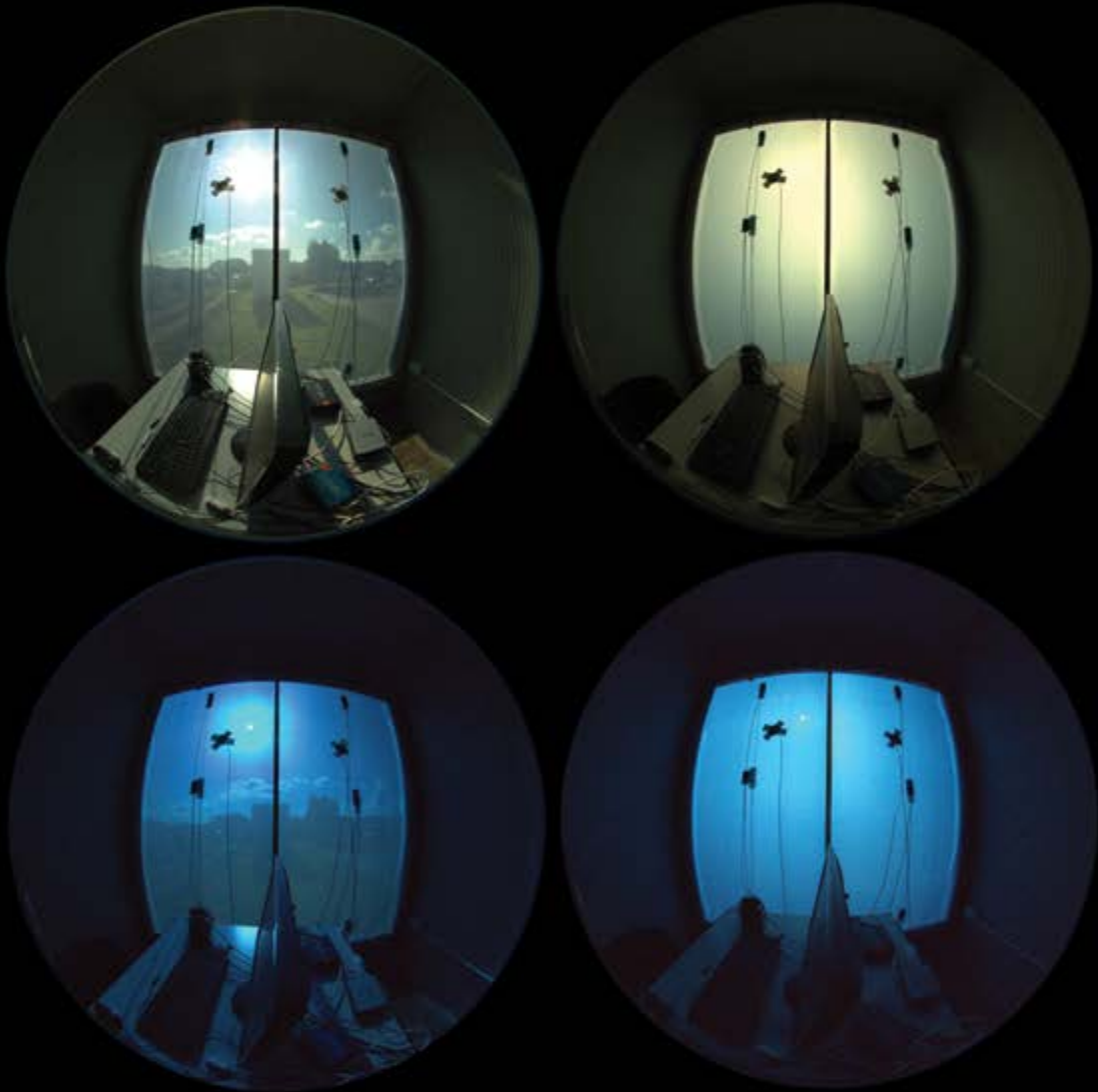


Switching the Light:

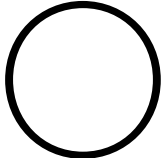


A New Era of Smart Glazing
for the Mediterranean
Built Environment

Left: Different switching states of the prototype switchable insulated glazing unit under investigation
Photo courtesy of Etienne Magri

Author: **James Moffett**

Architect and doctoral researcher within the Faculty for the Built Environment, Etienne Magri explores how adaptive glazing could redefine comfort, privacy, and energy efficiency in buildings exposed to intense Mediterranean sunlight.

 In a bright Maltese afternoon, sunlight floods the island's limestone façades, glinting off glass windows along the skyline. For architect Etienne Magri, this abundance of light represents both an asset and an enduring architectural challenge. 'I am an architect and civil engineer by profession, having been engaged in private practice for over 26 years,' Magri states. 'One of my interests has always been the human-building interaction and the sense of wellbeing that our buildings need to instil within their occupants.'

