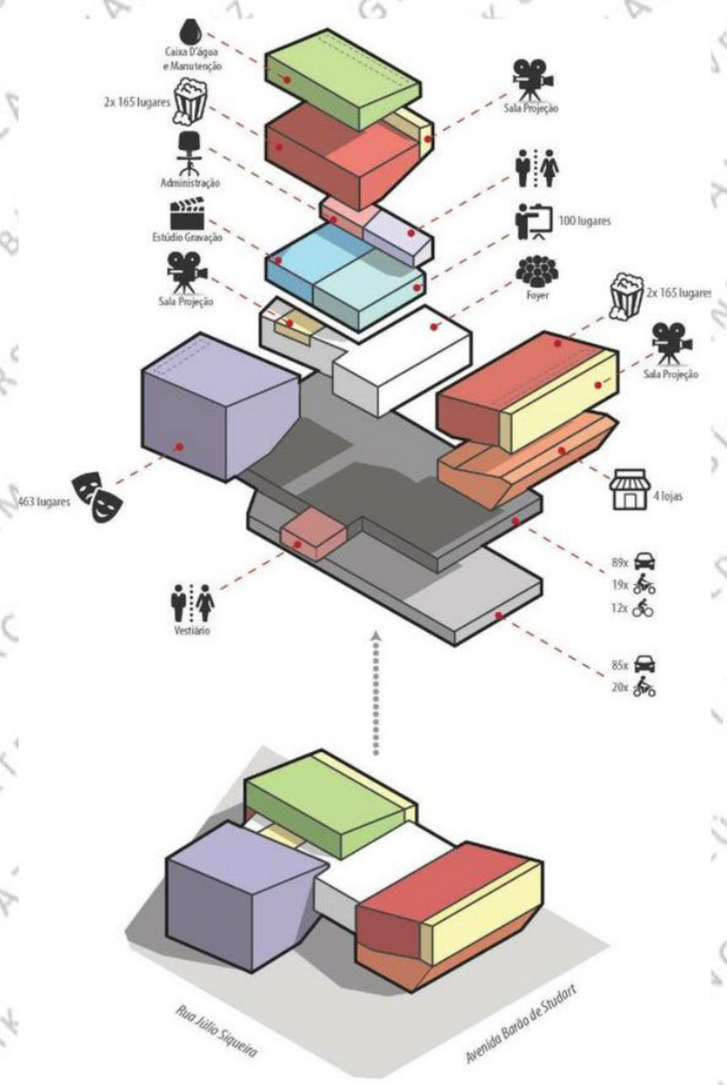
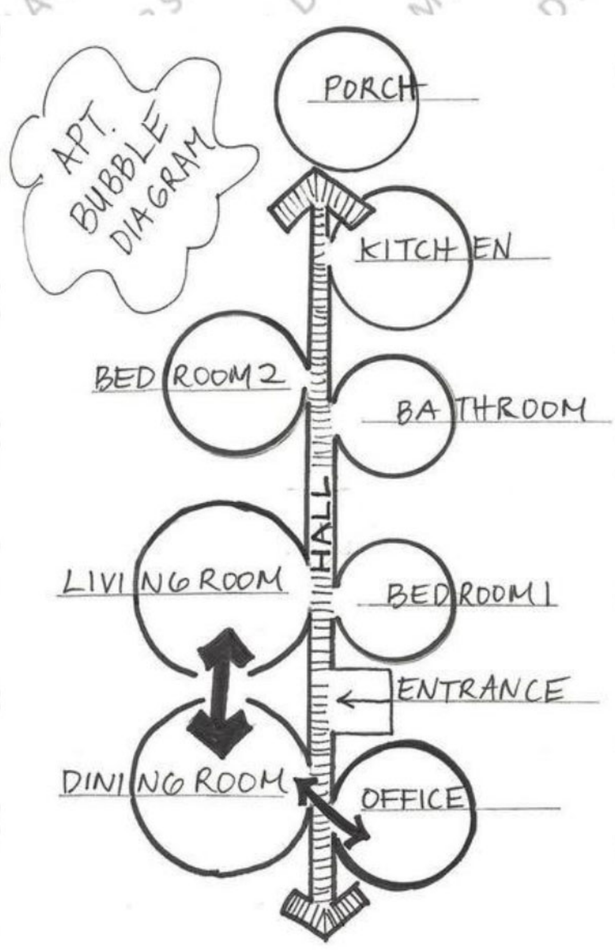
YILDIZ TECHNICAL UNIVERSITY – DEPARTMENT OF ARCHITECTURE
2017 -2018 ACADEMIC YEAR – SPRING SEMESTER
BUILDING MATERIALS LECTURE NOTES / Dr. Polat DARÇIN

BUILDING PRODUCTS

Humans, in order to maintain a healthy and good life, require re-organized living spaces compatible to their needs. By separating a part of the natural environment with an envelope (in other terms: by generating a man-made environment), they can gain the necessary living spaces bearing essential living conditions. Based on this statement, **the primal function** of a building is **to offer a healthy and safe living environment** to its users by **protecting them from the negative features** of natural environment (Balanlı, 1997).

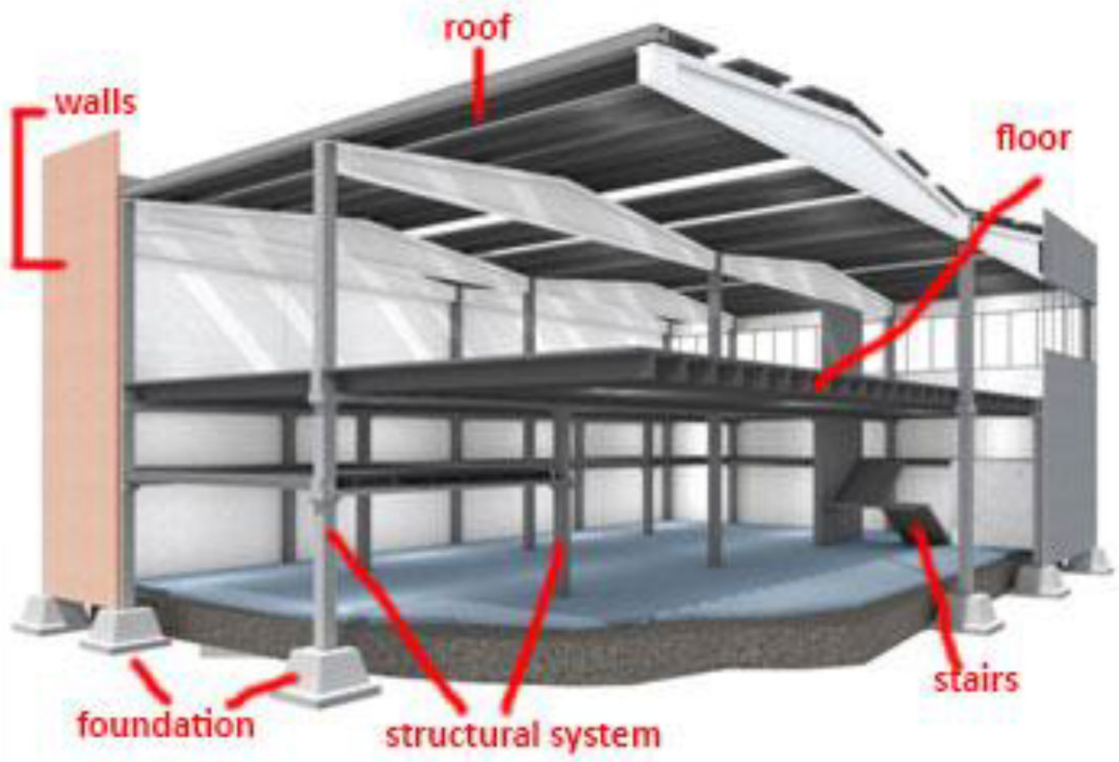
A building can be defined as any fixed or mobile, private or governmental **construction** that is temporarily or permanently **erected** on or under the surface of the earth or water (Hasol, 1998). **An architect** is the person who **designs buildings** and other made-environments, the **director of the team** cooperating **to materialize a building** through **technical, aesthetic and functional** issues (Hasol, 1998).





