TOWARDS SMART VENTILATION

FLANDERS INNOVATION & ENTREPRENEURSHIP

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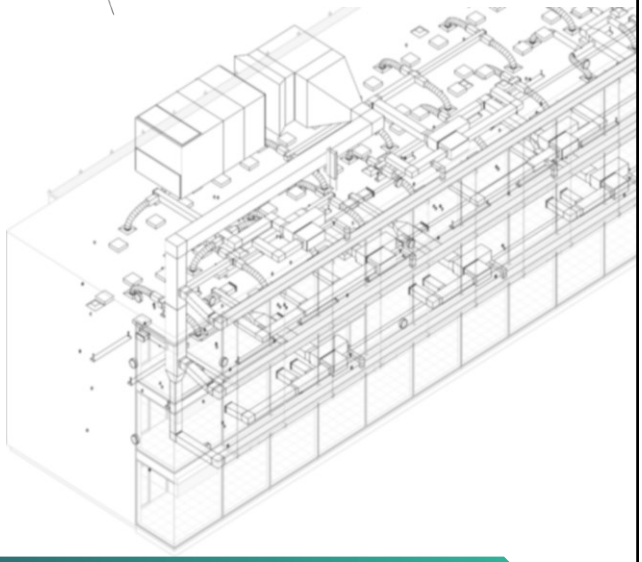
Simulation-based design of smart centralized ventilation systems

Easing design engineers' challenges and generating optimized designs



Zakarya Kabbara (EMIB-research group, University of Antwerp)

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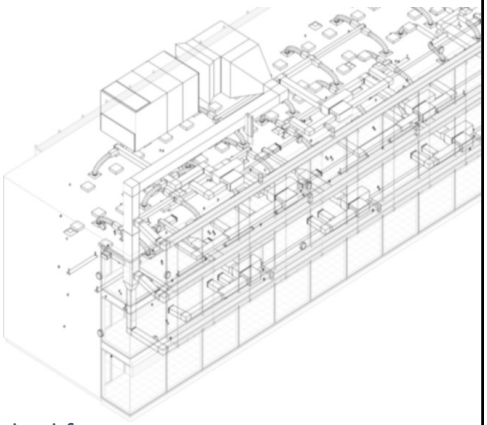
Design challenges of centralized air distribution systems

- Cost efficiency
- Energy-efficiency
- Acoustical comfort
- Hygrothermal comfort
- Healthy IAQ
- Aesthetic - Architecture limitations
- …

All these have to be achieved within a limited budget and time



Simulation-based design method for informed decision making

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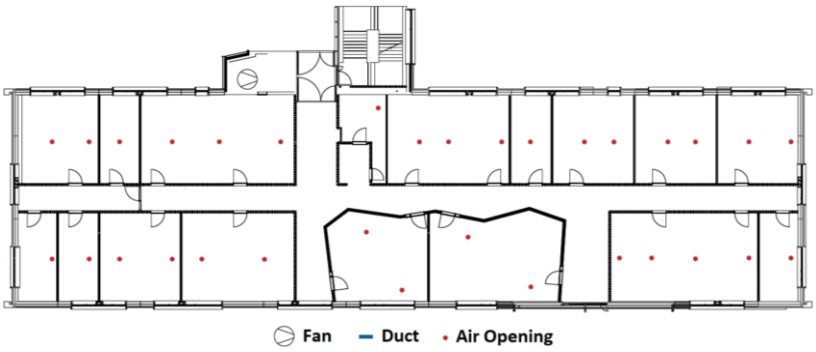
Aimed simulation-based design method:

For a random floor plan:

Automatically generate optimized ductwork configuration (= layout + sizing)

Min. LCC: Ductwork material and installation costs and fan energy costs



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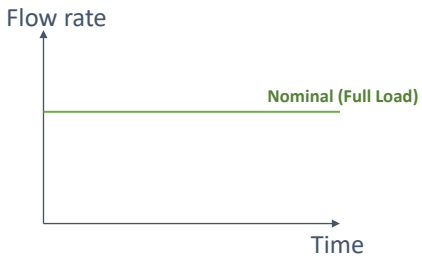
Aimed simulation-based design method:

For a random floor plan:

Generate ductwork configuration (= layout + sizing) with minimum life cycle cost

Design inputs:

- Nom. Flows + Demand profiles (smart systems)



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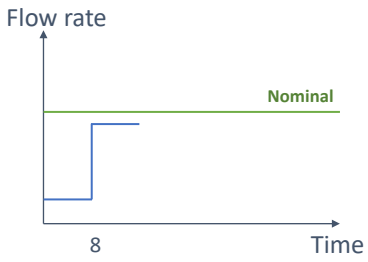

