Bridging the gap

between predicted and actual performances through measurements and quality checks along building life

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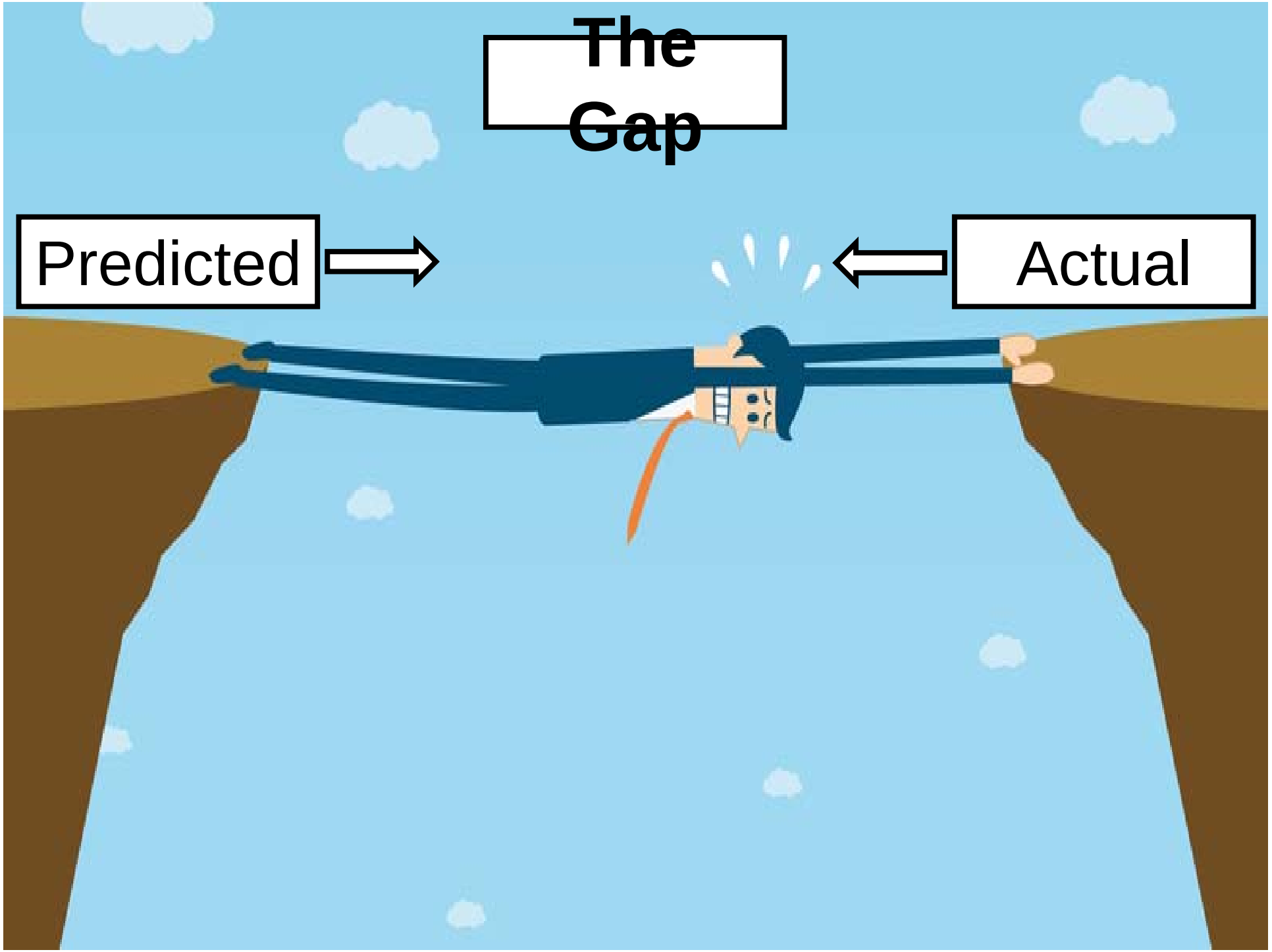
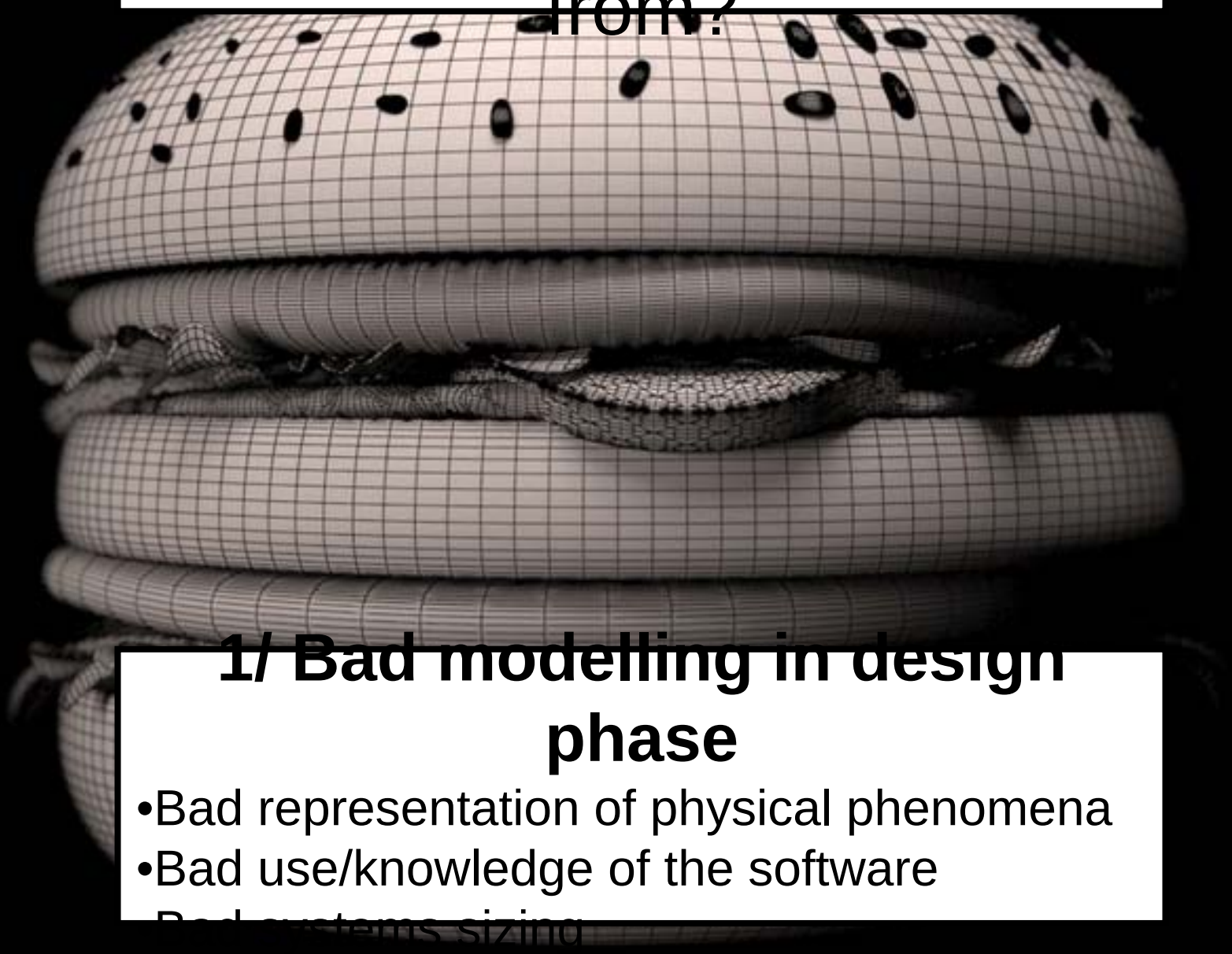
CSTB
le futur en construction


