

# DESIGN



Future of Healthcare

**RAMBOLL**

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# Synopsis

In this edition of DESIGN, Healthcare is addressed in some of the topics below:

## 1. Nature and Biophilia

We are not separate from nature. Nature is all around us and can aid recovery by providing natural views, sunlight, clean fresh air, biophilic elements, and calming sounds, which help promote both physical recovery and emotional well-being.

Therefore, it is essential to incorporate elements of nature into hospital design. This can be done through providing operable windows, balconies, outdoor accessible exercise areas, sun decks, parks and accessible herb gardens for both patients and healthcare workers.

## 2. Environmental Resilience

As climate alters weather patterns and disease trajectories, resilient infrastructures are vital to meet expanded healthcare delivery challenges. Climate change risks such as earthquakes, flood, sea level rise, strong winds, wildfires and droughts emphasize the need for robust and adaptive healthcare systems.

## 3. Community and Collaboration

An increasing and ever-changing patient demographic calls for adaptive, flexible, and positive environments, creating a great need for health infrastructures that work at multiple scales to improve health.

A global increase in life expectancies is the main driver behind the ongoing transition towards older societies, highlighting the importance of creating supportive healthcare systems for aging populations.

Having an active and engaged community fosters resilience and mutual support, helping to counteract urban loneliness and build stronger, more connected communities.

Interdisciplinary collaboration, scientific innovation, and the integration of natural and built systems can inform hospital design.

## 4. Logistics

In today's rapidly evolving healthcare landscape, hospital resilience hinges on the ability to manage internal pressures; staff shortages, escalating operational demands, and the burnout of healthcare professionals.

Cross-disciplinary collaboration among experts in engineering, healthcare, technology, logistics, and robotics streamlines workflows and enhances resource utilization, resulting in significantly reduced operational costs and alleviating the burden on healthcare workers.

## 5. Technology, AI and Innovation

Technology and innovation in healthcare are transforming the industry, improving patient care and logistics.

Advanced technologies like telemedicine, artificial intelligence, robotics, and wearable devices enable remote monitoring, personalized treatments, and predictive analytics.

Innovation fosters new medical techniques, drug development, and modern healthcare infrastructure. Robotics enhances surgical precision, automates routine tasks, and supports rehabilitation efforts. These advancements enhance diagnostic accuracy, streamline workflows, and offer accessible, high-quality care.

Embodied Intelligence in a form of advanced robots and Artificial Intelligence can further innovate and redefine how we perceive, act, and collaborate in healthcare logistics.

## 6. Safety and Security

Hospitals have unfortunately been identified as a targets in many conflicts. Redundant supplies of water and energy, as well as bomb shelters, have become necessary to keep hospital operational in case of a crisis.

Safety and security in healthcare are crucial for protecting patient data, ensuring physical security, and maintaining operational continuity. Implementing strong cybersecurity measures, access controls, emergency preparedness, staff training, and adherence to regulations are essential.

On-site renewable energy with battery storage can indeed provide a resilient energy supply to healthcare buildings. This provides uninterrupted care during adverse events, including power grid disruptions.

These actions collectively safeguard patient privacy, maintain trust, and provide a safe environment for delivering quality care.

## 7. Flexibility and Adaptability

Accessibility and inclusivity are essential in hospital design. This ensures that all individuals, regardless of their physical limitations or disabilities, can access, navigate, and use hospital spaces efficiently and comfortably.

New hospital designs should incorporate strategies for future changes and flexible spaces to

achieve adaptability and accommodate rapidly evolving technologies and workflows.

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## 8. Building Transformation and Circular Economy

Refurbishing older hospitals, many of which are over 50 years old, presents unique challenges but also valuable opportunities. Innovative solutions are required to improve infrastructure while preserving historical architectural elements.

Key transformation strategies include:

- Upgrading outdated systems to improve functionality and safety
- Enhancing energy performance through smart technologies and passive design
- Phase out fossil fuels and replace them with renewable energy
- Going beyond current healthcare standards and regulations

Sustainable practices, such as waste reduction and efficient logistics, are vital in transforming these buildings to meet contemporary needs and future demands.



