

SIMULATING A BUILDING DIGITAL TWIN PROCESS

› WOUTER BORSBOOM

ORGANIZED BY:



THIS PROJECT HAS RECEIVED FUNDING FROM THE EUROPEAN UNION'S H2020 PROGRAMME UNDER GRANT AGREEMENT NO. 820805.

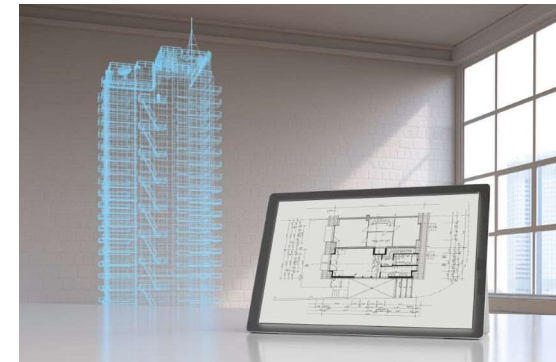
WOUTER BORSBOOM



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Senior Business Consultant TNO

Energy Built Environment,
Monitoring and assessment of
dwellings and offices, energy,
ventilation and health, Country
representative IEA-ANNEX V:
AIVC.org, Board Member
INIVE.org, BDTA.

TNO (www.tno.nl) is an independent and not-for-profit organization. TNO connects people and knowledge to create innovations that boost the competitive strength of industry and the well-being of society in a sustainable way. This is our mission and it is what drives us, the over 3,400 professionals at TNO, in our work every day. We work in collaboration with partners and focus on nine domains.

