

# Noise impact in the workplace



**Ecophon**<sup>®</sup>  
— SAINT-GOBAIN

A SOUND EFFECT ON PEOPLE

# Noise

## - a superdriver

Shaping common workday activities is sound, which constantly affects an organisation's performance. Individual focus and collaborative work, meetings, phone conversations and conferences, reading, restoration, thinking and imaginative – just to mention a few.

Creating the right levels of sensation for these different activities is crucial. The sound environment affects them all. It's the reason why noise is a **superdriver** in workplace experience according to Leesman. Noise levels and quiet spaces for working are two criteria scoring only about 30% in workplace satisfaction – meaning 70% are dissatisfied with noise. <sup>1</sup>

### Cognition and psychology

The key to this is worker cognition; being able to process and use the brain – the primary muscle enabling us to perform well. Important to note: a majority of noise impact is subjective, with actual impact representing only a fraction. This is why understanding the psychological impact of noise is vital if we want to minimise its impact.

In this summary we'll highlight how sound affects people and organisations. What we discover is that there's room for improvement. Sound is neither appropriately considered or getting the attention it merits. By shining a light on sound's impact, we can get to work on creating environments where we can thrive, create and evolve as individuals, teams and organisations.

# Optimal performance

## how it's created

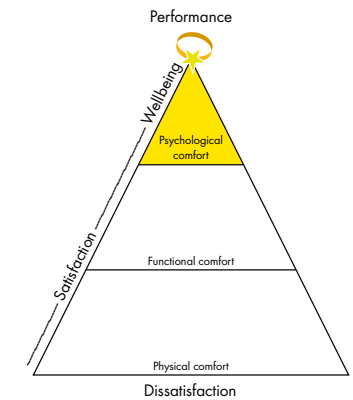
Understanding the basic principles of performance is essential in user based design. This includes the environment's impact. Environmental psychology focuses on the interplay between individuals and their surroundings. It examines the way in which the natural environment and our built environments shape us as individuals. Looking at the needs to achieve good performance can be represented in a hierarchical format.

### Achieving optimal performance based on environmental needs

**Physical** - The foundation represents creating a basic physical environment. From sound, it's about getting the right amount of sensation for stress, cognition, blood pressure and feeling well.

**Functional** - After meeting basic needs, next comes utilising functionality. From sound, it's about creating enough spaces fit for purpose – enabling people to maximise the environment's intended use.

**Psychological** - Understanding and addressing psychological needs in design ensures that organisations make people feel well and happy, thus performing to their maximum abilities.



The role of comfort in performance<sup>2</sup>

# Noise

## – an ongoing challenge

For decades, noise has been a massive workplace challenge. Improvements made over time, given the proof of its impact, are so disconcerting it implies an underlying cause, namely the psychological aspect of noise impact. This is where environmental psychology comes into play.

The undisputed No. 1 cause of dissatisfaction in offices are sounds that you don't want to hear. Or in one word – noise. Yet in most cases, acoustics don't receive the same level of design attention as thermal, ventilation and other architectural and engineering considerations.<sup>3</sup>

- “Noise is probably the most prevalent annoyance source in offices, and can lead to increased stress for occupants.”<sup>4,5,6</sup>
- “Looking at different aspects of environmental satisfaction, it was clear that most dissatisfaction concerned noise and privacy...”<sup>7</sup>
- “Without going into details of the Why, what is discovered time and time again is that occupants are extremely dissatisfied with the current level of noise control.”<sup>4</sup>

Top 5 activities of importance <sup>1</sup>
Individual focused work, desk based
Planned meetings
Telephone conversations
Collaborating on focus work
Audio conferences

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Sound vs. Noise

Sound is  
wanted.

Noise is  
unwanted.

