OPTIMISING PASSIVE DESIGN

REDUCING OUR RELIANCE ON MECHANICAL SYSTEMS

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INTRODUCTION

Prior to the invention of HVAC and other contemporary building technologies, the built environment was greatly restricted in scale and usability. In order to ensure comfortable temperature and lighting conditions, architecture around the world was defined by the climatic conditions of the region, spawning a variety of indigenous and vernacular styles. These styles evolved over the years as different ways of environmental manipulation were discovered or introduced, but the largest increases in building sizes were made only after the widespread implementation of mechanical systems.

The results of such a paradigm shift in how we approach occupant comfort has produced buildings across the world capable of operating regardless of climate. While certainly a noteworthy feat, the recognition of the dangerous impacts of climate change and the role our mechanical systems have in it, means contemporary large-scale development must embrace the best of old technology and design understanding in tandem with the new. Embracing passive design techniques is not to reject mechanical systems entirely. Rather, they reduce the reliance that buildings today have on mechanical systems.[1]

The reduction in energy use through passive heating and cooling measures not only leads to a reduced environmental impact, but also holds a large economic incentive for reducing overhead operational costs. Passive cooling particularly is expected to become more valuable in the coming decades, as temperatures rise globally and singular methods of environmental control won't be enough.

Architects vision

Reality – Internal blinds, lights on and localised AC units

IMPORTANCE OF THERMAL COMFORT

Maintaining a comfortable temperature goes beyond workers simply wanting to be "comfortable", as if workplace temperatures are too high or too low, it can contribute to heat illness and cold-related medical conditions. The risk to workers' health increases the further thermal conditions move from those which are considered comfortable and the more extreme the environment, the larger the risk of workers being exposed to serious illnesses and injuries. Prolonged exposure to thermal discomfort can lead to fatigue, lowered concentration and productivity and seriously impact on a worker's overall morale. Worker complaints and absenteeism can also increase.[2] Multiple studies have identified the link between temperature and productivity. Research shows work performance will dip 2% per degree above 25°C. This means a business with workers exposed to a constant temperature of 30°C will lose 10% of potential productivity over any given time period, which translates into a significant cost burden over time.[3]

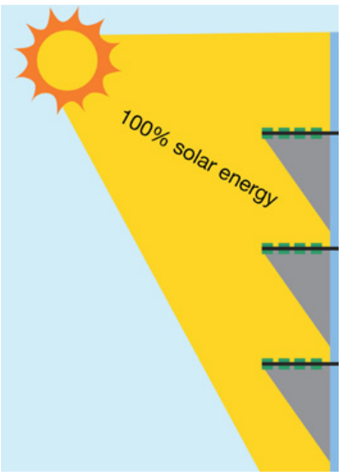
In addition, while the work health and safety legislation does not mention thermal comfort specifically, employers are required to "ensure, as far as is reasonably practicable, they provide a work environment (including layout and ventilation) that is without risk to a worker's health and safety". This means the work environment must be comfortable, not place workers at risk, must suit the work they are doing and enable them to function efficiently both physically and mentally.[4] The Compliance Code for Workplace amenities and environment covers temperature in more detail, stating "Workplaces that are buildings need to be capable of maintaining a temperature range that is comfortable and suitable to the work".[5] Therefore an employer is required to do their best to provide employees with a thermally comfortable and safe environment. The most effective, cheapest and environmentally friendly way to ensure thermal comfort is to utilise passive design. By using passive design, a building will remain comfortable year-round and have reduced needs for additional heating, cooling and lighting.

METHODS OF PASSIVE DESIGN

Passive design ties in a many different elements to achieve the best results for the particular project. Many methods are intended to adjust their operation across the year to facilitate passive heating and cooling. There is no one-size-fits-all solution for passive design as good passive design employs the most appropriate design objective and responses for the project's climate zone.[6] Some of the key methods of passive design are:

Orientation: The orientation of a building will allow it to take advantage of the climatic features such as natural airflow and heating and cooling. It will consider the seasonal variations, the sun's path and the direction and type of winds.

