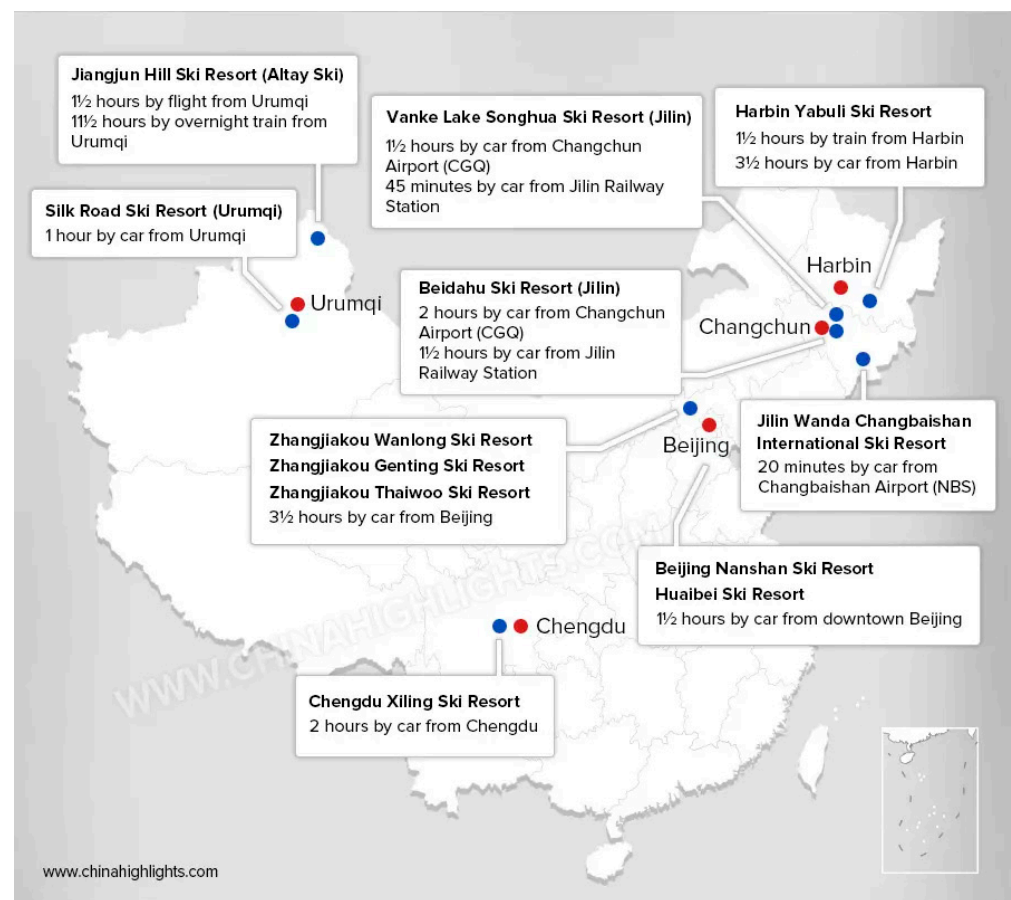


Figure 1. Selected ski resorts of blue dot and provincial capital city of red dot in China. (source: <https://www.chinahighlights.com/travelguide/china-ski-resort/#top> (accessed on 2 February 2023)).

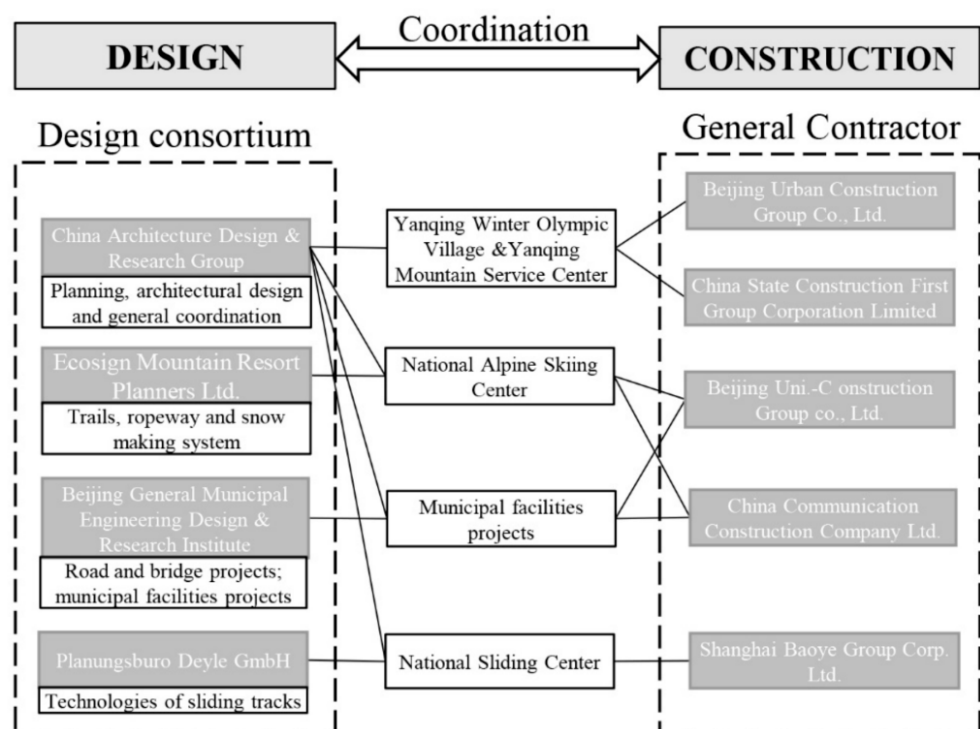


Figure 2. Design consortium and general contractors of the Yanqing Competition Zone [13].

