A BIM TOOL SUPPORTING DECISION MAKING AT EARLY STAGE DESIGN

– *Towards a Transformable Architecture*

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iwt

Buildings have a vast share in our environmental impact, including resource depletion and pollution.

Construction and maintenance initiate 50% of all **material** flows.

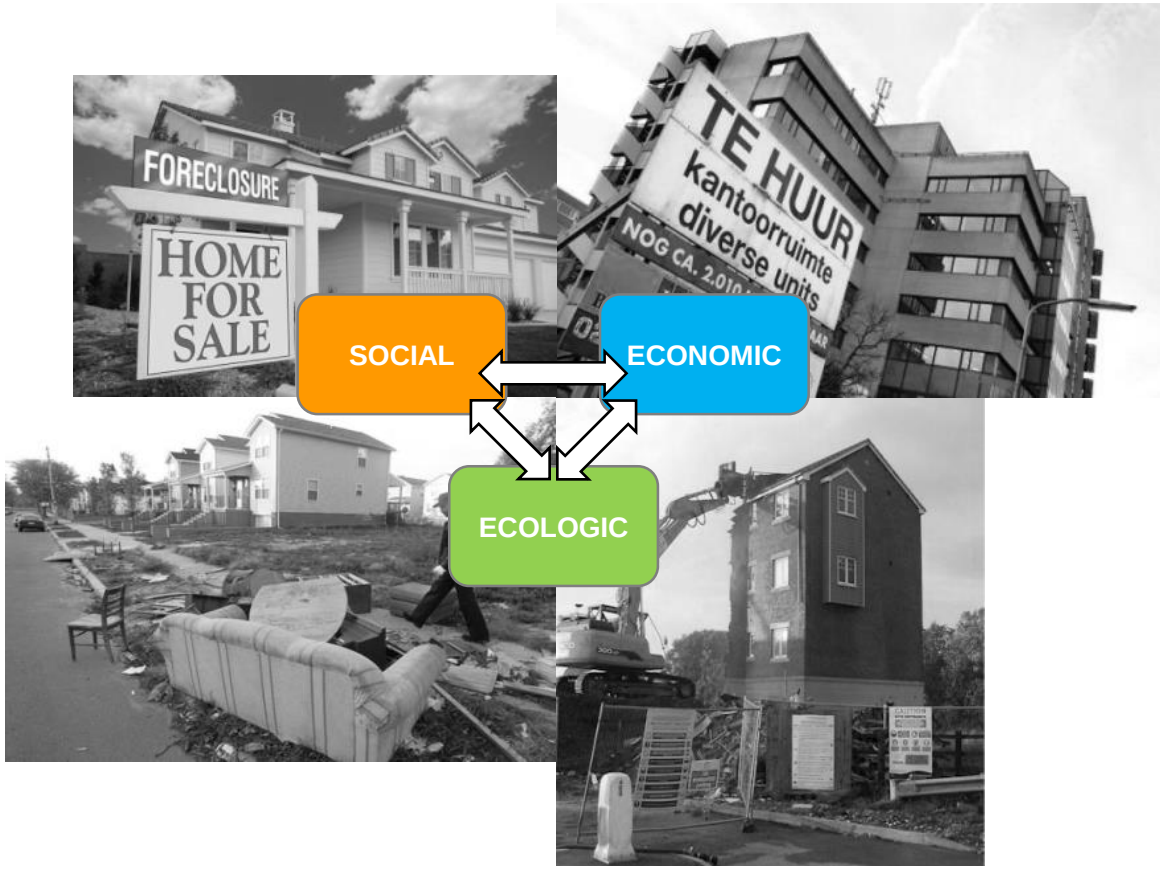
European Environment Agency. (2012 & 2015) *European Environment State and Outlook: Material resources and waste*. Luxembourg: Publications Office of the European Union.

Buildings have a vast share in our environmental impact, including resource depletion, land use and pollution.