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## ...in the workplace

Arguably the world authority on subjective workplace satisfaction criteria, the Leesman Index has mapped the complex interplay of criteria comprising worker satisfaction. “Data shows ‘noise levels’ remain a widespread and highly problematic issue, with a catastrophic average satisfaction score of just 33.4% across all new workplaces, with one in four scoring below 25% satisfaction.”<sup>8</sup>

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This improvement  
is a disappointing  
2.6%.

specially given that noise is deemed a ‘superdriver’  
amongst occupants.”<sup>8</sup>

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**Before moving to a new  
working space**  
69.2% are dissatisfied with noise  
levels.<sup>1</sup>

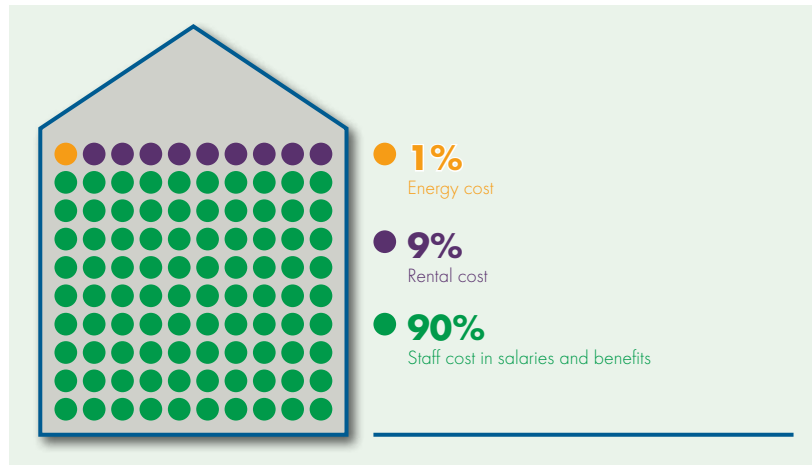
**After moving to a new  
working space**  
66.6% are dissatisfied with noise  
levels.<sup>8</sup>

## Sound design a smart & sustainable investment

Acoustic comfort is not just about making people perform and feel good. It's a vital part of the cost and sustainability structure. If people feel less disturbed in their environment, they work better, with enhanced efficiency and productivity as a result. Simply put, organisations maximising the usage of their workplace to support their most valuable asset – its people – is both a smart and sustainable investment.

“In a business climate where it is increasingly important to get and keep the best talent and have them engage in more productive teamwork and solo work, the design of the workplace plays a much stronger role than we believed.”<sup>9</sup>

**The cost of the people is 90% of the total cost of an office over ten years of work.**<sup>10</sup>



## Decreased focus increases sick leave

Noise interruptions are known to reduce the ability to focus and are a source of annoyance. Perhaps less widely known are the effects on worker health and the increased number of sick days.

- **Noise exposure is significantly correlated to absence due to sickness:** the more complex the task, the more significant the correlation becomes.<sup>11</sup>
- **Evidence suggests that noise is the most widespread stressor in the physical work environment** among the industrial work force in USA and Europe.<sup>11</sup>
- **Moderate levels of noise may also contribute to adverse psychological and physical reactions.** These include: somatic complaints, sleep disturbances/ elevated blood pressure, increased secretion of stress hormones.<sup>11</sup>

“We have shown, perhaps for the first time in a large field study, that moderate levels of noise can become harmful, as indicated by increased absenteeism among employees performing complex jobs.”<sup>11</sup>

# Distraction

## the cost

### A loss in productivity

Workers are on average required to spend 60% of their time in focused concentration in order to achieve their daily work.<sup>9</sup> Disruptions from noise are not simply a source of annoyance, the time it takes for workers to recover slows down productivity.

**Perceived annoyance: speech is more disturbing than noise levels.** The higher the speech and noise levels, the higher the levels of annoyance.<sup>12</sup>

The relationship between the speech intelligibility index and performance loss makes it possible to design based on productivity. The improvement results in a comfortable acoustic working environment and is also a consistent financial advantage for the organisation.<sup>13</sup>

“It takes on average 25 minutes for a worker to return to the original task after an interruption, and another eight minutes pass until the worker has reached the same level of concentration.”<sup>14</sup>



# Privacy and noise

## shared values

The new gold: privacy, or; controlling distractions. Going hand in hand with noise control, speech privacy may be equally, if not even more important, to occupants than noise control.<sup>6</sup>

In open workplaces, privacy has been a hurdle, especially when more demanding tasks on the brain now also take place in open office plans. Strong evidence supports that working in open spaces reduces privacy and job satisfaction. It's also believed that working in open areas intensifies cognitive workload and worsens interpersonal relations due to close proximity between workstations and reduced privacy.<sup>15</sup>