2. The Existing Design Challenge for Ski Track Design and Planning

Alpine skiing involves a variety of formats and tracks with the terrain and environmental conditions changing greatly. A variety of studies have investigated alpine skiing in relation to tracking methods for athletes [15,16], injuries [17–19], and sports equipment and achievements [20,21]. There is little research focusing on the technology used to plan the construction of ski tracks.

2.1. Advantages of Selected Design and Planning Tools

The economic factor of the alpine skiing resort plays a significant role in restricting its construction and development. Mature civil engineering software, such as Civil 3D, has been widely employed in complex site design and mega construction projects. Building information modeling (BIM) helps architects draw from a range of perspectives to control complex situations from the design process to the construction [22]. It has advantages in processing complex sites and line selections. It provides not only more efficient workflows with high accuracy but also faster inspection activities as well as real-time 3D digital design data for determining the investment in engineering quantity statistics [23]. Thus, it can control economic investment effectively in the whole process from the design process to the construction drawing. For the design drawings, the civil 3D data adopt the linkage mechanism. For a little adjustment, all relevant drawings such as the snow track plan, the profile view, and the cross-sectional view are updated with the linkage, which can save a lot of drawing time. Civil 3D can accurately create the existing topography. It is one of the design platforms of BIM technology in the field of municipal engineering, so it is suitable for the vertical planning and design of large-scale sites in mountainous areas. Civil 3D has been widely applied to earth rock calculations and site leveling design in some related projects [23–25].

2.2. The Application of the Tool in the Design and Planning of the Ski Tracks

The advantages of Civil 3D help to deal with the complexity of the design and planning of the ski resort, including site information confirmation, ski track selection, and so on. Autodesk Civil 3D was the main software used in the ski track design for the National Alpine Skiing Center of the 2022 Beijing Winter Olympic Games. When using Civil 3D, there are four main stages in the process of ski track design. The first is to perform in-depth research on the topographical features, hydrogeological conditions, and landscape transformation and propose a rational overall layout of the ski tracks. The second is to determine the key characteristics of each ski track, including the reasonable grades, width, and slope. The third is to refine the ski track model based on the terrain and geological conditions, including the slope retaining walls, intercepting ditches, drainage ditches, flood discharge ditches, and other structural models. The fourth is to calculate the main engineering quantities and estimate the economic cost to ensure a reasonable and affordable design of the ski track. Designers manipulate the model on the platform to continue to optimize the design of the ski track. The four-step design of ski tracks reduces labor workload and improves work efficiency.

2.3. The Challenge of the Application of Civil 3D in the Design of Ski Tracks

However, the application of Civil 3D in the design of ski tracks still has its limitations. Firstly, large-scale building models in the design of an alpine ski track contain many interdependent objects, and the response speed and data synchronization are affected. When the number of BIM objects is relatively large, the search/scanning process carries with it a significant computational cost, which eventually slows down the computer and reduces work efficiency [26]. Secondly, the perimeter of the ski tracks can be calculated based on their contour lines. The contour lines of the ski tracks in the building information model are always distorted and uneven. Thirdly, the existing programming in Civil 3D cannot directly generate cross slopes and integrate this information into the contour lines. Fourthly, the earthwork calculation needs to be refined to be more accurate to avoid large deviations in the calculation results. Finally, a series of cross-section tools have been

provided in the platform, but these do not meet the requirement of Chinese architects' drawing habits.

Based on the construction experiences of the National Alpine Ski Center for the 2022 Beijing Winter Olympic Games, Civil 3D indeed played a significant role in the site and ski track model building. However, there is limited application of Civil 3D to refine ski track design. The existing package cannot directly guide designers to manage the required workload for ski track design. The existing challenges in the use of Civil 3D in the design of ski tracks require optimization to improve work efficiency. This study aims to employ a parametric approach to optimize ski track design to overcome the challenges in the construction practice.

3. Methodology

3.1. Description of the Case Study

The success of the National Alpine Skiing Center was achieved through the research and development of a number of key technologies that were explored by the design consortium (see Figure 2). This successful construction experience shines a light on the future design of ski resorts. To realize China's pledge to motivate 300 million people to be involved in winter sports and take advantage of the Beijing 2022 Winter Olympic Games, the warm-up and training ski track (WTST) of the south area in Yanqing Competition Zone was planned at the very early stage of the design. It was designed to be the best experience place for the public and the first stop of the Winter Olympic alpine skiing in the Yanqing Competition Zone. With several skiing facilities, including three detachable cableways, one towing track, and six magic carpets, and various themes including an interesting snow trail, a mushroom trail, and a veneer park, the WTST is one of the best ski resorts with abundant snow trails and the most advanced facilities in Beijing. As the first smart ski resort, it employs an information and intelligent service management system in ski tourism product design and activity planning. The venue enhances the richness and interest of the ski tracks and strengthens the uniqueness and respective characteristics of the different ski tracks. Given the high standard of research and development experiences in the design and construction of the WTST, the WTST is selected as a case study to examine the effect of the proposed optimal digital approach.

3.2. Analysis Tools

The planning and construction of ski tracks use the Civil 3D software as a model-making platform and AutoLISP in Autodesk CAD as a data manipulation tool. AutoLISP is a dialect of the programming language Lisp built specifically for use with the full version of AutoCAD and its derivatives, which include AutoCAD Map 3D, AutoCAD Architecture, and AutoCAD Mechanical [27]. Through AutoLISP, designers select control points and objects and import numbers for interacting with models in AutoCAD. AutoLISP integrates a graphical programming interface into AutoCAD, which can be opened by typing "*vlisp*" on the command line. The statistics system attempts to simplify digital elevation model (DEM) data and optimize ski track contour lines in a mathematical way.