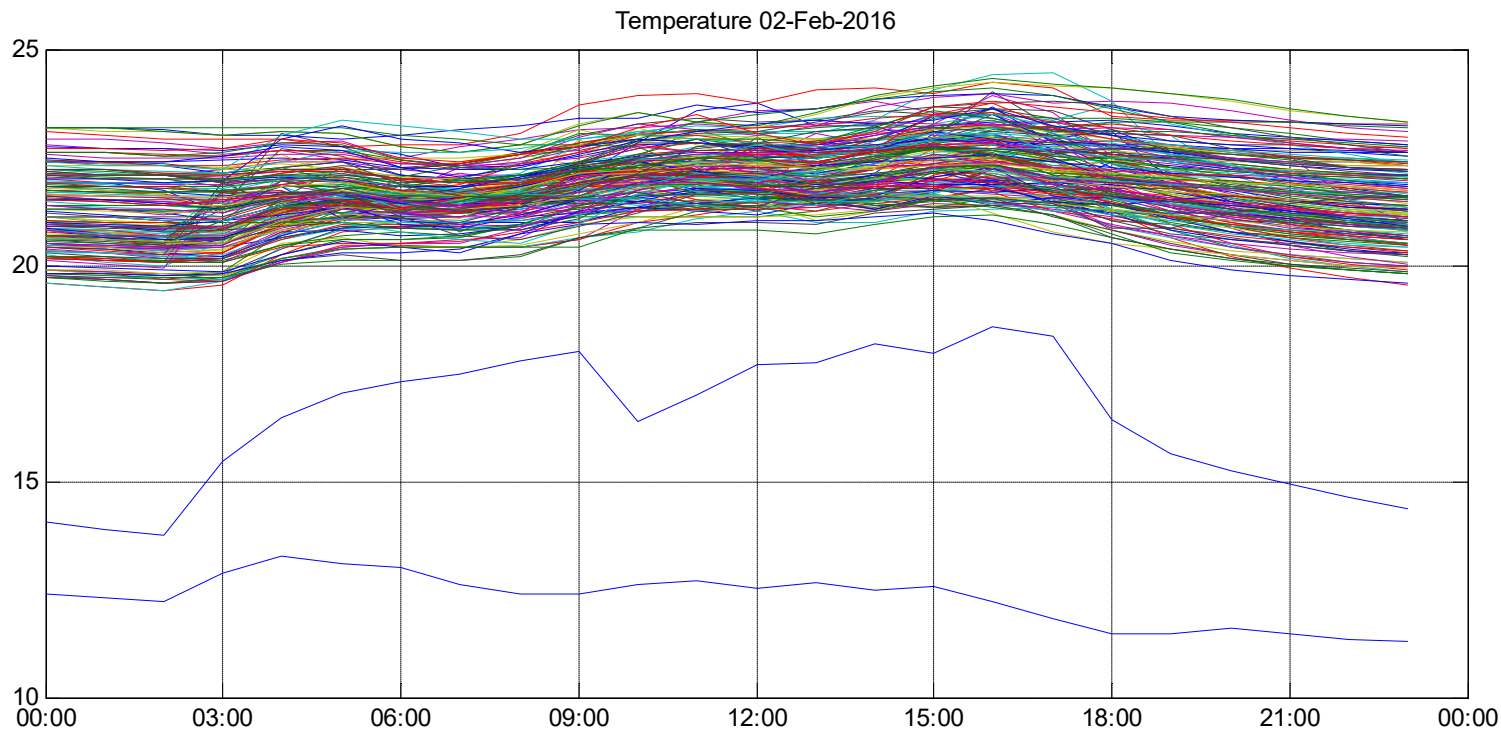


Towards Networks of predictive twins in the Built Environment, Arjen Adriaanse, Wouter Borsboom, Rob Roef, 2021

<https://repository.tudelft.nl/islandora/object/uuu:d:ba8043dd-1dfc-4469-bfeb-53006de6e88a>

BUILDINGS PROVIDE TONS OF DATA, BUT DO WE HAVE INFORMATION TO IMPROVE ENERGY AND IAQ ?

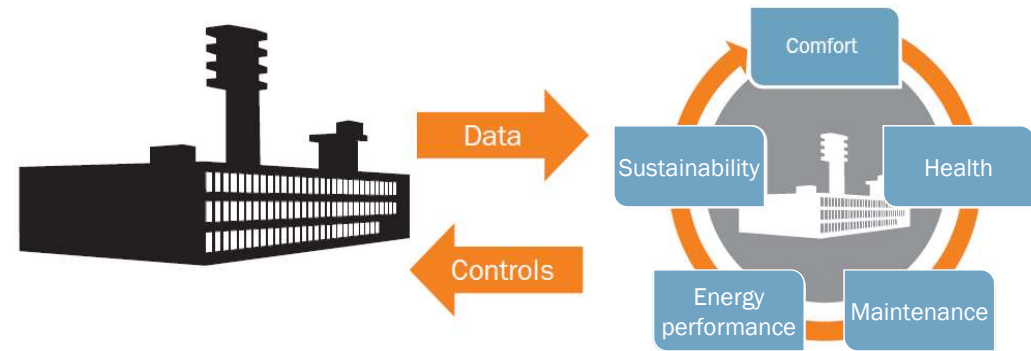
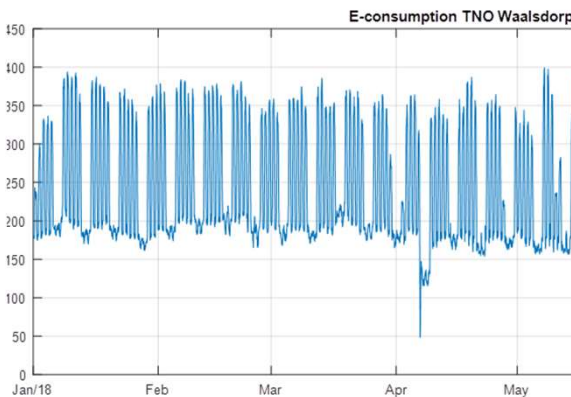
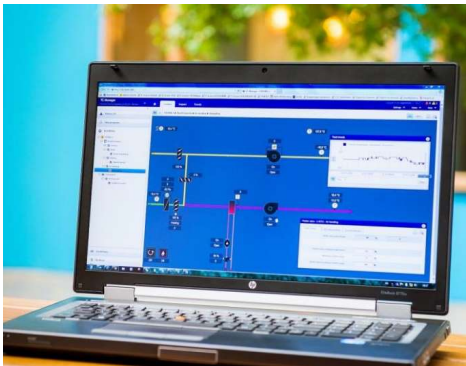
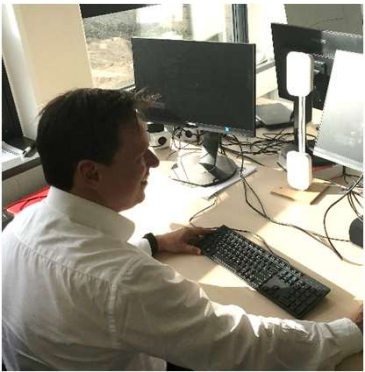
WHAT CAN BIM AND PREDICTIVE TWINS MEAN?