Buildings may consist of closed, semi-closed and / or open **living spaces** particularly arranged and organized in order to fulfill their users' needs by architects. These spaces, which **execute a function themselves** (such as a kitchen, a living room, a classroom, etc.), are defined as **building units** (Balanlı, 1997).

All the spaces of a building (including building units) are formed by **building elements**, which are defined as integral products, composed to **physically meet one or some of the functions of a building** (e.g. walls, floors, etc.) (Balanlı, 1997). Building elements are formed combining other building products with various construction methods.



The elements of a building can be classified as

- foundations,
- floors,
- roofs,
- walls,
- stairs,
- structural system,
- carrying services,
- shells,
- sanitary system,
- heating, ventilating and air conditioning system,
- electrical installation system,
- gas installation system,
- … (Balanlı, 1997)

These elements, defining and bordering a space, are kept sustained by the system called **structure** (Balanlı). **Structure** is the anatomy / framework / carcass that **holds the form sustained** (Yavuz). The **process of production of a building** is defined as **construction** which includes some basic stages such as: definition of a specific need, the design of a form to fulfill this need, the design of a structure to hold this form up; using proper products, vehicles and methods to materialize this design (Kuban, 2010). As in all the production activities, the construction of a building can be executed by natural, financial and human resources – in other words: **production resources**. Natural resources are energy and materials (Balanlı, 1997).

Building elements are formed with building **materials**, **pieces** and **components** which are put together in order to impose a specific element with one or more functions that will eventually be owned by building itself.

Building materials are the **basic mass and mostly raw products** for construction of a building (e.g. wood, stone, etc.), which are **obtained at the end of natural or artificial processes** and do not have **definable geometrical forms** and all the mixtures (concrete, mortar, etc.), alloys (bonze, brass, etc.) and compounds (plastics, paints, etc.) made with these (Balanlı, 1997).

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Some of the building materials are

a. natural stones

marble

sandstone

b. clay

c. metals

steel

copper

d. wood

pitch pine

oak

e. fibers

plant fibers

glass wool

f. plastics

rubber

polyamide

g. glass (silica)

h. aggregates (fillings)

sand

vermiculite

i. binders

cement

gypsum

j. concrete, mortar

lime-cement mortar

gypsum mortar

k. bitumen materials

bitumen

tar

l. paint, varnish

paint

lacquer

Building pieces are the every one of all objects which are made by **forming materials for a special function** and these objects **constitute a whole when brought together** (Balanlı, 1997).

By shaping different materials, various building pieces can be made:

a. blocks (solid, porous, etc.)

marble blocks

clay bricks

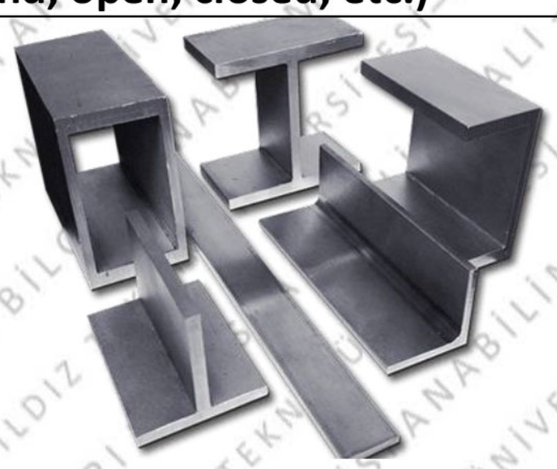
b. tiles (flat, corrugated, etc.)

clay tiles

ceramic tiles

c. profiles (round, open, closed, etc.)

steel profiles



plastic profiles

d. pipes, tubes (wide, narrow, etc.)

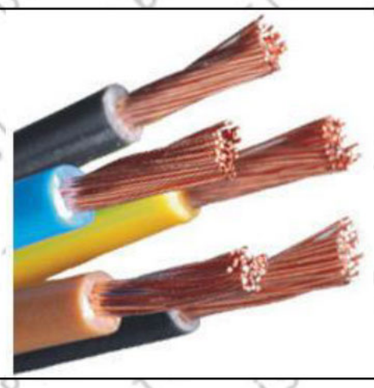
plastic downspout

concrete tubes

e. cables (thick, thin, etc.)

steel cables

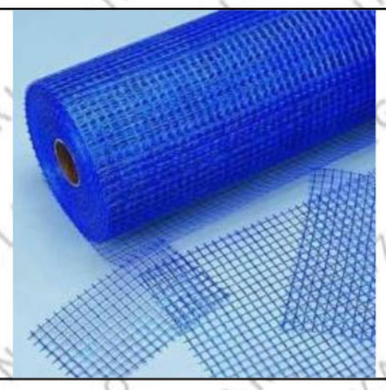
copper cables



f. meshes, mats (loose, dense, etc.)

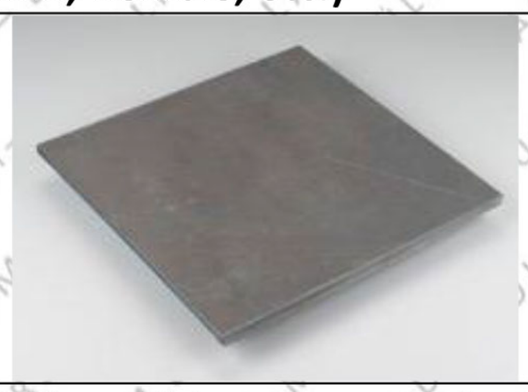
steel reinforcement mesh

fiberglass mesh

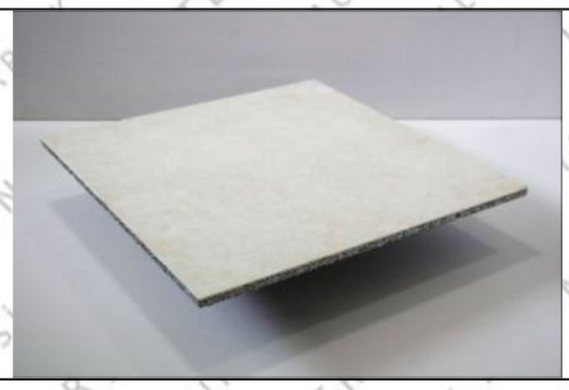


g. plates (thick, thin, flexible, etc.)

steel plates



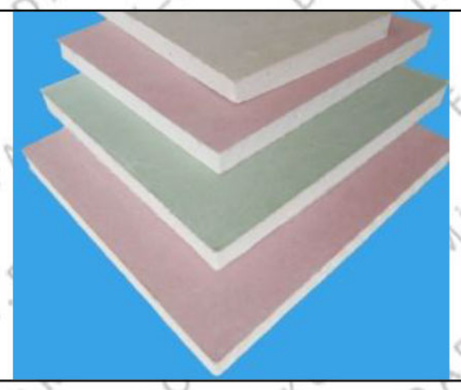
marble plates



h. boards (thick, thin, solid, porous, etc.)

chipboard

gypsum board



i. sheets (thick, thin, etc.)

