

An IAQ and thermal comfort coach prototype to improve comfort and energy consumption thanks to adequate management of natural ventilation:

Genesis, development and first feedback results

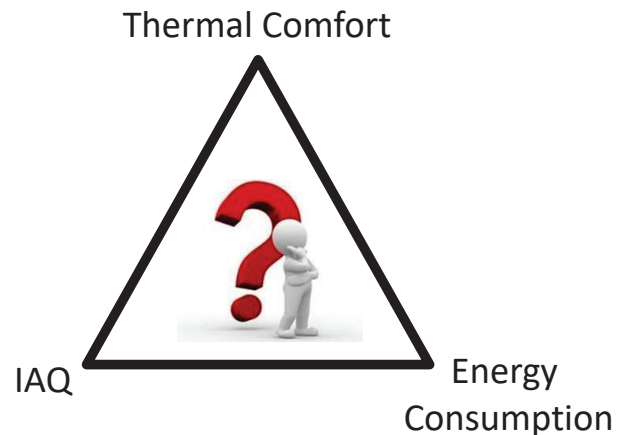


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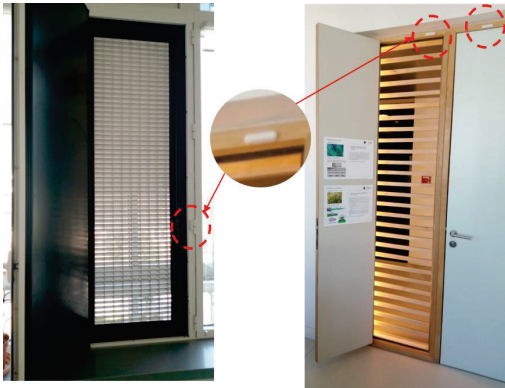
CONTEXT

- Natural ventilation through open Windows allows to exchange easily 5 - 10 ACH for free
- But might bring some additional energy consumption or incomfort if open at inappropriate time



Wind'ose genesis :

Monitoring of our Naturally ventilated Office Building in Summer period



Monitoring of Windows /Doors opening

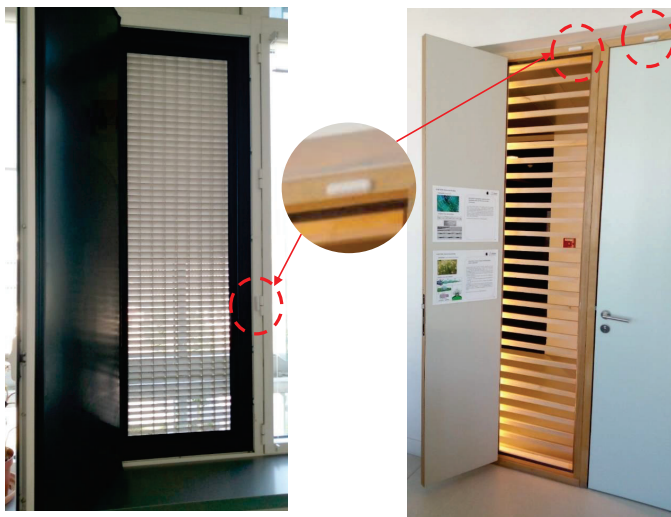
Interface to collect User feedback



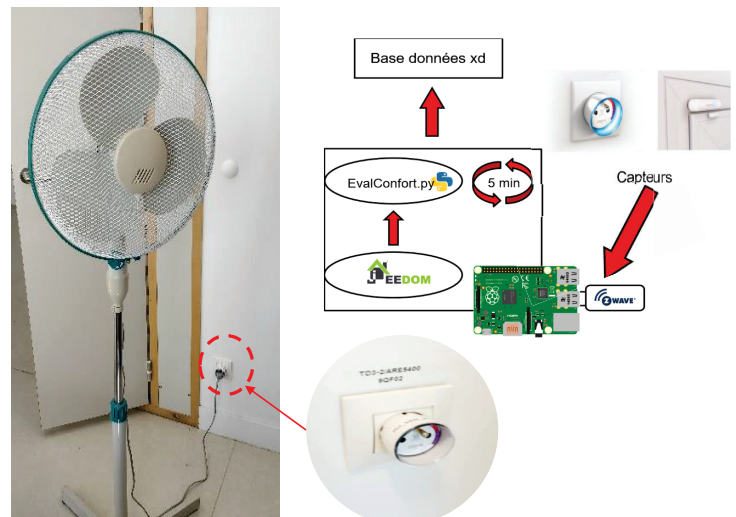
Exploring window opening behaviour for optimal cooling and thermal comfort

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OPENINGS STATUS AND FAN MONITORING



Contact sensors on all openings on 2nd floor of west wing.