A DEM is a digital simulation model of ground terrain that plays a significant role in the construction of ski tracks [28]. However, if the model data are not analyzed and manipulated in detail, but simply imported directly into BIM software such as Civil 3D, the DEM model will be oversized and the operation will be very slow in Civil 3D. When using the 2012 or higher version of Civil 3D, it takes a long time to build a model, which seriously affects work efficiency. Hence, it is necessary to optimize the topographic map and further simplify complex data. The analysis tool generates the definition of vectors to simplify DEM data by deleting middle points that do not affect the accuracy of the overall topographic map.

Through analyzing the DEM data, many straight lines can be expressed by two points that have many redundant points between them (See Figure 3a). Hence, if the characteristics of a series of points are consistent with the description of the overall topography, they can

be optimized by removing redundant points as shown in Figure 3b. More specifically, this optimization method compares the cross product of vectors formed by several adjacent points. A threshold value is set to decide if the point can be optimized. If the value of the cross product of vectors is closer to 0, it means that the directions of the two vectors are closer. In this case, the point can be optimized without affecting the accuracy of the overall topographic map.

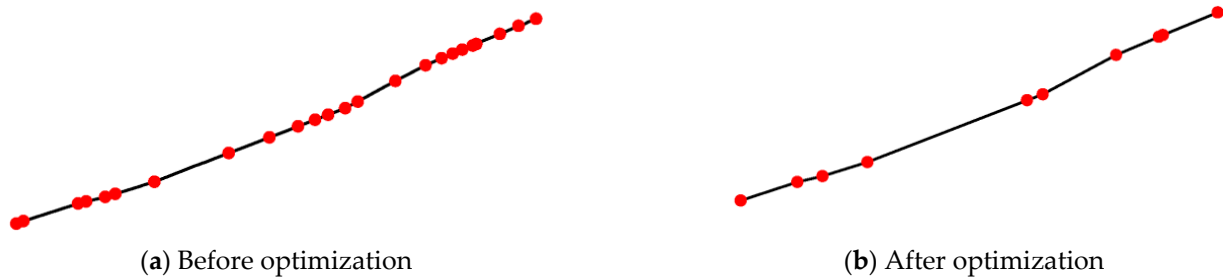


Figure 3. Optimization for a sample of redundant points in the middle of straight lines.

Snow track design is a process of gradual refinement from the ski track foundation to the snow path surface. The skeleton is first built and then the contour distance of 5 m or 10 m for the design of the contour line of the ski track is set. At the same time, the designed contour lines should be as close as possible to the elevation of the original terrain to avoid over-modification of the terrain. The preliminary model of the WTST combined ski track skeleton with contour lines is shown in Figure 4. The designated contour lines highlighted in purple were defined in the process of planning, and the blue contour lines highlighted in blue were defined in the process of calculation.

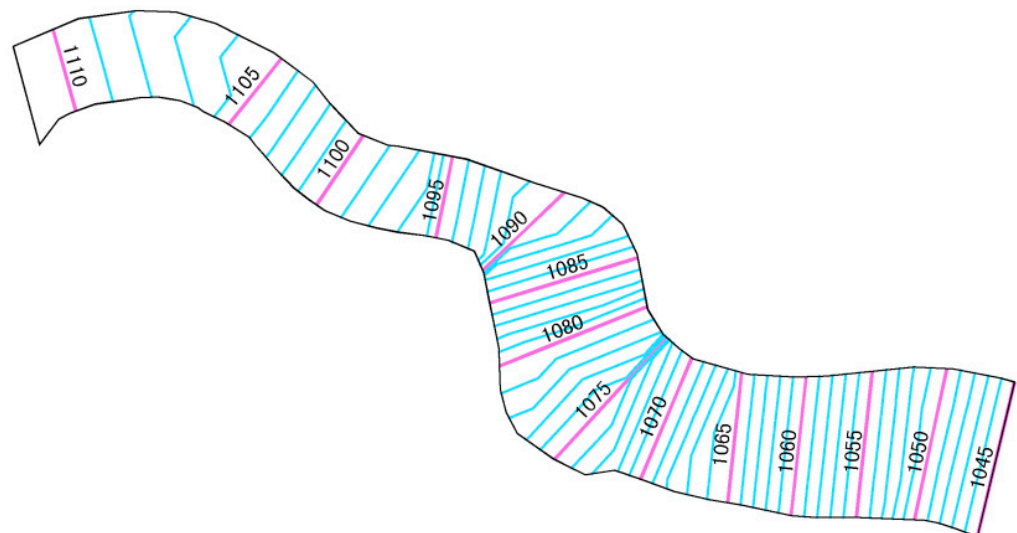


Figure 4. Examples of ski track contour lines of WTST.

The 1-meter contour lines will be distorted and uneven on the snow track surface in certain situations, which requires optimization. In practice, manual adjustment of contour lines is always time-consuming. The constructors wanted contour lines that were perpendicular to the centerline and as even as possible (see Figure 5). Based on the experience of the construction of the National Alpine Skiing Center of the 2022 Beijing Olympic Games, a method combining mathematics and computer science with three steps is proposed: (1) to set the point with a 1 m contour distance on the centerline; (2) generate a perpendicular line of the centerline based on the point set based on step 2; (3) increase the ski track cross slope.