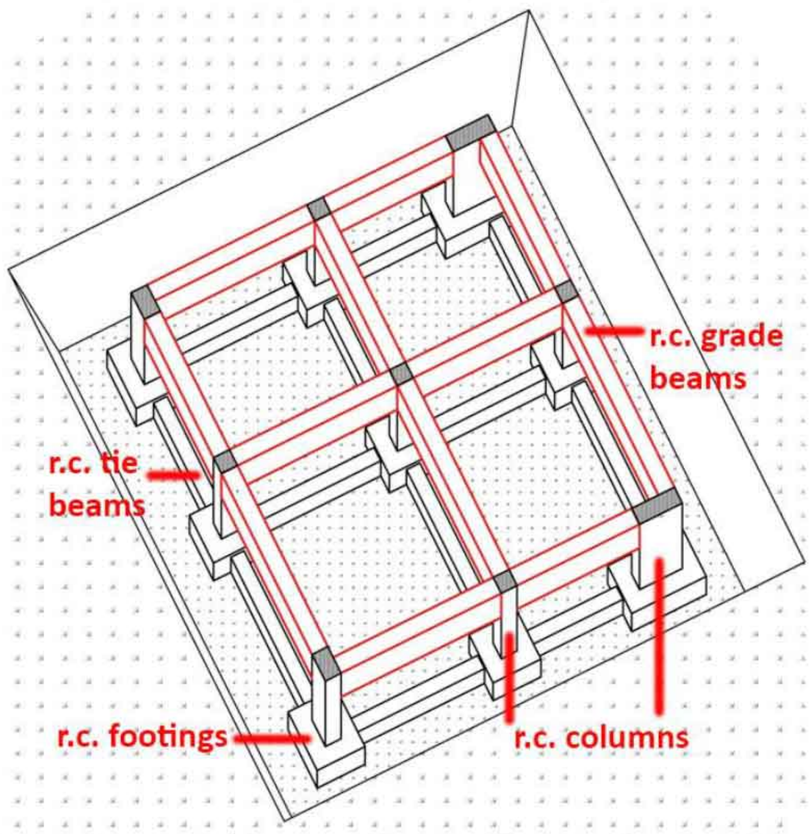
bitumen sheets

plastic sheets

Building components are produced by combining the materials and pieces or by forming them distinctively. These products have **a specific place and function** in the building (e.g. windows, washbasins, radiators, etc.) (Balanlı, 1997).

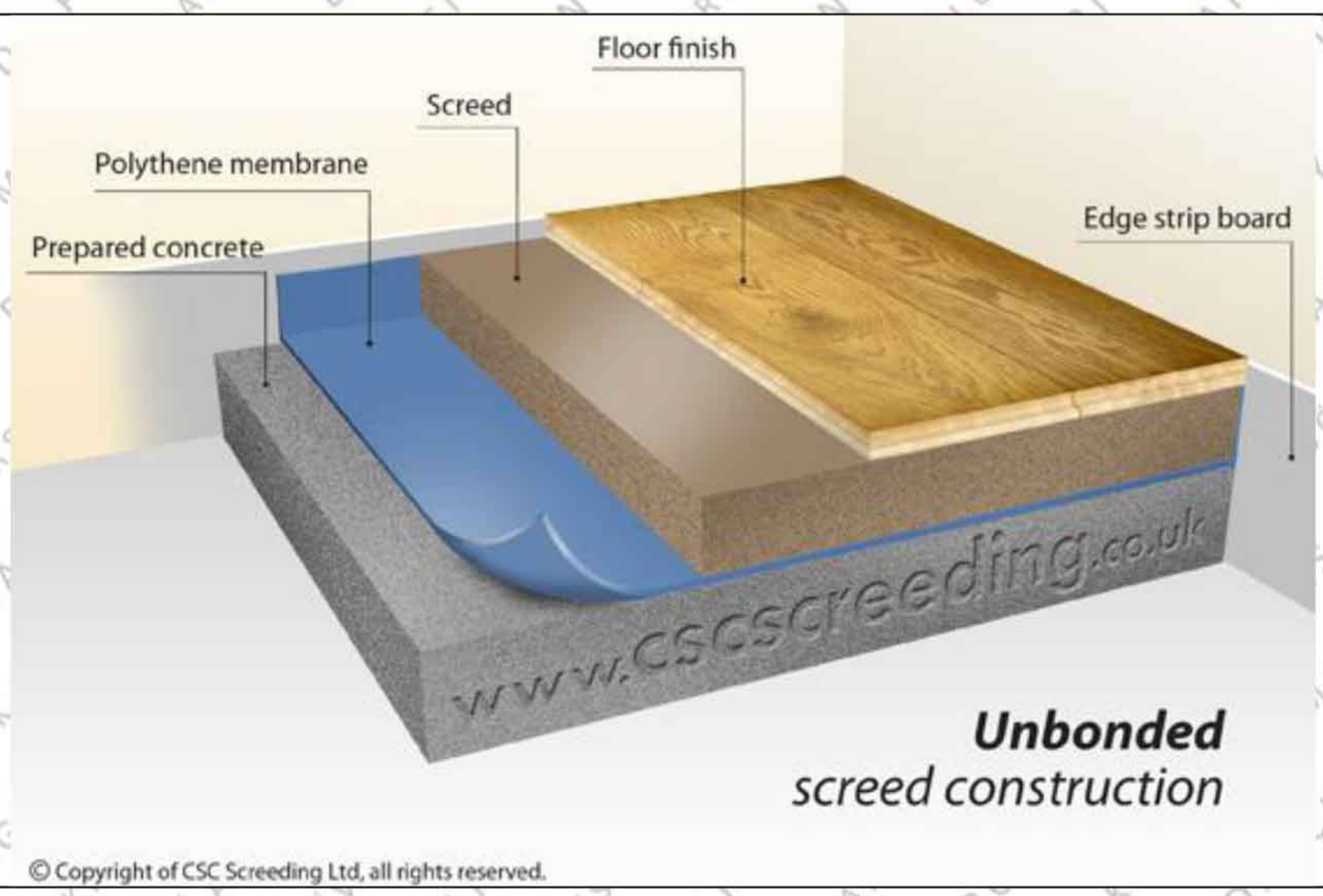
a. foundation components

reinforced concrete footings, tie beams, grade beams, etc.