Construction and demolition result in almost 40% of all **waste**.

European Environment Agency. (2012 & 2015) *European Environment State and Outlook: Material resources and waste*. Luxembourg: Publications Office of the European Union.

Buildings are demolished because they are not compatible with our current standards



Towards a Transformable Architecture

Concerns, mission, means

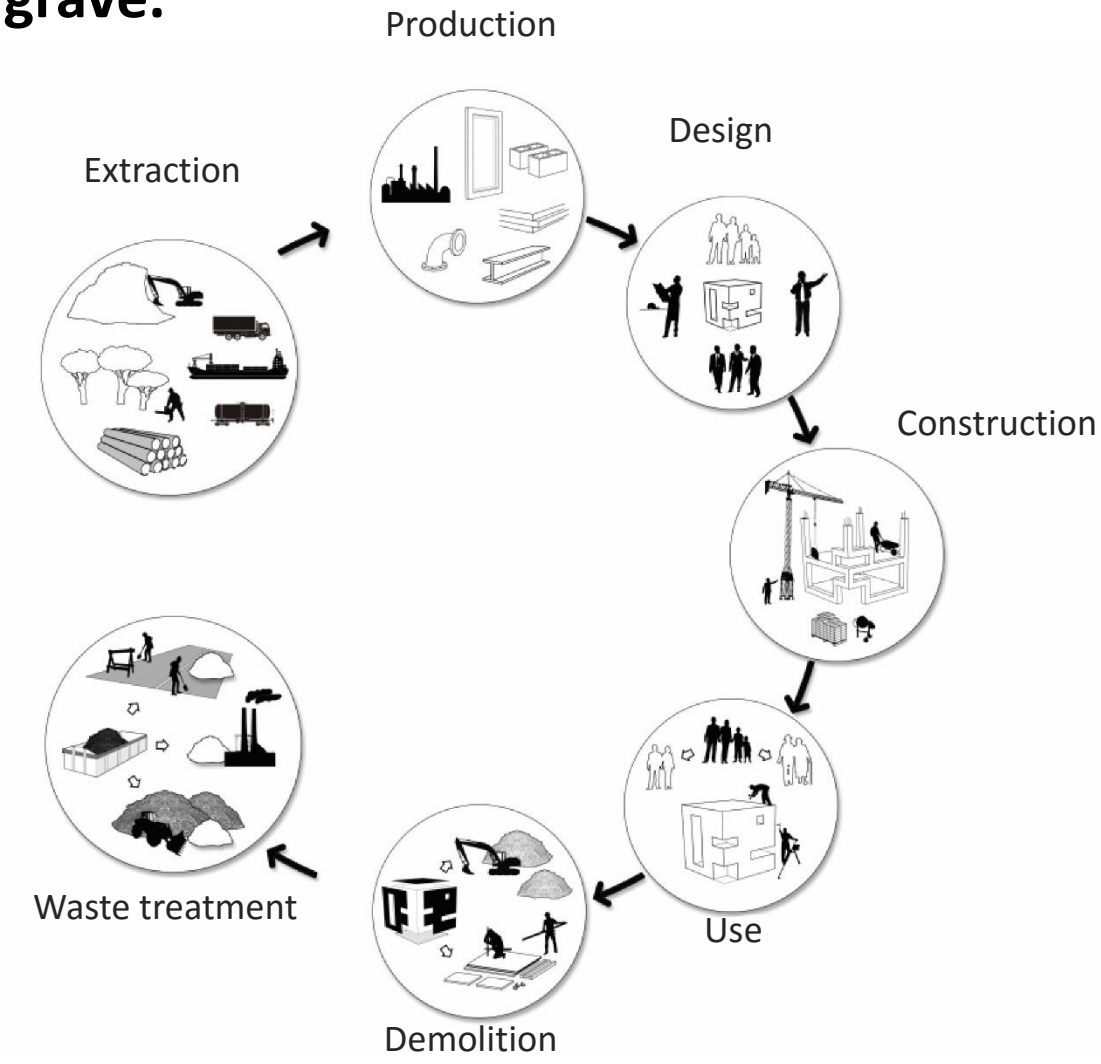
Towards a Transformable Architecture

Concerns, mission, means

We live in an age where changes increasingly lead to resource depletion and **waste** production.