600 room temperatures, which one to choose?

BUT HOW ARE DIGITAL SOLUTIONS REALLY GOING TO MAKE A DIFFERENCE TO THESE CHALLENGES?

Living lab TNO (NL)



Physical building

Predictive building
Digital Twin

Predictive twins are predictive digital replicas of physical structures such as bridges, tunnels, homes and offices. With these twins, the future behaviour and use of structures and networks of structures can be predicted and influenced

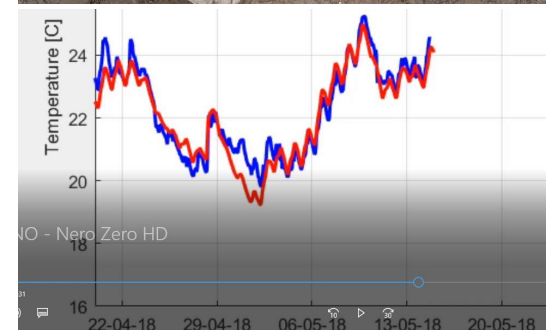
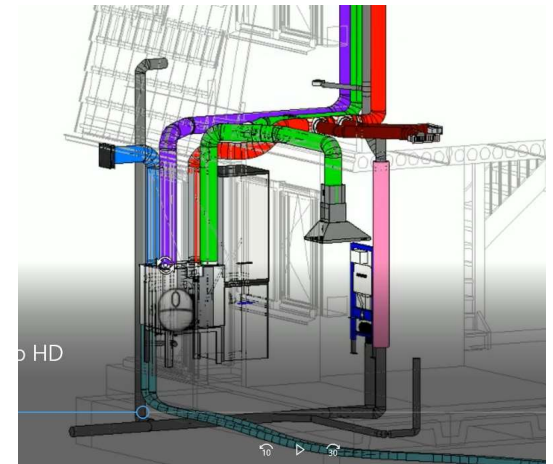
BIM 2 PREDICTIVE TWIN



SPHERE
BIM DIGITAL TWIN PLATFORM

- › How can we use BIM information to structure and analyze data from building systems to check the current performance, detect events, predict, control and optimize?
- › How to make it operational in the form of workflows in both design commissioning and operation?
- › How to use it to improve IAQ, reduce energie, event detection, optimize building processes & commissioning?

Development of predictive twin methodologies and tools to meet these challenges for clients.

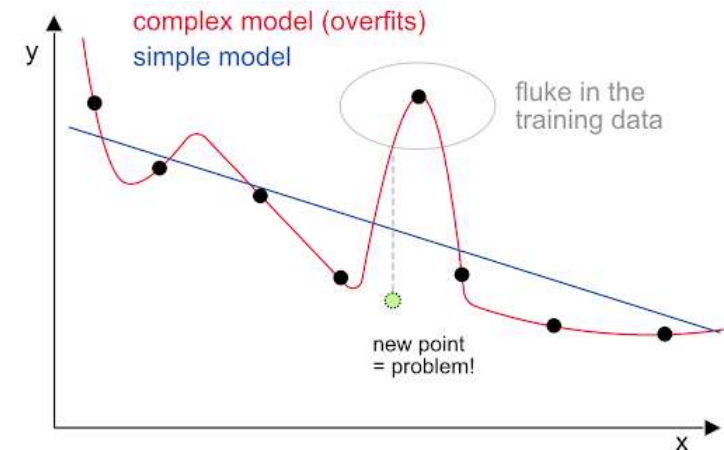


WHY USE BIM DATA, WE HAVE AI

- › Usually a **big set of Measurement data** is available, but often **important physical variables are unmeasured**
- › Many parameters in a data driven model with low quality data → **overfitting** -> poor estimation