**Hospital Nova (JKMM Architects)**  
In Finland, the old central hospital in Central Finland has been replaced with a new, more extensive central hospital that will provide more patient-oriented and interactive care in efficient and well-functioning premises

Photo credit: © 2020 Kuvatoimisto Kuvio Oy



# Prologue: The Rise of the Anthropocene

By: Hossein Rezai and Wan Sing Lai, Ramboll

The Anthropocene marks a period in which human activity has become the dominant force shaping Earth's systems. It is driving many of the most pressing environmental issues and wicked problems of our time, including species extinction, habitat loss, and climate change.

Advancements that have improved human well-being have also deepened our separation from nature. No longer dependent on

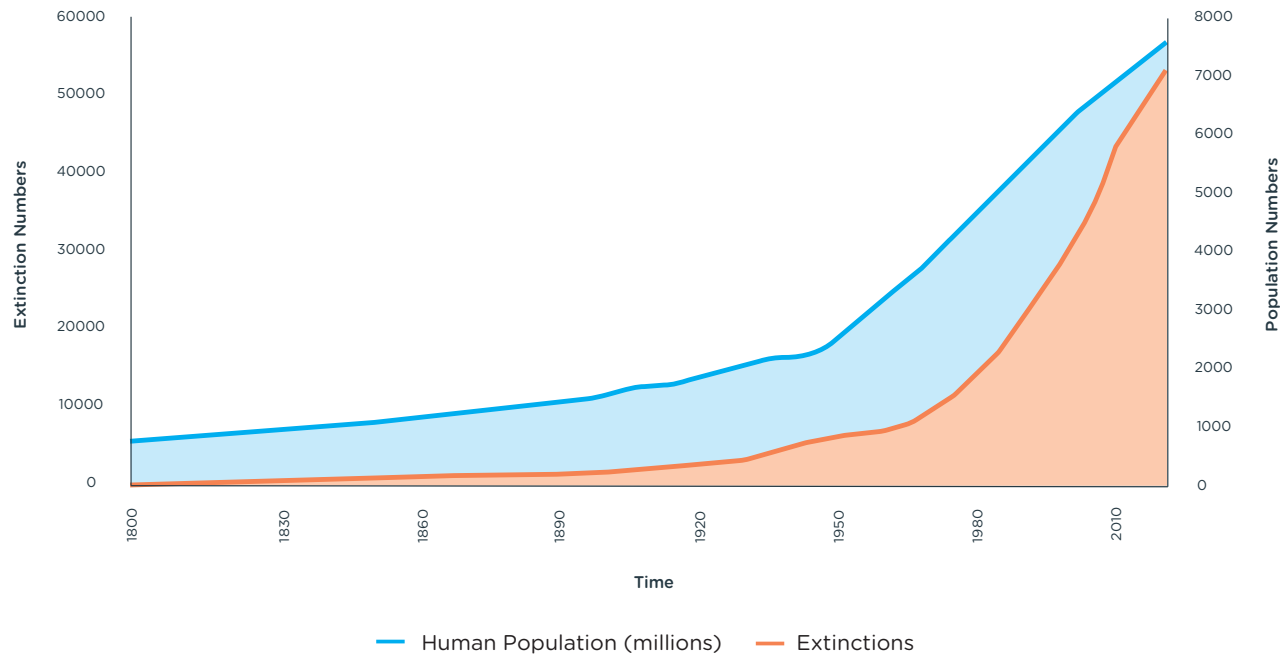
the immediate environment for survival, humanity has expanded and industrialised in ways that strain the planet's ecological limits.

Globally the life expectancy increased from less than 30 years to over 72 years after two centuries. It is one of the few indicators that has shown consistent and measurable progress. While the advancements in technology, innovation, healthcare, and more has improved the lives of

many, this progress has come at a significant cost.

What is the cost? As other indicators directly or not has been affected, biodiversity has declined over the years.

**Species Extinction and Human Population**  
Source : Scott, J.M. 2008. Threats to Biological Diversity: Global, Continental, Local. U.S. Geological Survey, Idaho Cooperative Fish and Wildlife Research Unit, University Of Idaho.



# Zipcode > Genetic Code

By: Hossein Rezai and Wan Sing Lai, Ramboll

“Your zip code is a better predictor of your health than your genetic code”

Life expectancy varies not only between countries, but also across regions and states. This demonstrates inequality as life expectancy is not only determined by our genetic code, it is shaped by behavioural patterns, social and environmental factors.