Because most of earth's resources are **finite**, we designers should **use** and **reuse** them **wisely**.

Our built environment is characterised as a linear process, from cradle to grave.



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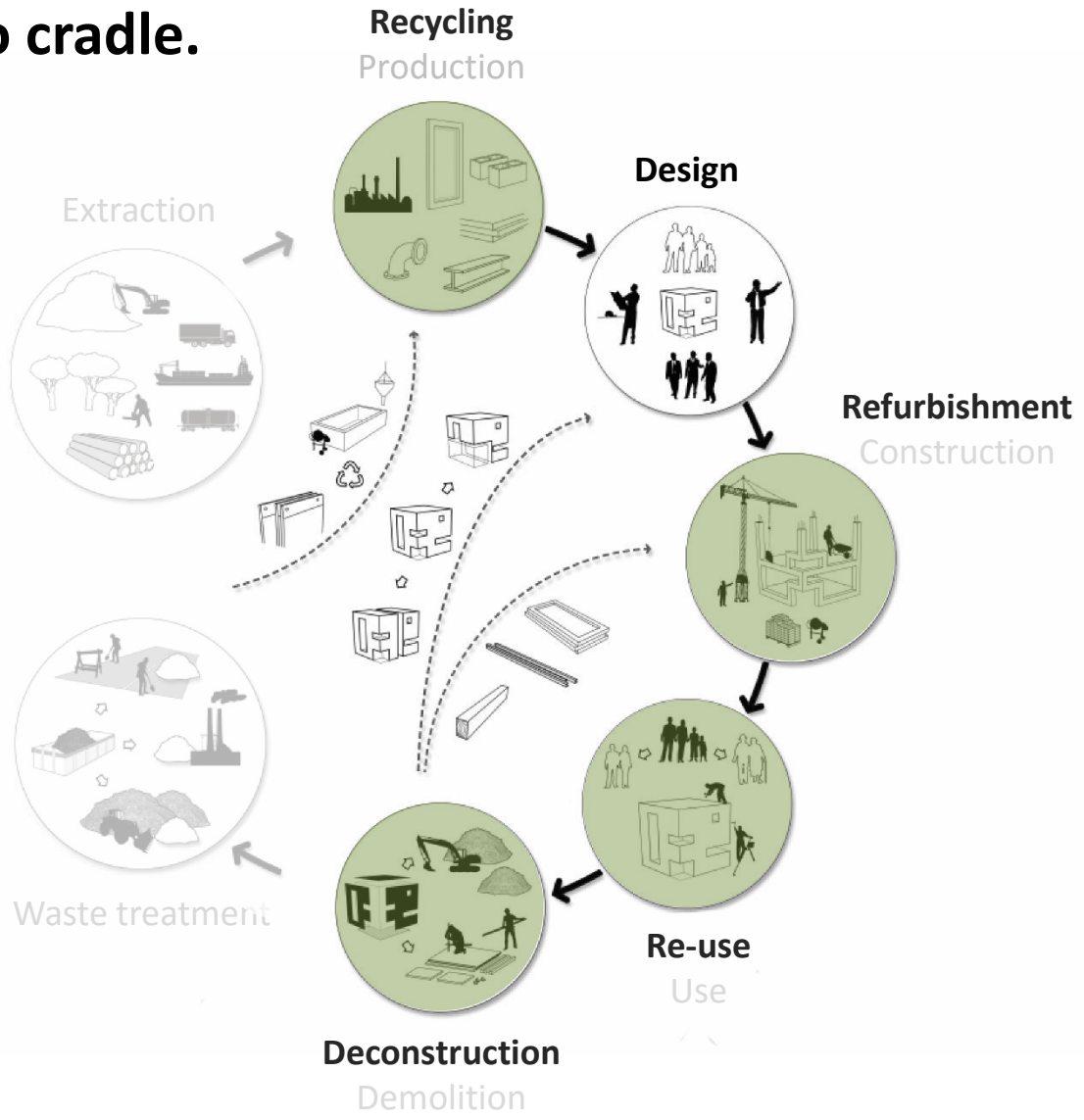
Servaes, R. et al. (2014) *Beleidsprogramma 'Materiaalbewust bouwen in kringlopen', het preventieprogramma duurzaam materialenbeheer in de bouwsector 2014-2020*. Mechelen: OVAM.