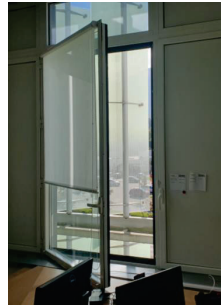
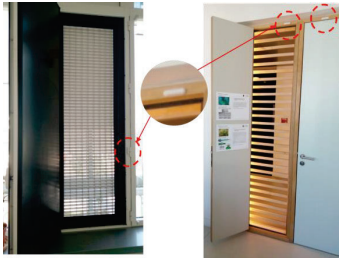
Power meters for fans .
+ Z-wave repeator



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Initial behavior campaigns: First results (1/2)

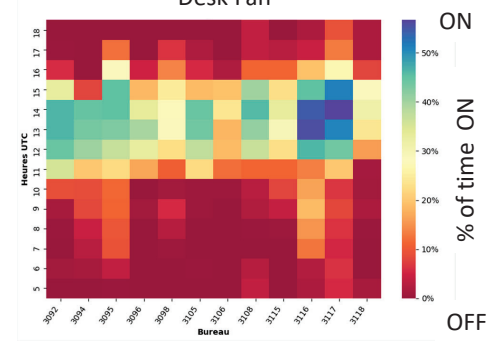
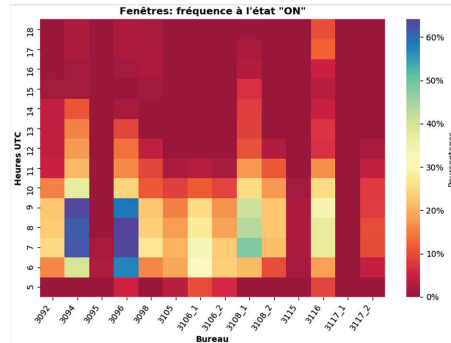
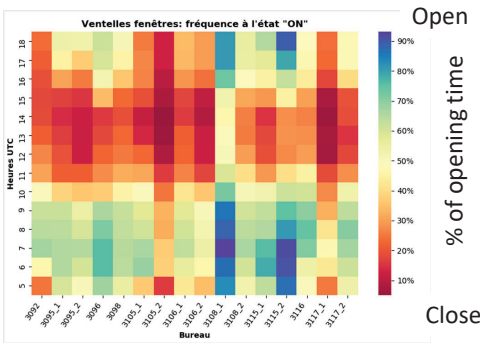


Window louvers to Outdoor and corridor

Windows to outdoor



Desk Fan



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Initial behavior campaigns: First results (2/2)

Clothing

Évaluation du Confort des Occupants

VETURE

Manch. 1/4e manche: court, manches courtes, manches longues

Manch. 3/4e manche: court, manches longues, pull

Bas (longueur): court, mi-long, long

Bas (taille): taille ajusté, taille adaptée

Chaussures: pieds nus, sandales (ou pieds nus), chaussures avec chaussettes, chaussures sans chaussettes, chaussures avec chaussettes épaisse

Thermal Comfort : sensation, preference, satisfaction, acceptation

CONFORT THERMIQUE

Comment vous sentez-vous maintenant, avez-vous ?

Taille: froid, légèrement froid, légèrement chaud, chaud, très chaud

Souhaitez-vous avoir ?

Plus froid, Pas de changement, Plus chaud

Êtes-vous maintenant satisfait de cette ambiance thermique ?

très insatisfait, insatisfait, satisfait, très satisfait

Trouvez-vous cette ambiance thermique acceptable ?

très insatisfait, insatisfait, satisfait, très satisfait, acceptable

Potential annoyance

NUISANCES

sonore, visuelle, olfactive, psychologique

Office Status : Windows, fans, ...

