



What are buildings for?

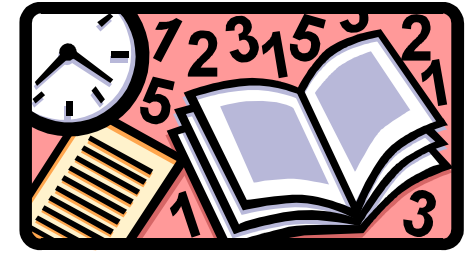


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About Me



- ***Ir. Dr. Sam C. M. Hui*** (*Building Services Engineer*)



- PhD, BEng(Hons), CEng, CEM, BEAP, BEMP, HBDP, MASHRAE, MCIBSE, MHKIE, MIESNA, LifeMAEE, AssocAIA
 - CEng = Chartered Engineer
 - CEM = Certified Energy Manager
 - BEAP = Building Energy Assessment Professional
 - BEMP = Building Energy Modeling Professional
 - HBDP = High-performance Building Design Professional
 - LifeMAEE = Life Member, Association of Energy Engineers
- ASHRAE Distinguished Lecturer (2009-2011)
- 20 yrs. teaching in HKU Departments of Architecture and Mech. Engg.
- Research interests: energy efficiency in buildings and sustainable building technologies

Contents



- My favourite building
- Architecture is ...
- Building science is ...
- Building performance

What makes these buildings look interesting?



How do people use these buildings?



Draw a sketch of your favourite building.

Write down why it is your favourite.

My favourite building is: _____

A sketch of the building:



Why it is your favourite?: _____

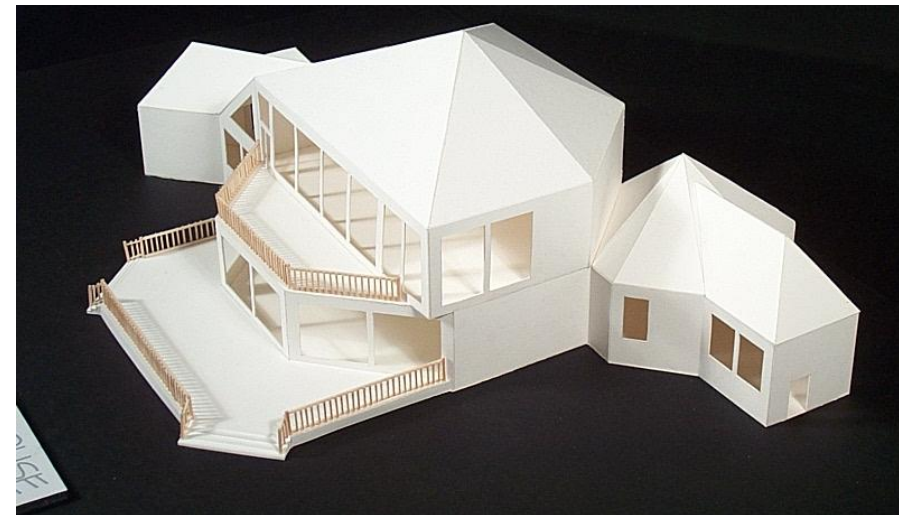
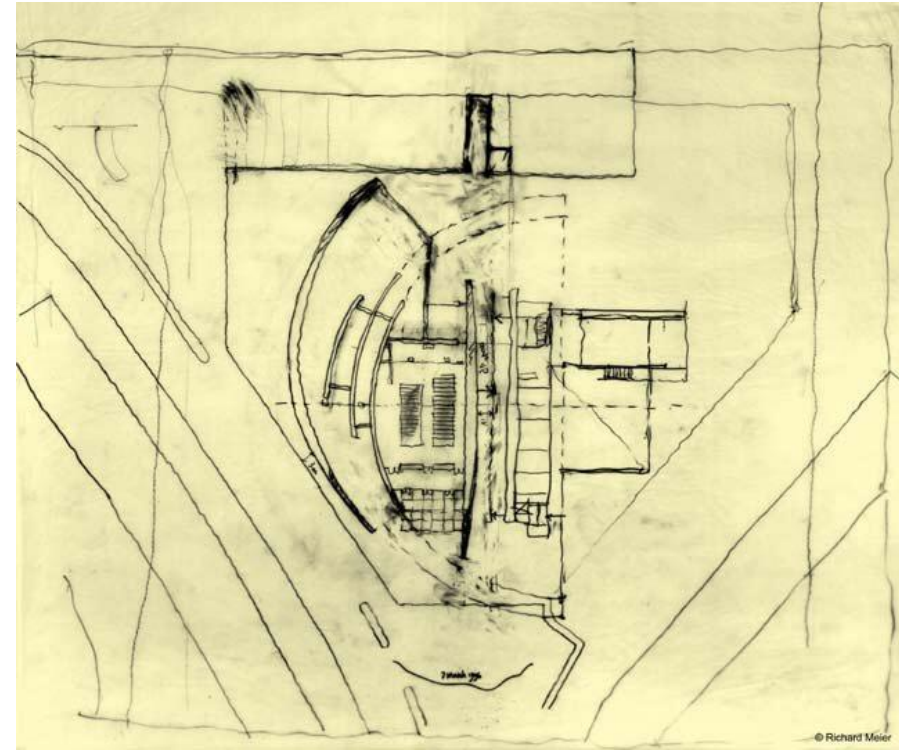
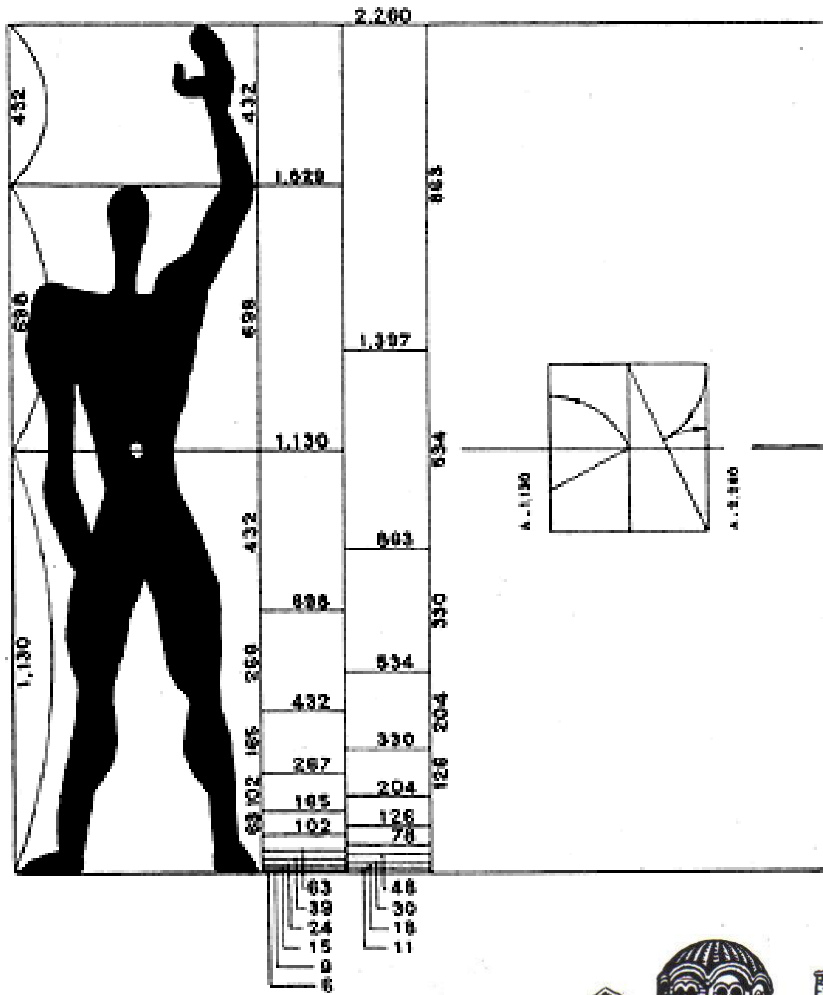
Architecture is ...