As an alternative we aim for closed loops, a circular process, from cradle to cradle.



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Concerns, mission, means

The structures of the built environment
are never in an end state, but
are rather part of a **process**.

Facilitating **transformations** is therefore
vital to alleviate future impacts.

Anticipating future alterations and reducing their impact is done from the initial design, at three levels.

Design for **building** reuse
Grundbau & Siedler, Hamburg

Design for **element** reuse
Loblolly house, Maryland

Design for **material** reuse
Villa Welpeloo , Rotterdam

Through various research projects a series of 23 design guidelines for transformable building have been developed and validated.

Technical

Conceptual

Qualitative Assessment and Design for Change Guidelines

	Interfaces	Sub-components	Composition
Element	Reversibility Simplicity Speed	Durability Reused Compatibility	Pace-layered Independence Prefabrication
Building	Accessibility	Demountability Reusability Extensibility	Versatlity
Neighbourhood	Clear Adaptable	Retrofitted Dimensioned Removable	Unified Multipurpose Diverse Densificable

The table above presents an overview of the Design for Change guidelines. A breakdown by scale (element, building, neighbourhood) and by theme (interfaces, sub-components, composition) makes it possible to establish a comprehensive and clear qualitative assessment of the design and construction of a building.

The OVAM study 'Case study, Adaptable Building Design: Mahatma Gandhi District (Paduart et al., 2013) already implemented a **widely applicable assessment framework** with a qualitative and a quantitative approach. This study

The table above presents an overview of all Design for Change guidelines. The synchronous treatment of three scales (building elements, buildings and neighbourhoods) ensures a holistic approach. To ensure the cohesion between