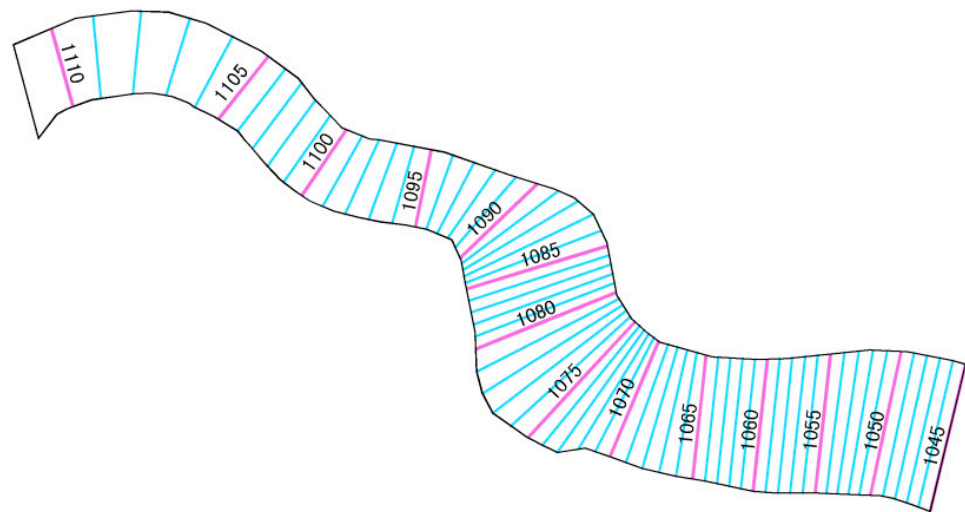


Figure 5. The contour lines that are perpendicular to the centerline and as even as possible.

The existing template of the Civil 3D could not fully meet the requirement of the Chinese project construction, and the expression of digital modeling drawing should be better understood by local designers and constructors. The localization of the design using AutoLISP includes three parts: (1) refining the earthwork calculation program; (2) localizing the graphical expression of section design; (3) providing a real-time 3D presentation during the life cycle design process.

4. Results

4.1. Simplifying Digital Elevation Model Data

The geometric meaning of the cross product is the area of the parallelogram formed by vector a and vector b (see Figure 6). As shown in Figure 6, suppose the three points on a line are point A, point B, and point C, and x , y , and z are the three-dimensional coordinates of the point, then Vector a and Vector b can be shown in the formula below:

$$\text{Vector } a = \vec{AB} = (ax, ay, az) \quad (1)$$

$$\text{Vector } b = \vec{AC} = (bx, by, bz) \quad (2)$$

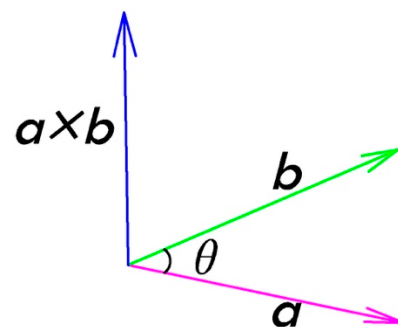


Figure 6. Vector a and Vector b .

Suppose i , j , and k are the unit vectors of the x , y , and z axes of the three-dimensional space, respectively. The cross product of Vector a and Vector b is as follows:

$$\begin{aligned} \text{Cross product } a \times b &= (ay \cdot bz - az \cdot by) \cdot i + (az \cdot bx - ax \cdot bz) \cdot j + (ax \cdot by - ay \cdot bx) \cdot k \\ &= \begin{vmatrix} i & j & k \\ ax & ay & az \\ bx & by & bz \end{vmatrix}. \end{aligned} \quad (3)$$

By using this optimal method, taking the red contour line as an example (see Figure 7), the number of points decreased from 20,139 to 11,642. The number of points is reduced to 57.81% of the original, which has greatly improved the computational speed of the subsequent calculations and met the speed requirements of the designers.



Figure 7. The selected contour line (marked as red in picture) of the digital model of the WTST.

4.2. Optimizing Ski Track Contour Lines

4.2.1. Setting the Point with a 1 m Contour Distance on the Centerline

The centerline of the ski track should first be marked. The designers could try their best to use engineering curves, including straight lines and arcs, and fit the centerline according to the plan. The point with a 1 m contour distance on the centerline was set based on the linear interpolation method [29]. Linear interpolation is a method of curve fitting using linear polynomials to construct new data points within the range of a discrete set of known data points. By using this method, the point with a 1 m contour distance on the centerline can be generated (see Figure 8).

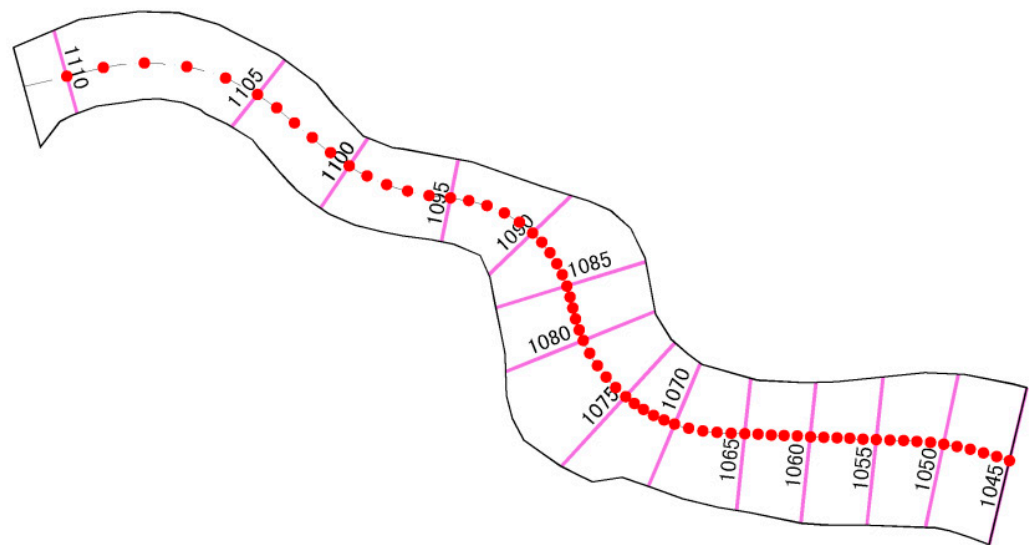


Figure 8. The points with a 1 m contour distance on the centerline by using linear interpolation.