ÉTAT PIÈCE

Ouverts / Fermés: fenêtres, stores

Stores / Protections solaires: fermés, ouverts

Plafond: fermés, ouverts

COMMENTAIRES LIBRES

Merci de valider vos choix en cliquant sur ce bouton

des questions, des remarques: evolution@ines.fr

Interface to collect user feedback

| | Number of answers for each user | | | | | | | Total |
|-----------------|---------------------------------|-------|------|------|------|------|------|-------|
| | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | |
| Nb users | 23 | 29 | 13 | 16 | 10 | 4 | 8 | 51 |
| Total | 2232 | 17479 | 2490 | 3192 | 585 | 236 | 701 | 26915 |
| User23 | 181 | 1393 | 176 | 508 | | 135 | | 2393 |
| User26 | 51 | 1058 | 530 | | | | | 1639 |
| User3 | 209 | 390 | 348 | 247 | | | 124 | 1318 |
| User51 | 161 | 991 | 0 | | | | | 1152 |
| User48 | 138 | 491 | 207 | 207 | | | | 1043 |
| User10 | 107 | 408 | 139 | 205 | 106 | | 63 | 1028 |
| User40 | 208 | 333 | 113 | 66 | 81 | 57 | 106 | 964 |
| User44 | 52 | 187 | 457 | 253 | | | | 949 |
| ... | ... | ... | ... | ... | ... | ... | ... | ... |
| User17 | | | 5 | 33 | | | | 38 |
| User47 | 30 | | | | | | | 30 |
| User31 | | | 26 | | | | | 26 |
| User20 | 18 | | | | | | | 18 |
| User19 | | | | | 8 | | | 8 |

7 summers campaign

| | Number of air temperature measured | | | | | | | Total |
|----------------|------------------------------------|--------|-------|-------|------|------|------|--------|
| | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | |
| Nb pers | 23 | 29 | 13 | 16 | 9 | 4 | 8 | 50 |
| Total | 12193 | 174058 | 61521 | 38804 | 6088 | 2958 | 7807 | 303429 |
| User27 | 342 | 26385 | 30619 | | | | | 57346 |
| User41 | 1349 | 20993 | 5216 | 585 | 624 | 669 | 1722 | 31158 |
| User24 | 1161 | 16902 | 2300 | 4935 | | 1327 | | 26625 |
| ... | ... | ... | ... | ... | ... | ... | ... | ... |
| User36 | | | | | | | | 115 |
| User20 | | | | | 112 | | | 112 |
| User47 | 100 | | | | | | | 100 |
| User46 | | | | | 23 | | | 23 |

Automatic air temperature acquisition



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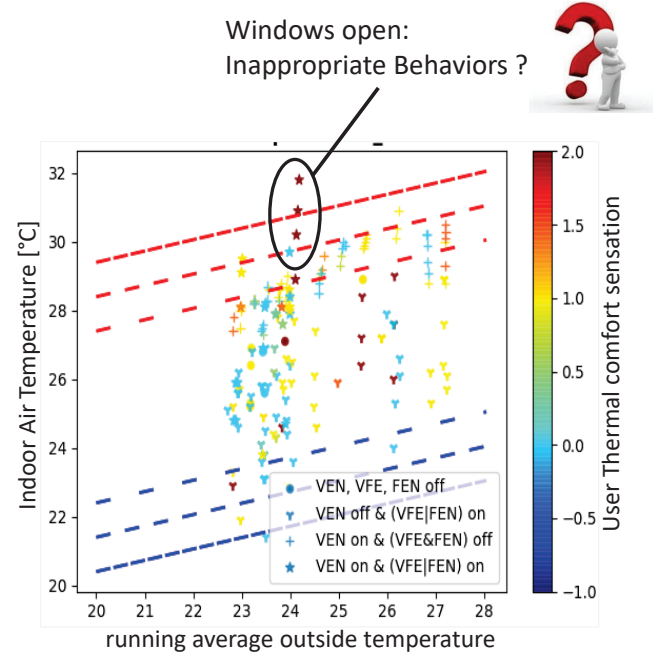
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Initial behavior campaigns: First results (2/2)

The interface is divided into several sections:

- Clothing:** Includes sections for 'VETURE' (Sleeves, Collar, Length, Fit, Foot) and 'NUISANCES' (Noise, Vibration, etc.).
- Thermal Comfort:** 'CONFORT THERMIQUE' section with questions about current and desired thermal comfort, and 'CONFORT AERAIQUE' section about air movement acceptability.
- Office Status:** 'Office Status : Windows, fans, ...' section.
- Global Comfort:** 'BILAN' section for overall environmental assessment.