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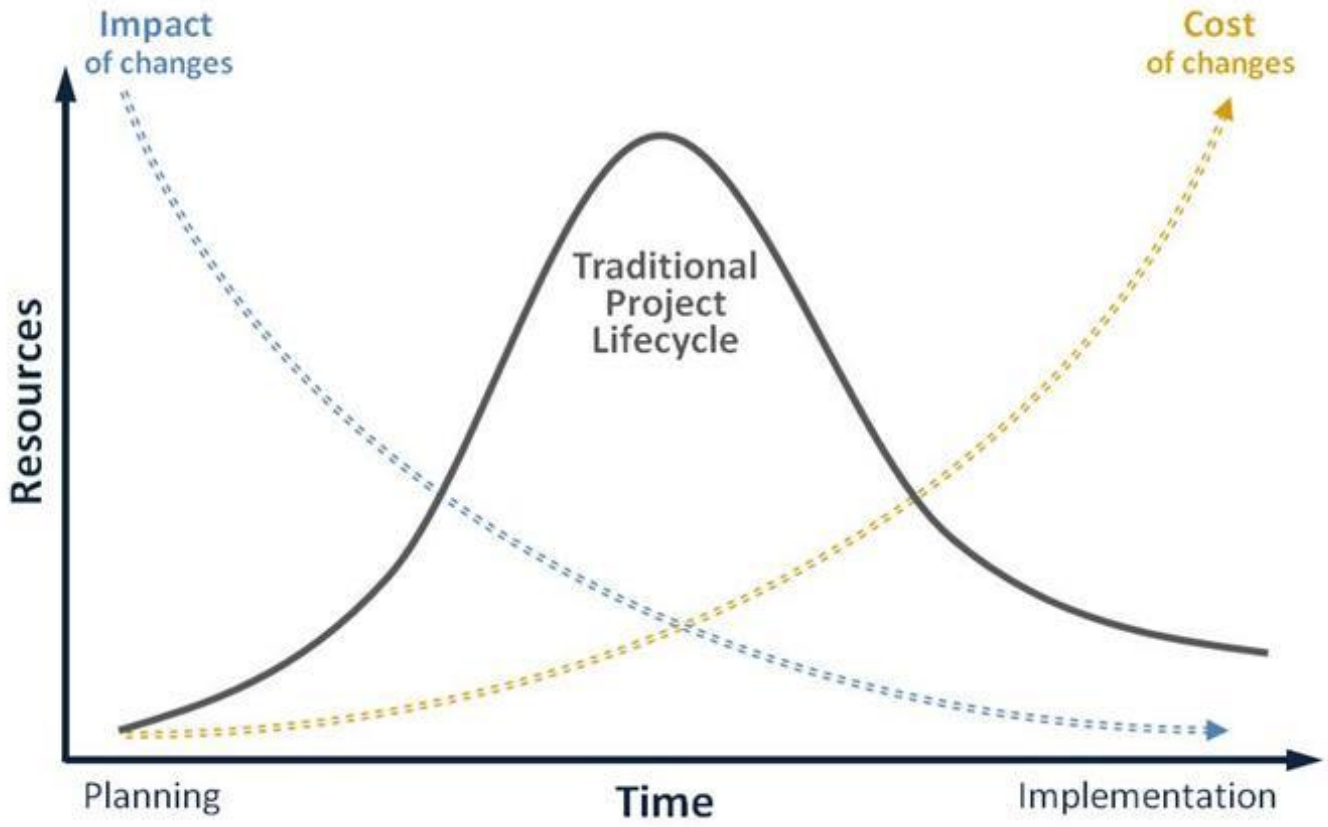
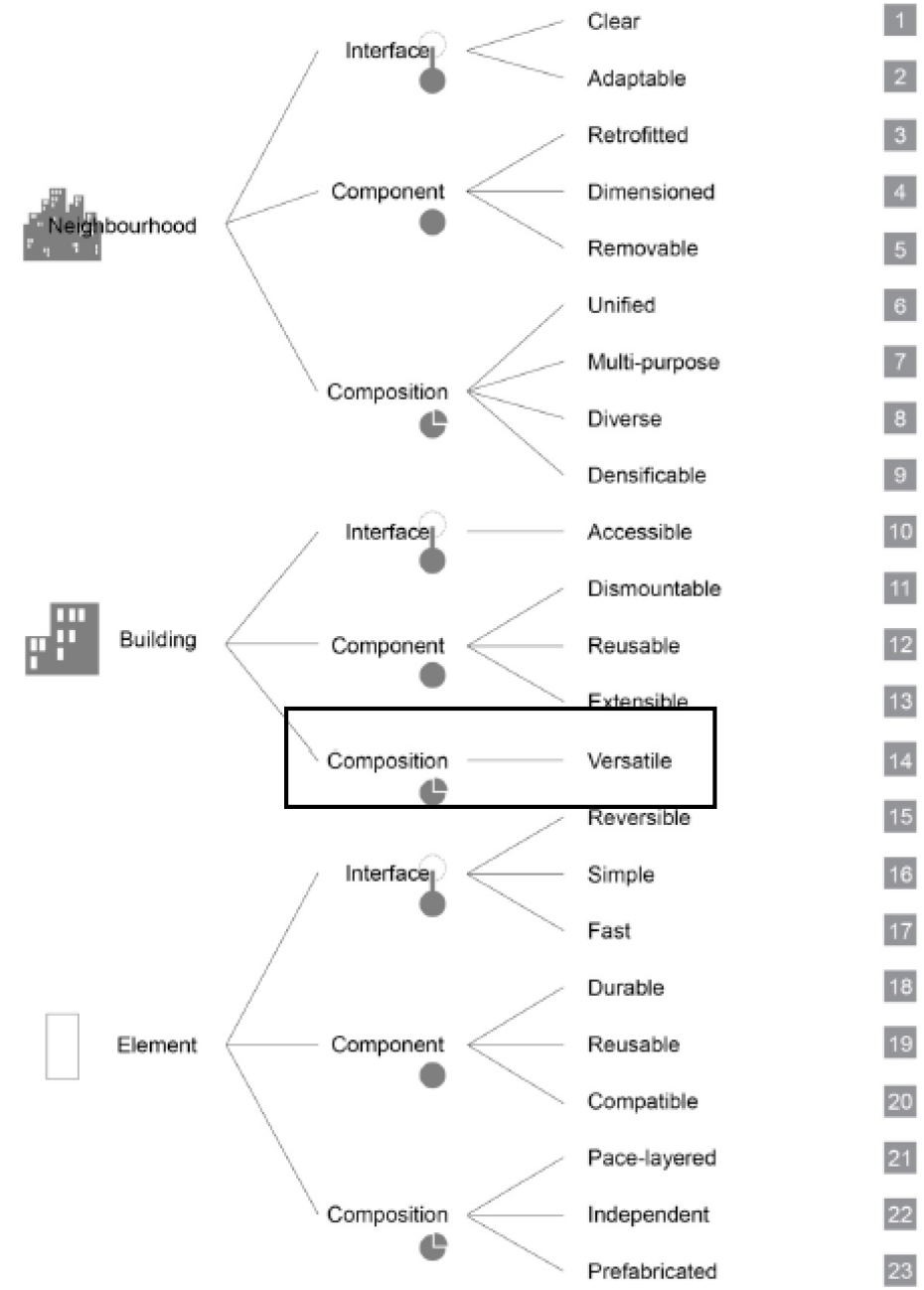
Concerns, mission, means