The **actual** performance of a building may deviate significantly from its **theoretically designed** performance.


The Gap
Predicted
Actual

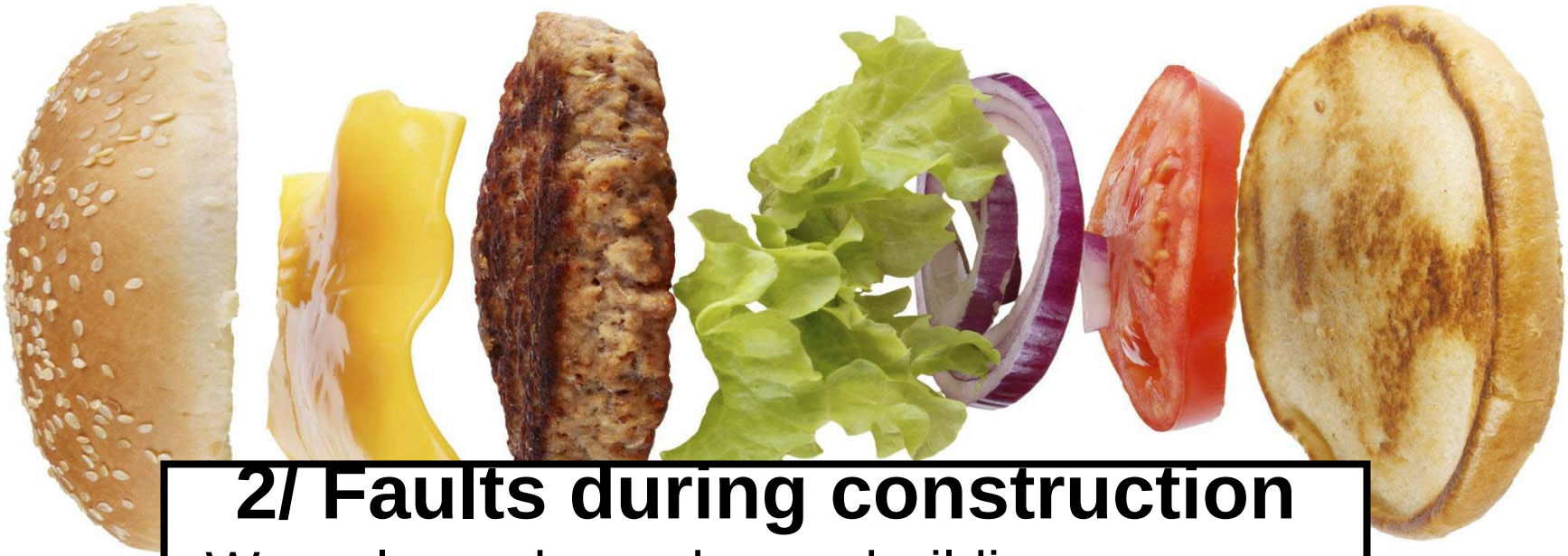
Where does this **gap** come from?