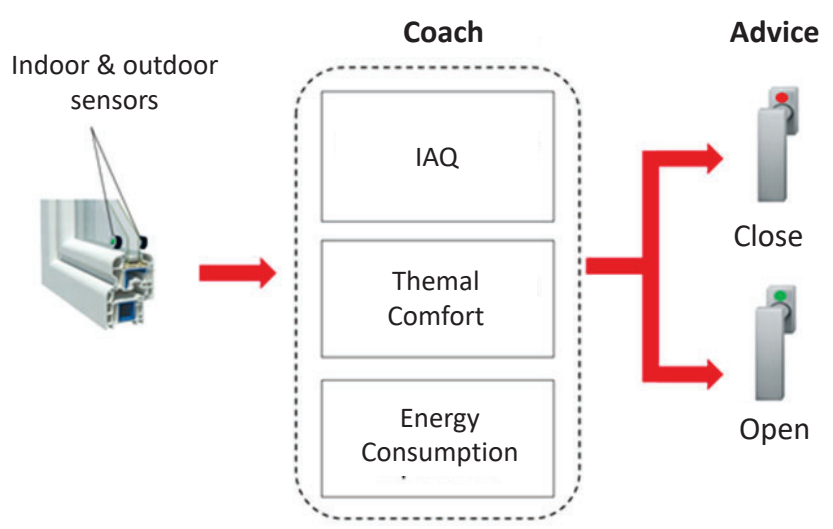
Interface to gather user feedback



User Comfort on Adaptive comfort chart

WIND'OSE OBJECTIVE

- Coaching tool developed to help occupants to know whether it is a good option to open or close their windows.
- Coach objective is to consider the three components:
 - thermal comfort,
 - indoor air quality (IAQ)
 - energy consumption

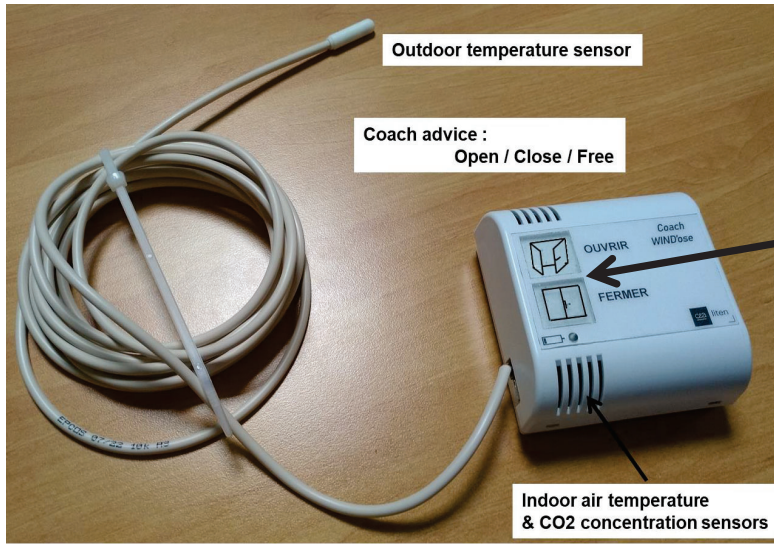


→ Based on Patent EP3971490 on "Method and system for advising on the opportunity of activating a door in order to improve the thermal comfort and/or the quality of the air"

WIND'ose an e-fAIR prototype

SPECIFICATIONS AND PROTOTYPE V1

- 2 Indoor Sensors:
- Indoor air temperature
 - CO₂ concentration
- 1 Outdoor sensor
- Outdoor air temperature



