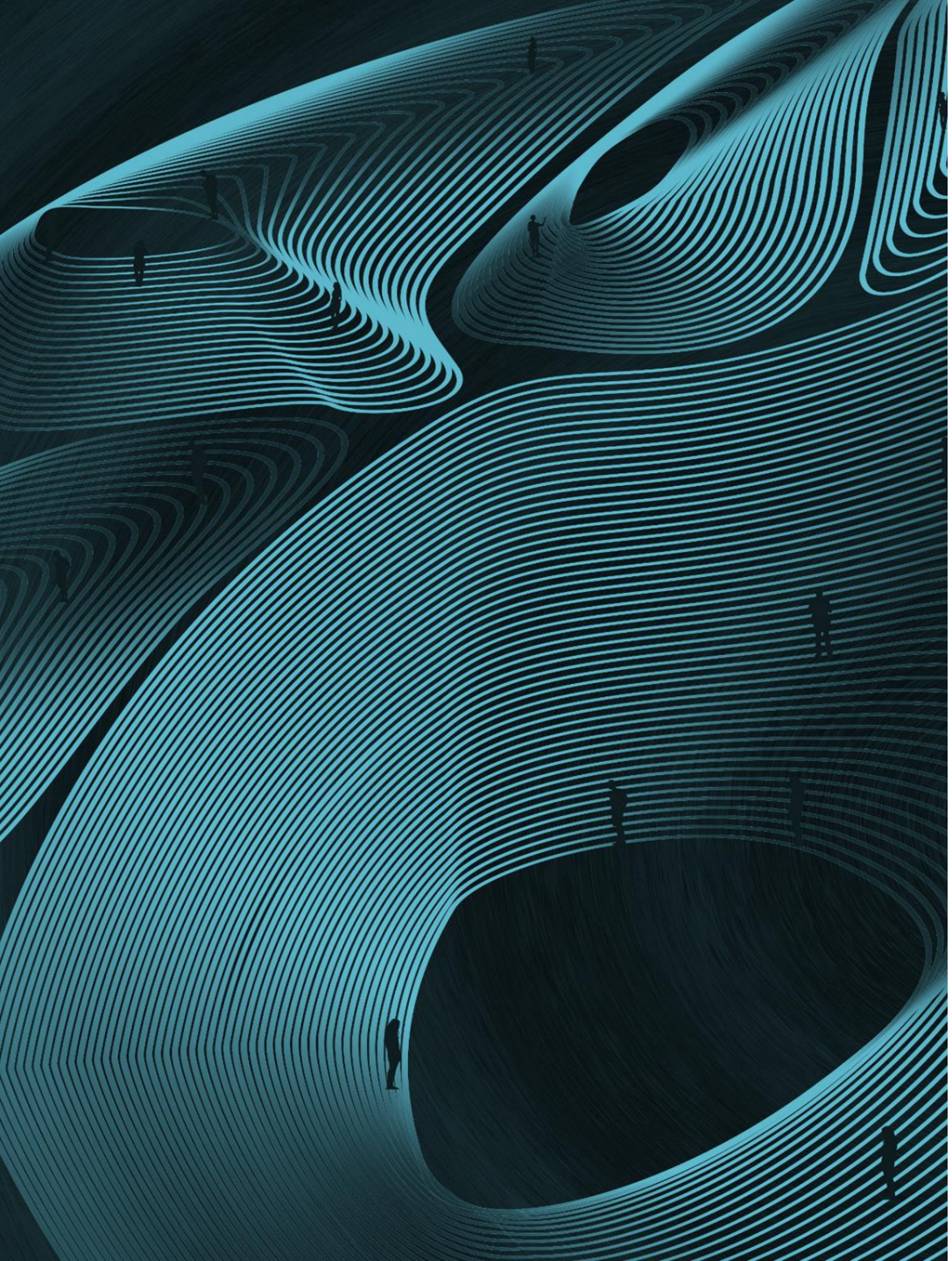


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Impact of BIM Tools on Sustainable Housing Design

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Impact of BIM Tools on Sustainable Housing Design

- **Sustainable Architecture**
- **Sustainable Housing Design**
- **Sustainable Architecture and BIM**
- **BIM Tools**
- **Conclusion**

Sustainable Architecture

- **Sustainability** is the decisiveness of the long-term continuation of the socially shaped relations between society and nature.