- What is Architecture?
 - The art and science of designing and constructing buildings
 - A style and method of design and construction
 - Buildings and other large structures
 - Orderly arrangement of parts, structure
- Major issues
 - Art and science
 - Regional identity
 - Reflection of place and time

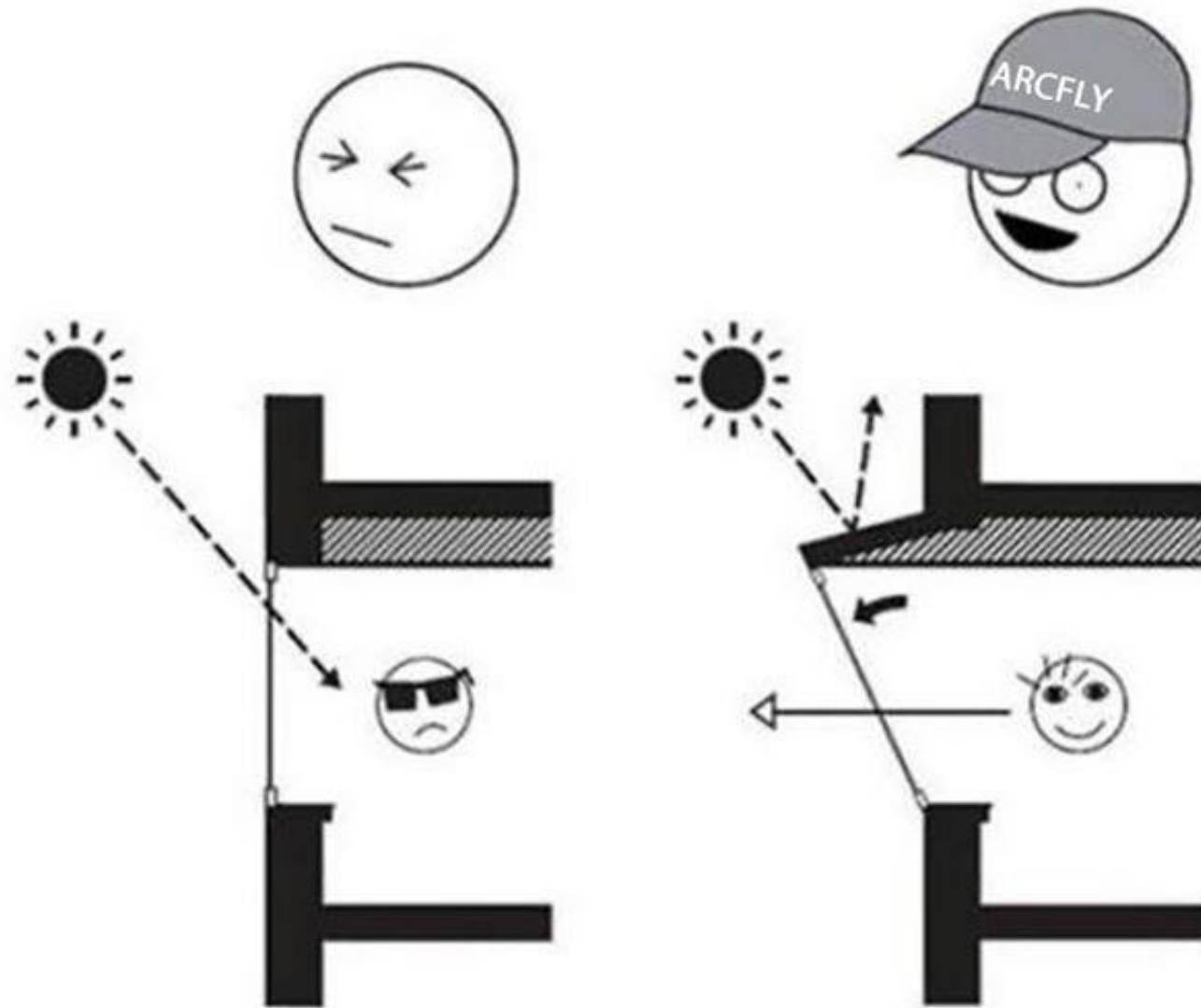


Architecture is ...



ARCHITECTURE

IS THINKING ON YOUR WELL BEING...



...IN THE SMALLEST DETAILS

Nowadays, architecture and building design are challenging tasks!

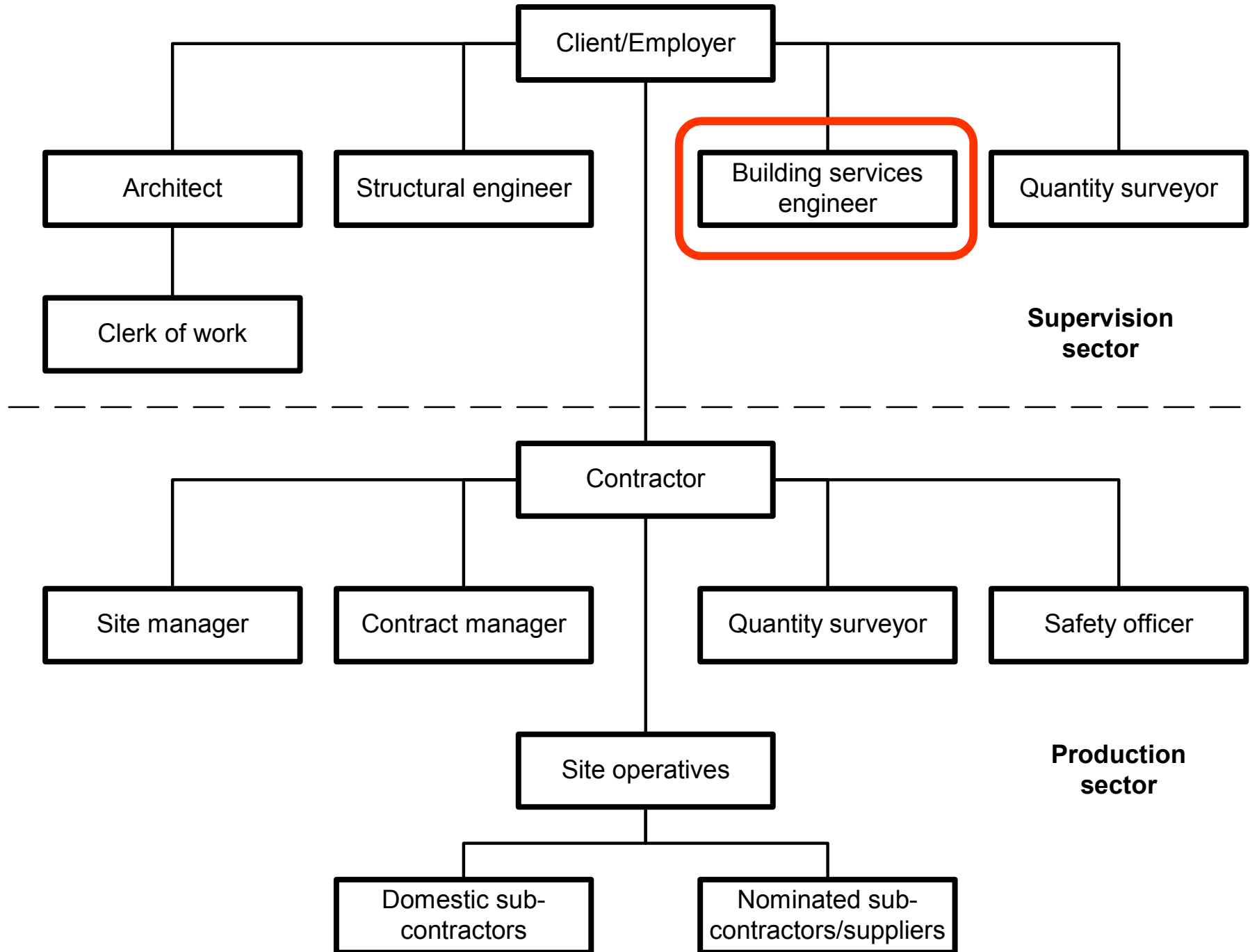


BSE = Building Services Engineer

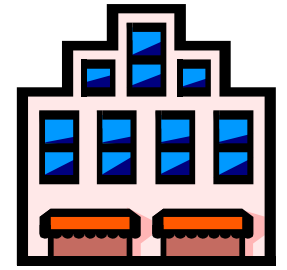


Building design is a team work.