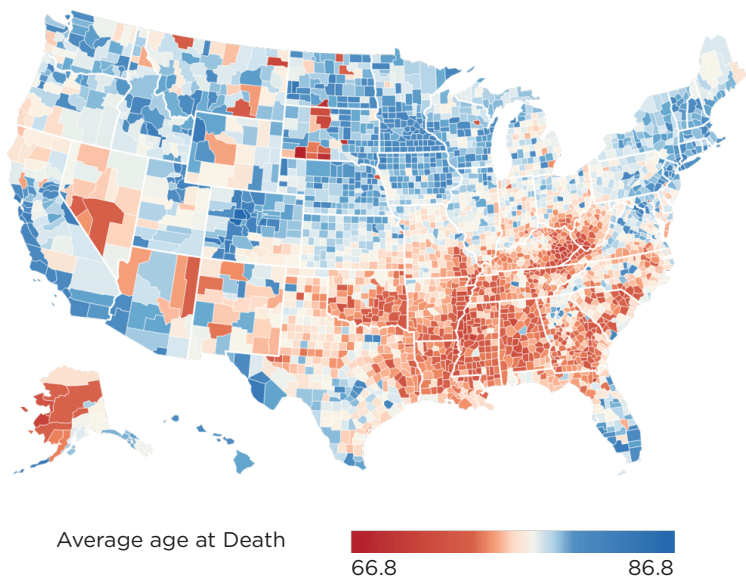
In many ways, our wellbeing is a reflection of how we live in relation to the location or geographic area and neighbourhoods.

Urban planning has a significant role to play in shaping the health of a location.

- Encouraging active lifestyles with bicycle lanes, walking paths, parks and exercise areas.
- Reducing urban loneliness with community hubs and fascilities that foster social connection
- Creating green blue infrastructure such as urban forests, wetlands, and waterways to improve air quality, reduce heat, and support mental wellbeing.

These urban and environmental factors are closely tied to the performance of our healthcare systems. A resilient and responsive healthcare system must go beyond treating illness. It should also address the root causes of poor health, promote prevention, and adapt to the evolving needs of aging populations. Global collaboration in research and innovation is essential to ensure that medical technologies and treatments become more accessible, inclusive, and equitable for all.

However, longevity is meaningful only if it's accompanied by good wellbeing. As the global population ages, health complications are likely to increase, particularly with the presence and increase of environmental contaminants such as PFAS, DDT, and various forms of pollution. Without addressing these environmental threats, the goal of healthy aging may remain out of reach for many communities as well as nature.



**U.S. Average Life Expectancies:** 20-year difference in average life expectancies across the U.S. Lowest in the Southeast, and the highest on the West Coast and the Northeast

Source: Jeremy Ney MPA 2021: Making inequality visible

Contributing writers: Hossein Rezai, Wan Sing Lai

“  
But man is a part of  
nature, and his war  
against nature is  
inevitably a war against  
himself.”

Rachel Carson

# The Paradox of Isolation and Integration

By: Hossein Rezai and Wan Sing Lai, Ramboll

We spend on average 90% of our time within the built environment. In modern high-density buildings, windowless offices can hinder visual recovery and emotional well-being during short workday breaks.

Employees who work in environments with elements of nature, such as greenery and natural light, reported:

- 15% higher perceived well-being,
- 6% increased productivity, and
- 15% increased creativity

The notion that vulnerable patients are isolated in hospitals underscores the importance of designing hospital environments that prioritize connectivity, comfort, and emotional support, so that they feel supported during their times of need.

Research has shown that patients in hospitals with views of nature such as trees recovered faster, used fewer painkillers, and had shorter hospital stays compared to those looking at brick walls

Nature is all around us and can aid recovery by providing natural views, sunlight, clean fresh air, biophilic elements, and calming sounds, which help promote both physical recovery and emotional well-being.

Therefore, it is essential to incorporate elements of nature into hospital design. This can be done through providing operable windows, balconies, outdoor accessible exercise areas, sun decks and accessible gardens for both patients and healthcare workers.





# A History of Hospitals

By: Wan Sing Lai, Ramboll

The English word “hospital” originally comes from the Latin noun “hospes”, which stands for “a guest or visitor” and “one who provides lodging or entertainment for a guest or visitor”. The earliest evidence for the word hospital is from around 1300.(14th Century)

## More than 2000 years ago The Roots of Ancient Medical Practice

In India, Buddha created Buddhist Viharas (monasteries) in different places, which cared for the sick and gave medical education.