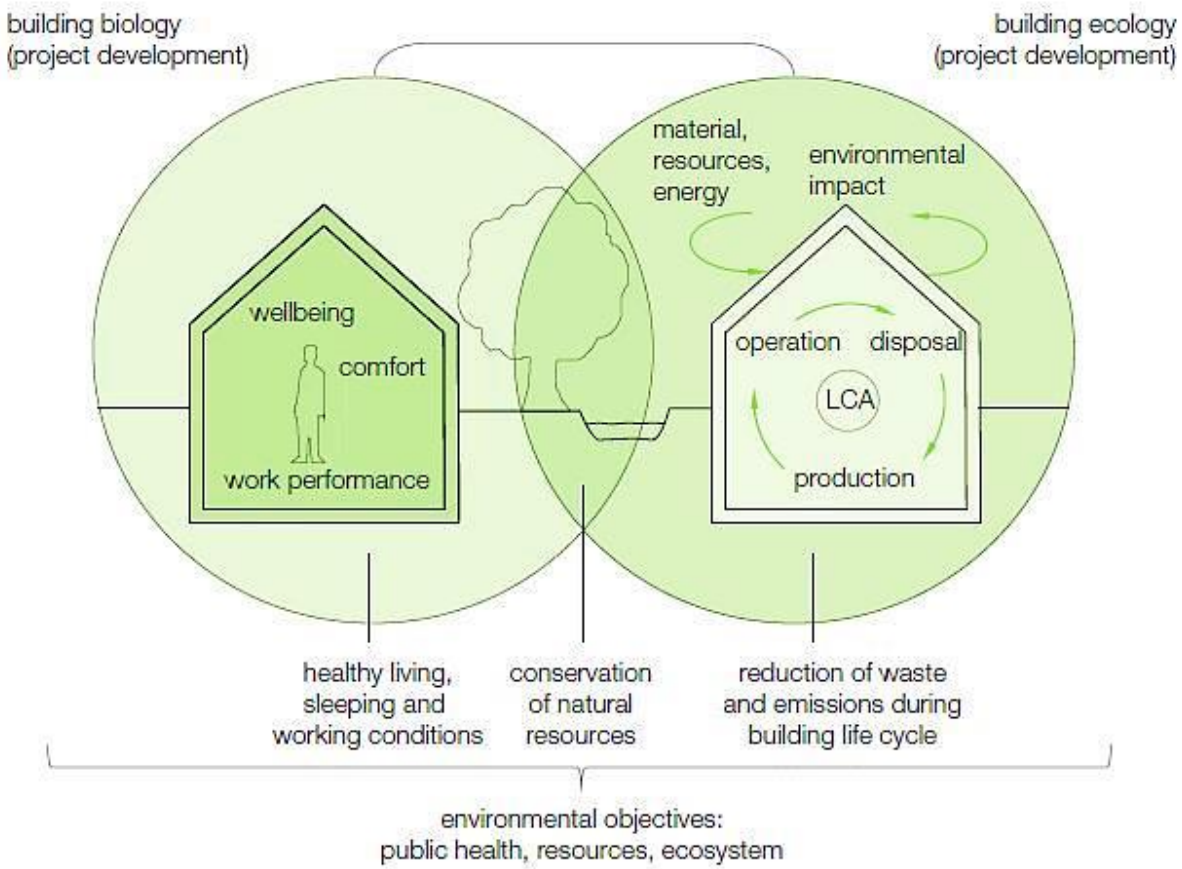
- It is a method of processing and/or using a resource in order not to be consumed, not to be finished, and not to be destroyed forever. (Akgül,2010: 143).