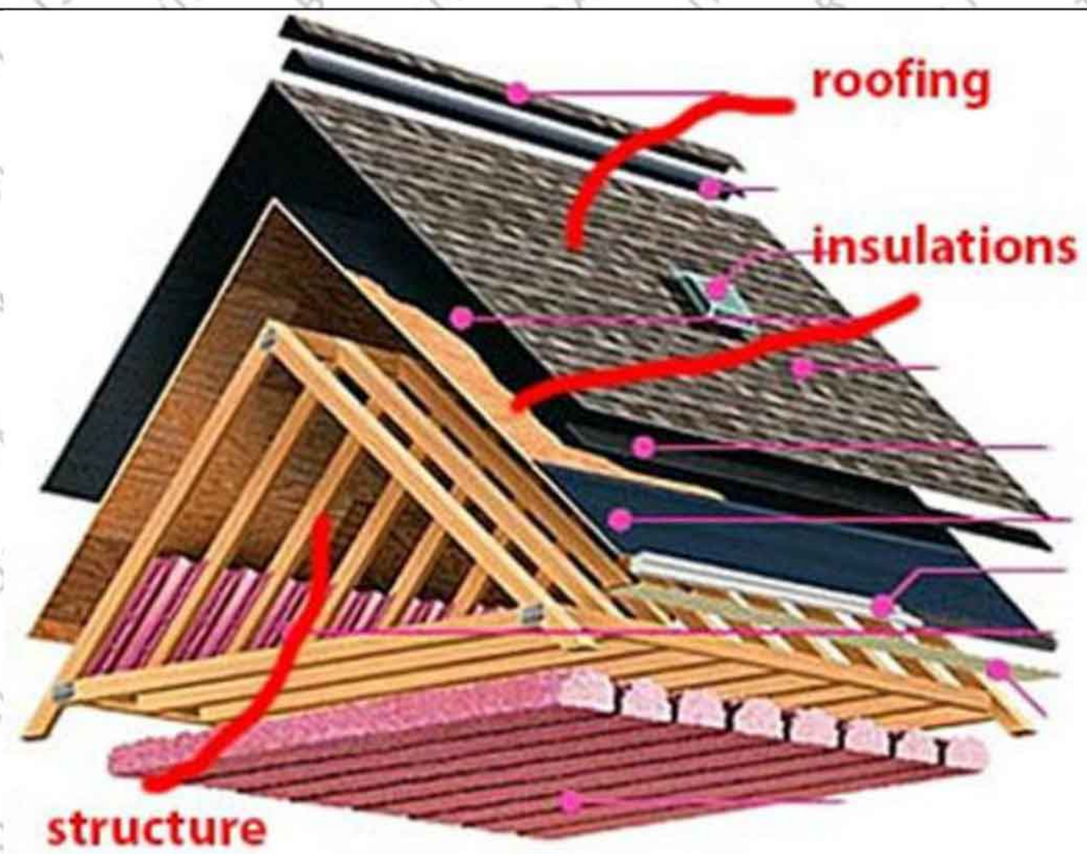
b. floor components

reinforced concrete floor slab, leveling concrete, oak hardwood flooring, etc.



c. roof components

elm roof structure, insulation layers, roofing products, etc.

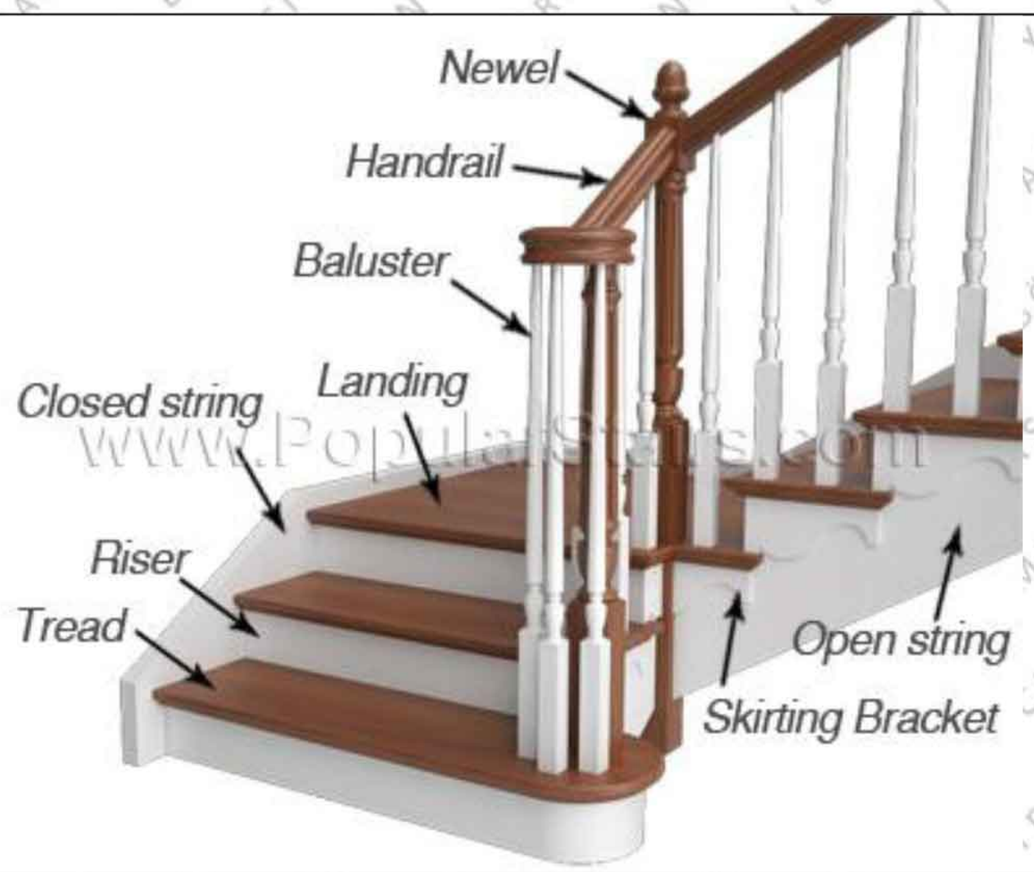


d. wall components

timber wall carcass, exterior coverings, windows, doors, etc.

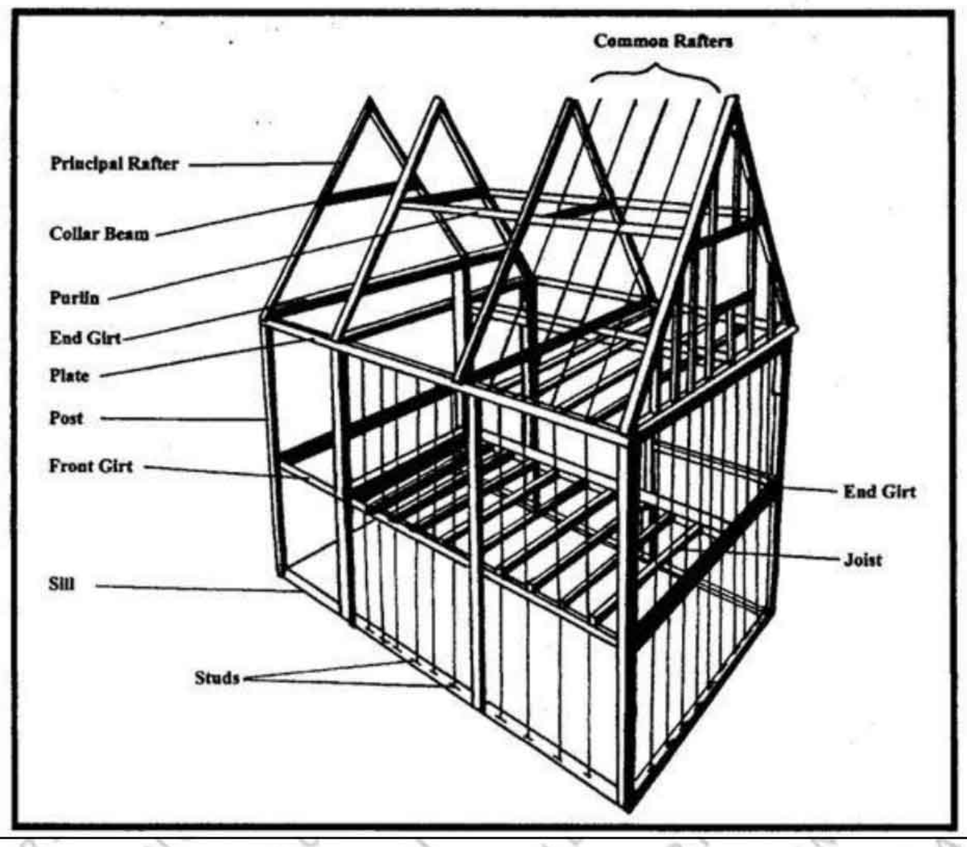
e. stair components

steps, handrail, guardrail, etc.