“The top 25% of workplace performers are more protected from disruptions, have interruption consciousness at their workplace and fewer phone interruptions.”<sup>16</sup>



# Reduced stress

## improved cognition

The Stress Research Institute in Stockholm conducted a unique field study carried out in real life conditions, which can produce significantly more credible results since psychological factors are taken into account. The aim was to determine how a ceiling's properties affect workers' health, productivity and the perceived disturbance. The findings were clear: a good sound absorbing ceiling improves overall satisfaction levels of occupants.<sup>17</sup>

- Up to 16% reduction in perceived disturbance in general
- Up to 25% reduction in disturbance at close range
- Up to 21% reduction in disturbance at long range
- Up to 11% reduction in cognitive stress – improving focus, memory, decision making



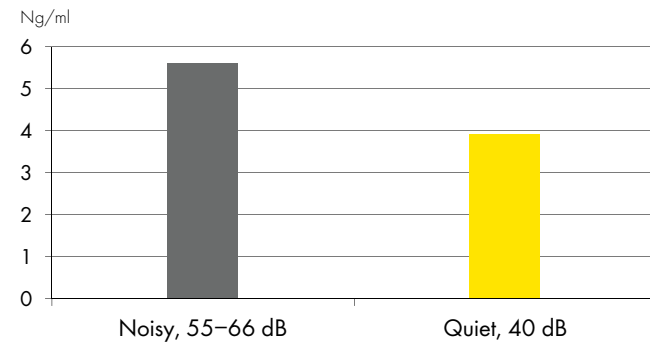
# Reducing noise

## raises motivation

The study tested 40 clerical workers for elevated levels of hormones in the urine after three hours exposure to low-intensity noise, in comparison to hormone levels in quiet office conditions.<sup>5</sup>

- The two groups of subjects did not differ in perceived stress
- Levels of the stress-indicator epinephrine differed between the two groups
- So called motivational after-effects, such as fewer attempts at unsolvable puzzles and a lower likelihood of making ergonomic postural adjustments were found
- The inability to control sound rather than its intensity is what makes it stressful. Even low-intensity sound levels can induce performance after-effects, indicative of diminished task motivation

### Increased epinephrine level



# Brain workload

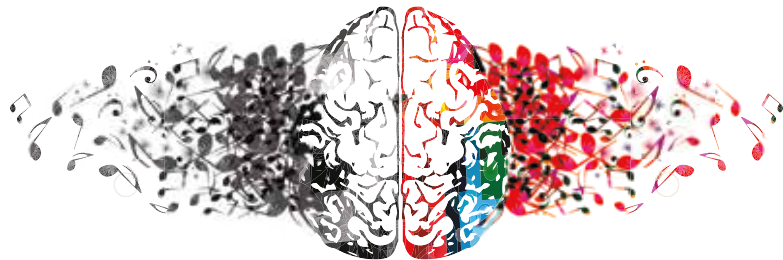
Cognitive skills continue to rise in demand due to rapidly increasing job complexity. Research indicates noise interference reduces these abilities, particularly in open office plans.

## Reduced memory

Office noise, particularly background speech, causes subjective disturbance and impairs performance in both verbal short term memory and working memory tasks. Not only causing dissatisfaction, it's associated with increased stress and diminished collaboration.<sup>18</sup>

## More time needed for task completion

Despite perceived privacy, irrelevant speech is a contributor to increased mental workload and poor performance, as well as increased fatigue and stress. Irrelevant speech appears to increase false alarms and extend completion rates. Workload ratings were higher when accompanied by irrelevant speech.<sup>19</sup>