Organisation structure of building projects

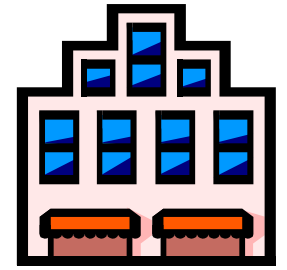


Building science is ...

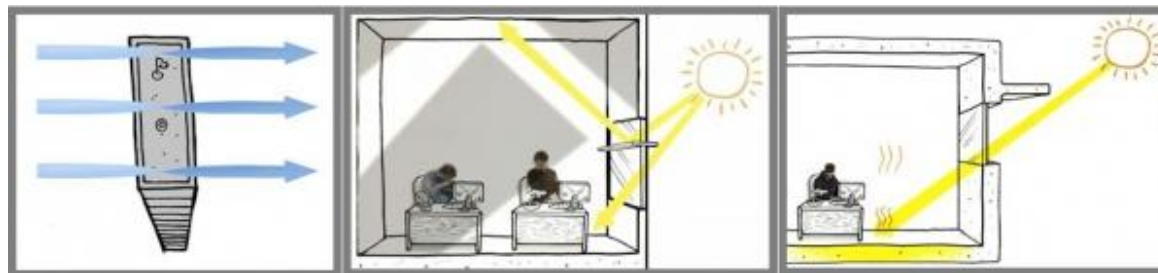


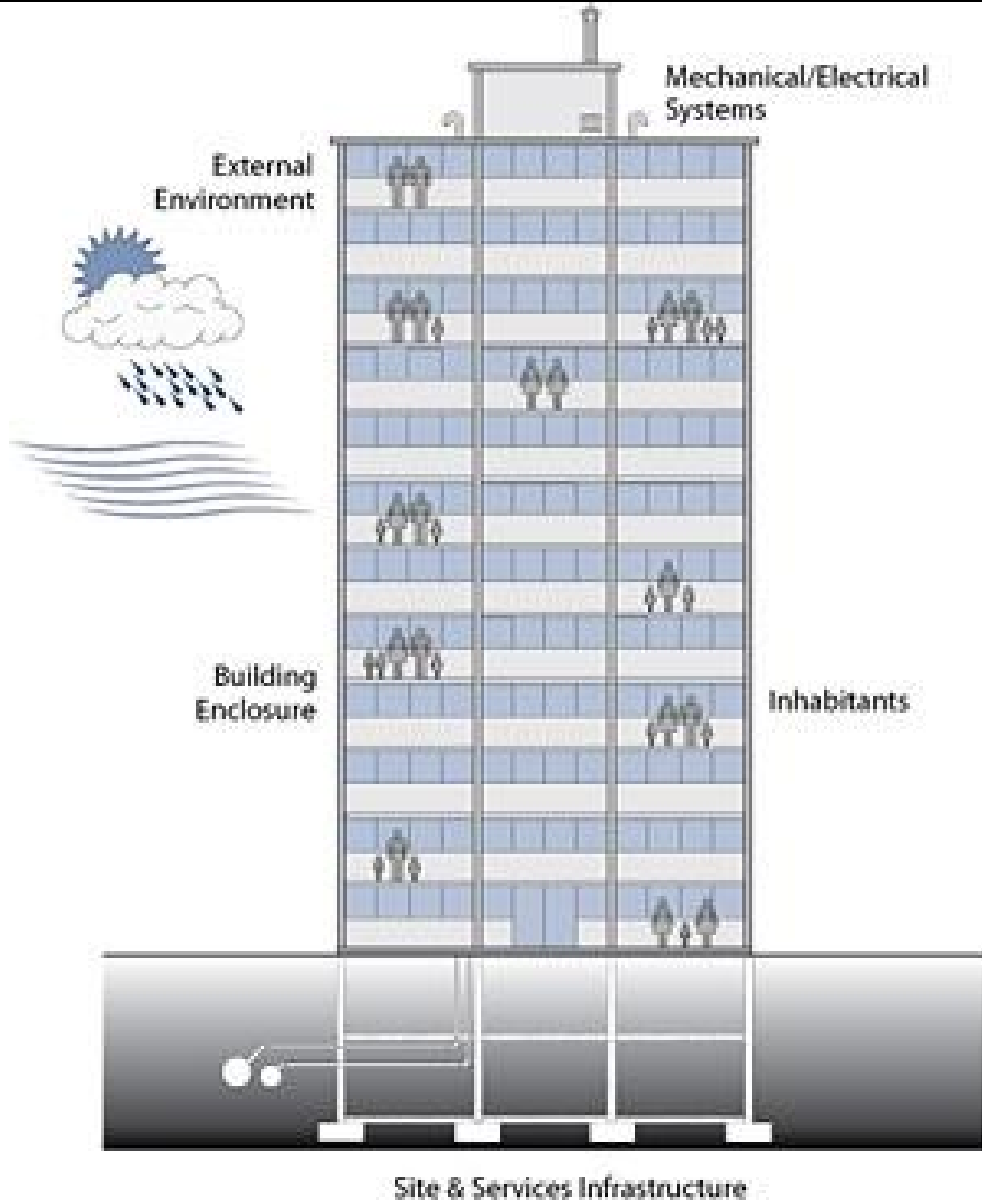
- A field of knowledge that draws upon physics, chemistry, engineering, architecture, and the life sciences
- Scientific knowledge that focuses on analysis and control of the **physical phenomena** affecting buildings and architecture
- Related terms: architectural science, **building physics**, environmental design

Building science is ...



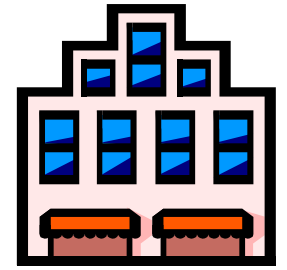
- The study of how buildings function under various environmental conditions
 - To understand the physical behaviour of the building as a **system** and how this impacts energy efficiency, durability, comfort and indoor air quality
 - To achieve acceptable/high **building performance**





The Building as a System:
apply building science principles to building behaviour and performance

Building science is ...



- The building as a system approach – primary elements:
 - Building enclosure (building envelope system)
 - Inhabitants (humans, animals, and/or plants, etc.)
 - Building services (electrical/mechanical systems)
 - Site, with its landscape and services infrastructure
 - External environment (weather and micro-climate)
- Harmonization of these elements is the key to well-performing buildings