1/ Bad modelling in design phase

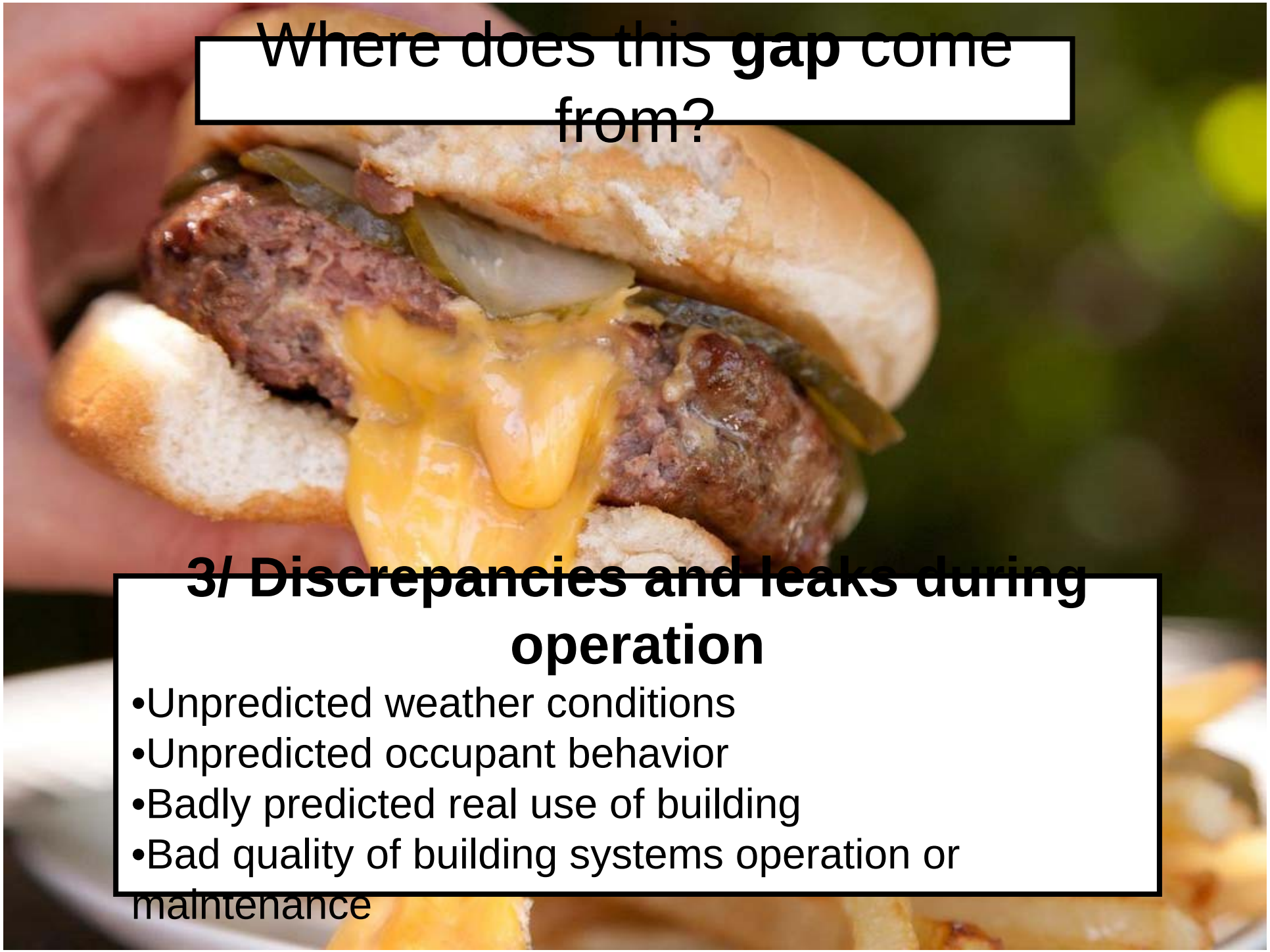
- Bad representation of physical phenomena
- Bad use/knowledge of the software
- Bad systems sizing

Where does this **gap** come from?



2/ Faults during construction

- Wrongly made or chosen building components
- Building components badly transported, stored or assembled

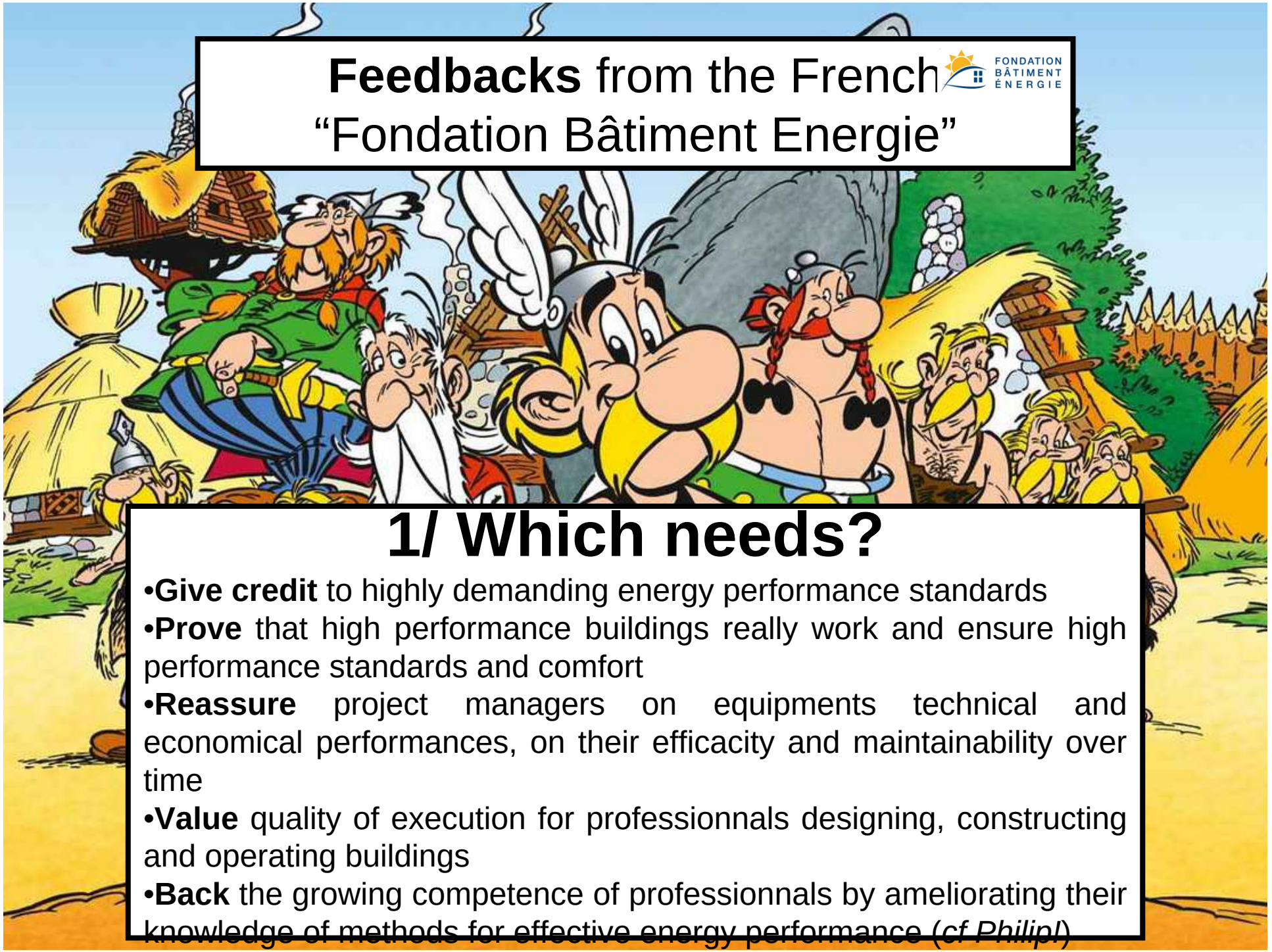


Where does this **gap** come from?

