Urban 2.0 profile - the UCL PEARL facility

By: Gareth Byatt – Principal Consultant, Risk Insight Consulting
Host: Professor Nick Tyler – Chadwick Professor of Civil Engineering
Director, UCL Centre for Transport Studies
Director, UCL PEARL

With thanks to Professor Tyler for his time and guidance to help create this profile.

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The exterior of the UCL PEARL facility in East Dagenham, London (photo: G Byatt, August 2025)

The UCL PEARL website

https://www.ucl.ac.uk/person-environment-activity-research-laboratory

A brief introduction to PEARL

The Person-Environment-Activity Research Laboratory (PEARL) is a unique and customisable laboratory space to study the senses and explore how people interact with their environment. Lighting, sound, smell and physical features can be configured, controlled and adjusted in different ways to create research outcomes showing how people react to their surroundings to support design for the real world.

The PEARL team's vision

The vision of the team at PEARL is to create a better world for a future in which people and the environment can thrive together in a mutually beneficial, safe, equitable and healthy way. They aim to improve the quality of life, health and well-being of all within the context of a sustainable environment – a world in which people and the environment come together.

How PEARL works

The team at PEARL works on client projects that have defined scope and objectives (for urban contexts and other settings) to investigate questions and probe for answers by creating specific lifelike test environments and capturing data and measurements of people who participate in these tests.

As Professor Nick Tyler explains: "The PEARL team explores deep questions of science, the fusion of sciences and arts, philosophy of method, the creation of perception, and other foundational questions. One of the unique things about PEARL is how these practical and theoretical worlds are brought together in a physical way to create new knowledge for both."

To achieve these aims, a broad range of lighting conditions can be set up for tests. Any type of sound can be added at different volume, variations and combinations. Smells can be added, from those that are harmful in the real world (such as simulating, in a fake and safe way, a gas leak or an explosion) to the sounds of nature and road vehicles. Through these capabilities, PEARL can synchronise different stimuli in different ways to simulate events in a safe and controlled way – for example, an explosion with sound, light, smell and smoke – and measure people's reactions to them. By capturing detailed data and observing people's responses to different stimuli in a test environment, the team can create observations, findings, and ideas for clients to review, consider and decide how they wish to move forwards with their activities.

PEARL links into overall citizen participation to help improve how urban environments function. The outputs generated for projects at PEARL can be used to complement other forms of engagement such as observations of people in real environments, holding different types of group discussions, and conducting surveys.

Some context to how people respond to their environment

We are what we measure. People who work in city and municipal authorities and various roles associated with urban environments, from planning and land management to climate change, energy, transport, waste management and others can see novel insights from high quality data and analysis about how people respond to different contexts through the types of experiments that are conducted at PEARL.

Different people respond to stimuli in different ways, and the team at PEARL conducts testing with people across the neural spectrum.

For example, observing how autistic people respond to a test environment can provide valuable insights, as can observing how the young and the elderly perceive things, how people with hearing or sight loss navigate their surroundings.

Measuring in detail how people interact with their environment provides insights that we would otherwise not be able to see. The human brain has something like 86 billion neurons, with only a small fraction used for conscious thought. The preconscious mind influences how our senses function and consumes a lot more brain activity, hidden away, than our conscious minds. The way individuals react to situations and circumstances is largely automatic, linked to their unique set of experiences. The team at PEARL measures brain activity and physical reactions people have to different settings, adjusting the control environment to see what happens when we change sound or lighting levels, or physical layouts, or smells. Various measurements, such as when people produce cortisol (which is typically produced to deal with stress) and other factors relating to how our brains respond to different stimuli, provide the team with deep insights into different solution options.

Another point about PEARL is the size of the open space available for large-scale control environment testing. The nature of the control group (its size and the range of people involved) changes depending on the project scope. Whilst it is not practical to involve the majority of the population of a city or a town in such a test environment, it is possible to obtain valuable insights by analysing the reactions of a control group of people to different designs. The outputs of this work help clients of PEARL to make decisions towards designing real world places, structures and systems.