In China, healthcare was primarily provided by individual healers, traditional Chinese medicine (TCM) practitioners, and charitable or religious institutions. Large central health care stations, which could be considered early forms of hospitals, served the royal family and catered to the the needs high-ranking officials and military personnel

## 1st Century to Middle Ages Early hospitals

In early Islamic societies, Bimaristans were not just hospitals but comprehensive healing centers that considered mental, physical, spiritual and social needs.

In ancient Greek society, Asclepions served as central hubs for healthcare, playing a vital role in advancing medical knowledge, promoting healing, and improving public health.

In the early years of Christianity a nursing tradition emerged. The church would care for the sick, widows and children, feed the hungry, provide clothing to the poor, and offer hospitality to strangers. Over time, monasteries established wards, where to care meant to give comfort and spiritual sustenance.

## 12th to the 18th Century The Black Plague and the Rise of Medical Knowledge

In Egypt, some bimaristans were extremely large and served as regional primary medical centres.

Cities began establishing institutions for those with contagious diseases, such as leprosy, marking an early form of public health response.

Universities became centers for training medical practitioners.

## 18th Century Isolation Facilities

Medical and surgical treatments became central to care. Hospitals began transitioning from religious to medical institutions.

In India (under British rule), colonial hospitals expanded. Missionary hospitals were introduced in China. Bimaristans (Islamic hospitals), once centers of medical excellence, experienced a notable decline.

Cities began establishing isolation hospitals, and almshouses emerged to care for the sick or infirm.

## 19th Century Large Hospitals Emerged

Large hospitals with over a thousand beds appeared. As industrialisation and urbanisation progressed, home-based care became less feasible.

Medical advancements and increasing complexity led to the professionalization of healthcare.

## Late 19th Century to the 20th Century Hospitals as Scientific Institutions

Hospitals evolved into modern, technologically advanced institutions.

Hospitals became the safest and most efficient places for surgery due to advancements like x-rays, laboratories, and sterile techniques, supported by specialized staff and equipment.

## 21st Century COVID19 and Regenerative Designed Hospitals

The COVID-19 pandemic highlighted the critical role of hospitals in global health systems. Emphasis on infection control, ICU capacity, and telemedicine accelerated hospital innovation and preparedness.

In response to both the pandemic and climate change, hospitals began adopting regenerative design

### Khoo Teck Puat Hospital, Singapore (RMJM and CPG Consultants)

Inspired by the ‘Hospital in a Garden’ concept, the hospital features exercise paths, roof gardens, and lush green terraces, blending seamlessly with nature to create a tranquil healing environment.

Photo credit: Vertical Green Global



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# Transforming Outdated Hospitals

## Pathways to Modern, Sustainable, Regenerative and Resilient Healthcare Buildings

By: Ulf Hedman and Björn Gernoth, Ramboll



University Hospital in Bon, Germany (Ramboll)

A new pneumatic tube system has been installed to enhance essential services, clinical areas, and building connectivity. It connects 152 stations across 23 buildings, with each station equipped with five carriers. The network's tubes run for approximately 20 km. Designed to be discreet, safe, and efficient, it optimises routes and reducing staff workload.

Transforming existing hospitals poses significant technical design challenges. Most current hospitals are over 50 years old, making refurbishment complex and sometimes impractical. The goal in such transformation projects is to optimize efficiency in logistics, energy management, and operations while ensuring resilience to future demands and conditions, staying within budget, and providing good value for money. When exploring the reuse of old buildings versus new construction, sustainable and regenerative design principles must guide decisions to ensure hospitals are adaptable, efficient, sustainable, resilient, and cost-effective.

Refurbishment of old buildings can preserve historical architectural elements while incorporating modern technologies. This approach requires innovative solutions to upgrade infrastructure while maintaining the integrity of the original design. Challenges include updating outdated systems, improving energy efficiency, enhancing resilience, ensuring compliance with current healthcare standards, and managing costs effectively. Sustainable design strategies, such as using renewable energy sources and implementing waste reduction practices, are crucial in transforming these buildings to be both resilient and environmentally friendly and affordable



On the other hand, new construction allows for the implementation of cutting-edge design principles from the ground up. This can lead to highly efficient, state-of-the-art healthcare facilities that are resilient to future challenges. New construction also provides the opportunity to incorporate advanced materials and technologies that enhance sustainability and energy efficiency. However, new construction projects need to consider environmental impacts, long-term sustainability, and cost management to ensure affordability.