3/ Discrepancies and leaks during operation

- Unpredicted weather conditions
- Unpredicted occupant behavior
- Badly predicted real use of building
- Bad quality of building systems operation or maintenance


Then...
How can **research** bring buildings to a **next level in global performance**?

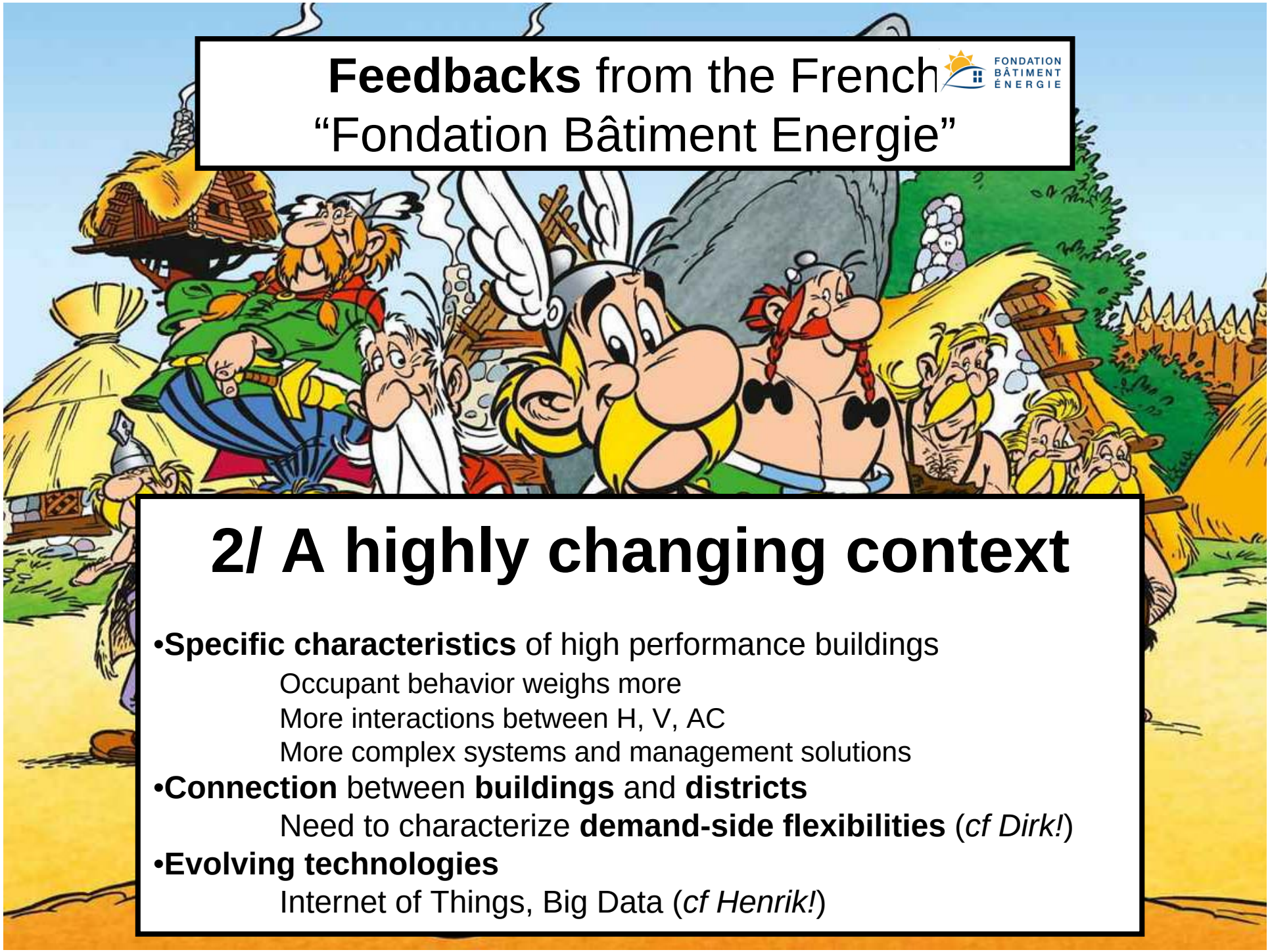


Feedbacks from the French “Fondation Bâtiment Energie”

FONDATION BÂTIMENT ÉNERGIE

1/ Which needs?

- **Give credit** to highly demanding energy performance standards
- **Prove** that high performance buildings really work and ensure high performance standards and comfort
- **Reassure** project managers on equipments technical and economical performances, on their efficacity and maintainability over time
- **Value** quality of execution for professionnals designing, constructing and operating buildings
- **Back** the growing competence of professionnals by ameliorating their knowledge of methods for effective energy performance (*cf Philipl*)