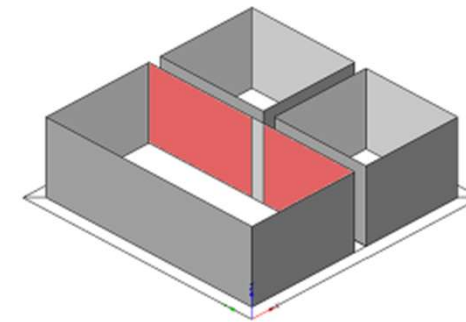
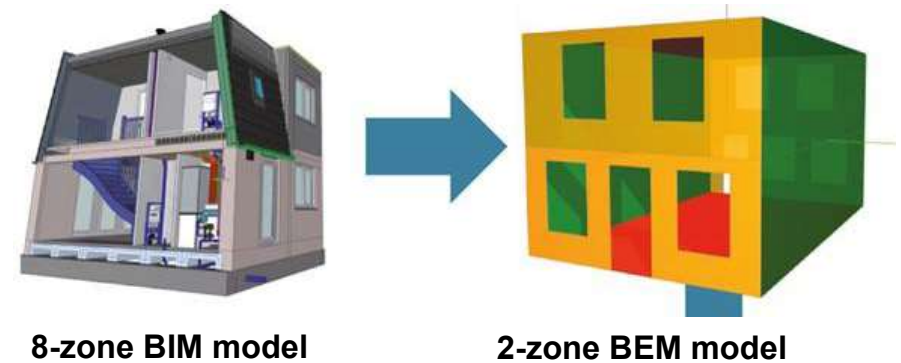
Advantages of using BIM in combination with physical models:

- › What you already know you **don't have to estimate**.
- › **Logical (physics determined) boundaries** on parameters prevent nonsense parameter values while fitting
- › You can do with **less informative data**