Sustainable Architecture

- Bringing the sustainability phenomenon to the forefront on the global plane and recognizing its importance in all areas of life, has parallels with the value given to the environmental system since the second half of the 20th century. Therefore, to understand the phenomenon of sustainability, it is necessary to introduce the relationship between sustainability and the environmental system.

- The purpose of the applications we face today, such as **"sustainable, ecological, green, climate and environment-friendly, high performance, intelligent, passive, carbon-zero building"**, is to build buildings that allow us to respect and pay the utmost consideration to nature.

Sustainable Architecture



- Sustainable architecture covers the effective use of renewable energy sources, the use of local materials, recycled materials, water, and energy protection, protection of clean water resources, efficient building space design, waste management, and waste reduction, ensuring healthy indoor air quality, minimizing health and safety risks, preserving biodiversity (fig). Architecture creates an environment isolated from natural domains of water, earth, air, and sun. Concept, planning, and design attach great importance to such energies, which are in their original places in nature.

- Figure. Protection goals of building biology and building ecology (Khouli S.E., John V., Zeumer M., 2015)

Sustainable Housing Design

- The need for livable, healthy, and sustainable production is increasing with the rapid development of urban areas for housing, which is the type of building that constitutes the majority of the construction sector.

- **Housing** is a **safe and comfortable** living space where individuals can perform their daily actions. Within the scope of sustainability, housing is a shelter that can play an important role in the development of individuals and families lives, can provide **flexibility and adaptation in the long term**, and can keep up with changing conditions. The residences should be capable of responding to sustainable changes and long-term user needs.

Sustainable Housing Design

TOOLS	DEFINITION	EXAMPLE
Building Standarts	The general framework for sustainable building design, standards containing performance values related to energy and resource consumption.	ISO ASTM ASHRAE EPBD
Product Certifications	Certification systems that determine the environmental impact of building materials in the production process.	GreenSpec EPA
Evaluation Systems	Voluntary assessment systems evaluate the environmental impacts of buildings according to various categories during the life period.	LEED BREEAM CASBEE GREEN STAR DGNB HK-BEAM NATIONAL GREEN BUILDING ASSESSMENT SYSTEM
Design Tools	Software that allows you to evaluate the environmental performance of buildings or Building parts from various angles during the design phase.	ATHENA SBTOOL BEES GABİ ENERGY PLUS BEP-TR

- The sustainable building design is a goal that requires it to be addressed holistically. To achieve this goal, complex and different strategies must be followed. The tools used to achieve the goal of the sustainable building design are shown in Table.

Sustainable Architecture and BIM

- Although the starting point of **BIM dates back to the 70s**; It coincides with the beginning of the 90s with the development of object-based systems and the commercial use of the internet. However, the use of BIM did not reach the desired level until the 2000s. The main reason for this can be shown as the limited representation of design information and the inability to fully establish the relationships between different objects.

- After this period, the current BIM structure was obtained by making use of successful applications **(parametric information technology)** in the automobile, aircraft, and production industries, and BIM was distributed to large masses (Autodesk, 2007a). It has supported this development in the competition caused by the increase of products offered by various software companies related to BIM (Autodesk, Graphisoft, Bentley, Vectorworks, Nemetschek, etc.).

- With its current structure, it is possible to define **BIM** as the **numerical representation** of its physical and functional qualities.

Sustainable Architecture and BIM

- The early design and pre-construction phases of a building are the most critical times for making decisions about its sustainability features. The CAD system cannot often conduct sustainability analyzes in the early stages of design development. Building performance analyses are usually done after the architectural design and documentation process. This failure to analyze sustainability throughout the design process results in an inefficient process of retrofitting the design to produce high-performance buildings.