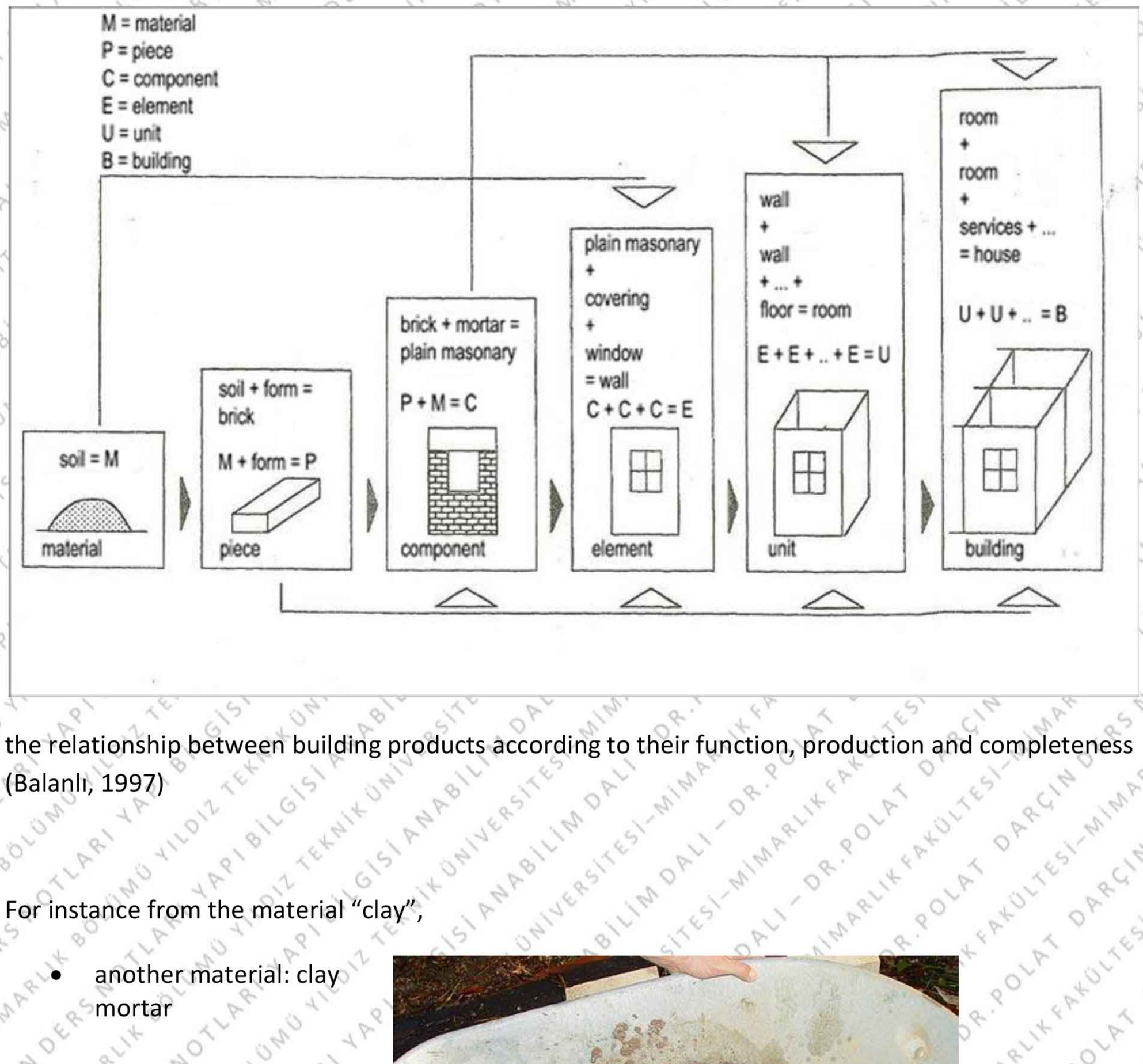
f. structural system components

columns, posts, beams, etc.



OBTAINING BUILDING PRODUCTS

The basic product for the construction of a building is **material**. **Other building products** (pieces, components, elements and units) are produced by **forming the materials** and **uniting these formed materials together** with different techniques for various purposes, gathering end products by using products of its sub-level (Balanlı, 1997).

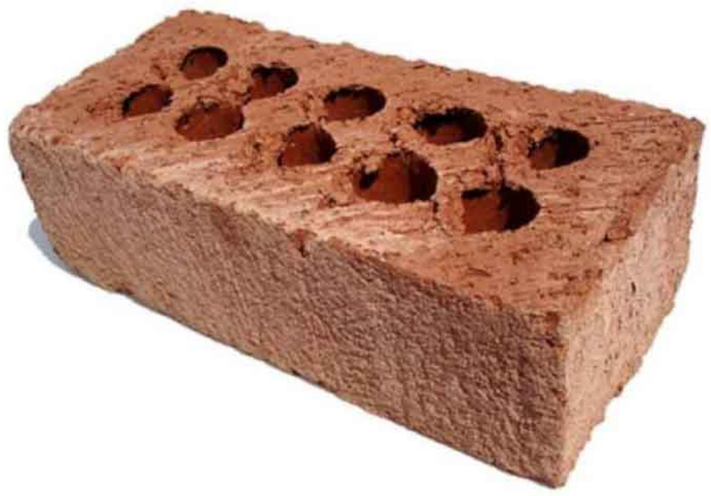


the relationship between building products according to their function, production and completeness (Balanlı, 1997)

For instance from the material “clay”,

- another material: clay mortar

- a piece: clay brick

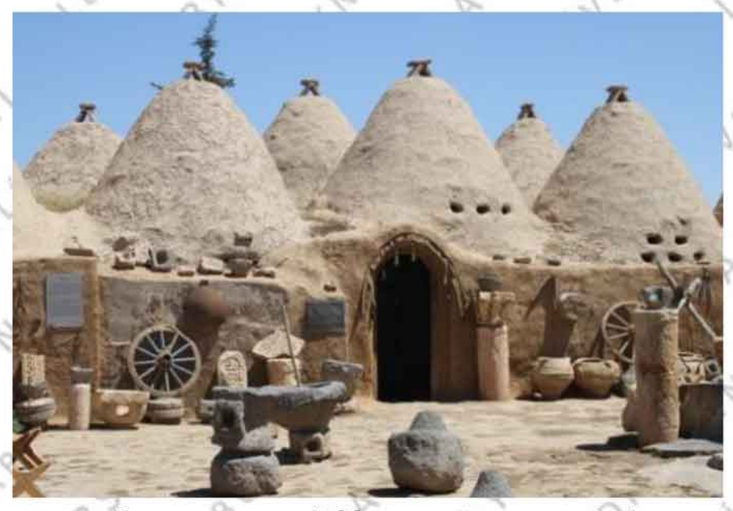


- a component: ceramic washbasin

- an element: rammed earth wall

- a unit: an adobe living room

- or even a building:
  Harran beehive homes



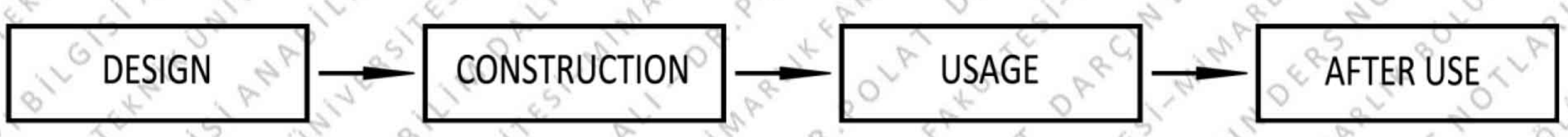
can be produced. Nevertheless, generally, many different materials and pieces are used to construct components, elements, units and buildings.