4.2.2. Generate a Perpendicular Line of the Centerline Based on the Interpolated Point

Based on the knowledge of the ski track centerline and the point set based on the linear interpolation method, the perpendicular line can be generated. Firstly, the first derivative of calculus can be employed to find the tangent line of the centerline at the selected point. The geometric meaning of the first derivative of a point is the slope of the curve at that certain point. By calculating the first derivative of a point, we can obtain the line tangent to that point. The tangent line can be generated by using the “*vlaux-curve-getFirstDeriv*” function. Secondly, a mathematical technique is employed to generate a perpendicular through a curve tangent line. The geometric meaning of the dot product is the product of the length of two vectors and the cosine of the angle between them. As shown in Figure 6, suppose the point of the centerline set is point A based on Section 4.2.1, then we set the tangent line as Vector *a*, and the vertical vector of Vector *a* is marked as Vector *b*. Vectors *x* and *y* are shown in the formula below:

$$\text{Tangent line Vector } a = \vec{a} = (ax, ay), \quad (4)$$

$$\text{Vertical Vector } b = \vec{b} = (bx, by). \quad (5)$$

Then the dot product of vectors *a* and *b* is

$$\vec{a} \cdot \vec{b} = |\vec{a}| |\vec{b}| \cos \theta, \quad (6)$$

where θ is the angle between Vector *a* and Vector *b*. The Vectors *a* and *b* are orthogonal (their angle θ is 90°), which implies that

$$\vec{a} \cdot \vec{b} = ax \cdot bx + ay \cdot by = 0. \quad (7)$$

Consequently, Vector *b*, the vertical vector of Vector *a*, is

$$\vec{b}_1 = (-ay, ax), \quad (8)$$

$$\vec{b}_2 = (ay, -ax). \quad (9)$$

Vectors *b*₁ and *b*₂ are two vertical vectors of the Vector *a*. Vector *b*₁ represents Vector *a* rotated by 90 degrees counterclockwise, and vector *b*₂ represents Vector *a* rotated by 90 degrees clockwise. Through the above method, we find the vertical vector to find the

position of the 1 m contour line, and we can easily draw a balanced and undistorted 1 m contour line (see Figure 5).

4.2.3. Increasing the Ski Track Cross Slope

The generated ski track still requires the inclusion of a cross slope for a more in-depth design. A cross slope is a geometric feature of a ski track surface; it is the transverse slope with respect to the horizon. It is an important safety and stability factor that provides a drainage gradient so that water can run off the surface to the designated drainage system. Considering snowy terrain, rainwater and snowmelt require the ski track surfaces to be at a certain angle for better drainage. Generally, the slope gradient of the cross slope is between 1.5% and 8%, varying according to the track's terrain conditions, geological conditions, construction conditions, and so on.

To set the ski track cross slope, Vector i is defined as the longitudinal vectorial slope of the ski track and Vector j is defined as the cross slope. The slope of the ski track is defined by Vector k (see Figure 9).

$$\text{Longitudinal slope Vector } i = \vec{i} = (ix, iy) \quad (10)$$

$$\text{Cross slope Vector } j = \vec{j} = (jx, jy) \quad (11)$$

$$\text{Ski track slope Vector } k = \vec{i} + \vec{j} = (ix + jx, iy + jy) \quad (12)$$

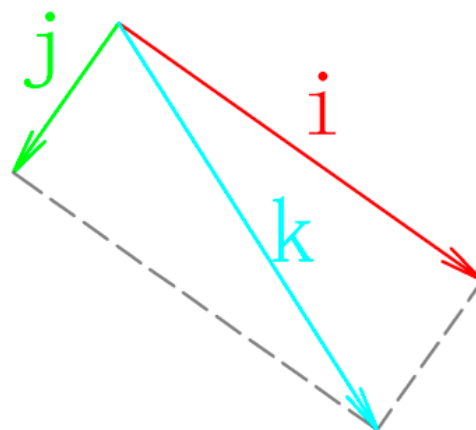


Figure 9. Increasing the cross slope for the ski track.

Vector k can be calculated based on Equation (6), and the contour line is perpendicular to the Vector k . Then, we can generate a perpendicular line of the cross slope and confirm the location and direction of the contour line of the ski tracks (see Figure 10).

4.3. Localizing the Design Expression

4.3.1. Refining the Earthwork Calculation Program

The earthwork calculation quantity and economic cost are extremely important for the feasibility of the project. During the design process of the ski tracks of the National Alpine Ski Center for the 2022 Beijing Winter Olympics, we found that the earthwork calculation software in the China localization package of AutoDesk Civil 3D has limitations in the calculation of the boundaries of the ski tracks, which result in large inaccuracies in the calculation results. Following an investigation of the issue, a secondary development was carried out on the Civil 3D platform, and we wrote an earthwork calculation program using AutoLISP to solve this problem. The program successfully resolved the limitations of the Civil 3D localized earthwork calculation program. The refinement of the earthwork calculation quantity has provided strong support for the high-quality completion of the WTST and reduced the time required for the design of a project.