- Access to a comprehensive dataset on the **building's geometry, dimensions, materials, location, context, climatic information, and mechanical-electrical-plumbing (MEP) systems** is required to accurately assess Building performance during the early design and pre-construction phases. Since BIM allows storing information from different disciplines in a single model, it is important to **analyze environmental performance (Energy consumption, daylight intake, wind, etc.)** during the design process and provides an opportunity for **sustainability** measures to be carried out fully and efficiently.

Sustainable Architecture and BIM



- **Sustainability, integrated design, and BIM** (Building Information Modeling) are interrelated concepts that support each other in the design process as shown in figure.

- **BIM** can be used in the entire life cycle of a building up to the stages of **design, projecting, construction, facility management, reuse, and demolition.**

1) Design Phase

The design phase occurs with **mass creation** commands based on parametric design principles. It is developed by performing performance analysis, thus forms and simulations are created. Simulations enable design decisions to be reviewed and improved and possible errors to be eliminated before they occur.

2) Projecting and Construction Phase

In this phase, reliable and simultaneous information sharing is made by creating an interdisciplinary parallel working environment. In this way, productivity increases. Different BIM models can be created as alternatives. The results obtained by overlapping these models can be converted into graphs and reports. Detecting conflicts in advance can significantly reduce time, labor, and cost losses. Unlike conventional building products, **with BIM, parameters related to (4D) time, (5D) cost, (6D) sustainability, and (7D) facility management** can be created and monitored.

3) Facility Management Phase

In the post-construction phase, BIM can be used **for building maintenance and operation purposes**. In the completed model, space arrangements, user activities, and habits can be examined, and air conditioning (HVAC), electricity, and information systems can be followed. In addition, security, disaster, and emergency evacuation plans for the building can be created, updated, and reviewed.

4) Reuse and Demolition Phase

BIM model alternatively; can be used **in building reinforcement and repair, improving spatial performance, new functional use, demolition, and material recycling**.

Sustainable Architecture and BIM

- BIM needs a series of analyses to be able to provide these conditions in the entire structure life cycle listed above.

- Climatic Analysis
- Energy Load Analysis
- Sun and Shadow Analysis
- Solar Radiation Analysis
- Whole Building Energy Analysis
- Wind and Airflow Analysis
- Daylight and Natural Lighting Analysis

BIM Tools

- Sustainability is considered the sixth dimension of BIM. It ensures that the sustainability criteria of the Project are estimated in the conceptual model and measures are taken for early solutions.