Magri's career has led him to an ambitious research project under the supervision of Prof. Dr Vincent Buhagiar from UM's Faculty for the Built Environment and Prof. Dr Mauro Overend from TU Delft (Netherlands). In his research, Magri aims to tackle one of the Mediterranean's most overlooked environmental paradoxes: how to let light in without letting comfort out. Buildings should not only look attractive, be well organised for their intended purpose, and remain structurally sound, but as Magri notes, 'they need to perform well in creating an indoor

environment that allows a sense of comfort and wellbeing – a matter that is so very often overlooked in the spaces that we create.'

MEDITERRANEAN LIGHT: A BLESSING OR A BURDEN?

The Mediterranean climate, with its long hours of sunshine and crystal-clear skies, is often celebrated as a natural gift. But for architects, it presents a technical and sensory dilemma: how to manage the intense, often harsh sunlight that can overwhelm interior spaces. 'Daylight in buildings situated in a Central Mediterranean climate presents a

key architectural challenge. One is not simply trying to capture light. Instead, the challenge involves finding a way to manage an abundance of intense sunlight to prevent overheating and glare,' Magri explains. The Mediterranean region enjoys a substantial number of days with clear skies and strong, direct sunlight, with outdoor light levels reaching up to 100,000 lux. Lux is the unit of measurement for how bright a surface appears to the human eye. As such, the higher the lux value, the stronger the illumination. In such conditions, conventional design strategies, such as relying on internal blinds and static external shading, are not always effective.

This creates a common scenario for occupants of glass-heavy Mediterranean buildings: blinds closed for much of the day to reduce glare, which block the outside view in the process, lights turned on indoors, and air-conditioning running constantly. The tension between abundant daylight and visual comfort motivated Magri to explore adaptive glazing technologies. These are systems capable of being adjusted in real time to respond to changing sunlight and user requirements. ➡



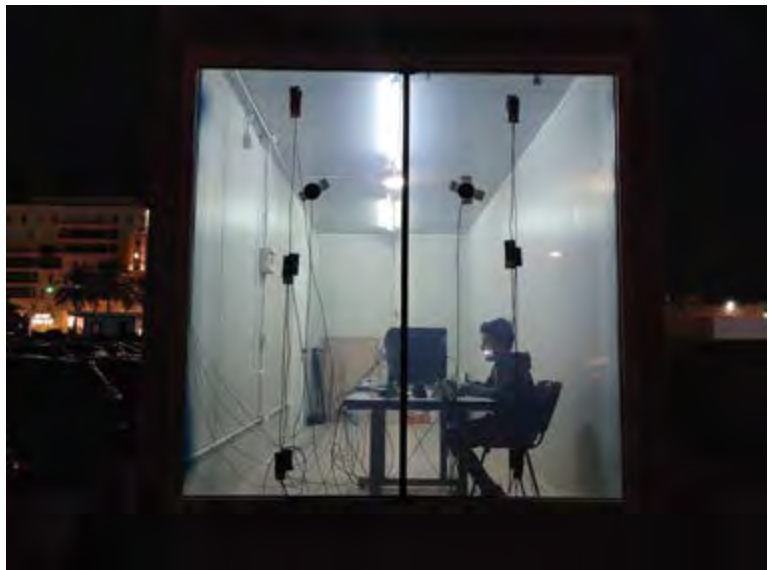
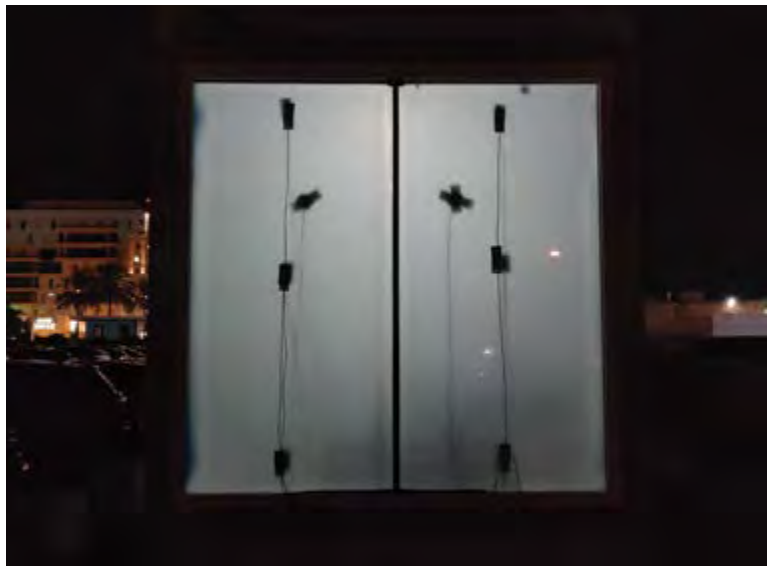
Etienne Magri

THE SWITCHABLE REVOLUTION

Unlike traditional static glass, switchable glazing offers adaptability and responsiveness. 'Switchable glass, commonly known as smart glass or dynamic glass, is an adaptive type of glazing that can instantly and reversibly change its appearance and properties, specifically its level of transparency, opacity or privacy, and tint, in response to an electric current or heat,' Magri explains.