Ultimately, whether we decide to transform existing healthcare buildings into future state-of-the-art hospitals or repurpose them, transforming hospitals involves striking a balance to achieve good value for money as well as long-term sustainable healthcare buildings. Using advanced technical design principles ensures that these healthcare facilities are not only efficient but also resilient, adaptable to changing needs, and sustainable for the long term.

Haukeland University Hospital, Norway (Henning Larsen Architects, PKA Arkitekter and KHR Architects)

The new children's and women's hospital within the university is designed to be childfriendly, warm and welcoming environment. High-performance thermal skin, optimised ventilation systems, heat recovery, and local district heating systems for temperature control are among its notable features.



# From Sustainability to Regenerative Design in Healthcare

By: Veronika Petrova, and Lars Kristoffersen, Ramboll

A new lexicon of multifunctional design initiatives is emerging, extending beyond primary function to positively affect the planet. This means moving beyond conceiving buildings as resource consumers to buildings that contribute to ecological health.

Going from sustainability to regenerative design would mean buildings with the capability to become net resource generators rather than lower resource consumers, aiming for zero-waste, passive effectiveness, and visual beauty.

An increasing and ever-changing patient demographic calls for adaptive, flexible, and positive environments, creating a great need for health infrastructures that work at multiple scales to improve health. Regenerative design produces cascading benefits and co-benefits

to ecosystems, essentially restoring the health of occupants. As climate alters weather patterns and disease trajectories, resilient infrastructures are vital to meet expanded healthcare delivery challenges.

Positioning our built environments with regenerative thinking will transform the way we design and operate our hospitals:

- By using biophilic design, utilizing nature-based initiatives with natural materials, promotes a sense of home and speeding up healing.
- By using on-site renewable energy automatically embody resilience principles, allowing them to provide uninterrupted care during adverse events, even when power grid disruptions occur.

The key message is that healthcare campuses offer a unique opportunity for restorative natural settings. Recognizing that the built environment impacts both patient experience and medical outcomes, focus on enhancing environments to promote healing is crucial.

Embracing biophilic design, reconceptualizing hospitals beyond resource conservation, and aspiring to exceed minimum standards will result in inherently resilient structures. Regenerative design presents a global vision for resilient, sustainable healthcare systems, advancing stronger, fairer world economies.

# Hospitals as Living Infrastructure

By: Stanislava Boskovic LRL Space (Lugano) and Imperial College London

Hospitals are not merely buildings; they are vital components of the urban fabric—dynamic systems through which people, goods, and information flow, shaping urban life and human interaction.

In a rapidly evolving and complex reality, hospitals must be reimaged as adaptable, transformable environments that extend beyond clinical functions to support

resilience, community well-being, and future demands. We examine how interdisciplinary collaboration, scientific innovation, and the integration of natural and built systems can inform hospital design.

By shifting the focus from static infrastructure to responsive, integrated systems, we explore how hospitals can operate as adaptable,

flexible platforms—catalysing continuous transformation in healthcare delivery and serving as proactive agents within the urban environment.

New Children's Hospital, Helsinki (SARC Architects and Architect Group Reino Koivula)

To accommodate children's sensory needs, this hospital was designed for human needs and senses. All visible surfaces were designed to look and feel interesting touch and safe to use.