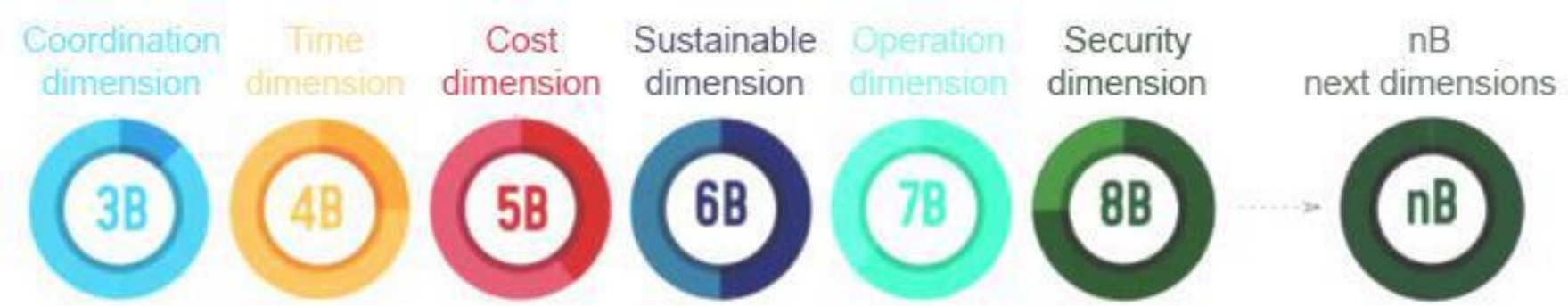


Fig. Model-Based Multidimensional Work with BIM

BIM Tools

Preliminary Design and feasibility stage

Preliminary Design and feasibility stage	
Autodesk / Revit Architecture	conceptual 3d modeling
Graphisoft / Archicad	conceptual 3d modeling
Google / Sketchup Pro	conceptual 3d modeling
Nemetschek / Vectorworks Designer	conceptual 3d modeling
Bentley Systems / Bentley Architecture	conceptual 3d modeling
Tekla / Tekla Structure	conceptual 3d modeling
Trelligence / Affinity	conceptual 3d modeling
Beck Technology / Dprofiller	conceptual 3d modeling and cost calculation
Vico Software / Vico Office	conceptual 5d modeling (3d + cost + quantity)

Architectural Modeling and Providers

Architectural Modeling and Providers
Autodesk Revit Architecture
Garphisoft Archicad
Nemetschek Allplan Architecture
Gehry Technologies / Digital Project Designer
Nemetschek Vectorworks Architect
Bentley Architecture
4Msa İdea Architectural Design (Intellicad)
Cadsoft Envisioneer
Softtech Spirit
RhinoBIM (Beta)

Structure Modeling and Providers

Structure Modeling and Providers
Autodesk Revit Structure
Bentley Structural Modeler
Bentley RAM, STAAD and ProSteel
Tekla Structures
CypeCad
Graytec Advance Design
StructureSoft Metal Wood Framer
Nemetschek Scia
4Msa Strad and Steel
Autodesk Robot Structural Analysis

Mechanical, Electrical, and Plumbing Modeling and Providers

Mechanical, Electrical and Plumbing Modeling and Providers
Autodesk Revit MEP
Bentley Hevacomp Mechanical Designer
4Msa FinaHVAC + FineLIFT + FineELEC + FineSANI
Gehry Technologies – Digital Project MEP Systems Routing
CadMep (Cadduct / Cadmech)

BIM Tools

Construction Simulations and Cost Analysis 4D+5D

Construction Simulations and Cost Analysis 4D+5D
Autodesk Navisworks
Solibri Model Checker
Vico Office Suite
Vela Field BIM
Bentley ConstrucSim
Tekla BIMSight
Glue (by Horizontal Systems)
Synchro Professional
Innovaya

Facility Management Software and Providers (7D)

Facility Management Software and Providers (7D)
Bentley Facilities
FM:Systems FM:Interact
Vintocon ArchiFM (For ArchiCAD
Onuma System
EcoDomus
IBM Maximo

Sustainability Software and Providers (6D)

Sustainability Software and Providers (6D)
Autodesk Ecotect Analysis
Autodesk Green Building Studio
Graphisoft EcoDesigner
IES Solutions Virtual Environment VE-Pro
Bentley Tas Simulator
Bentley Hevacomp
DesignBuilder

File Sharing and Collaboration

File Sharing and Collaboration
Autodesk, BIM 360
Bentley, ProjectWise Share
Allplan Share BIMPlus

- Among the BIM software, the ones that are widely used in sustainable energy analysis are Autodesk Insight, Green Building Studio, Design Builder, Autodesk CFD, and Ingrid Cloud.

Conclusion

- We are in an age that requires more efficient use of energy. The majority of the energy spent in the world is used in residential buildings. Housing is the living space of an individual. For this reason, designers need to take responsibility for making energy-efficient sustainable designs.