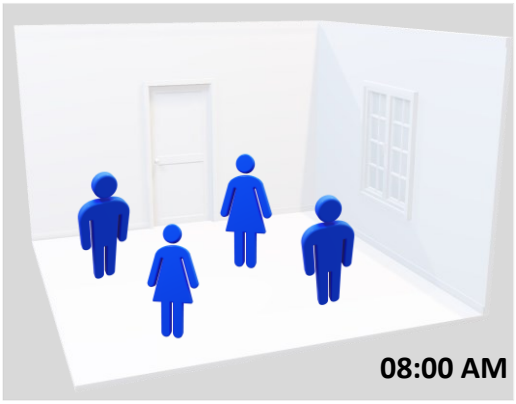

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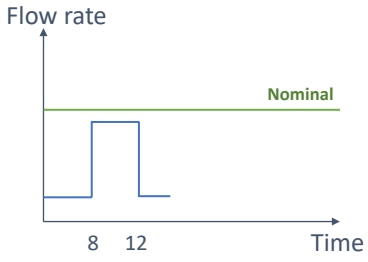

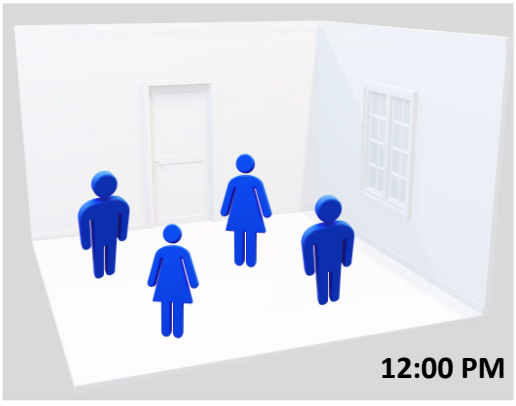

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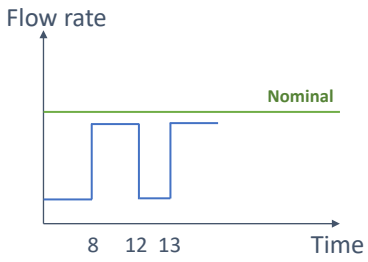

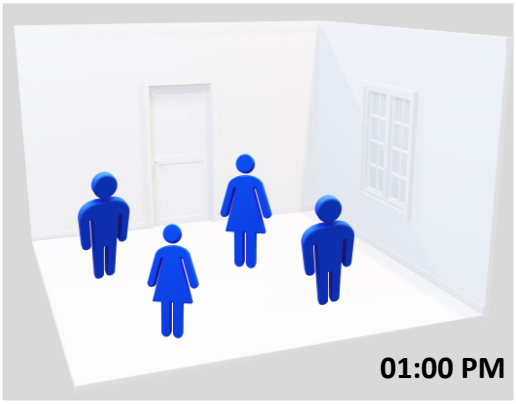

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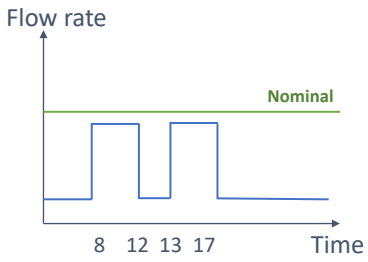

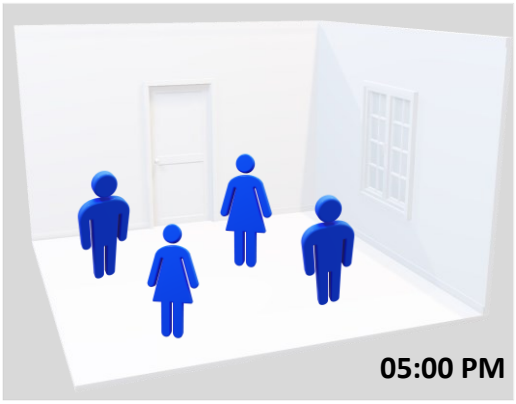

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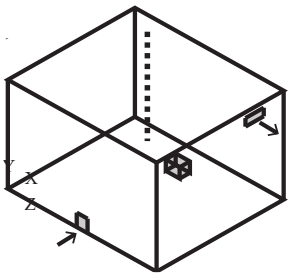
Aimed simulation-based design method:

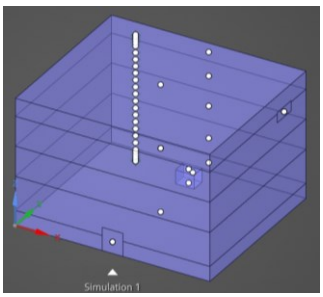
For a random floor plan:

Generate ductwork configuration (= layout + sizing) with minimum life cycle cost

Design inputs:

- Nom. Flows + Demand profiles
- **Location of air openings**





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Aimed simulation-based design method:

For a random floor plan:

Generate ductwork configuration (= layout + sizing) with minimum life cycle costs

Design inputs:

- Nom. Flows + Demand profiles
- Location of air openings

Boundary conditions:

Hard boundary conditions

- Maximum velocity
- Maximum duct dimensions

Soft boundary condition

- Pressure-balancing

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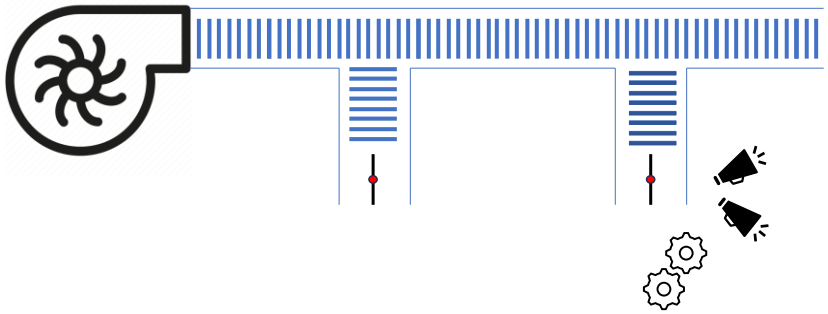

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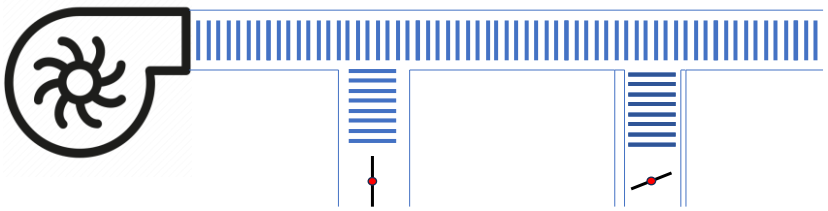

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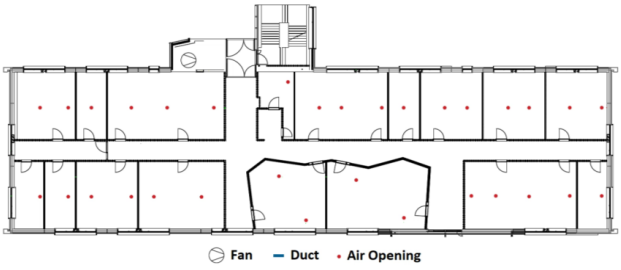
Design method outputs

Existing design



Optimized design

- 18.5 % reduction in material & installation costs
- 10% reduction in fan energy costs
- 15% reduction in LCC
- 25% more balanced designs

Zakarya Kabbara, Sandy Jorens, Houssam Matbouli, Jitse Van Thillo, Ivan Verhaert,
Heuristic optimization for designing centralized air distribution systems in non-residential buildings,
Energy and Buildings,Volume 292,2023,113161,ISSN 0378-7788, https://doi.org/10.1016/j.enbuild.2023.113161.

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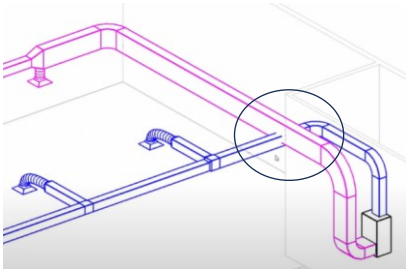
A glimpse into our future work

- Method's valorization
- Implementation of the method in BIM software (i.e., Revit)
- Method's expansion:
  - Simultaneous supply and extraction
  - Retrofitting/renovating applications



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Thank you for your attention!

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Zakarya Kabbara, Sandy Jorens, Ehsan Ahmadian, Ivan Verhaert,
Improving HVAC ductwork designs while considering fittings at an early stage,
Building and Environment, Volume 237, 2023, 110272, ISSN 0360-1323,
https://doi.org/10.1016/j.buildenv.2023.110272.

Zakarya Kabbara, Arne Dijckmans, Sandy Jorens, Jitse Van Thillo, Ivan Verhaert,
A performance-based acoustical design strategy for centralized air distribution networks,
IBPSA, Building Simulation, 2023, Shanghai, China

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