How the PEARL facility was realised

PEARL is hosted by UCL through the Centre for Transport Studies, which is a part of the UCL Department of Civil, Environmental & Geomatic Engineering.
It is part of the UK national research facility for infrastructure and cities, known as the UK Collaboratorium for Research on Infrastructure and Cities (UKCRIC).
Capital funding for PEARL was provided by the UK government Department for Business, Energy and Industrial Strategy (BEIS), which existed until 2023, through the Engineering and Physical Sciences Research Council (EPSRC), and UCL. UCL covers core operational costs.

PEARL was designed and built during Covid, with approximately one year of design, with Penoyre and Prasad (now Perkins&Will) as the architects, and construction taking place on time in 2020-21, with VolkerFitzpatrick the main contractor. The facility was awarded the Net Zero Project / Initiative of the Year in the Building Awards 2022, the Environmental Sustainability Prize in the New London Awards 2022, and the RIBA London Award 2023.

The PEARL facility is situated on a site that used to be a May and Baker, then Sanofi, pharmaceutical facility. The local area of Dagenham in East London where PEARL is located underwent major social change when the Ford car plant and Sanofi closed their operations (both were major contributors to the local economy).
The team at PEARL is active in supporting the local community, including activities to support education and schools.

Structurally, the interior of PEARL is 14 metres high and it contains approx. 3,000 sq. m (32,300 sq. ft) of configurable floor space (the total interior building footprint including workstations is about 4,000 sq. m / 43,000 sq. ft).

The building structure is matt black outside and inside, which helps the control of lighting inside. Its open plan frame maximises the available space for experiments. The building is energy negative and was UCL's first net zero carbon building, in part thanks to its rooftop solar panels which generate its energy needs and energy that is provided to neighbours.

The air flow rate inside is very low, and the air intake is measured for particulates as part of operating the control environment. The matt black interior panels lining the walls have several million small, perforated holes that support the controlled regulation of soundwave reverberation.

The ceiling LED lighting system is unique, with total controllability to a precise level of detail. In fact, PEARL is, according to Hollywood film studios, the only space in the world with lighting that can match the entire colour sensitivity range of the human eye. PEARL's control centre can move around to suit what is being analysed at the time.

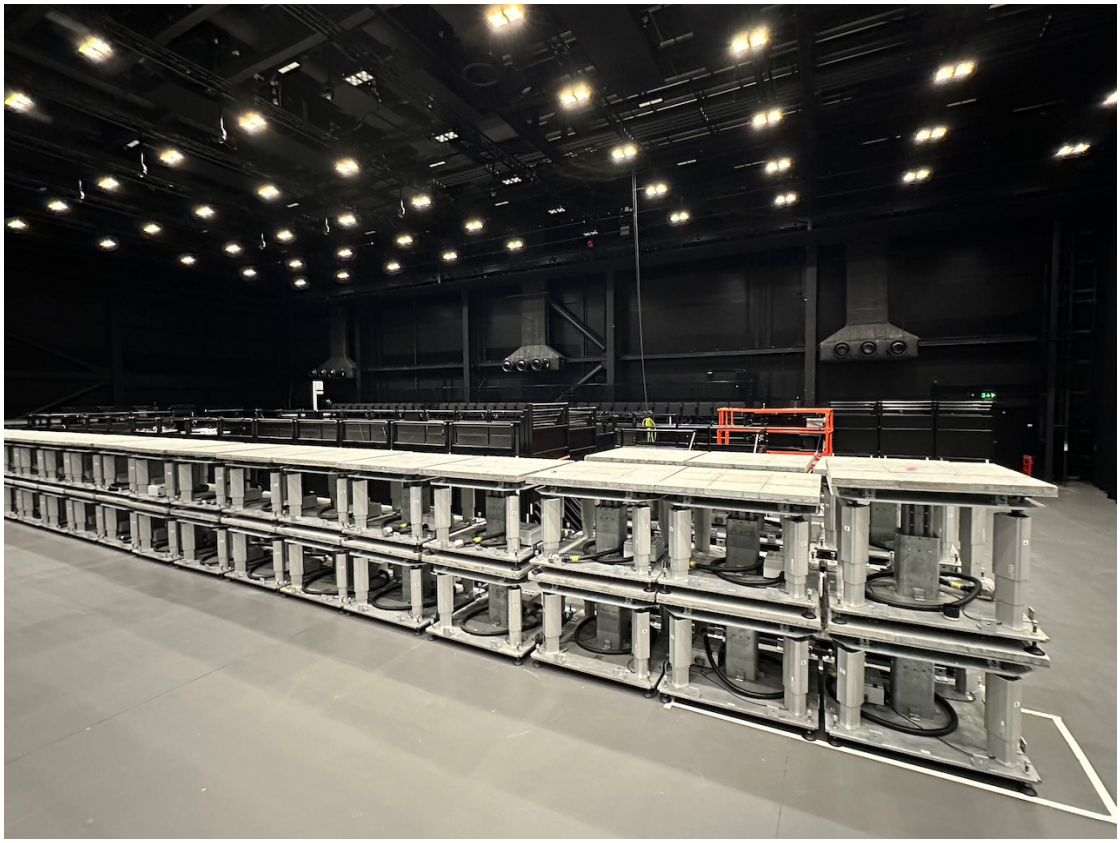
Examples of work undertaken by the team at PEARL