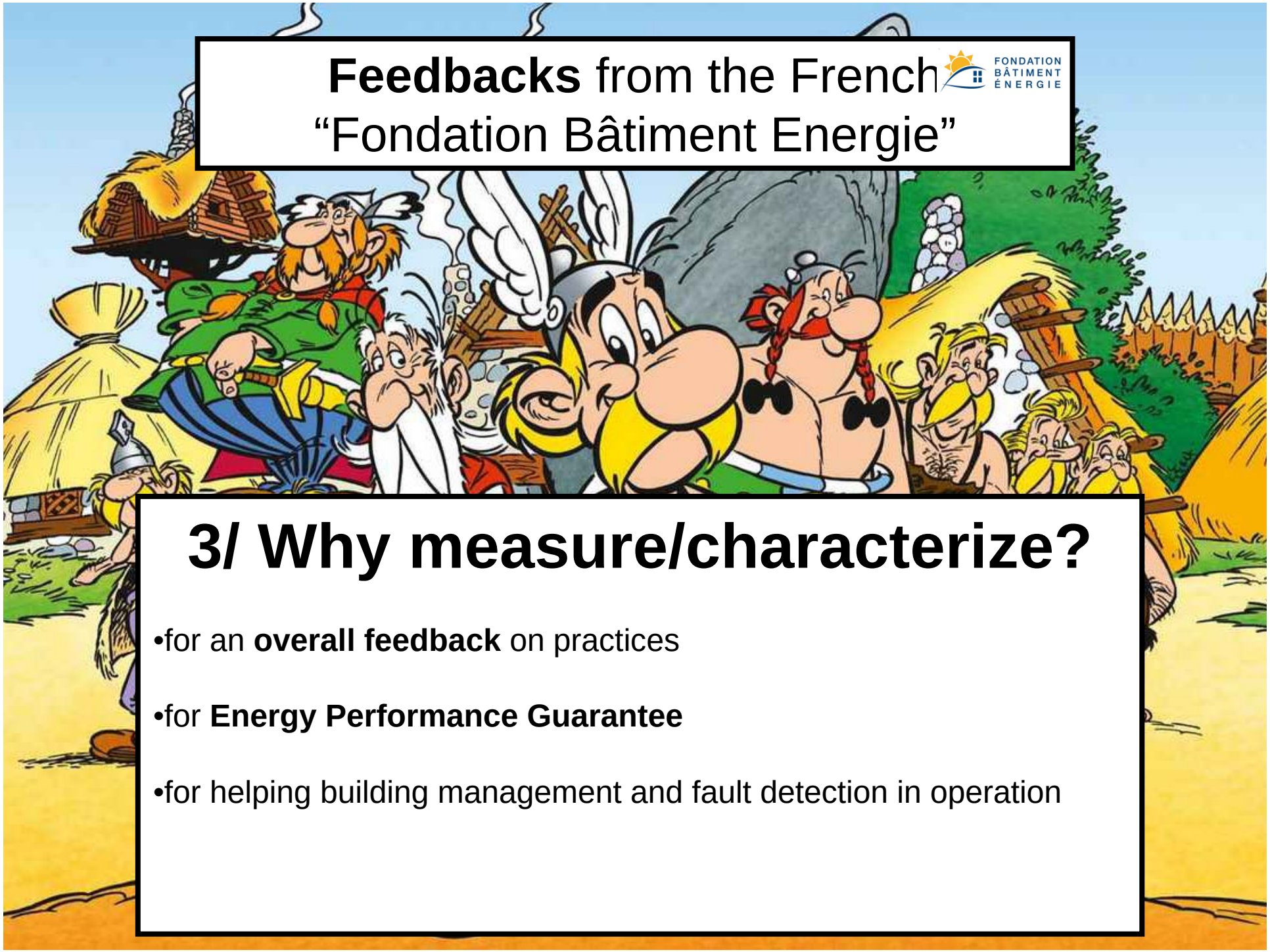


Feedbacks from the French “Fondation Bâtiment Energie”

FONDATION BÂTIMENT ÉNERGIE

2/ A highly changing context

- **Specific characteristics** of high performance buildings
  - Occupant behavior weighs more
  - More interactions between H, V, AC
  - More complex systems and management solutions
- **Connection** between **buildings** and **districts**
  - Need to characterize **demand-side flexibilities** (*cf Dirk!*)
- **Evolving technologies**
  - Internet of Things, Big Data (*cf Henrik!*)



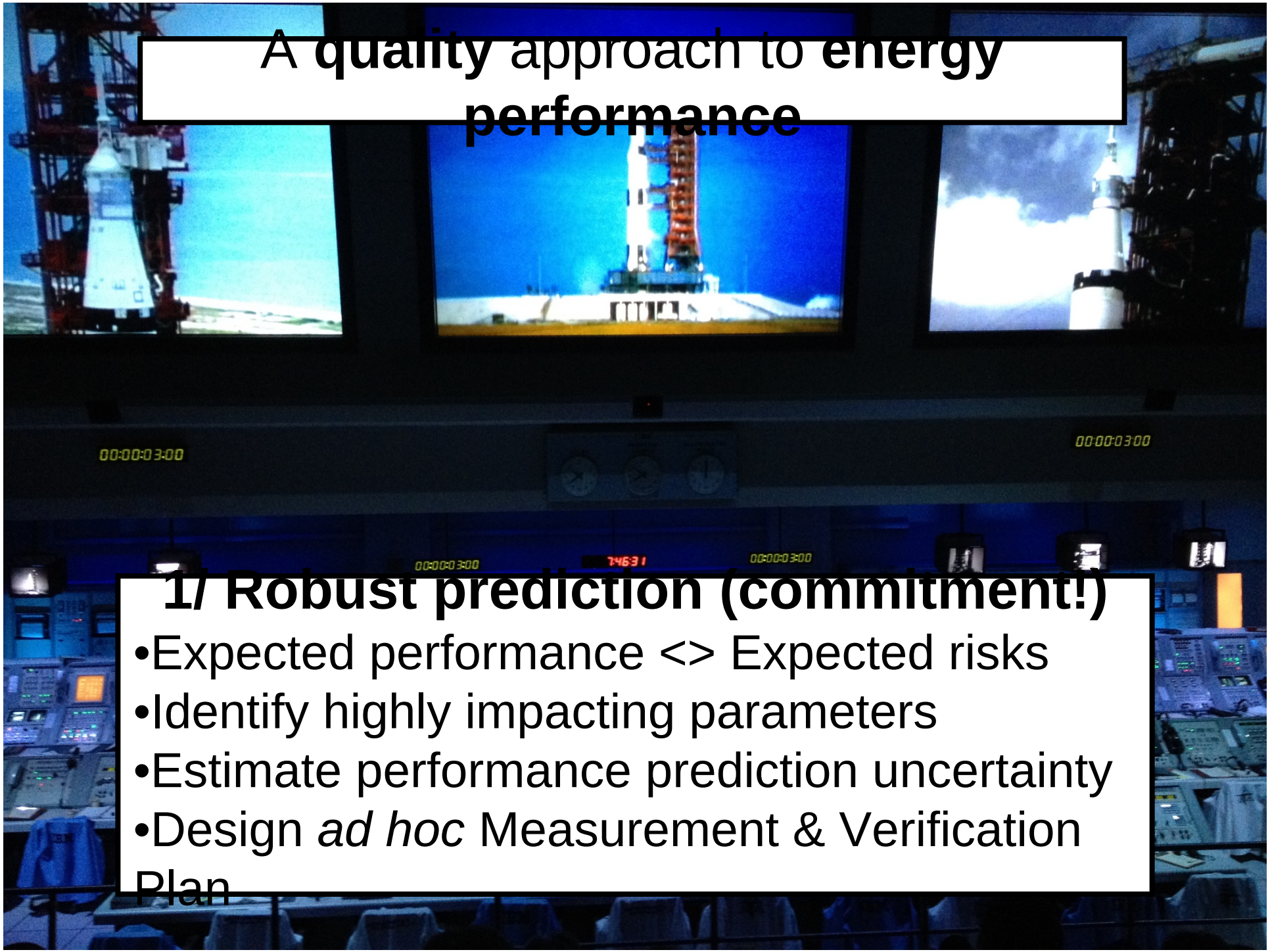
Feedbacks from the French "Fondation Bâtiment Energie"