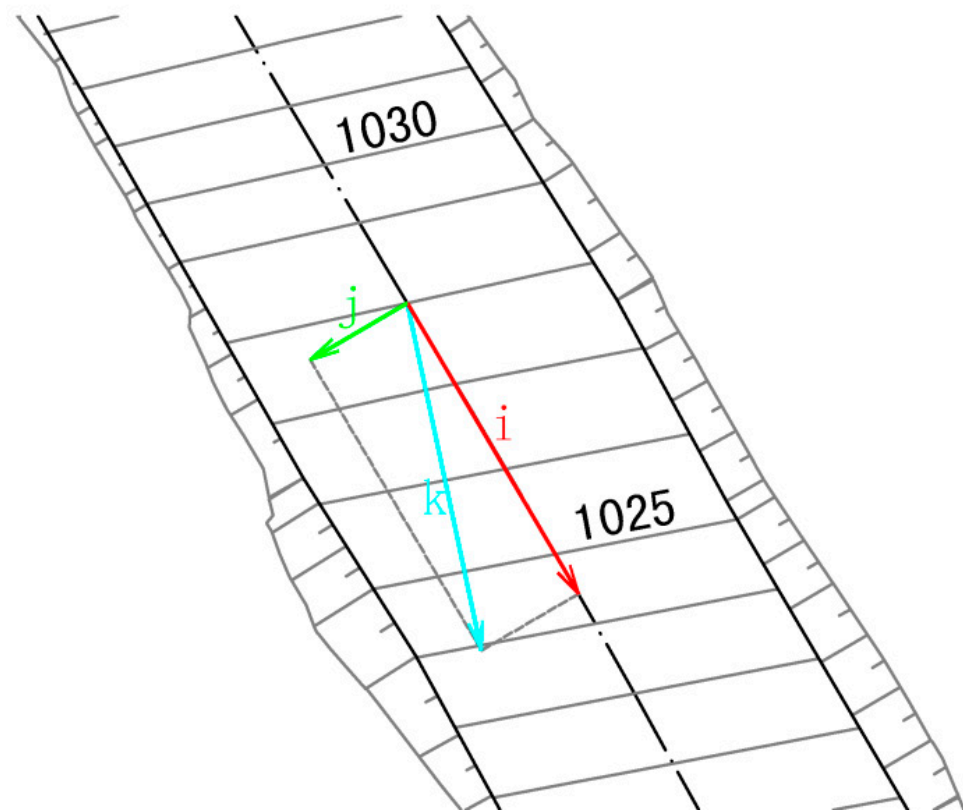


Figure 10. The contour lines of the ski track with cross slope.

4.3.2. Graphical Expression of Section Design

To facilitate the expansion of different drawing expression styles, Civil 3D provides a series of tools, such as “label” and “code set”. These tools make it convenient for designers to control the Civil 3D platform. Some of the tools can also be customized by designers using their own programs. However, based on the practice experience, the researchers found that it is more complicated than expected to use these tools, as their use requires users to spend plenty of time studying and adapting to this series of customized rules in Civil 3D. However, some of the functions we desire are difficult to obtain using these tools.

The cross-sectional view of the ski tracks of the National Alpine Ski Center can be seen in Figure 11. The designers have not yet well developed a cross-sectional module that conforms to Chinese drawing standards. With more lessons learned from the National Alpine Ski Center and more flexible time and workload in the design of the WTST, cross-sections were created using the Longitudinal and Cross Sections module we developed to fit the expression of China’s cartography and fully meet our requirements (see Figure 12).

4.3.3. The 3D Presentation during the Design Process

Civil 3D software is suitable for the planning and construction of ski tracks even though the hardware requirement is relatively high. However, its intuitive visualization is worse than that of other 3D visualizing BIM software tools such as SketchUp, Revit, Infraworks, Navisworks, Catia, and so on. Consequently, the combined model of Civil 3D + SketchUp is employed. Civil 3D is used to design and build 3D curved surfaces in the early stages and is convenient for design adjustment and construction operation and maintenance in the later stages. Meanwhile, SketchUp helps to integrate models, make animations, and render the images in the early stages and assists the designers by facilitating intuitive analysis and presentation of the designs in the later stages. Figure 13 shows the generated key characteristics of the ski tracks that were imported into SketchUp to render the models. The relationship between ski tracks and the mountain terrain can be visually seen through the 3D visualization. The rendering can also directly present

information on the thickness and range of earth filling and digging and quantitatively guide the planning and construction of the ski tracks. For visualizing the construction of the ski tracks, the slope protections were marked as green in the model. As Figure 14 shows, the size of the slope protection of the ski track was extremely reduced for this period of the ski track after the optimization.