Design of the built environment

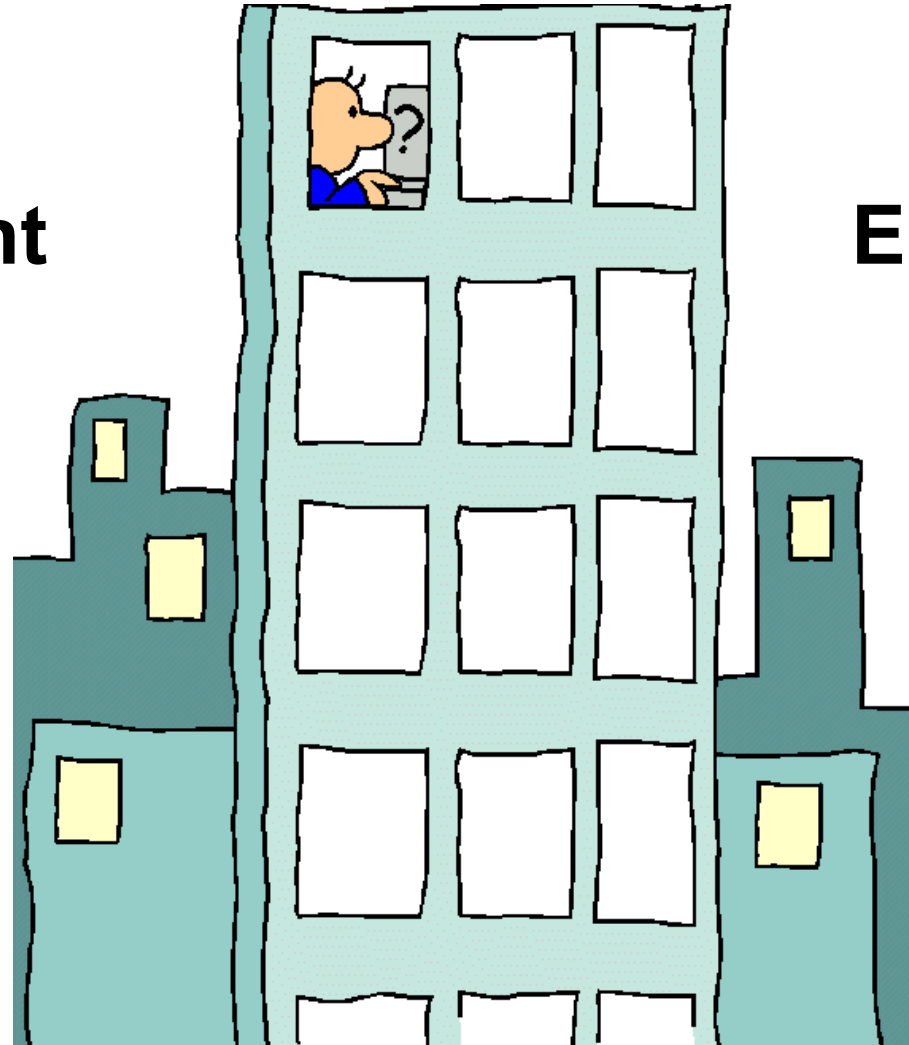
Shelter

Building Envelope

Outdoor Environment



Human Environment

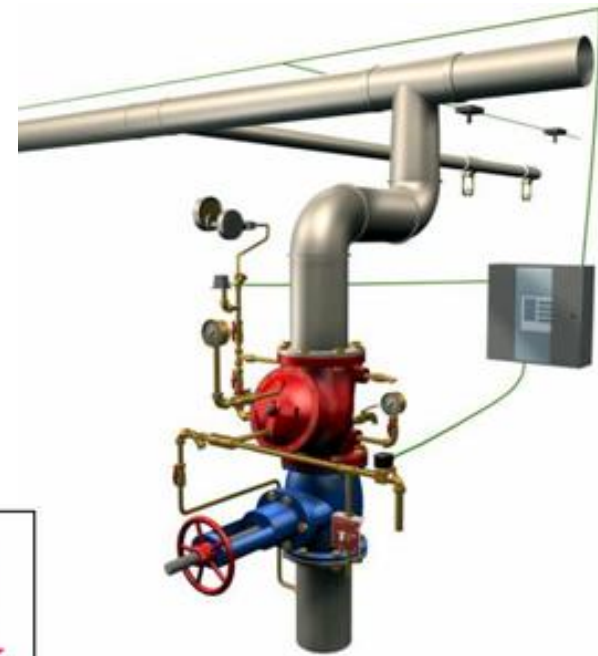


Energy demand and energy use by the building and its building systems

Energy supply to the building



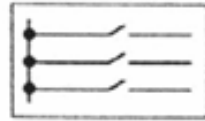
Major Building Services Systems and Components



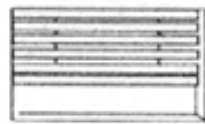
風 火
水 電



More ...