# Embodied Intelligence for Logistics and Automation

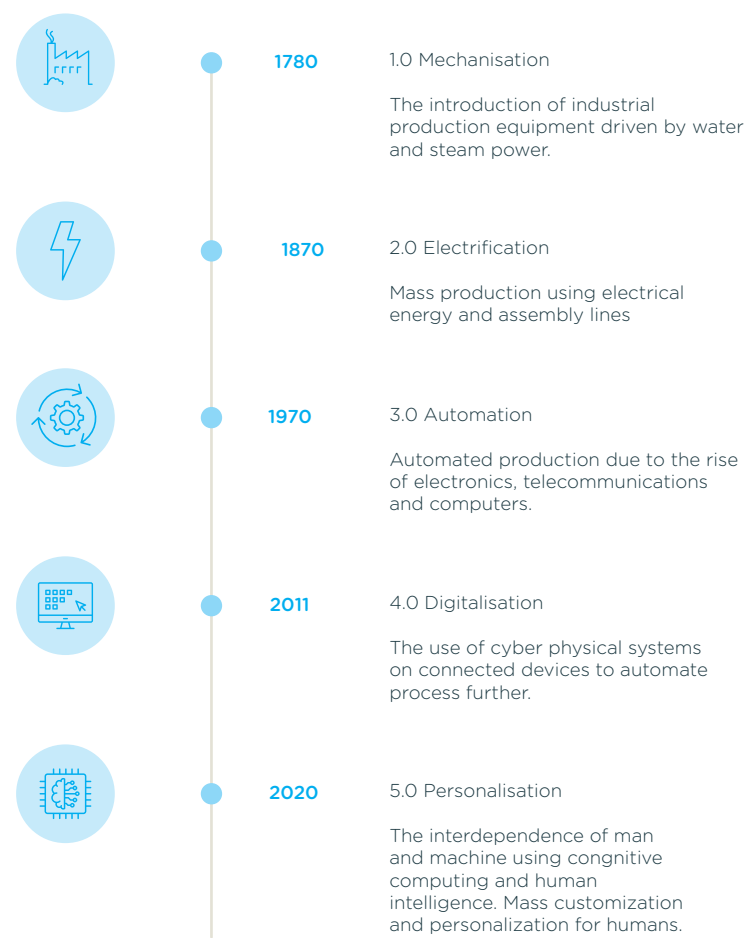
By: Thomas Leitner-Marzano, Ramboll

Building a hospital with logistics and automomation powered by embodied intelligence reflects the emerging **Fifth Industrial Revolution**, where the synergy between advanced technologies and human intelligence drives innovation and resilience.

Advanced intelligence is destined to become ingrained in everyday automation, fundamentally altering how systems like hospitals and logistics, both inside and outside, operate.

The timeline of industrial revolutions and the emergence of society 5.0 amid the COVID-19 pandemic in 2020.

Source: Sarfraz, Zouina & Sarfraz, Azza & Iftikar, Hamza & Akhund, Ramsha. (2021). Is COVID-19 pushing us to the Fifth Industrial Revolution (Society 5.0)?, Pakistan Journal of Medical Sciences. 37. 10.12669/pjms.37.2.3387.



The concept of Embodied Intelligence is set to revolutionise the future of logistics and automation. Advanced intelligence is destined to become ingrained in everyday automation, fundamentally altering how systems like hospitals and logistics, both inside and outside, operate.

By developing models that predict both **internal** and **external** influences, we can minimize errors and optimize efficiency.

Large models are crucial, but obtaining the necessary **data** involves capturing real-life experiences through knowledge, sensors, cameras, and continuous learning.

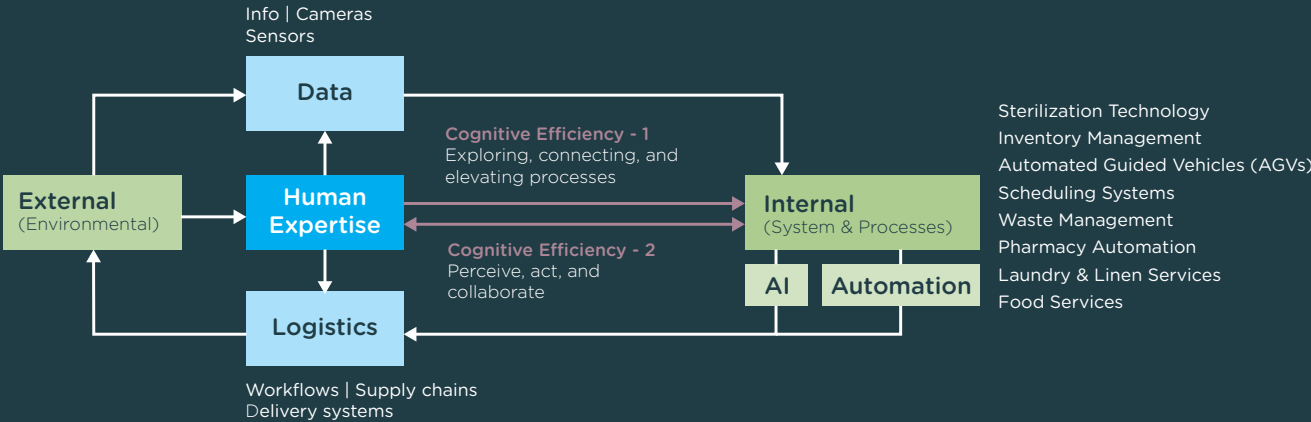
The move from large language models to substantial behavioral, action, and world models is essential for understanding and improving **logistics**.