With the aim of producing the building, building products can be obtained via

- selecting the proper produced / finished products according to the properties of these products gathered through an information system,
- producing finished products by combining different sub-level products,
- developing new products.

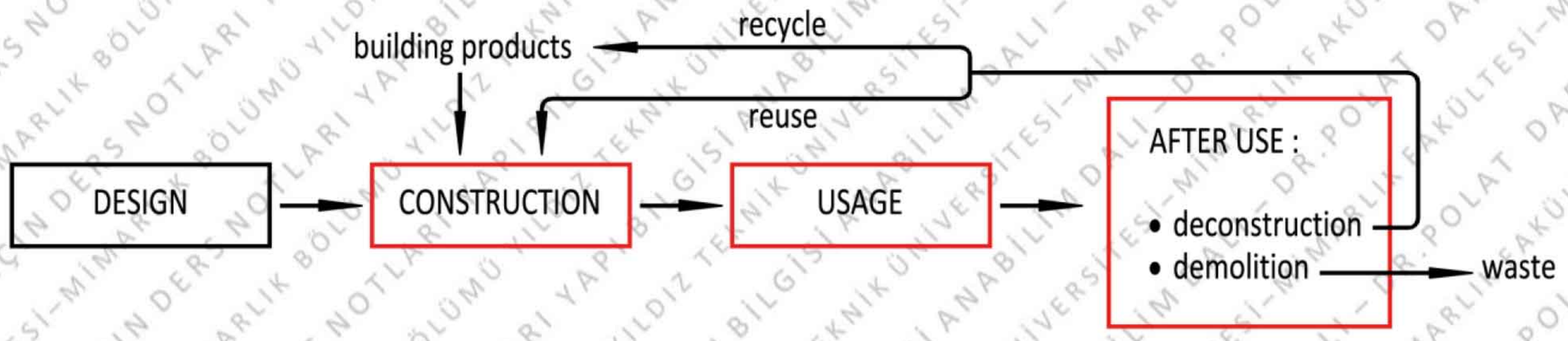
LIFE CYCLE OF BUILDING PRODUCTS

There are four main stages of a building, generally following each other in an order: design, construction, usage and after use.



stages of building

After the design stage is completed, the construction starts with decided building products. As the construction is finished, people start to use the building – therefore the products – and when the useful lifetime of building products are completed, building can be demolished to become a waste or it can be deconstructed for the products to be re-used or recycled.



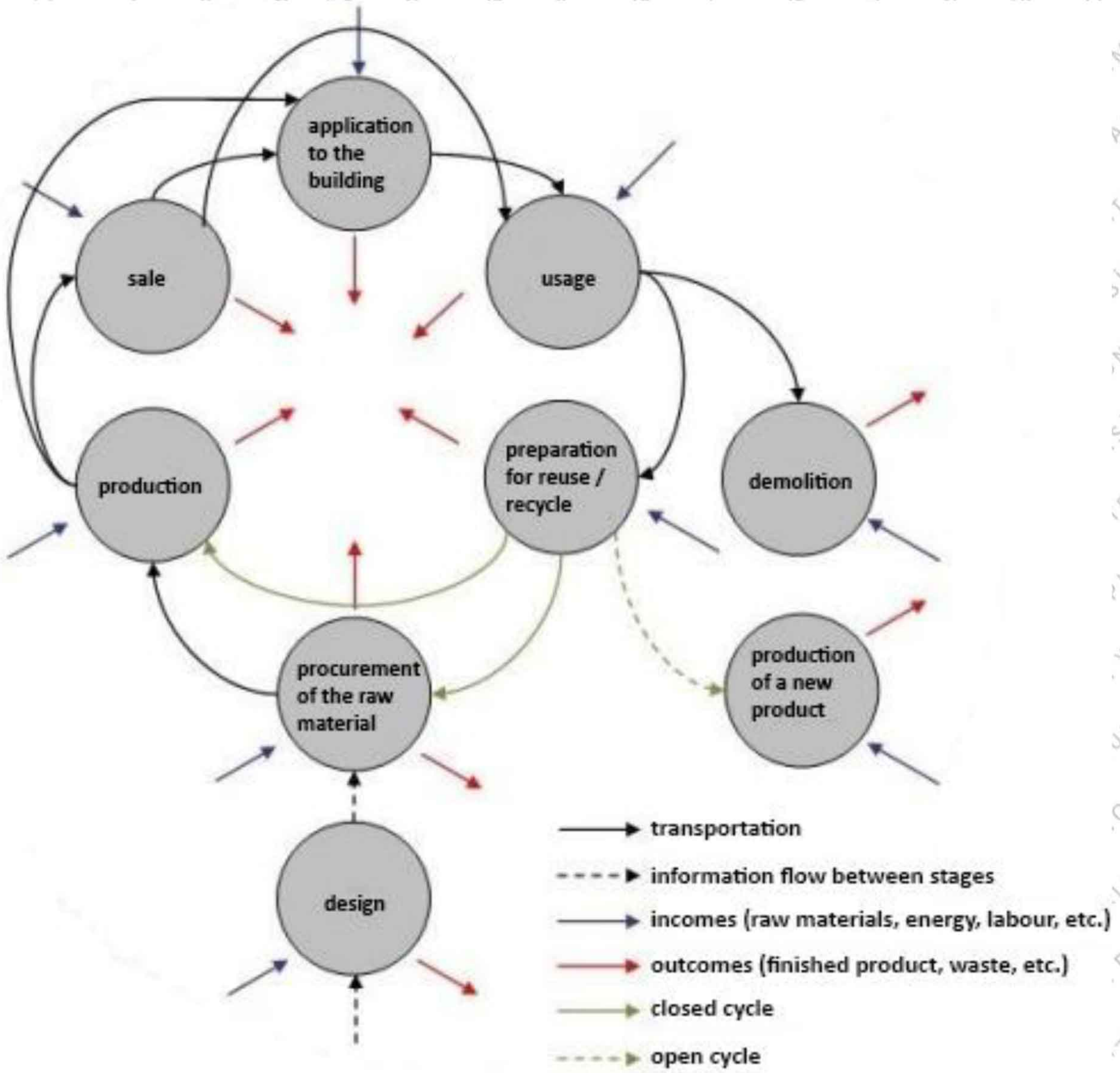
life of building products in the stages of building

Based on these stages the life of a building product starts with its design and continues as

- raw material procurement [and transportation of this raw material to the production area],
- production of the product,
- sale of the product [and transportation of the product to the construction site],
- application of the product to the building during construction,

- usage of the product,

and by the end of its useful life, in the after use stage, the product can be demolished to become waste or reused / recycled (Tuna Taygun, 2005).