Electrical installation



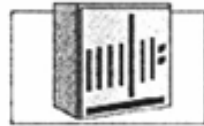
Blinds and shutters



Ventilation



Air conditioning

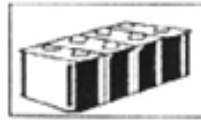


Switchgear and controlgear

Building Services Systems



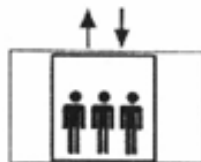
Heating



Stand-by power supply



Cooling



Elevator



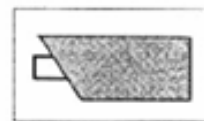
Sanitation



Security



Lighting



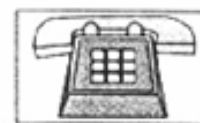
Video



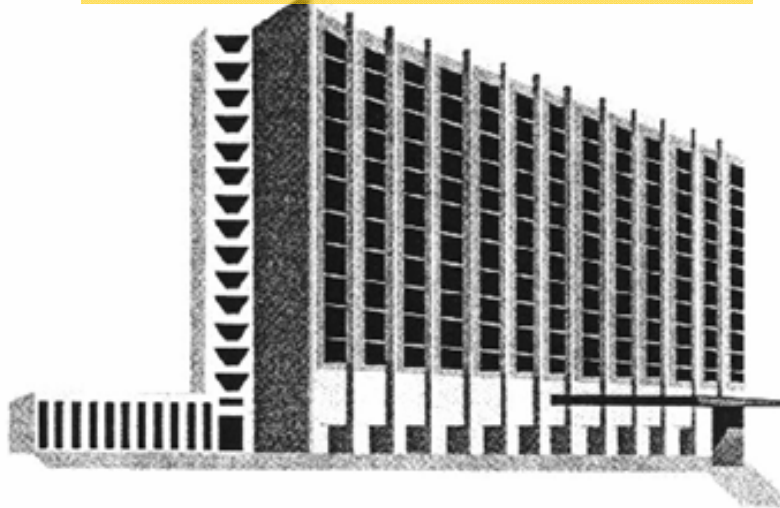
Waste disposal



Office and data systems technology

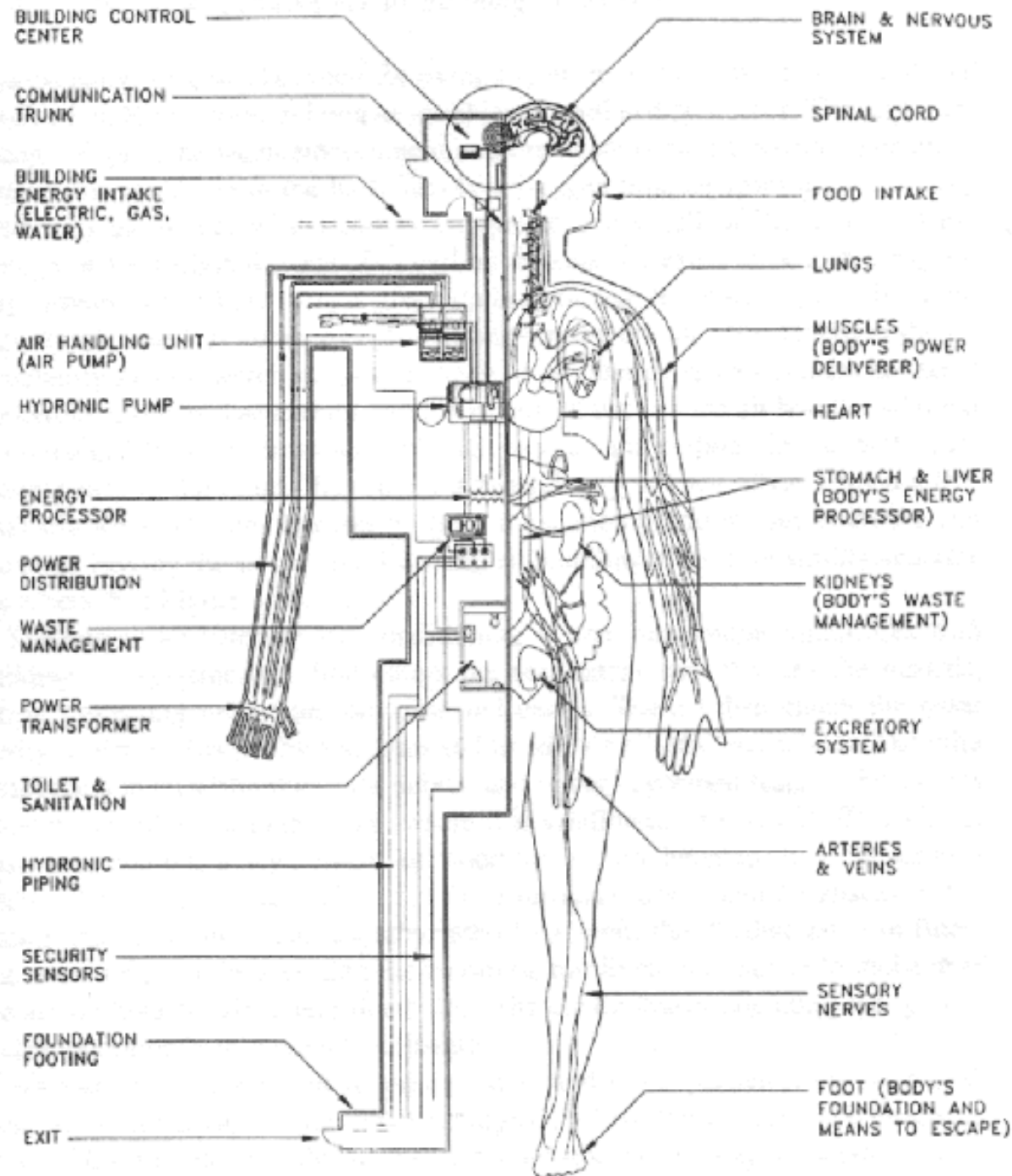


Telephone



Compare building systems with human body

Building Systems

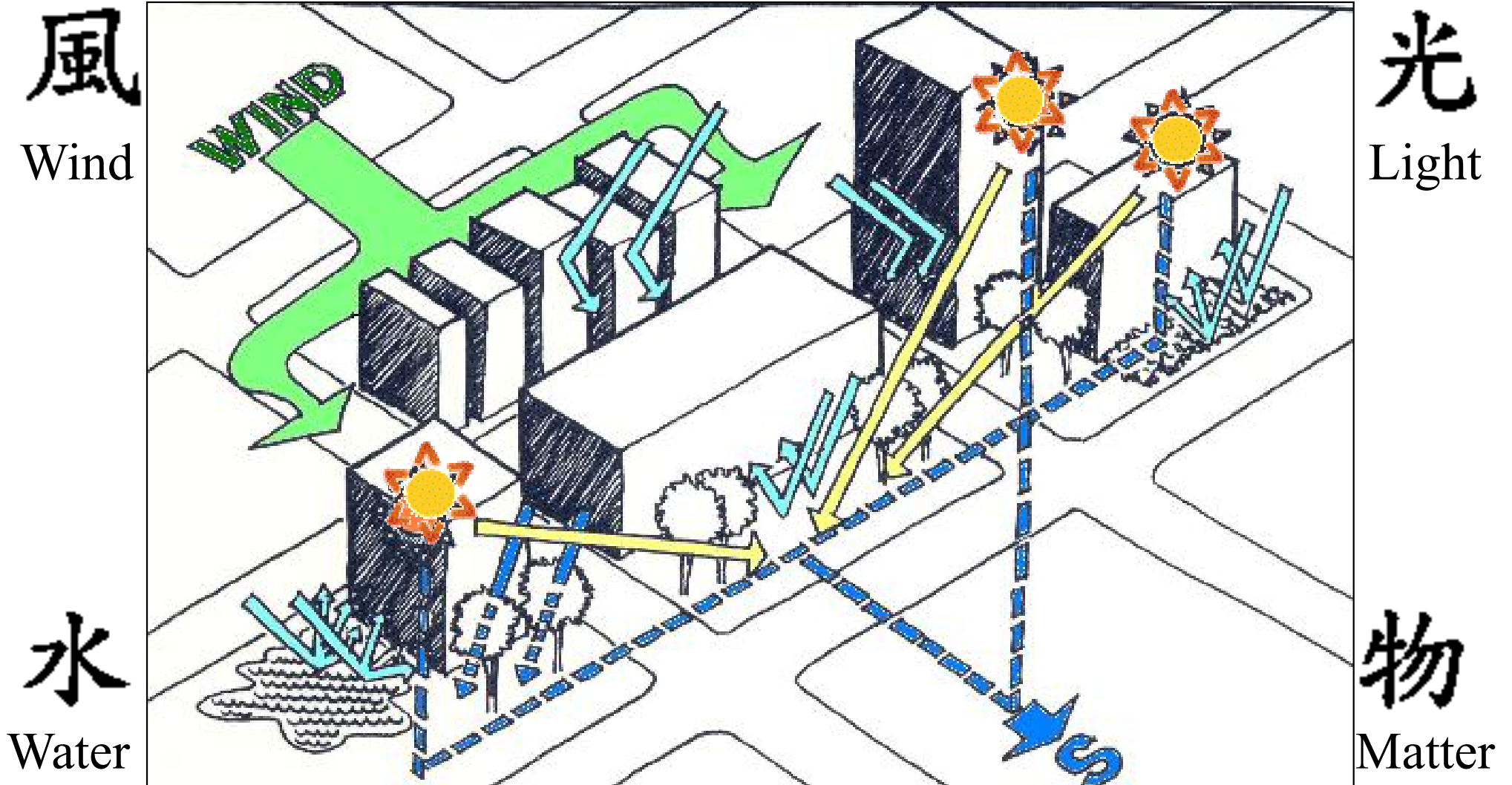


Human Body

Figure 14.4 Body-building system integration.

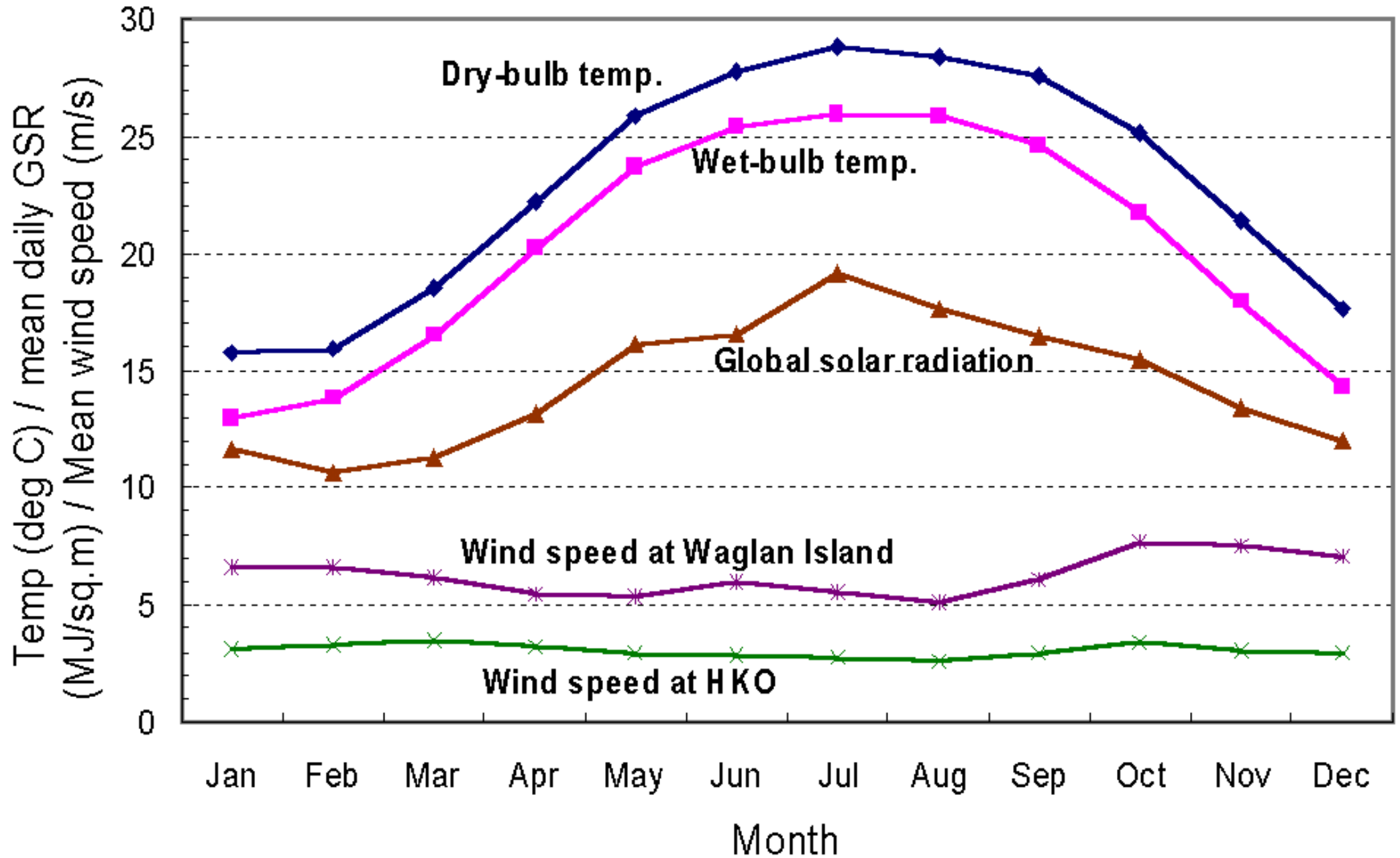
(Source: Ahuja, A., 1997. Integrated M/E Design: Building Systems Engineering, Chapman & Hall, New York.)