- Work for Transport for London (TfL) includes helping with the design of the latest Piccadilly Line tube carriage doors as part of the Piccadilly Line upgrade (a tube carriage was brought into the facility for this testing with people).
- Investigations into thermal comfort on buses.
- Work for Guide Dogs for the Blind on Floating Island Bus Stops.
- Investigations into how people react to different sounds for e-scooters and e-bikes to review what type of sound is most appropriate.
- Supermarket design for autistic people (for Oxford and Reading Universities).
- Helping a community of artists to co-design their live-work space.
- Exploring the interface between patients trying to describe their symptoms and clinical practitioners and carers.
- How musicians perform in different spaces.
- Understanding how autistic children respond to noises in an urban park.

The team has a range of work in the pipeline for the next few years, as well as continuing to support the local community of Dagenham.

Work at an early stage for the City of Osaka, Japan, of a street layout for testing how people respond to different measures (to contain various street life once finished) (photo: N Tyler, September 2025)

Each section of the configurable street contains sensors, and each section can be adjusted to introduce bumps or slopes for measuring responses in experiments (photo: G Byatt)

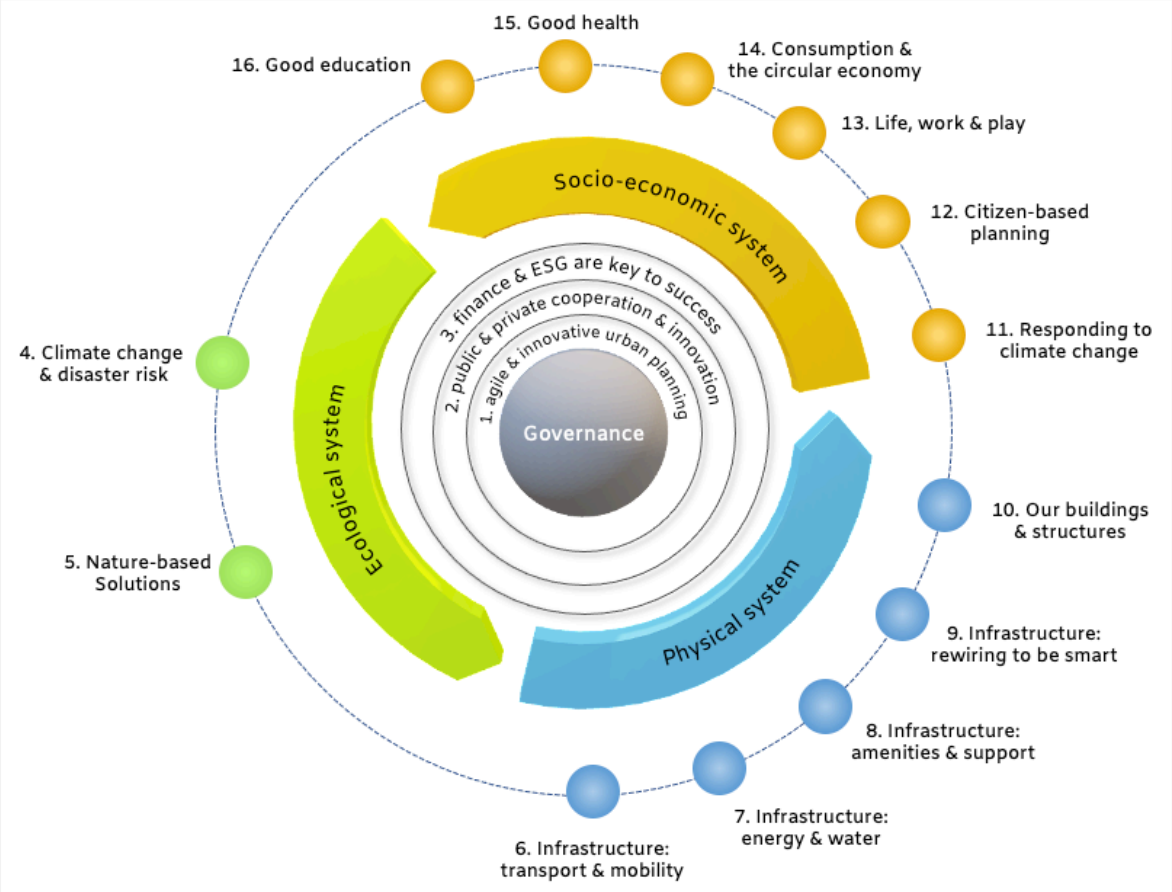


Applying PEARL to solve challenges and opportunities in the urban system

An urban environment exists as many different integrated parts in a system. For example, how we can best design and maintain a good physical system that links and integrates with nature and ecology is a key challenge, and opportunity. How we achieve this has implications for the urban socio-economic system.