What if changing only a few small details would allow to design buildings facilitating change.

Decisions made early in the design phase have as significant impact on the final result





Design Dynamic Matrix (Louise Deprins, Master's thesis)

Spatial Composition is made
quite early in the design process

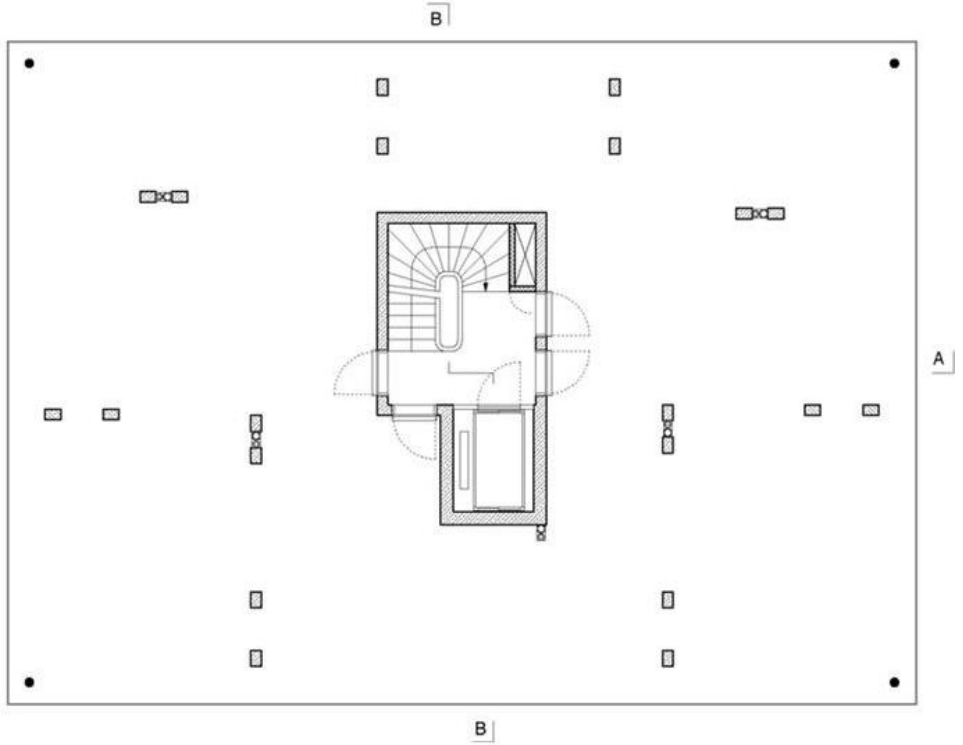
Is it possible to **quantify** the **versatility** of a building?