Shading: Shading minimises summer temperatures by reducing unwanted heat gain. Unprotected glass is often the greatest source of heat gain and effective shading can block 90% of the heat from the sun. This must be balanced with the need for winter sun and by calculating sun angles for the project's location and considering orientation, thermal comfort can be maximised.



A typical brise soleil system to help reduce solar heat gain and glare by using a horizontal protection from the sun side façade on a building.

Passive solar heating and passive cooling: Design for passive solar heating keeps out the summer sun and lets in the winter sun. It ensures the heat is kept in during winter, and excess heat can escape in summer. Passive cooling is achieved by utilising air movement, evaporative cooling and thermal mass.

Sealing: 15-25% of winter heat loss in buildings is due to air leakage, which can be eliminated by sealing. This can effectively increase comfort, reduce energy bills and greenhouse gas emissions.

Insulation: Insulation works as a barrier to heat flow, keeping heat in or out and can help with weatherproofing and soundproofing. The climate zone will determine whether to use bulk, reflective or composite insulation. To get the maximum benefit out of insulation it is vital to ensure it is correctly installed.

Thermal mass: Thermal mass refers to a material's ability to store and absorb heat energy. Choosing materials based on their thermal mass will determine how easily a space is heated and how it maintains that heat. Good use of materials with high thermal mass can create significant heating and cooling savings, but poor use can exacerbate temperature extremes.

Glazing: Glazed windows let in light but they can be a major source of unwanted heat gain or loss. Selecting the correct glazing systems for orientation and climate and taking into consideration the size and location of windows can manage these thermal performance problems.

Ventilation and roof ventilators: Can admit three times the amount of natural night into a space as a vertical window of the same size and can improve natural ventilation allowing trapped air at high level to escape, with low level facade ventilators. Cross flow ventilation is achieved.

REAPING THE BENEFITS

A well-designed project which embraces passive design is both environmentally friendly and cost effective. It reduces the need for additional heating and cooling, therefore providing substantial energy savings which continue for the life of the building.[7] Approximately 40% of building energy consumption is used for heating or cooling, but this rate can be cut to almost zero by using climate responsive design.[8] By incorporating passive design principals throughout a design, energy savings of up to 90% can be achieved, when compared with typical existing buildings and over 75% when compared with average new best-practice constructions.[9]

Achieving passive design isn't as simple as ticking the boxes set out by the BCA. The standards set by the BCA are a minimum and to reap the full benefits of passive design, architects must go beyond these standards. Architects should strive to achieve alternative standards in addition to the BCA's, such as the goals set by the Passive House or the Living Building Challenge which both strive to increase the quality of occupation by creating buildings which maintain a comfortable temperature year round. Passive House standards aims to create truly energy efficient, comfortable, affordable and ecological buildings. Using passive design, it relies on building physics and carefully integrated, minimal building services and technology to eliminate the need to add expensive technology to a poorly performing building. It focusses on occupant comfort, energy efficiency and operational costs to ensure passive design principals have been optimally used. Similarly, The Living Building Challenge is "the built environment's most rigorous performance standard". It calls for projects to operate as "cleanly, beautifully and efficiently as nature's architecture" and requires projects to achieve net zero energy, waste and water, over a minimum of 12 months of continuous occupancy.

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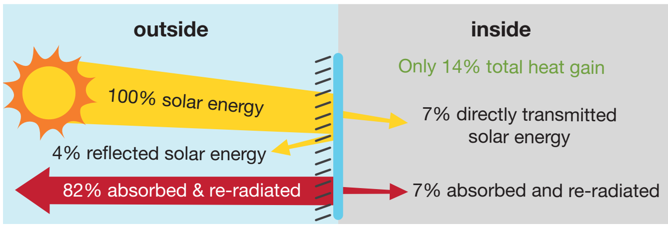
MICROLOUVRE™

A core element of passive design is choosing products which respond appropriately to the climate around it. MicroLouvre helps control the amount of solar heat gain and glare that reaches a window. It is a fine mesh, woven from miniature bronze louvres, which are pitched and angled for optimum performance. MicroLouvre effectively reduces the subsequent energy usage of a building by limiting the need for mechanical cooling.