For embodied intelligence to transform logistics, we need models that comprehend the physical world. This requires not only advanced data and automation but also **human expertise** in the physical elements that shape our environment.

Building a hospital with the logistics powered by embodied intelligence necessitates this synergy of technology and human intelligence.

**Cognitive efficiency** involves transitioning from mere execution to exploring, connecting, and elevating processes. It's about redesigning interactions between humans and machines. The question is no longer if they will collaborate but how to purposefully orchestrate this partnership. Tomorrow's organisations will operate through a system of interactions, demanding novel methodologies to achieve effective collaboration between humans and machines.

Embodied Intelligence promises to innovate and redefine how we perceive, act, and collaborate in logistics, paving the way for a more integrated and efficient future.





# International Projects

By: Kristoffer Setsaas, Ramboll



New Karolinska Hospital, Sweden



Automated Guided Vehicle (AGV)

Ramboll Healthcare collaborates across borders and disciplines to achieve the next level of healthcare facilities. Leveraging the diverse expertise and resources available within the global company, Ramboll delivers innovative and sustainable healthcare solutions through international projects. This collaboration encompasses sharing knowledge, best practices, and technical proficiency among teams based in various countries.

One exemplary project is Project X, a versatile clinical research building in the UK, currently in its preliminary design stage. Ramboll is applying global expertise to meet the project's ambitious targets, including passive design, circularity, pre-demolition audits, and building-integrated photovoltaics. The aim is to create a state-of-the-art hub that attracts top scientists and entrepreneurs, revolutionizes healthcare, and bolsters local social value and economic growth.

The New Karolinska hospital in Sweden stands as a testament to Ramboll's adeptness in navigating complex sustainability requirements. The project involved delivering a comprehensive array of design and management

services while fostering collaborative environments and maintaining seamless operations throughout construction. In Norway, the Central Sterilization Unit (Sterilsentralen) project exemplifies cross-disciplinary collaboration, integrating experts from engineering, logistics and robotics, healthcare, and sterilization technology worldwide. Their concerted efforts optimize workflows and resource utilization, significantly lowering operational costs.

Meanwhile, Årstadhuset, a patient treatment center for psychiatry and substance abuse in Norway, highlights the value of international expertise. By leveraging technology and best practices from various countries, the team has ensured a high-quality, sustainable, and innovative project.

By collaborating across countries, Ramboll Healthcare ensures that projects adhere to international standards and incorporate global best practices. This approach is crucial for projects aspiring to lead in healthcare innovation and sustainability, ultimately setting new benchmarks in the industry's advancement and environmental responsibility.



