# Challenge

## Challenge MZB: Routing a Pipeline in 3D Space with Obstacle Avoidance

Designing a pipeline route is a complex and time-consuming process that requires consideration of numerous technical and environmental factors. Automating this process is crucial for our company as it directly impacts the improvement of operational efficiency. Reducing the time required for pipeline route design will contribute to lowering costs and increasing our competitive advantage in the industry. This project is a key component of our long-term digitization and innovation strategy, which will open up new development opportunities and enhance the quality of our services.
The goal of the challenge is to develop a comprehensive algorithm for routing a pipeline in three-dimensional space. The algorithm should take into account constraints such as minimizing the route length, avoiding collisions with neighboring elements and pipeline curvature. Participants are tasked with implementing the solution in any programming language, with the added requirement of visualizing the proposed solutions in a simplified graphic format (lines, points, surfaces, solids).

**Requirements for the Solution:**

1. **Pathfinding Algorithm:**

   The algorithm should consider minimizing the total length of the pipeline, but must also consider safety margins around obstacles to prevent the pipeline from intersecting with objects. Depending on the type of object in space, the gap between it and the pipeline may vary.

2. **Obstacle Avoidance:**

   - Obstacles will be defined as planes or volumes with specified dimensions in the 3D space.
   - The pipeline must not intersect or come too close to any of these obstacles, requiring the pathfinding algorithm to include spatial awareness for accurate obstacle avoidance.
   - The environment may feature a combination of static and dynamic obstacles, and participants may choose to account for potential real-time changes in the environment.

3. **Pipeline Characteristics:**

   - The pipeline should be routed with additional constraints, such as usage of only 90 or 45 degree and take into account that the pipelines may have a given diameter.

- While minimizing the length of the pipeline is a priority, participants are encouraged to explore how factors like pipeline curvature, cost of materials, or installation ease could be included in the solution.

4. **Visualization:**
   - The solution must be presented as a visualization of potential pipeline routes in a simplified graphical form.
   - At a minimum, the visualizations should display lines (representing the pipeline), points (key points along the route), surfaces (representing obstacles such as planes), and volumes (representing solid obstacles).
5. **Efficiency and Performance:**
   - The algorithm should be designed to handle real-world complexity, where multiple obstacles exist in 3D space, and should be computationally efficient for large-scale environments.
   - Participants are encouraged to consider various optimization techniques that can improve the execution time of the algorithm, such as spatial partitioning.