Outdoor temperature sensor

Coach advice :
Open / Close / Free

Intuitive message
communicate to users

Indoor air temperature
& CO₂ concentration sensors

Autonomous (Energy & embedded algorithm)
and easy to set up

WIND'OSE ALGORITHM

1 Separate evaluation of each criteria

2 Check consistency between the 2 separate evaluations

3 If necessary – Arbitrate between criterias

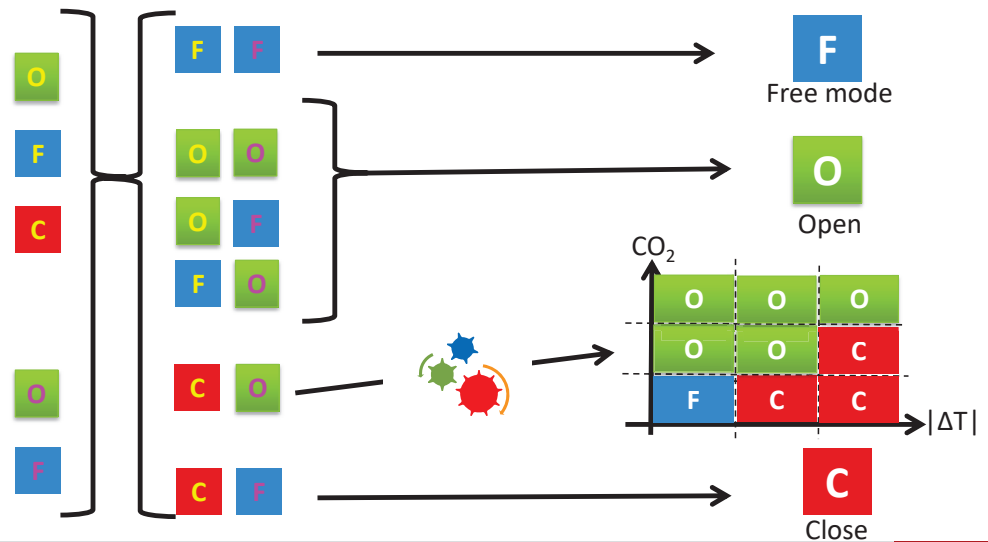
4 Advice push to user

Thermal criteria

Potential depending on Tint-Text + Opportunity based on adaptive comfort

IAQ criteria

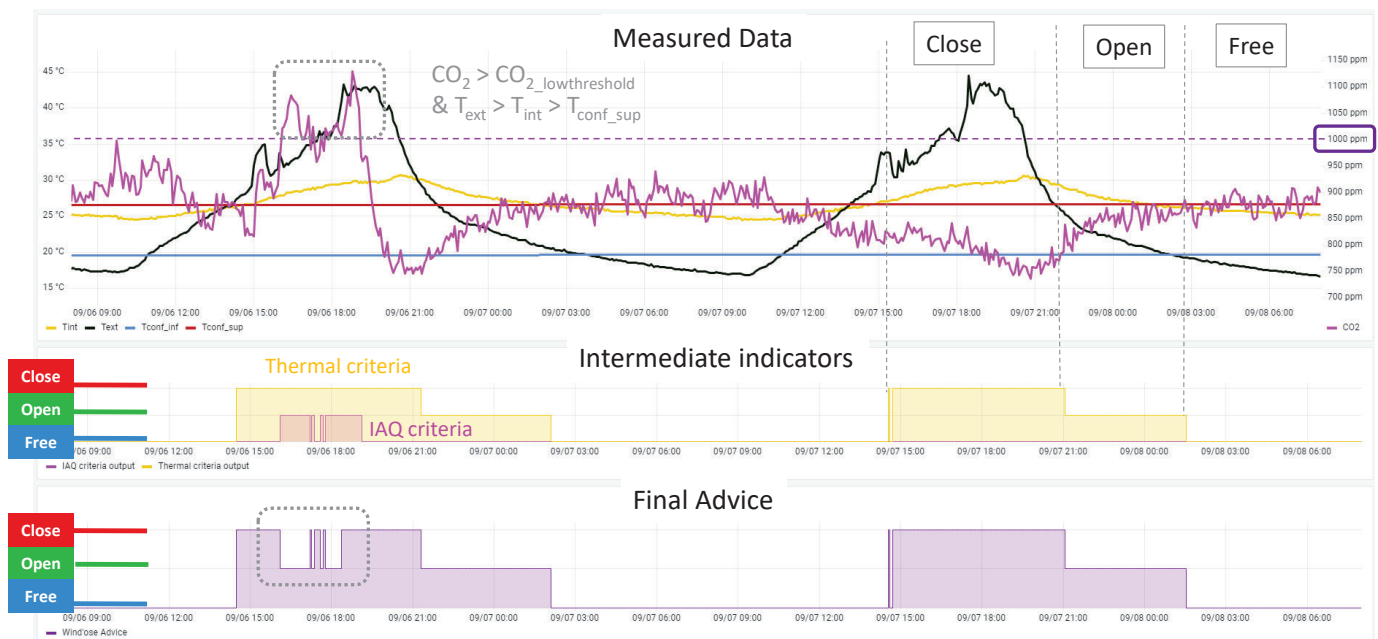
Indoor CO₂ concentration compared to a lower threshold



EXPERIMENTAL CAMPAIGN SET UP ON A REAL BUILDING.



FIRST RESULTS



CONCLUSION AND PERSPECTIVE

- Wind'ose prototype answer our 1st requirements and specifications
- What's next:
 - Increase period and number of user feedback
 - Improve algorithm, and integrate specificity for
 - Mid-season
 - Winter
 - Enhance battery autonomy or integrate PV cells to get it fully autonomous.
 - Integrate other pollutants sensors.
 - Integrate shutter advice for solar control
 - ...



Thank You for your attention

Next presentation :

Coupling methodology of windows and ceiling fan occupant behaviour models
with building energy models: a tropical case study

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