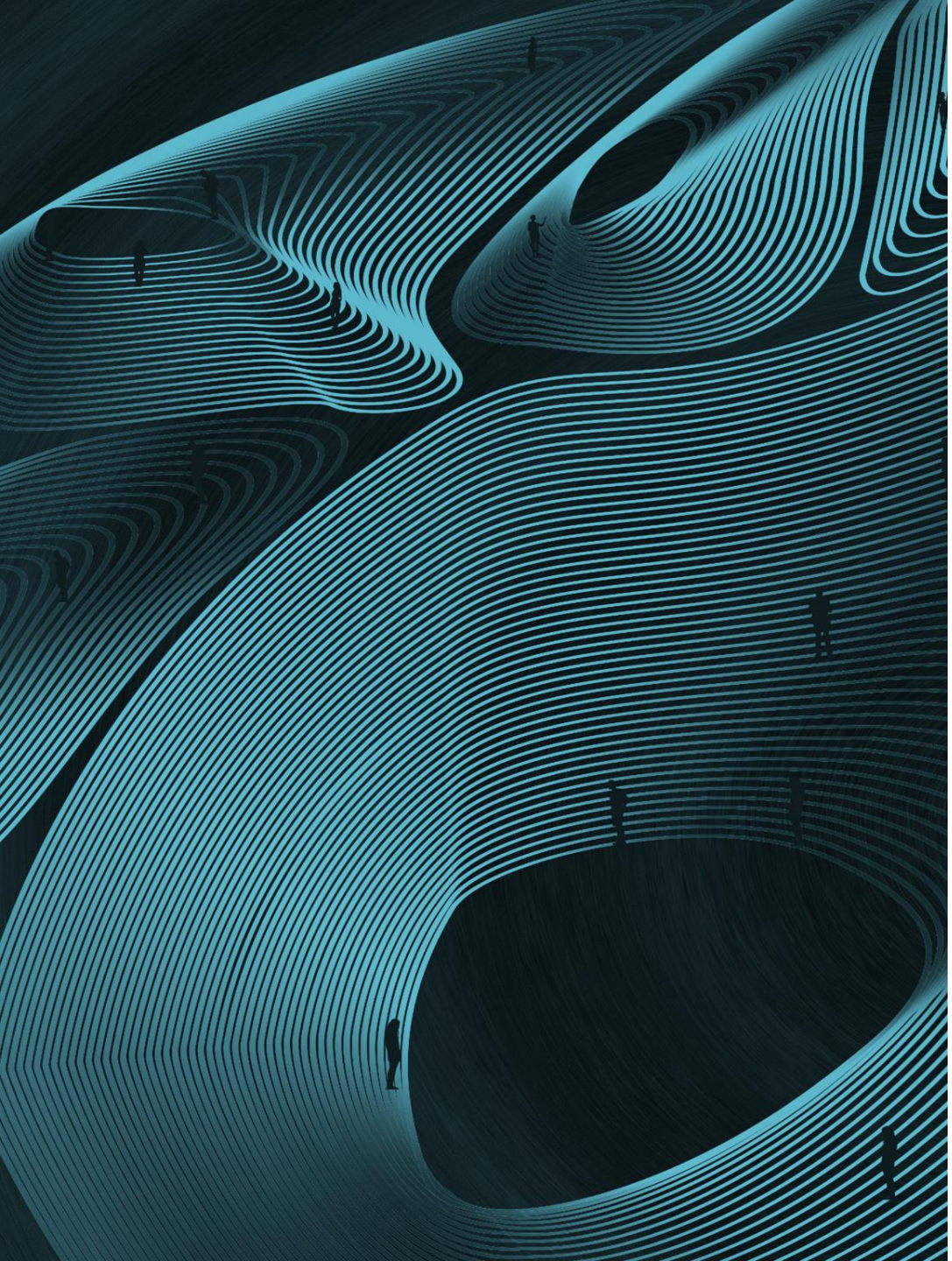
- The software examined in the study is the most common program used to measure the sustainability performance of buildings. Through this software, it is possible to realize the situations that should be prevented, especially at the design stage of the structure.

- Through these softwares, the effects that are especially important for sustainability are as follows:

• BIM-supported analysis software enables us to perform cost control by providing feedback through simulations performed during the building design phase.

• It provides energy performance improvements by conducting environmental performance analyses.

• By planning the entire life cycle of the structure in the context of sustainability, it allows predictions to be made about its future condition.



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Thanks for listening

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