The type of testing and analysis undertaken at PEARL can provide valuable insights into how to optimise urban design and lifecycle management. It brings rigorous science approaches together with the creativity of arts approaches to provide a solid basis to create environments and experiences that are better for people and the planet. PEARL can also help reach all members of a local community through interactive urban interventions and public participatory workshops which includes a focus on [designing places for people](#).

The Urban 2.0 system (image by G Byatt)



Example tests that could provide insights into how to achieve a good, healthy urban system, across the physical environment, ecology and socio-economics, include:

- The best types of Nature-based Solutions that contribute to urban health.
- A range of elements to improve public transport (structure, lighting, noise etc).
- How to best design public transport for equality, and integrate with nature.
- Pragmatic and innovative options for public transport “interchanges and node points (e.g. bus stops and subway stops), that link with nature in a good way.
- How to redesign existing streets for better socialisation, with all the benefits this can achieve (from commerce to climate adaptation)?
- Good designs for streetlamp networks to provide safe lighting and much more, and the best locations to place them.
- Benches that work for everyone and where to place them in different settings.
- How to achieve low noise levels in urban environments (including learning from some cultures that are better than others).

Of course, other types of physical testing are undertaken around the world. They can all help us understand how to create good urban places. For example the University of Ottawa’s Human and Environmental Physiology Research Unit (HEPRU) which is focused on assessing human heat stress response, and AMS Institute collaboration with researchers from TU Delft and Wageningen University & Research on De Nieuwe Straat (The New Street) for infrastructure solutions.