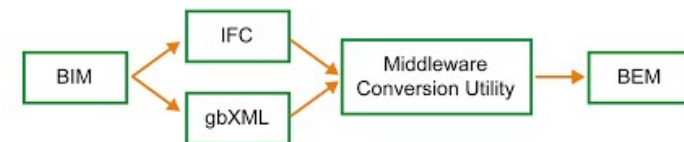


EXAMPLE BIM 2 PREDICTIVE TWIN: BIM 2 BEM CHALLENGES

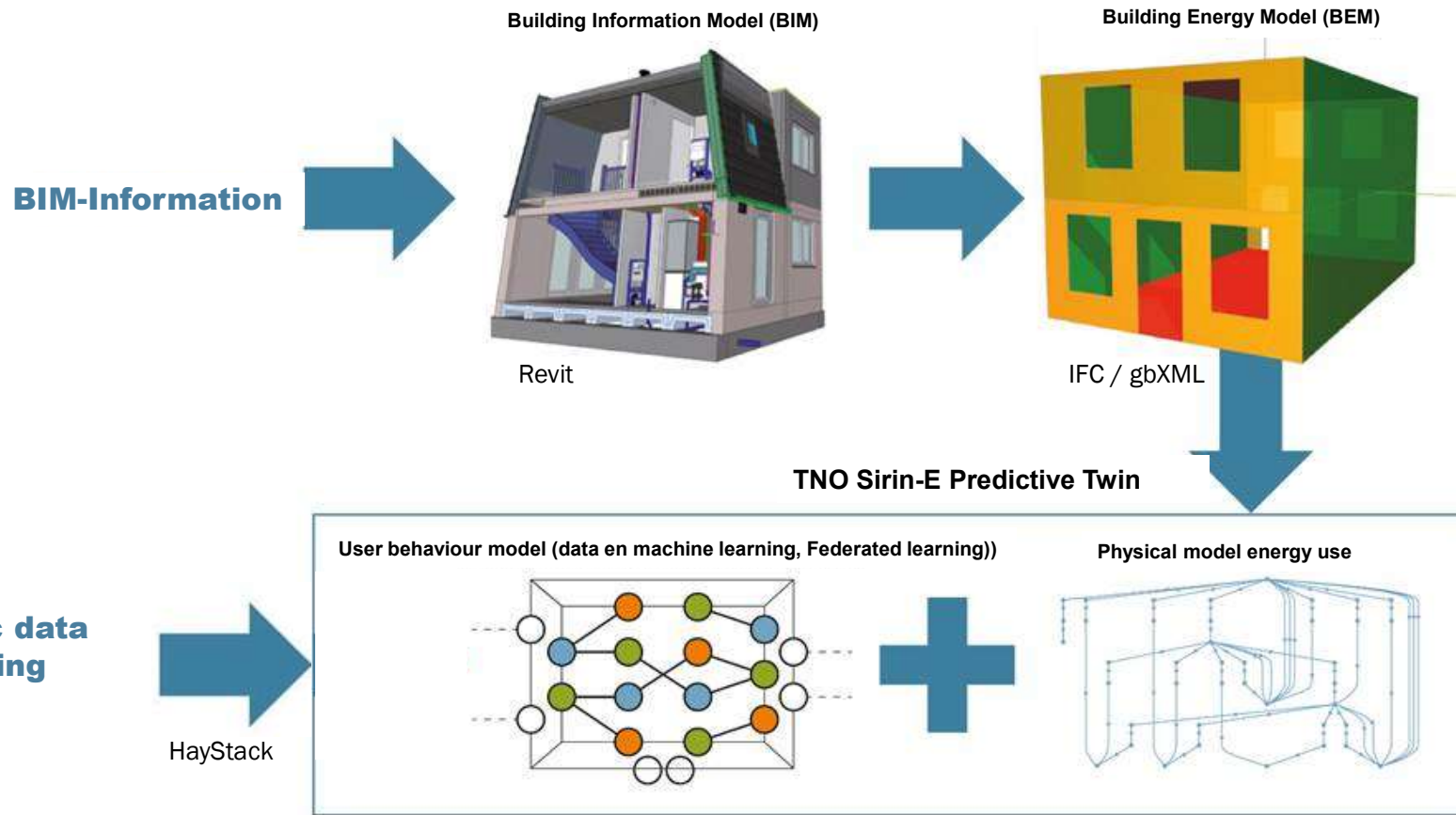
- › BIM models not made for simulation models
- › Decisions have to be made for zoning, and also for space boundaries.
- › Inconsistencies especially on the space boundaries can give issues for building model.
- › Different standards: IFC, gbXML, and don't contain all necessary data.