Aarhus University Hospital, Denmark



Cambridge Children's Hospital, UK



Carlanderska Hospital, Sweden



Katharinen Hospital, Germany



The University Hospital in Düsseldorf, Germany



NÄL Hospital, Sweden



University Hospital Hamburg-Eppendorf, Germany



Sahlgrenska Life, Sweden



Malmö University Hospital Sweden



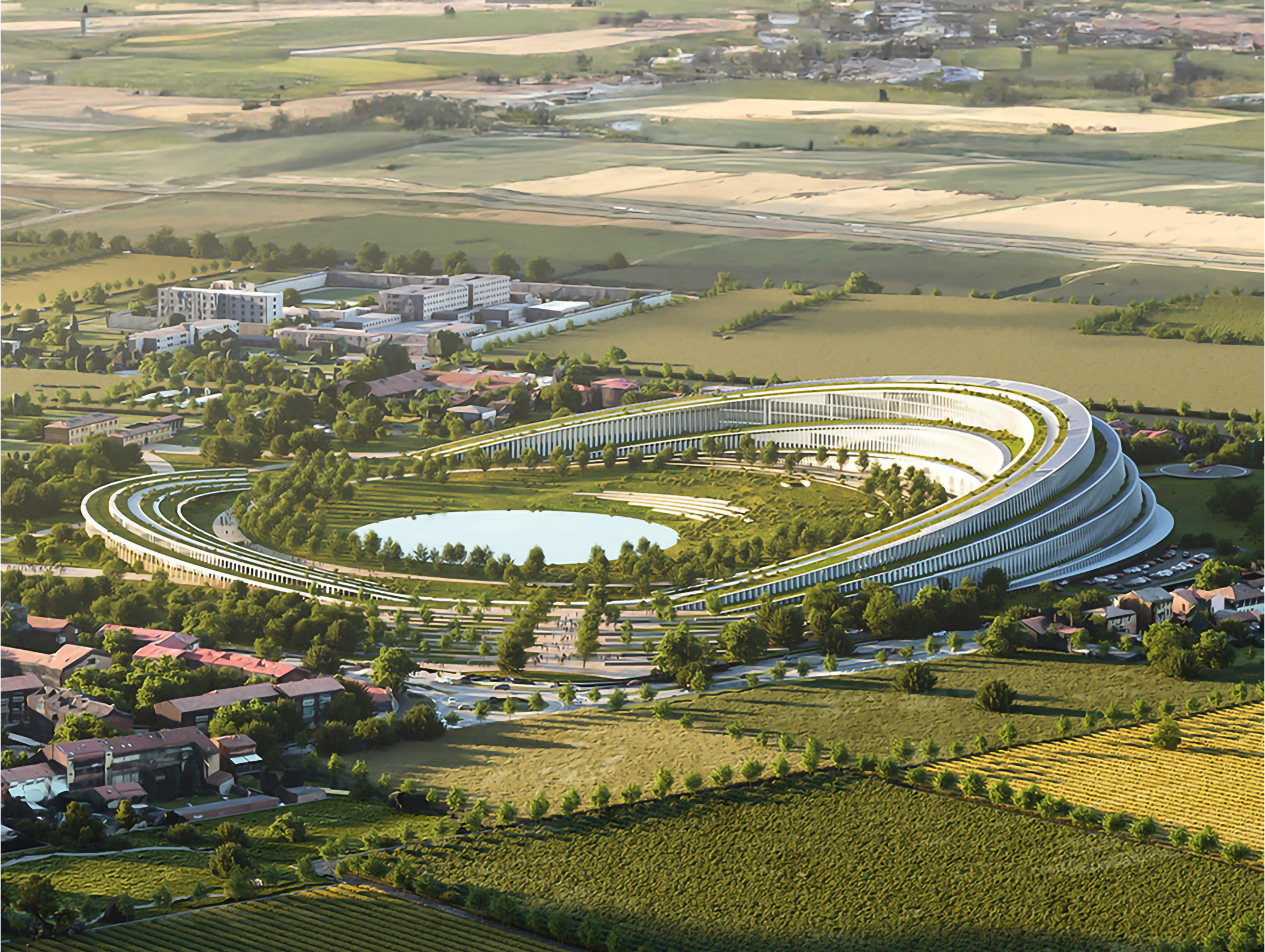
# Epilogue

This edition addresses pertinent questions on health and wellbeing of primarily the human species integrated systemic wellbeing of other lifeforms of nature.

1. Can one species in a system thrive where others suffer?
2. How many dimensions of health is there? Social, Physical, Emotional, Spiritual...? Can these be addressed separately?
3. What is the balance between isolation of vulnerable patients and integration with nature?
4. What are the conflicting elements between our demand for long lasting buildings that cater for rapidly changing technologies?
5. What is the future of healthcare? How is well being purveyed in the next 50 years for an ageing population?
6. More people consult the internet compared to the GP... What's the next trend for health or healing in the future?

“More patients today consult the net than do a doctor”

Richard and Daniel Susskind  
The Future of the Professions



These are some questions we have addressed in this edition.

Some we have answered.  
Others remain open.

## The dialogue continues...

The Cremona Hospital, Italy  
(MCA - Mario Cucinella Architects)

Described as a “city within a city” this hospital is designed as an integrated complex that combines flexibility in spaces, leisure spaces, and nature based solutions, embodying a holistic vision for care and wellbeing.

Photo credit: © MCA - Mario Cucinella Architects



Ramboll is a global engineering, architecture and consultancy company founded in Denmark in 1945. Across the world, our 18,000 experts create sustainable solutions.

We combine local experience with a global knowledge base to create sustainable cities and societies, driving positive change for our clients, stakeholders and society. We enable our stakeholders to realise their goals and navigate the transition to a more sustainable future.



## Bright ideas. Sustainable change.

**DESIGN** is a periodical publication by the Design Excellence Board (DEB) within the Buildings Market in Ramboll.

The publication promotes and articulates latest ideas on matters relating to design, technology, environment and ethos within the design industry and the built environment, at large. It aims to address key issues facing contemporary design professionals, including our evolving relationship with the natural environment; as well as pressing political and social agendas for the built environment.

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**Photo credit:** Herzog & de Meuron