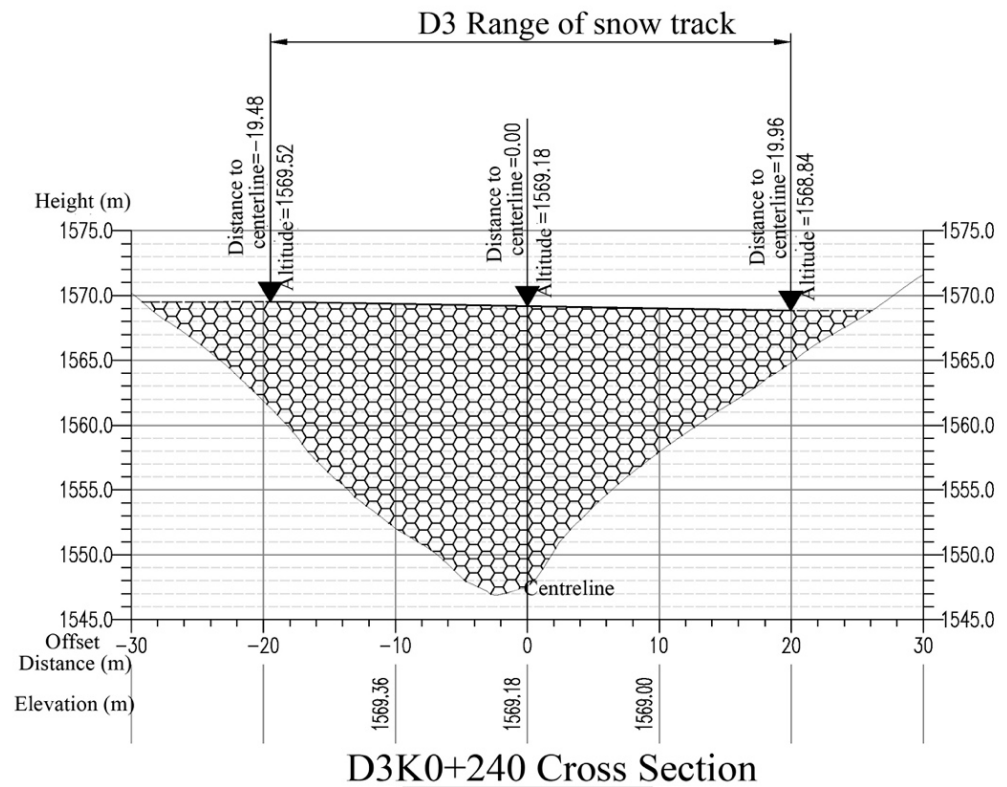


Figure 11. The cross-sectional view of the ski tracks of the National Alpine Ski Center.

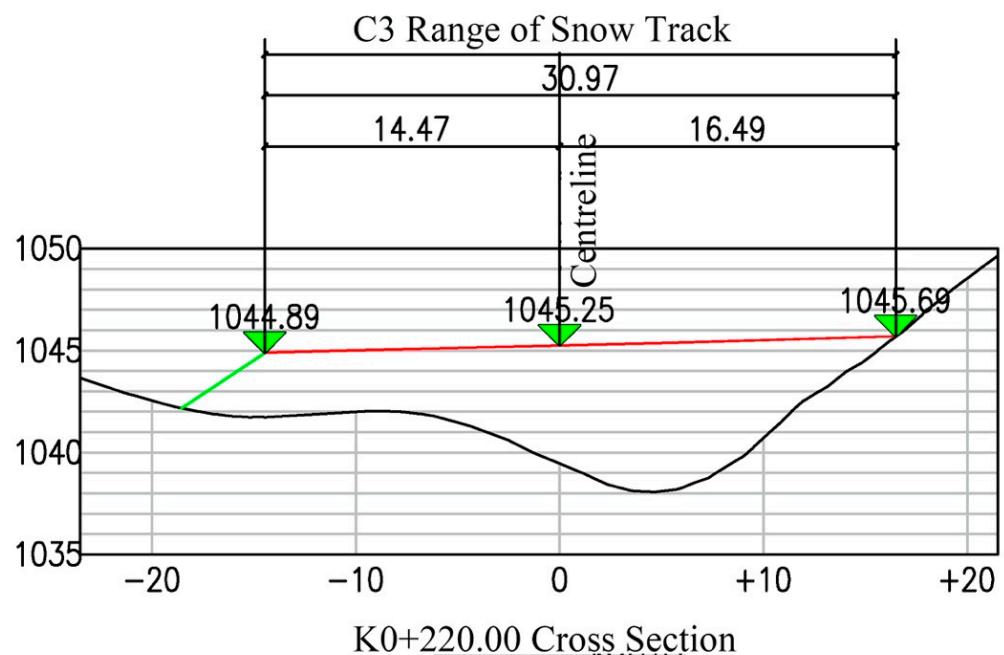


Figure 12. The cross-sectional view of the ski tracks of WTST.