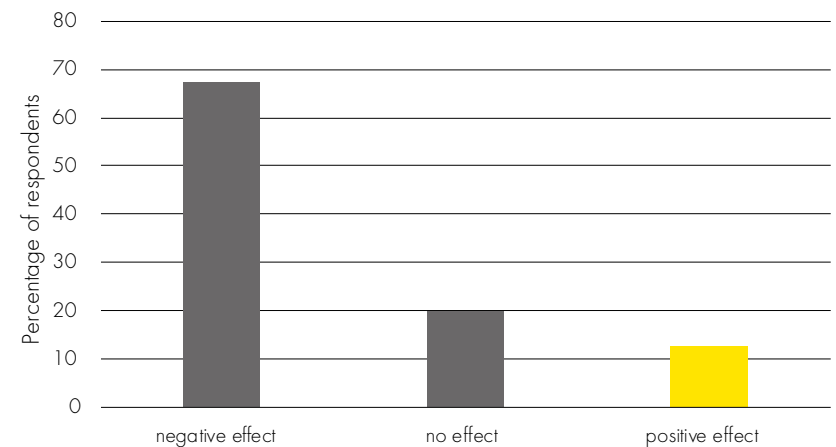
# Performance drops 6% due to noise

67% of respondents rated the effects from noise on performance as negative and a mean estimated impact on work performance was -6%.<sup>20b</sup>

## Greater cognition equals greater sensitivity to noise

“Analysis compared the part of cognitive work with worker’s “negative” experience (acoustic “hardness”, high sound levels dissatisfaction). It confirmed, similar to other studies, the more cognitive the work, the more sensitive office workers are to acoustic conditions.”<sup>21</sup>

Evidence suggests that the presence of meaning in irrelevant sound (understanding background speech) increases disruption of performance in cognitive tasks that require processing of meaning.<sup>22</sup>



# Noise

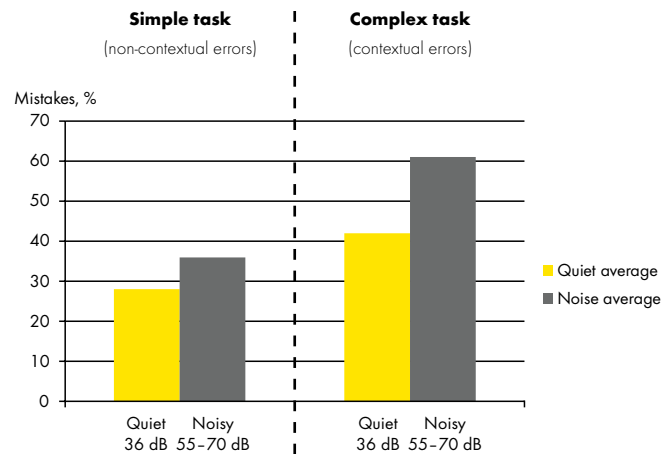
## on concentration levels

### Loss in concentration

Building on previous findings, research reports that distraction from noise is a key issue in offices, affecting performance – in particular, concentration and speech interference or disturbance.<sup>23</sup>

### Performance increases during tasks of concentration by up to 50%

College students divided into two groups performed both easy and complex tasks. One group had a noisy background and the other a quiet one. Results determined no significant difference between the two environments when performing the easier task. But with the complex task, performance with the noisy background was 50% less accurate.<sup>24</sup>



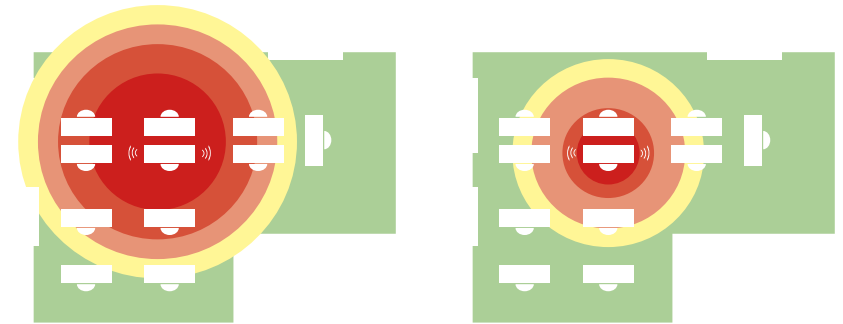
# Open plan

## comfort

Normally room acoustic demands are set with a reverberation time that's based on a typically furnished space. The lack of diffusion existing with more open workplaces has prompted a shift within the acoustic world on how to determine acceptable acoustic levels in an open office.