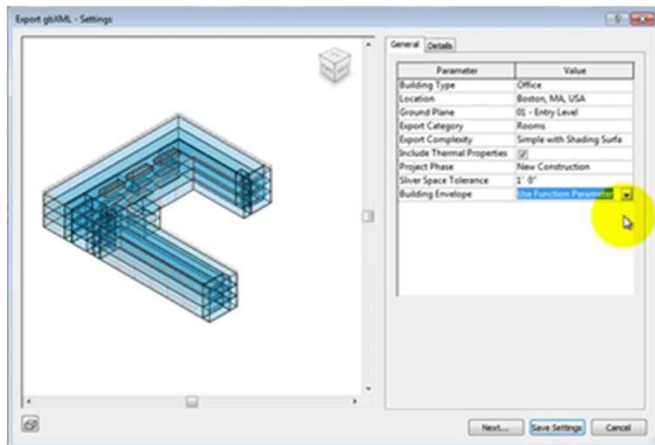
Space boundaries issues



BIM 2 PREDICTIVE TWIN FOR IAQ AND ENERGY USE



› BIM INFORMATION: EXAMPLE OF GBXML 2 MODEL

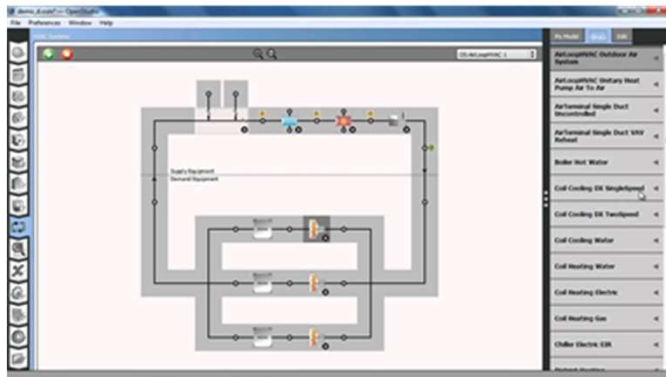


gbXML

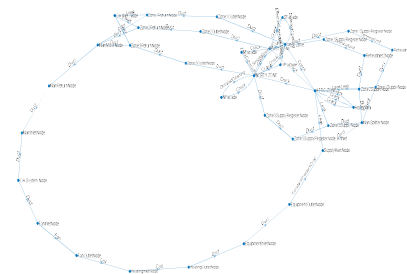
gbXML data container standard 6.1 / IDF

File import / data selection

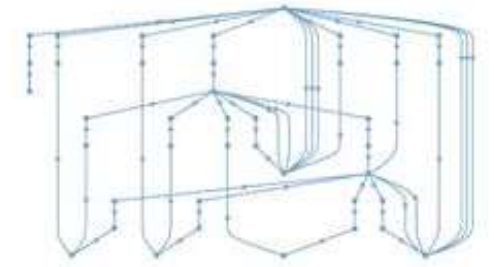
Generation of a general struct containing all information needed for building simulation



IDF (EnergyPlus data format)



TNO AirMaps ventilation model



TNO Heat transfer model

DEMONSTRATION USE CASE GUI SCALABLE MODELS

The screenshot displays the TNO Building Simulator web interface. The browser address bar shows 'Not secure | pc-21288:4005'. The interface is divided into several sections:

- Dashboard:** Contains a 'Menu' with options for 'New Project', 'Open Project', and 'Save Project'.
- Map:** A map of Amsterdam with a callout 'This is Dam Square Office'. Map controls include 'mapbox', 'Amsterdamse Bos', and map style options: 'light' (selected), 'streets', 'dark', and 'satellite'.
- Simulation Settings:** Includes tabs for 'Project Info', 'Scenario Schedule', and 'Simulation Settings'. Fields include:
 - gbXML: office_dam_square.xml
 - Start Date: 01-09-2020 04:54 PM
 - End Date: 17-09-2020 04:54 PM
 - Timestep: 1 [hour]
 - Calculation Mode: HeatA 'Simulate' button is located at the bottom of this section.
- 3D Model:** A 3D rendering of a building with yellow walls and green windows. A 'rotation' panel above it shows 'office_dam_square.xml', 'bytes loaded: 16,625,160 of 16,625,160', and 'time in milliseconds to load: 15199'.
- Building Property:** A panel with tabs for 'surface', 'surfaces', 'edges', and 'all'. The 'surface' tab is active, showing a list of surface IDs (aim30579 to aim30671) and a detailed view for 'aim30671' with properties: name 'S-152-E-W-1051', type 'ExteriorWall', and area '577.3 ln 15.000 wd 38.487'.



light streets dark satellite

Project Info Scenario Schedule Simulation Settings

Project Name: Unknown

Project Info:

Empty text input field for project information.

rotation

Building Property

Empty text input field for building property.

MANY STAKEHOLDERS INVOLVED,



INTEGRATION WITH BIM IN OPERATION AND WORKFLOW ORGANIZATION IS CRUCIAL TO EFFECTIVELY IMPLEMENT BDT



1st BUILDING DIGITAL TWIN International Congress

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