FONDATION BÂTIMENT ÉNERGIE

3/ Why measure/characterize?

- for an **overall feedback** on practices
- for **Energy Performance Guarantee**
- for helping building management and fault detection in operation

A **quality** approach to **energy performance**



1/ Robust prediction (commitment!)

- Expected performance <> Expected risks
- Identify highly impacting parameters
- Estimate performance prediction uncertainty
- Design *ad hoc* Measurement & Verification Plan

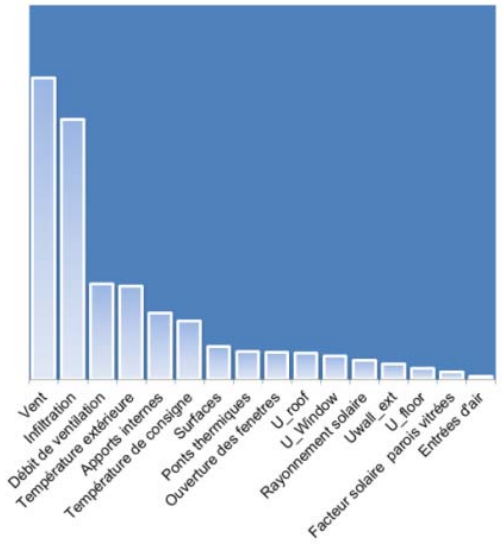
Robust prediction

Sensitivity Analysis

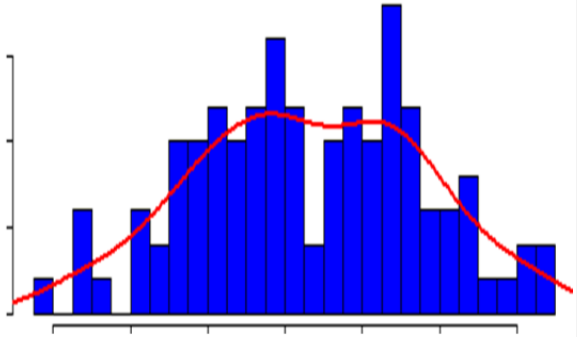
Dynamic Energy Simulation

Propagation of Uncertainty

Identify highly impacting **parameters**



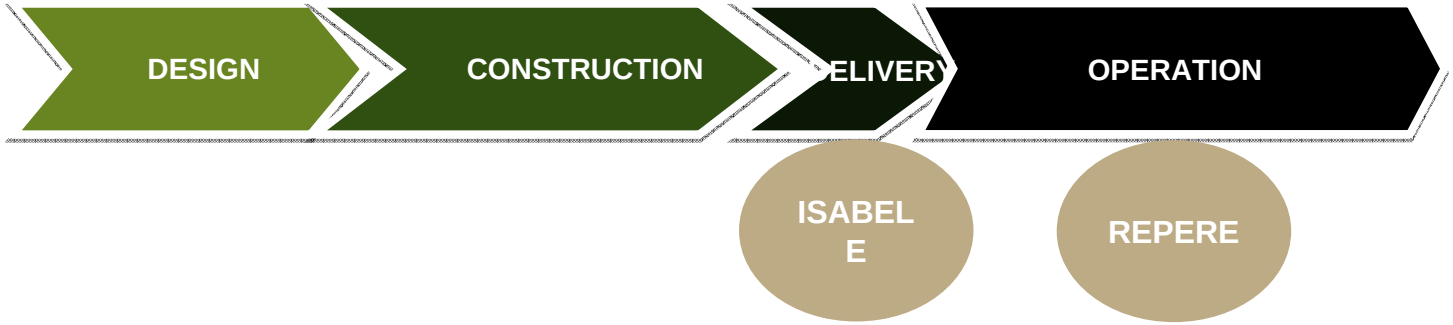
Estimate the **uncertainties on performance**



MIRACLE tool (Python) developed at CSTB

A **quality** approach to **energy performance**

2/ In-situ performance assessment (= The Building You Actually Get!)