### Distance of comfort and speech propagation

These studies revealed that the performance of the ceiling is significant to occupants' overall satisfaction, wellbeing, cognition and potential for distraction. The changes of ceiling performance minimised speech propagation so that the reduced radius of noise discomfort was beneficial to occupants.<sup>17</sup>



Distance of comfort scenarios; how the sound pressure of speech is being distributed over workplaces. The higher absorption in the ceiling the shorter spread of speech, which is beneficial for occupants.<sup>17</sup>

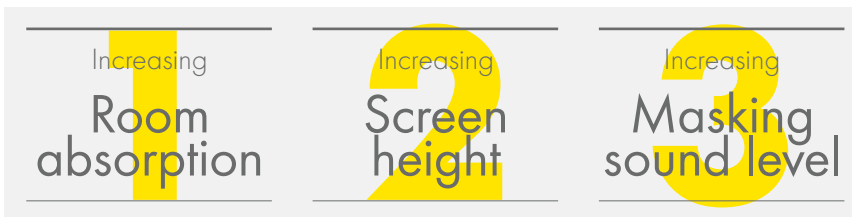


# Speech intelligibility over distance

Multiple independent laboratory experiments have shown that noise, in particular speech, reduces task performance of cognitively demanding tasks.<sup>25</sup>

Speech intelligibility on cognitive performance. “The performance starts to decrease when STI exceeds 0.2. Highest performance decrease is reached already when STI (Speech Transmission Index) exceeds 0.60.”<sup>26</sup> This means there is a slope between 0.2-0.6 in STI in decreased performance. STI levels 0.6-1.0 is on the same and highest levels in decreased performance.

**Achieving the right level of distraction distance between workstations comprises three main factors:**<sup>25, 27, 28</sup>



This pilot study gives suggestive evidence that masking can be recommended in open offices when workers are dissatisfied with the acoustic environment and the background noise level is low.<sup>25</sup>

# Sound masking...

## Pros and cons

The use of sound masking in open plan offices has been and is still being debated, with attitudes towards “killing sound with sound” differing substantially on a global scale. The controversy pivots around the potential for masking sound to be effective (at masking speech), without becoming an added noise burden in itself. The added noise could drive sound levels up and potentially lead to fatigue or performance drop.<sup>29, 30</sup>

## How much is too much

It’s proven in laboratory experiments that reducing speech intelligibility improves cognitive tasks.<sup>31, 32, 33, 34, 35</sup>

However, the significance of this effect has only been demonstrated when background noise is much higher than the level of speech. Field studies<sup>36</sup> and laboratory studies<sup>37, 38</sup> indicate that “noise levels much greater than 45 dB(A) are judged to be too loud”<sup>37</sup>

High background noise levels can also stimulate the Lombard reflex, meaning people instinctively raise their voices which results in even higher sound levels.



## ... considerations

### A natural approach

Natural sound such as falling water may be preferred over pseudo-random noise.<sup>33,39</sup> Plantings and water features, or any other visual or aural attributes, can be relevant for approval of natural sounds<sup>40</sup>, as well as the involvement of people in the choices.

### Factors to consider

Factors such as office size, workplace density, occupancy ratio, the type of tasks undertaken (concentration, collaboration, individual work, group work etc.) and the office culture, as well as the room acoustic response, affects the acoustic environment.

This makes the acoustic environment, without masking sound, vary widely between different offices. Thus the use of masking sound should always be considered in the context of the overall design, the occupants, and the activities undertaken.



Photographer: Rodger Bosch

## Sound, psychology & environment

Sound perception is highly subjective: only 25% of noise impact is actual while 75% is perceived, making addressing noise impact an even more complex challenge to address. Noise perception levels reside in the core of psychological environments – a combination of psychology and behaviour linked to habitat. This area of study is called psychoacoustics and is important to consider when creating sound environments for optimal performance.<sup>23</sup>

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### The need for activity based acoustic design

Often, acoustic design of offices doesn't receive the same attention as most other architectural systems. Unwanted levels of ambient noise can cause difficulties with communication and concentration at work. Similarly, sound expert Julian Treasure concludes: **“Despite huge advances in almost every area of architecture and interior design ... sound and acoustics, for the most part, have remained secondary concerns”**. So, it appears that, despite noise remaining a significant problem in office environments and affecting worker satisfaction and productivity, the problem of poor acoustics is often ignored.<sup>20a</sup>

# Psychoacoustic approach



There are four main psychoacoustic qualities to consider when creating an optimal acoustic environment.

**Task and work activity** – the nature of the task in hand or work activity; whether it involves cognition or memory; the complexity of the task; whether it involves multitasking; and whether the task requires quiet.