This transformation is made possible through the lamination of switchable formulations within Indium Tin Oxide (ITO)-coated Polyethylene Terephthalate (PET) films laminated between sheets of glass. Within these layers, materials respond to low-voltage inputs, altering the light transmittance and appearance of the window. Two specific technologies underpin Magri's current research: Polymer-Dispersed Liquid Crystal (PDLC) and Suspended Particle Device (SPD) glazing. In PDLC technology, liquid crystals are embedded randomly within a polymer film. When in the off state, the crystals scatter light, giving the glass a frosted appearance. Applying a low voltage aligns the crystals, allowing light to pass through and making the glass clear or transparent.

In contrast, SPD technology uses tiny rod-shaped particles suspended in a liquid layer. When in the off state, the particles are dispersed randomly, blocking most light and heat and giving the glass a dark tint. Applying a low-voltage charge aligns the particles, permitting light to pass and rendering the glass lightly tinted or nearly clear. While these technologies are increasingly being used in high-end vehicles and aircraft, Magri's research seeks to combine their benefits for architectural applications.



Top: The twin environmental testing chambers for the collection of thermal and visual performance data

Middle & Bottom: View of the effect of the switchable privacy interlayer within the prototype switchable insulated glazing unit

Photos courtesy of Etienne Magri

'The concept behind this research is about the potential of combining the distinct benefits of both these technologies for deployment in the architectural field, specifically façade glazing,' he says. This combination has led to the development of a dual dynamic insulated glazing unit (IGU) – a layered assembly in which PDLC and SPD technologies work together to control glare, daylight, and privacy.

BALANCING COMFORT AND FUNCTIONALITY

A fundamental question in daylight design is how to maintain a visual connection with the outdoors without suffering from glare or overheating. Test results show that even in 'an extreme case when a person is sitting at a desk facing the window, with the sun in the field of view, the switchable window with the SPD layer in its darkest state is capable of reducing the level of glare to an acceptable level recommended by the European Standards.'

Importantly, the combination with PDLC allows users to preserve or block their view at will. 'While keeping the outer PDLC layer switched on, thus in a fully transparent state, the view outside of the building can be effectively retained,' Magri explains. 'If privacy becomes an issue at any point, the external PDLC layer can be switched off for a complete disconnection of the external environment, thus converting a transparent window into an opaque, wall-like element.'

In controlled tests, the improvement is striking, not only in terms of comfort but in the potential for energy savings. This is because occupants are less likely to resort to artificial lighting or blinds. Magri emphasises that glare control is just one aspect of the system's appeal. The dual glazing offers a multi-layered

solution that addresses privacy, adaptability, and sustainability.

By combining both PDLC and SPD technologies, the system would allow an individual to adjust privacy, natural light, and glare levels in various combinations. The unit can also be adjusted remotely through a wireless controller or using a mobile phone app. This adaptability extends to energy management. 'With this capability, one can start looking at the concept of "switching off the windows" when a space is not in use,' Magri adds. This could allow for space to be potentially shielded from excessive heat gain while reducing air-conditioning demand.

REIMAGINING THE FAÇADE

While Magri's primary focus is on window units, his research has also opened up intriguing possibilities for integrating switchable glazing into external architectural elements, such as overhangs and shading devices. 'Façade retrofitting is a critical strategy for modernising old structures, often done to address a building's poor energy performance and outdated appearance,' he notes.

His studies show that solar-PDLC laminates could be applied not only to windows but also to switchable overhangs that modulate sunlight dynamically. Such an approach could significantly reduce material use in retrofits. 'Further development of this concept would mean that a building façade can have its visual and thermal performance improved without having to replace the glazing. In this way, lesser quantities of glass would be used alongside lesser quantities of switchable films, both resulting in lesser costs and wastage.'

The switchable glazing assembly is still at an experimental stage, as focus is directed more towards the academic aspect of the subject.

The next steps involve real-world testing, which has already begun. Two prefabricated portacabins have been transformed into controlled test environments. 'The reference portacabin has been fitted with a conventional insulated glazing unit with static solar control coatings, whereas the other features the prototype switchable IGU.' Over the coming months, the research team will monitor thermal performance and comfort levels. The results, Magri hopes, will 'give us further insight into this exciting field of adaptive façades.'

SEEING THE FUTURE THROUGH A SMARTER WINDOW

What emerges from Magri's research is not simply a technological innovation, but a rethinking of architectural interfaces – how glass mediates light, heat, privacy, and perception. In a region where sunlight is both abundant and challenging, this new generation of glazing could help architects design spaces that are healthier, more comfortable, and more energy-efficient. The implications extend beyond Malta or the Mediterranean. As global urbanisation drives demand for glass-heavy buildings, adaptive façades could play a key role in reducing cooling loads and improving wellbeing in cities worldwide.

For Magri, however, the motivation remains deeply human. 'Nowadays, people spend most of their time indoors,' he reminds us. 'So if architects fail to create comfortable spaces in their buildings, they would not have executed their professional task effectively.' His work invites architects to rediscover what windows were always meant to do – not merely separate us from the outside world, but connect us to it in a way that feels right. 