In situ assessment of actual building energy performance

- Intrinsic performance
  - Envelope
  - Technical equipments
- Effective operating performance
- Measurement of exogenous parameters (weather, occupancy…)

Intrinsic performance assessment

EBC Energy in Buildings and Communities Programme A58

In Situ Assessment of the Building EnveLope pErformance

WHAT

innovative set of **sensors** and **software** for **characterizing effective thermal insulation level**

HOW

1/ impose a **specifically crafted** thermal solicitation profile on the building
2/ get measured temperatures and consumptions
3/ identify global insulation coefficient using an ***ad hoc*** thermal building model

CHALLENGE

find the **right balance** between **precision**, **ease of use**, **intrusiveness** and **cost**

✓ **March 2016: first full scale tests on two houses in Normandy, France**

ISABELE framework developed a CSTB

Operational performance assessment

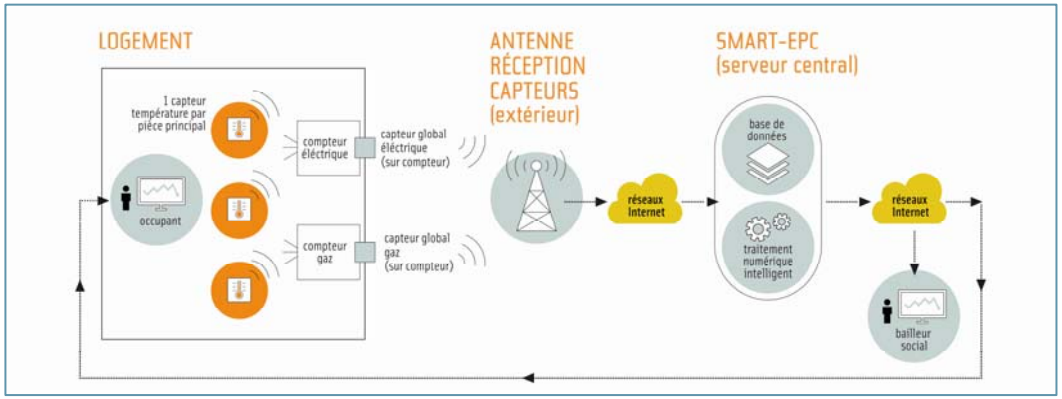
WHAT

lightweight and cheap ambiance and consumption sensors
data analysis tools for identifying building models and decorrelating consumption from weather and usage

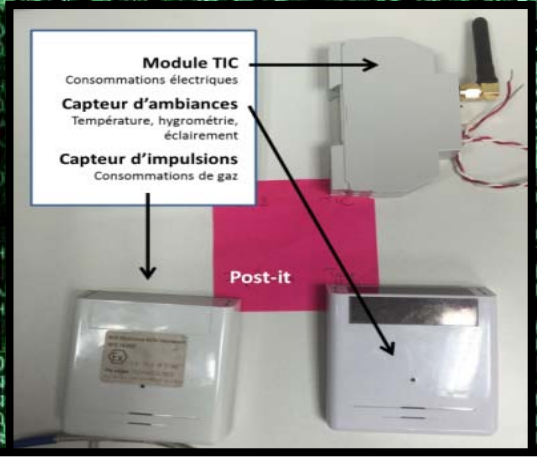
WHY

qualify performance gains before/after retrofitting

HOW

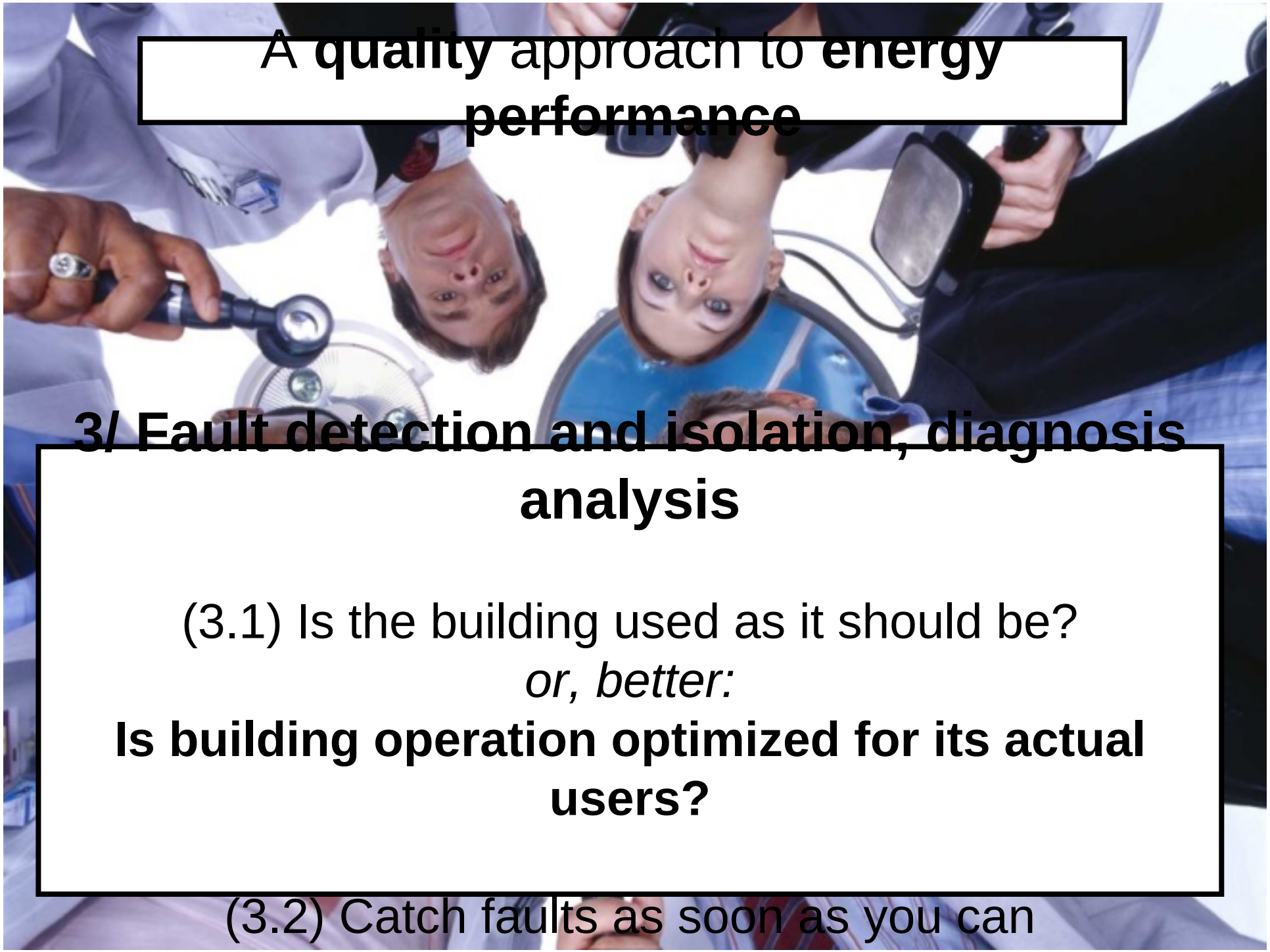


Implemented on 160 retrofitted dwellings in Toulouse, FR



Lightweight & cheap

REPERE tool developed at CSTB



A **quality** approach to **energy performance**

3/ Fault detection and isolation, diagnosis analysis

(3.1) Is the building used as it should be?