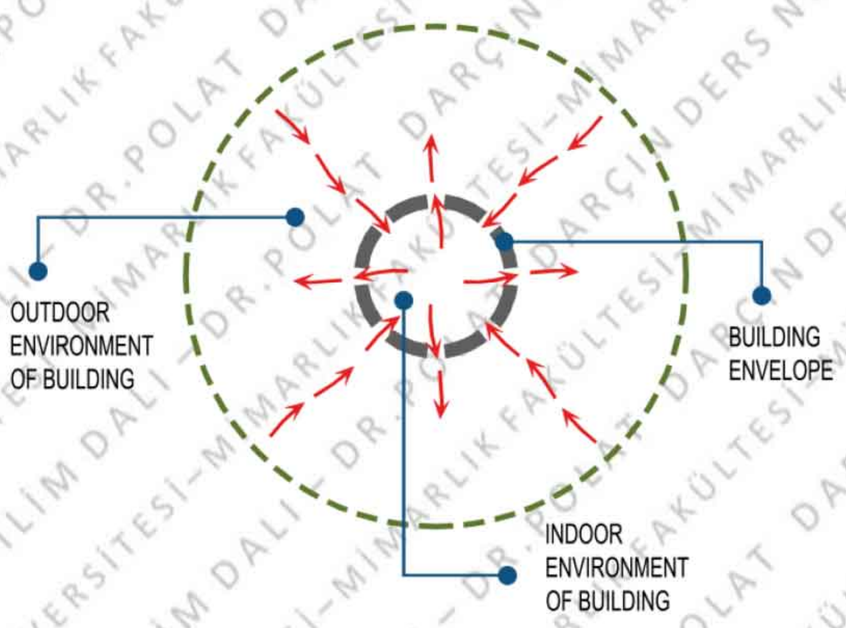
life cycle of a building product (adapted from Tuna Taygun, Balanlı, 2013)

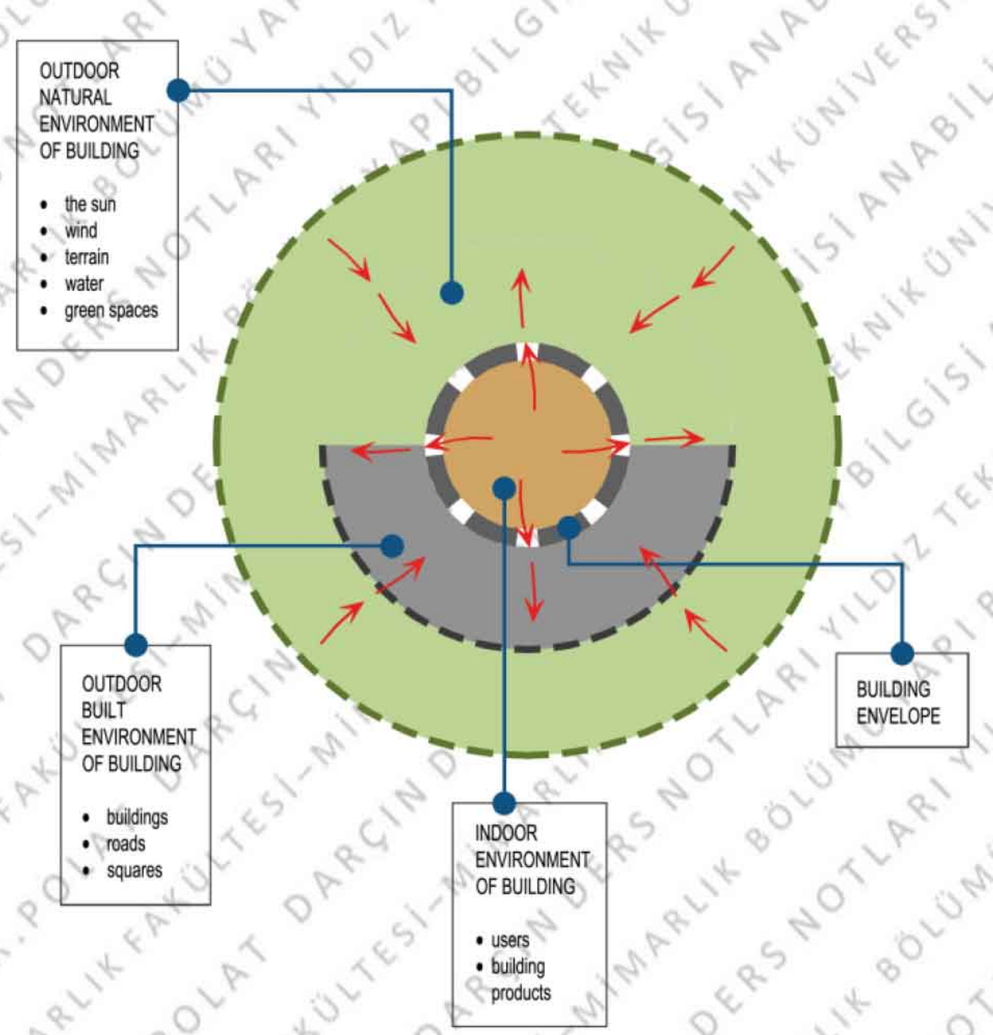
DECISIONS ABOUT BUILDING PRODUCTS

The **properties of a building**, compared to the **requirements of its users** and the **envisaged concept** by the architect, is directly related with the **product selection decisions**. To make proper decisions about the products, an architect should determine the **functions** of these products to meet the requirements of the user and their **aesthetical features** to meet the envisaged concept.

Environment is described as “an ambience, which surrounds an entity, has an interactive and mutually influencing relationship with it and can sometimes be changeable, complex and multi-

directional" (Balanlı and Öztürk, 2006). Buildings are man-made / built environments, produced as re-organized part of natural environment in order to acquire necessary living conditions needed by their users (İzgi, 1999). Inside the buildings there are living (users: humans, animals, plants) and non-living (building products) entities that constitute the indoor environment and outside the buildings there may be living (society and nature) and non-living (other buildings) entities which constitute outdoor environment of a building.





building and its environments

A building has an interactive and mutually influencing relationship with its outdoor and indoor environments. Due to this relationship, in all stages of building, there is a mutual interaction between the building, its users and other entities of indoor environment and entities of its outdoor environment.

All the factors effecting the environments of building are called environmental factors that can be classified into four main groups (Balanlı, 1997):

A. factors related to the user
   a. factors related to the biological properties of the user (e.g. physical properties [age, sex, weight, height, etc.], sensations [visual, auditory, olfactory, etc.], movement ability, etc.),
   b. factors related to the psychological properties of the user (e.g. behavioral patterns, compatibility, mental development, etc.),
   c. factors related to the sociological properties of the user (group properties, religion, manners and customs, social relationships, etc.),
B. factors related to the natural and made environment

a. factors related to temperature (sun, air temperatures, etc.)
b. factors related to noise
c. factors related to water, humidity and other liquids (precipitation, air humidity, water supplies, waste water, etc.)
d. factors related to gases (air, odors, ventilation, etc.)
e. factors related to light (daylight, artificial lighting, colors, etc.)
f. factors related to electricity
g. factors related to fire
h. factors related to animals, plants and microorganisms (pets and wild animals, insects, etc.)
i. factors related to solid hazards (dust, sand, mud, chemicals, solid wastes, etc.)
j. factors related to forces and loads (structural loads, temporary loads, horizontal loads /earthquakes, wind/, etc.)
k. factors related to settlement (region, urban structure, ward, plot, parceling, etc.)
l. factors related to usage stage (maintenance and repair, costs, etc.)
m. factors related to construction stage (construction duration, transportation, building site organization, etc.)

C. factors related to production resources
   a. factors related to building products and energy (availability, production duration, energy resources, costs, etc.)
   b. factors related to labor (design team, application team, skilled / unskilled workers, security, etc.,)
   c. factors related to finance and machinery

D. factors related to obligations (e.g. laws, municipal corporations, etc.)

Each factor or combination of different factors may cause a requirement. Although many of the requirements occur in the usage stage of a building, some may arise during construction.