Major site factors



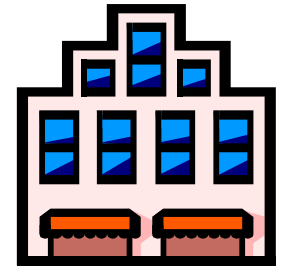
Building designer is like a “Feng Shui” master.

Major climatic elements of Hong Kong



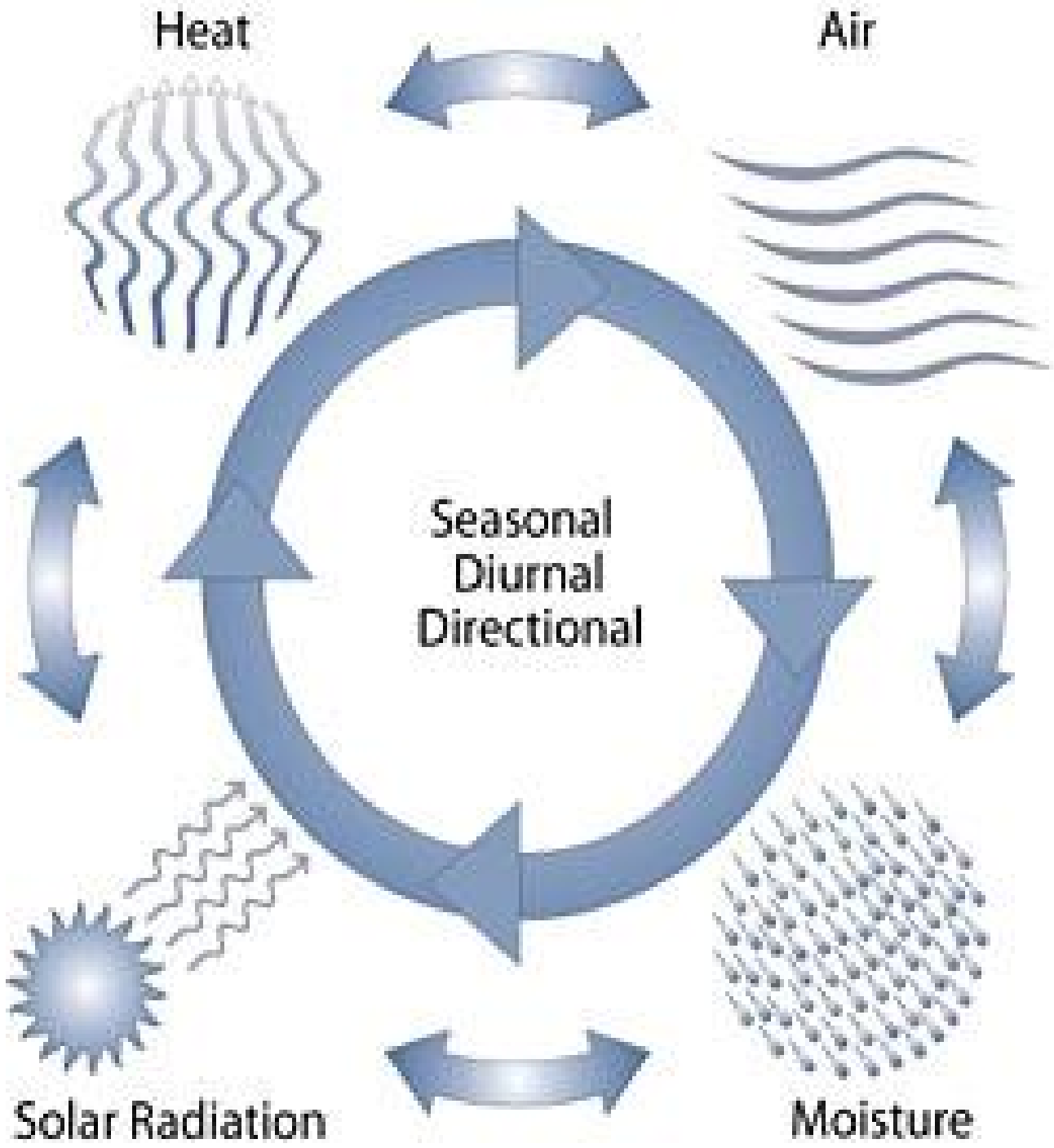
(Data source: Hong Kong Observatory)

Building science is ...



- Physical forces and primary physical mechanisms associated with climate and weather:
 - Heat Flow - the conductive, convective, and radiative flow of heat;
 - Air Flow - the air flow across and within the building enclosure due to air leakage and ventilation;
 - Moisture Flow - the flow of water and vapour across and within the building enclosure; and
 - Solar Radiation - the influence of insulation on the opaque and transparent enclosure components

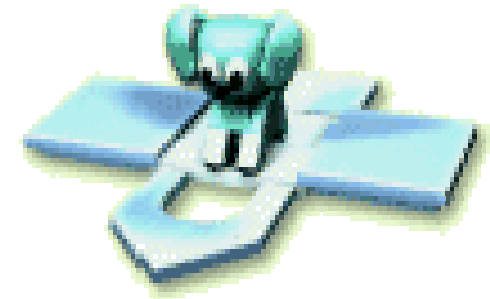
Physical mechanisms driving the behaviour of the building as a system



Building performance



- “*Performance*” may be defined as the level of service provided by a building material, component, or system, in relation to an intended, or expected, threshold or quality
- Performance parameters, e.g.
 - Structural
 - Fire and safety
 - Sound insulation (acoustic)
 - Environmental
 - Energy efficiency



Index of Building (Houses) Performance (Japan)