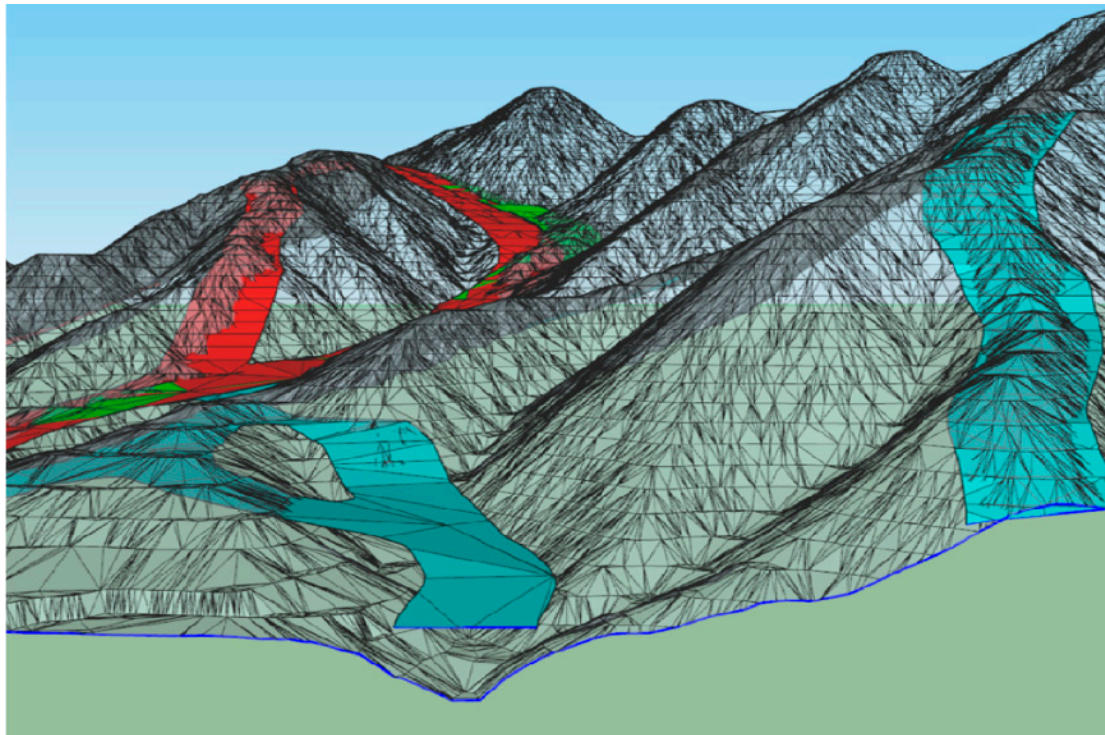


Figure 13. The combined 3D visualization of ski track models.

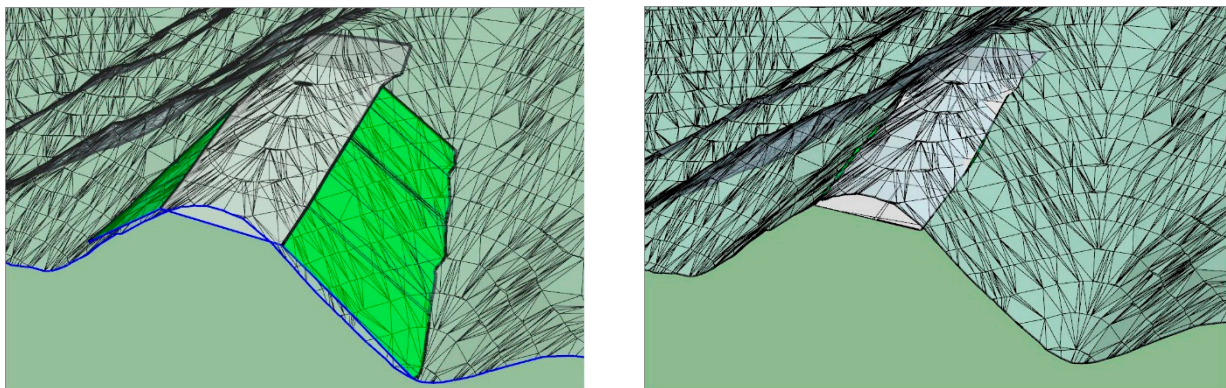


Figure 14. The comparison before and after optimization through 3D visualization.

5. Discussion

The Civil 3D package provides a mature design platform for designers to present their design idea digitally. However, its application in the planning and construction of ski tracks requires improvement. This paper attempts to tease out evidence for more efficient and accurate catering to the designers' working patterns and customs of drawing.

The generated model is oversized and difficult to be edited further based on the Civil 3D platform. A digital optimization was proposed to solve the problem. The cross product was employed to find the redundant points along the contour lines. The results indicate that around half of the points are redundant points, and removing these points helps decrease the size of the overall model and simplify the DEM data. The existing contour line button cannot locate ski track contour lines precisely. The centerline was generated first, and the points with a 1 m contour distance on the centerline were marked based on the linear interpolation method. The perpendicular line of the centerline was generated based on the interpolated points and adjusted considering the cross slope. The logic is simple and clear, and the whole process was executed using AutoLISP. The process helps designers create an accurate model for further analysis. The theme and style templates that come

with the Civil 3D platform do not adapt to local drawing methods. The design expression requires localization for better collaboration with other specialists and constructors. The results refine the earthwork calculation program, modify the graphical expression of the section design, and combine with the other platforms to generate a 3D model. The strategy is successfully examined based on the WTST case. Even though there are more possibilities, such as reverse modeling based on radar scanning and cloud-based mapping based on ArcGIS, for optimizing the workflow and design processes, the proposed approach did not involve new tools, and the data were manipulated based on the existing BIM application platform, which extremely reduced the financial cost and is applicable to a wider range of application scenarios. This study shed light on a digital method to optimize the existing working pattern. However, this method requires the designer to have relatively strong computer technology and mathematical knowledge and the ability to formulate different calculation programs according to the data at any time to meet the needs of the project. Hence, the optimal approach needs more time to be widely used in practice and still requires examination in more empirical research and to be adjusted accordingly. Meanwhile, we claim that designers should broaden their horizons and accept new technologies.

6. Conclusions

This research summarizes the optimal digital method of planning and constructing the ski track of the National Alpine Skiing Center in the Yanqing Competition Zone of the Beijing 2022 Olympic Games. The main optimal digital approach includes three aspects: (1) simplifying DEM data; (2) optimizing ski track contour lines; (3) localizing the design expression. The approach was examined using the construction project of the WTST. More specifically, by simplifying DEM data, the number of points is reduced to 57.81% of the original to accelerate the computing speed of the designers. By optimizing ski track contour lines, the building information modeling can be more accurate in reflecting the real situation of alpine ski tracks, further benefiting design and construction cooperation. By localizing the design expression, the designers could better deliver design ideas to local constructors. The project was examined in practice and indicates that the digital optimization method was successful. It seems that mature software sometimes cannot fulfill the requirements of the designer's routine workload. It is necessary to learn and master new technologies to simplify repetitive tasks but not be limited by the existing design patterns. A variety of mathematical tools and computer technologies should be utilized to complete more complex project designs. This paper attempts to promote the digital design of ski tracks and helps to provide strong technical support for more intelligent building and site design in the future.

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