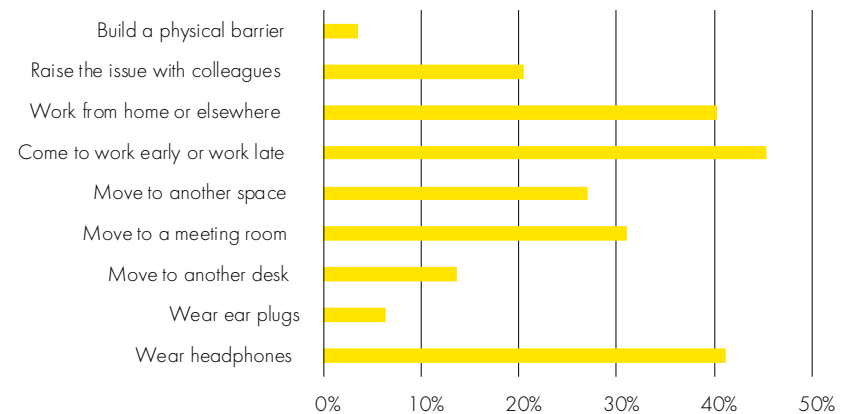
**Context and attitude** – feelings towards the noise source; the perceived need for it; the meaning attached to it, and whether the noise (e.g. conversation) is perceived as useful.

**Perceived control and predictability** – whether the noise source is intermittent or steady; whether it is predictable; and whether those exposed to the noise believe they can control it.

**Personality and mood** – differences in those who are more noise sensitive, and in those who seek stimulation versus those that prefer solitude; as well as the effects of moods such as anger and anxiety.<sup>23</sup>

# Coping mechanisms

Noise impacts our behaviour and in doing so we create coping mechanisms. From the Lombard effect (the involuntary tendency for speakers to gradually raise their voices in high density populated workplaces, such as call centers) to moving away from a noise source, efficiency and productivity declines.



## Screening ability and coping mechanisms

The image shows that moving away from the source of noise, by working outside the office or at home is the primary coping mechanism. However, given the provision, moving to a quiet area is also a readily adopted coping alternative. Few however say they move to another desk. The proportion of respondents who say they come in early or work late to avoid noise and the numbers that wear headphones at work was higher than expected. Interestingly, fewer respondents say they raise the issue with colleagues and would rather change their own behaviour than make demands of others.<sup>20a</sup>

# Conclusion

The success of a company depends on how well people work – including how well they thrive in and with their acoustic environment. It's displayed in how well they can concentrate, collaborate and ultimately, perform.

Sound is a **superdriver** in workplace experience; a potential resource in making people more productive. Sound affects us continuously, and proven repeatedly, has a great effect on our cognition, wellbeing and health.

Reducing noise and distraction levels can improve a worker's ability to focus and think more clearly and to be less stressed. There's a growing demand for workers to perform more complex problem solving with various teams, colleagues and partners. So, the importance of a good sound environment can't be underestimated.

## **The importance of Activity Based Acoustic Design**

There is a value in understanding your workers' basic personality types (eg. being an intro- or extrovert) to determine which conditions best suits them, as well as what certain activities require – from spaces in which to collaborate, to make phone calls and areas for quiet contemplation.

Knowing the types of people and activities that make up your organisation will help inform you of what a good sound environment comprises. This environmental-psychological approach will make your organisation more effective by stepping up your company's own pyramid of performance.

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Ecophon is the leading supplier of acoustic solutions. We contribute to healthier indoor environments, improving quality of life, wellbeing and working performance. As evolution has adapted the human senses to a life outdoors, our focus is to bring the ideal acoustic environments of nature into our modern indoor spaces. We know they will have a sound effect on people.



The principles guiding our work are grounded in our Swedish heritage, where a human approach and a common responsibility for people's lives and future challenges come naturally.

Ecophon is part of the Saint-Gobain Group, a world leader in sustainable habitat solutions. This is also one of the top 100 industrial groups in the world, constantly innovating to make living spaces more comfortable and cost-efficient. Saint-Gobain offer solutions to the major challenges of energy efficiency and environmental protection. No matter what new needs emerge in the habitat and construction markets, the future is made of Saint-Gobain.



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