住宅性能表示のイメージ

※これはあくまでも平成11年5月現在で検討中の資料をもとに構成したものであり、今後、変更・追加される場合があります。

Structure strength

構造耐力（建築基準法の求める構造強度との比較 〇倍）

床の遮音性（ランク〇）

省エネルギー性（ランク〇）

Energy efficiency

Daylight, ventilation

採光・換気性（開口率〇%）

壁の遮音性（ランク〇）

Sound insulation

Fire resistance

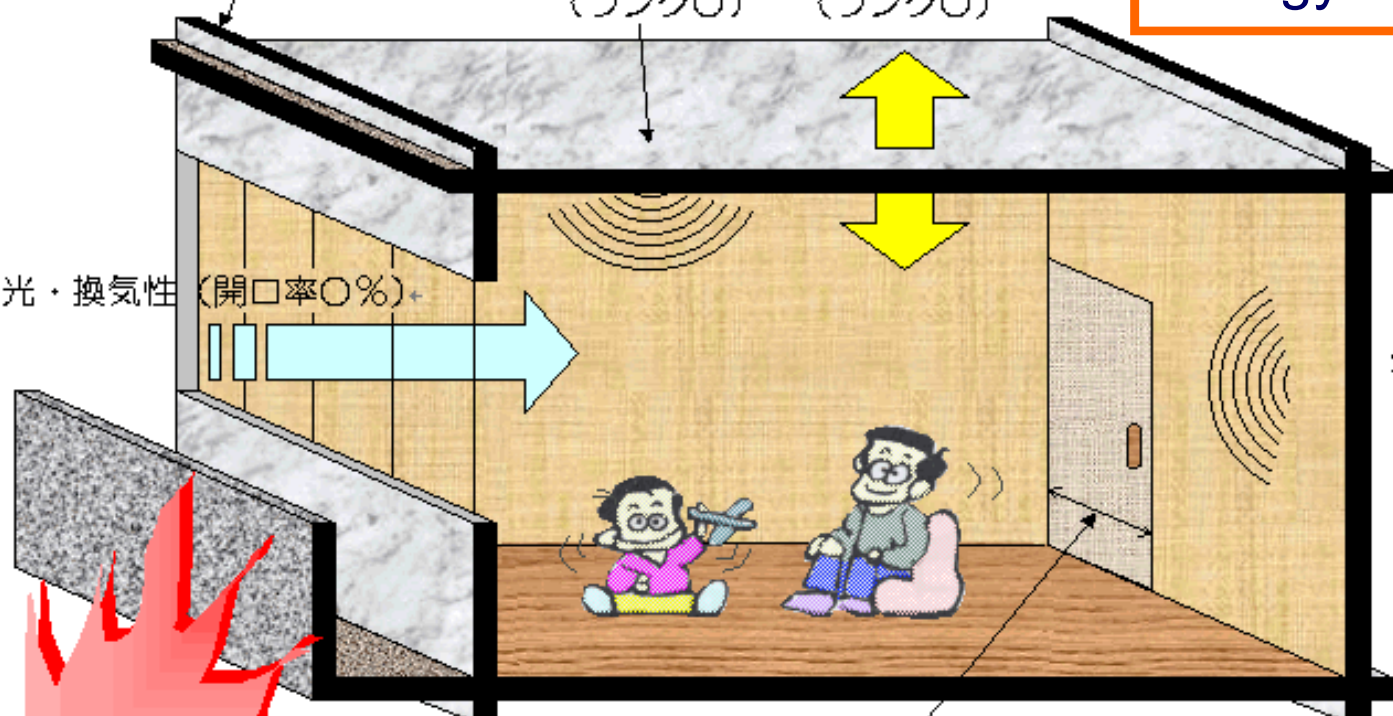
防・耐火性（耐火時間〇時間／法定耐火時間〇時間）

長寿社会対応性（ランク〇）

Design for the aged

耐久性（ランク〇）

Durability



Building performance



- CIB definition *:
 - *“The objectively identifiable qualitative or quantitative characteristics of the building which help determine its aptitude to fulfil the different functions for which it was designed.”*
- Trends:
 - Use it as the major criteria for building design
 - The need to study, measure, and predict the level of building performance (to *quantify*)

Performance of a car



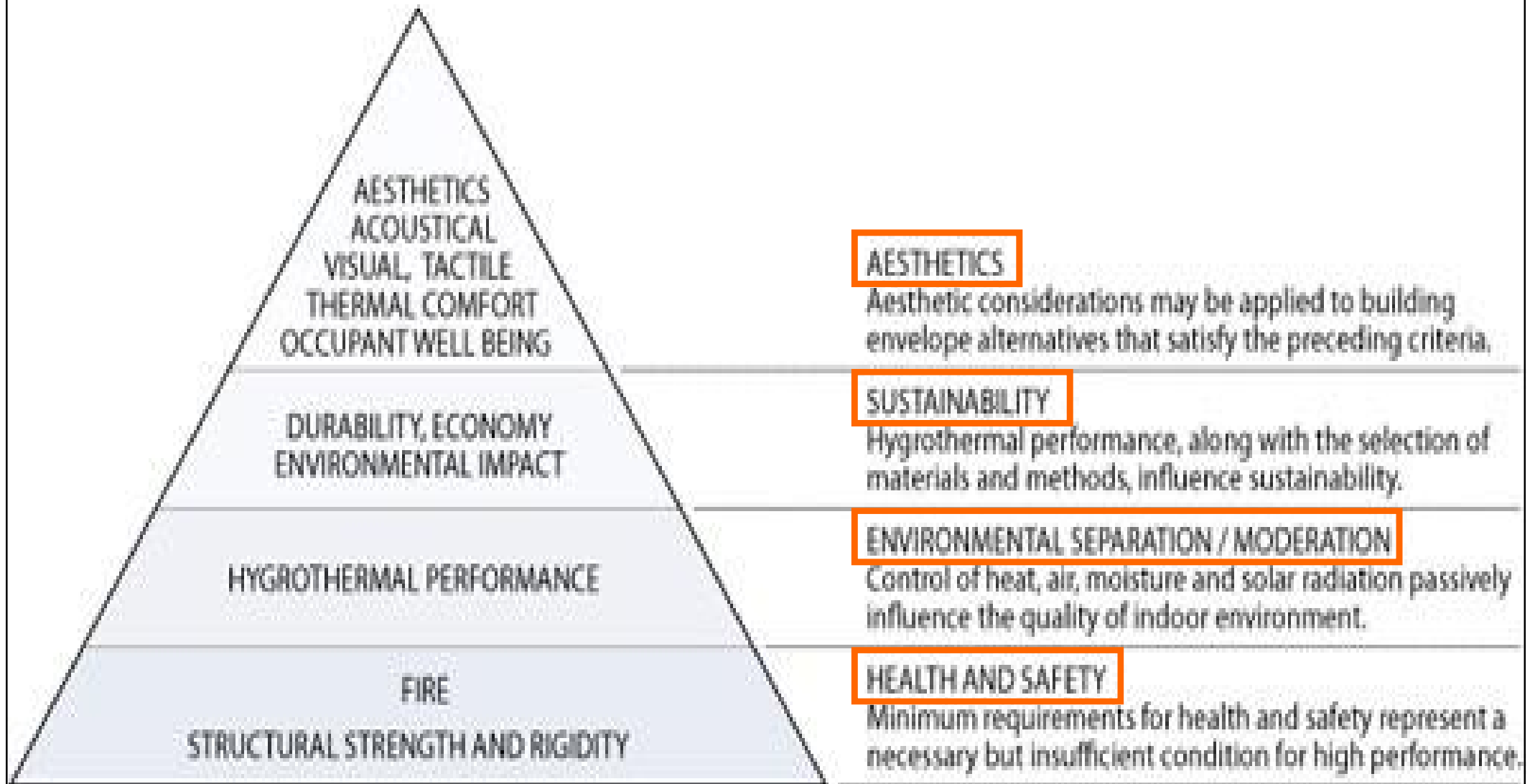
(Such as fuel efficiency)

Performance of a building/flat



We get info. about performance of a car, what about buildings?