Windows exposed the sun allow short wave radiation to flow through where it converts to long wave radiation. This radiation is trapped and builds up, allowing temperatures to exceed 38°C. MicroLouvre external solar screens provide 100% solar shading at peak times on the hottest days, absorb 92% of solar radiation and reduce the total solar heat gain by 86%. This means occupants of a building fitted with the technology avoid the consequences of working in excessively high temperatures. **In 2016, the energy savings of installing MicroLouvre were demonstrated in research by Lawrence Berkeley National Laboratory California. The study found MicroLouvre reduced air conditioning by 68%, even with modern HVAC systems and the latest 'super glass' technology.** In addition, MicroLouvre reduces external noise intensity by as much as 50%, provides uninterrupted outward vision and provides 80% open area, allowing natural light and ventilation.



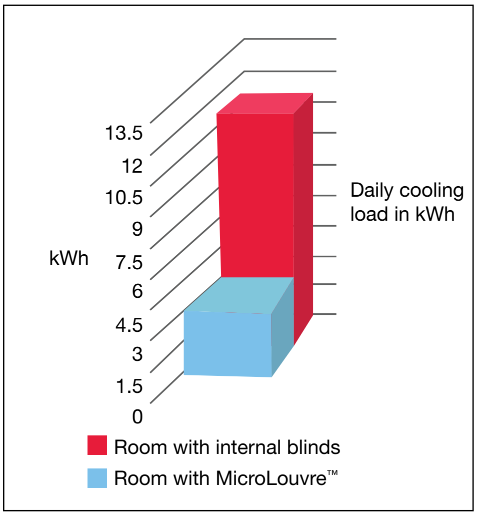
Sun and solar glare control using MicroLouvre™

MicroLouvre screens have been used extensively all over the world on every type of building and the benefits have been realised by commercial and multi residential developments and individual homeowners. MicroLouvre screens are easily and inconspicuously installed externally on any type of fenestration. The screens also provide protection from pests with bodies larger than 1.2mm.

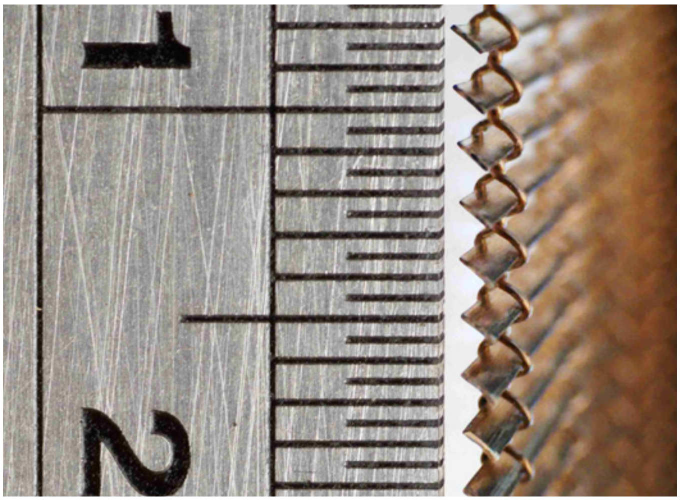
More recently, MicroLouvre screens have been fire tested and provide compliant screening of windows up to BAL-FZ in bush fire areas. They are also used as attenuation screens to protect windows near property boundaries, providing up to 50% heat reduction.

MicroLouvre is a long-term solution and has proven to provide ongoing energy savings. The 28-storey Indianapolis City County Building was fitted with MicroLouvre screens in 1976 and is still reaping the benefits.

Greene Fire is an Australian manufacturer and supplier of fire curtains and smoke curtains and of numerous fire protection, smoke control and environmental solutions for the construction industry. The company offers an extensive range of complementary products and services, allowing them to provide complete solutions for your project.



MicroLouvre™ - A fine mesh using woven bronze louvres provide 100% solar protection with a sun angle of 40° or more, with 80% free area and maximum vision to the external environment.



To find out how Greene Fire can deliver the right solution for your project, head to www.greenefire.com.au.

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