A. requirements related to the user
   a. biological requirements of the user (e.g. compatibility to the physical factors, sensations, relevance to movement, physiological requirements, etc.),
   b. psychological requirements of the user (e.g. compatibility to behavioral patterns, adaptability to environment, suitability to mental progress, etc.),
   c. sociological requirements of the user (compatibility to group properties, religious requirements, suitability to customs and manners, etc.),

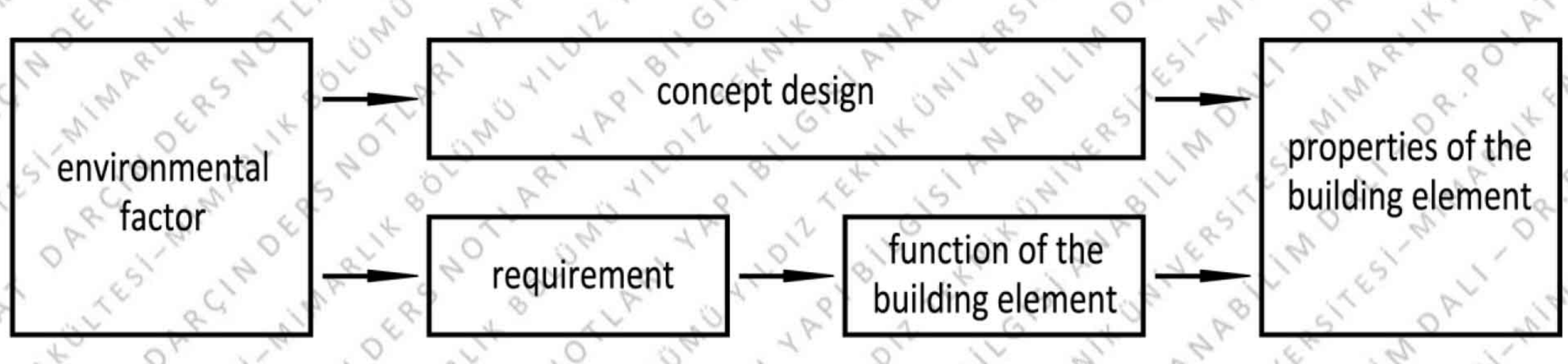
B. requirements related to the natural and made environment
   a. requirements related to temperature (utilization of or abstain from sun, protection from air temperatures, etc.)
   b. requirements related to noise (protection from environmental noise, etc.)
   c. requirements related to water, humidity and other liquids (protection from affects of precipitation, regulating the humidity, supplying clean water, etc.)
   d. requirements related to gases (breathing clean air, preventing malodors, etc.)

e. requirements related to light (utilization of daylight, protection from ultraviolet light, etc.)
f. requirements related to electricity (providing electrical current, preventing static electric, etc.)
g. requirements related to fire (protection from fire, preventing fire starters, etc.)
h. requirements related to animals, plants and microorganisms (protection from wild animals, protection from insects, etc.)
i. requirements related to solid hazards (protection from dust and sand, storing and throwing away solid wastes, etc.)
j. requirements related to forces and loads (meeting lateral loads, etc.)
k. requirements related to settlement (compatibility to regional and urban properties, etc.)
l. requirements related to usage stage (simplicity and cheapness of maintenance and repair, etc.)
m. requirements related to construction stage (relation of construction – climate, high quality for site organization, etc.)

C. requirements related to production resources
a. requirements related to building products and energy (availability of building products, supplying the necessary energy, etc.)
b. requirements related to labor (adequate design and application team members, skilled laborers, etc.,)
c. requirements related to finance and machinery (organization of financial resources, obtainment of required tools, etc.)

D. requirements related to obligations (legality, etc.)

Requirements can be used to determine functions. The main functions of a building are met by the building elements and other products of building (materials, pieces and components) are brought together to materialize a building element and impose determined properties. Furthermore, a concept design can be constituted according to the research about environmental factors. Consequently, the first step for the decisions about product selection is the determination of functions and aesthetical features of building elements according to the pre-design research and concept design decisions. The characteristics of building elements can be revealed based on their functions and aesthetical features and all the materials, pieces and / or components can be determined to materialize these building elements.



relations for determining properties of building elements

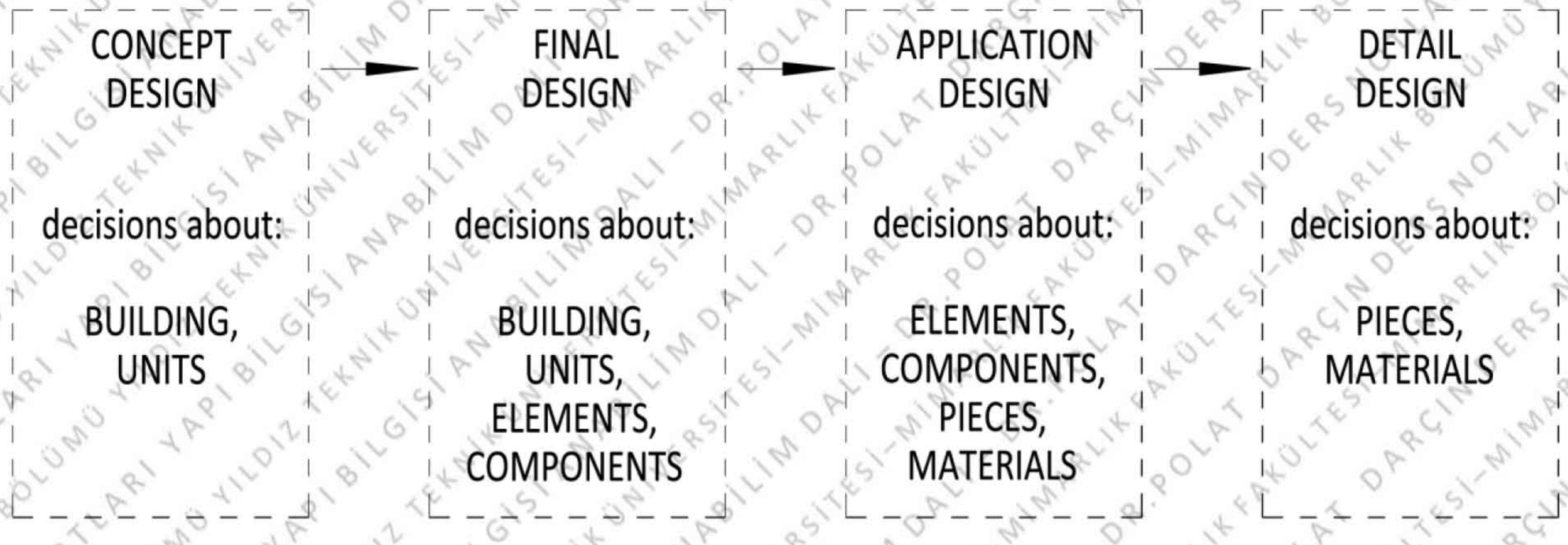
For instance, in order to determine one of the functions of a wall separating outdoor and indoor environments of a bedroom, an architect should start with the research for environmental factors

mutually relating indoor and outdoor environments of this bedroom unit. If there is a noise of 60 dB in the outdoor environment, the requirement of the user in this bedroom is to sleep in max. 10 dB of acoustic ambience. According to this, one of the functions of bedroom wall can be determined as to present min. 50 dB of soundproofing. In order to achieve this function, this wall should be designed accordingly.

environmental factor	**requirement of the user**	**function of the building element (wall)**	**one of the properties of this building element**
60 dB of outdoor noise level	to sleep in 10 dB of acoustic ambience	to supply 50 dB of soundproofing	to contain a component for designated soundproofing

(adapted from Balanlı, 1997)

Research with intend of deciding products begins with the concept design and continues through to the end – the detail design stage, or even to the usage stage. Because of these relationships, **decisions for the selection of building products** in the design stage should be made considering **the whole life of products and building** and according to the **functions and aesthetical features** imposed to the building.



main stages of building design (adapted from Balanlı, 1997)