Building science hierarchy of performance requirements

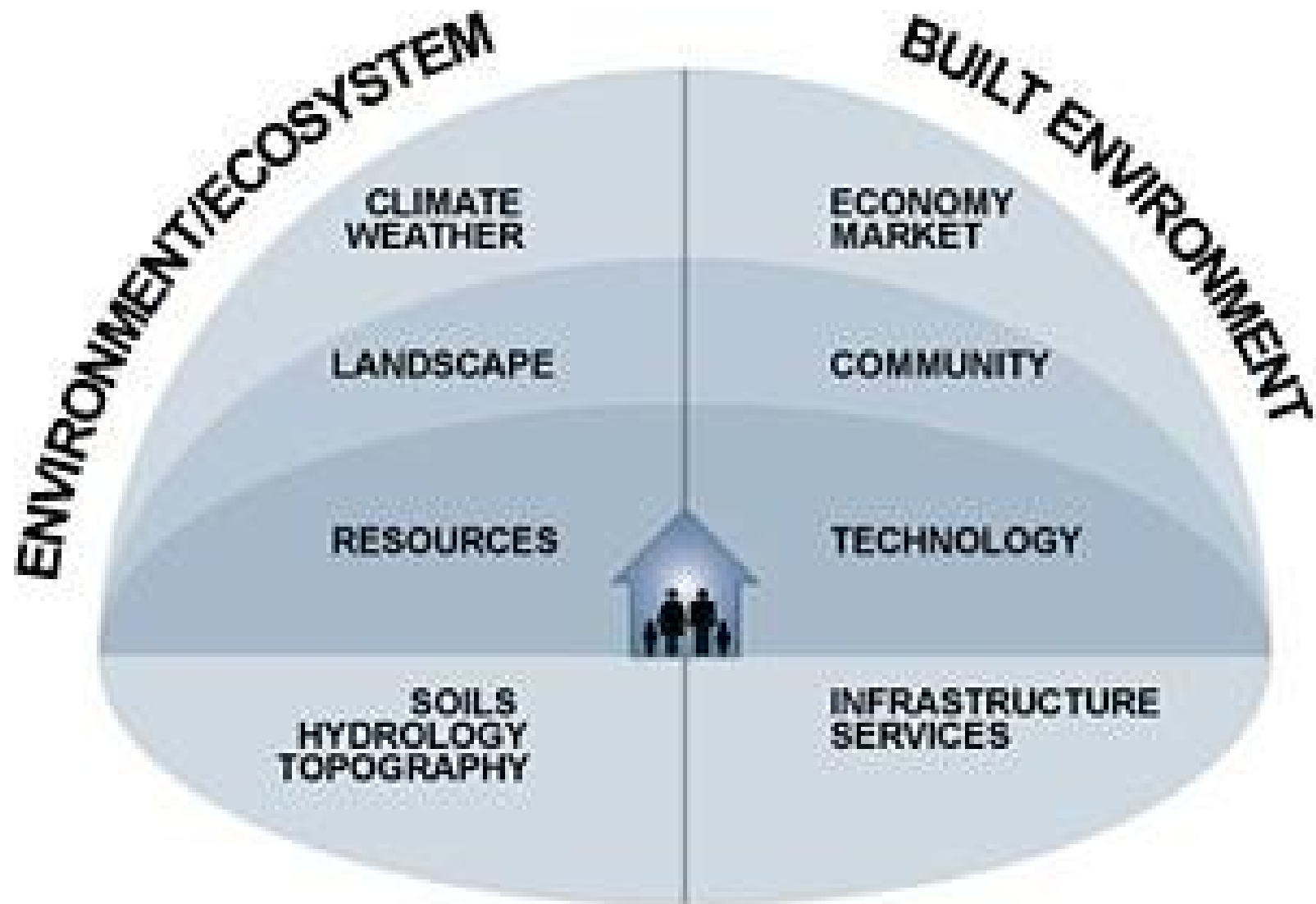


Building performance



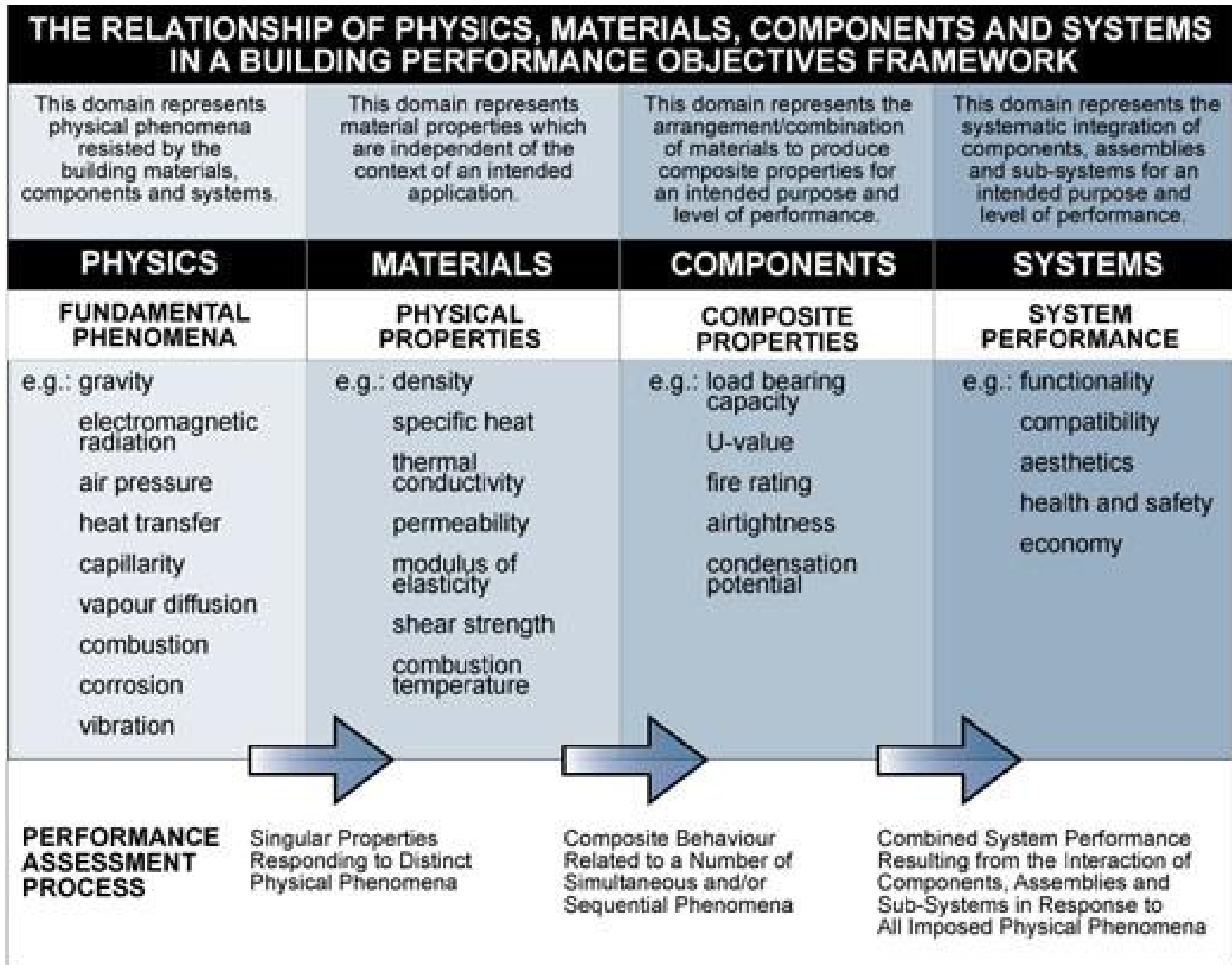
- Set up a framework to represent:
 - **External & internal conditions** affecting a building system
 - (e.g., climate, weather, site, occupancy, and indoor climate class)
 - **Parts and inter-relationships** comprising a building system
 - (e.g., the behaviour of materials, components, equipment and sub-systems)
 - **Parameters or indicators** defining acceptable performance
 - (e.g., aesthetics, health and safety, economy, sustainability, etc.)
 - **Methods, tools, and techniques** for designing and analyzing performance according to the parameters, inter-relationships and conditions cited above

Contemporary context for building performance objectives

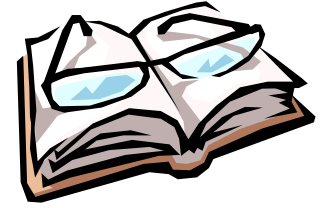


The assessment of building performance involves numerous interfaces between the building, its occupants, and the natural and built environment.

Physics, materials, components, and systems



Further Reading



- Building science - Wikipedia
 - http://en.wikipedia.org/wiki/Building_science
- Building Science Concepts | Whole Building Design Guide
 - <http://www.wbdg.org/resources/buildingscienceconcepts.php>

Useful References



- Hens, H. S. L. C., 2012. *Building Physics: Heat, air and moisture: fundamentals and engineering methods with examples and exercises*, 2nd ed., Ernst & Sohn, Berlin.
- Pohl, J., 2011. *Building Science: Concepts and Application*, Wiley-Blackwell, Chichester, West Sussex, United Kingdom.
- Szokolay, S. V., 2014. *Introduction to Architectural Science: the Basis of Sustainable Design*, third edition, Routledge, Abingdon, Oxon and New York, NY.