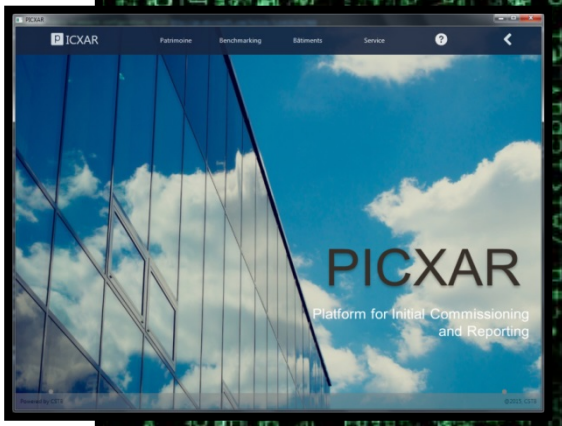
or, better:

Is building operation optimized for its actual users?

(3.2) Catch faults as soon as you can

Initial & Continuous Commissioning

Platform for Initial (and continuous) Commissioning and Reporting



WHAT

a platform for **commissioning** and **supervision**

WHY

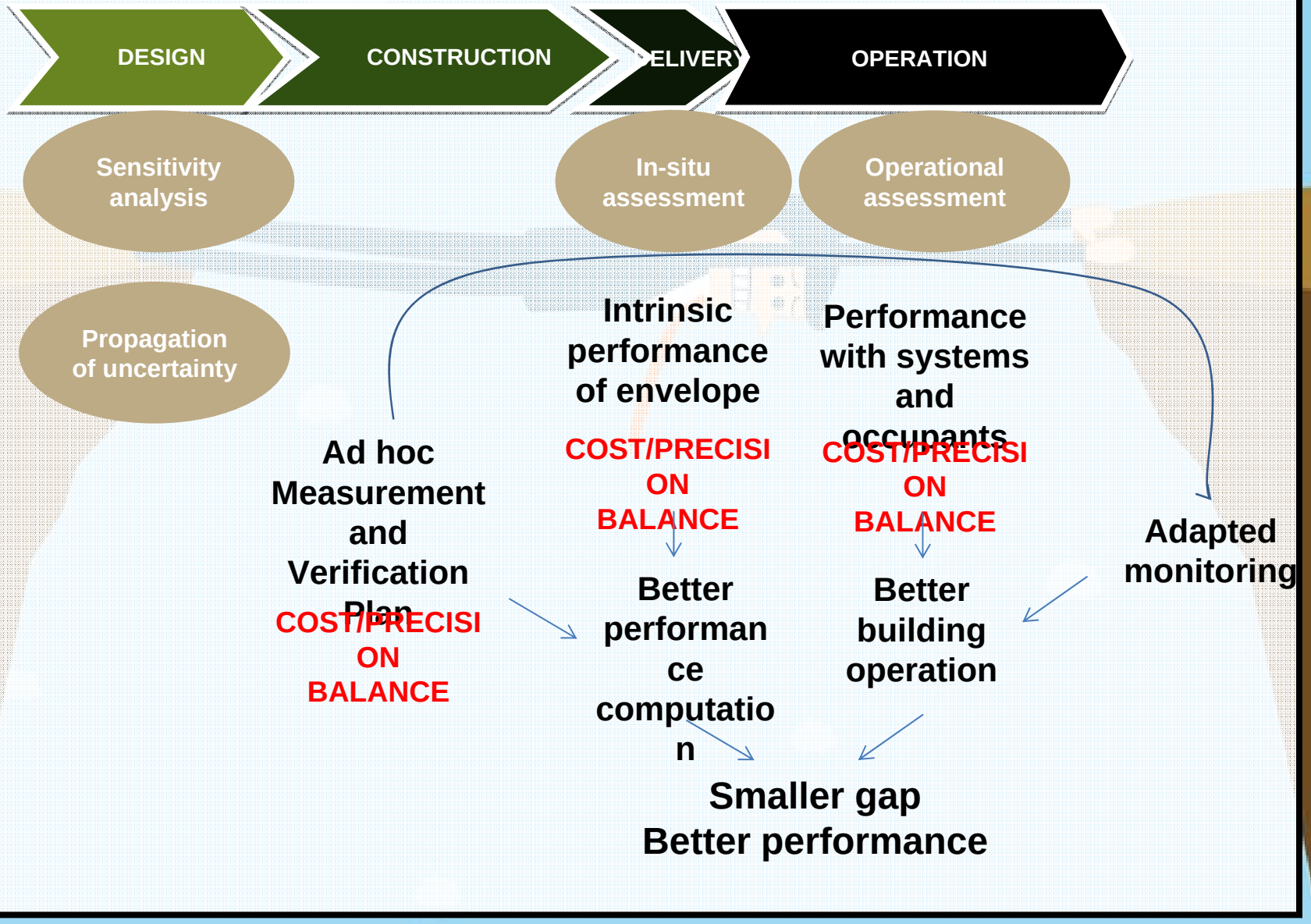
help maintain and optimize energy performance in operation
Evaluate building performance and health/tuning of systems

HOW

generate **valuable indicators**, **data visualizations**, **reports** in order to illustrate
overall performance and necessary actions

PICXAR tool developed at CSTB

To sum up


DESIGN
CONSTRUCTION
ELIVERY
OPERATION
Sensitivity analysis
In-situ assessment
Operational assessment
Propagation of uncertainty
Intrinsic performance of envelope
Performance with systems and occupants
Ad hoc Measurement and Verification Plan
COST/PRECISION BALANCE
COST/PRECISION BALANCE
COST/PRECISION BALANCE
Adapted monitoring
Better performance computation
Better building operation
Smaller gap
Better performance