Some buildings seem to pass the test of time

Herenhuizen or gentry housing (Belgium)

Hausmann style apartments (Paris)

Generality is an indication of the extent to which a building is independent of change.



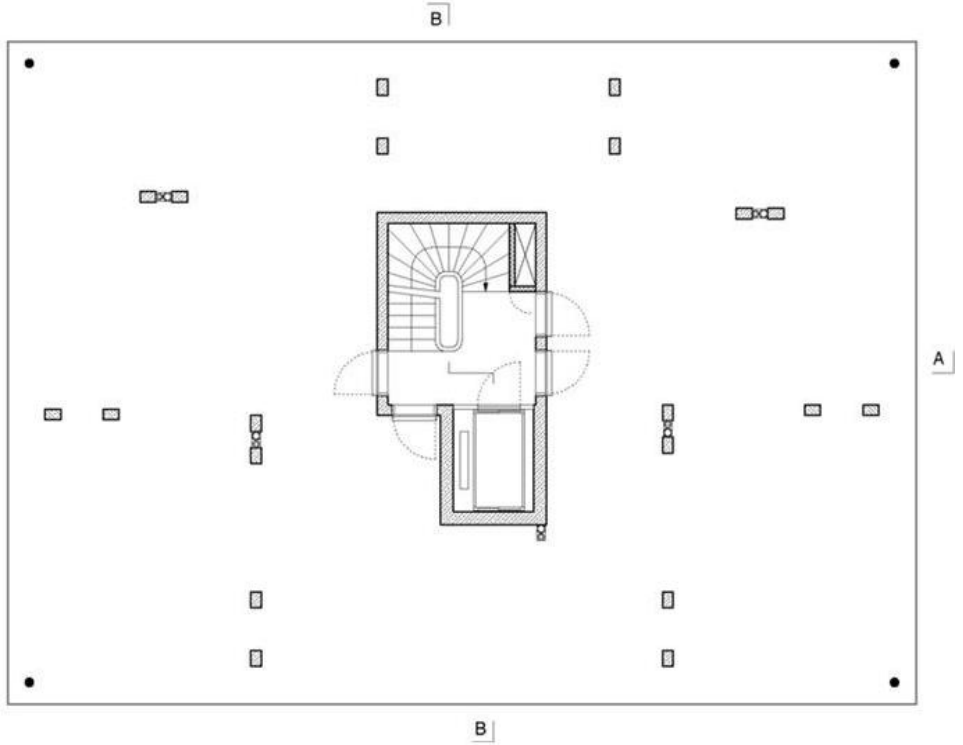
IBA Grundbau und Siedler, BeL Architekten, Hamburg

Generality is an indication of the amount of potential functionality a building has without making changes to it.

Versatile building layout

Natural ventilation

Generality is an indication of the extent to which a building is independent of change.



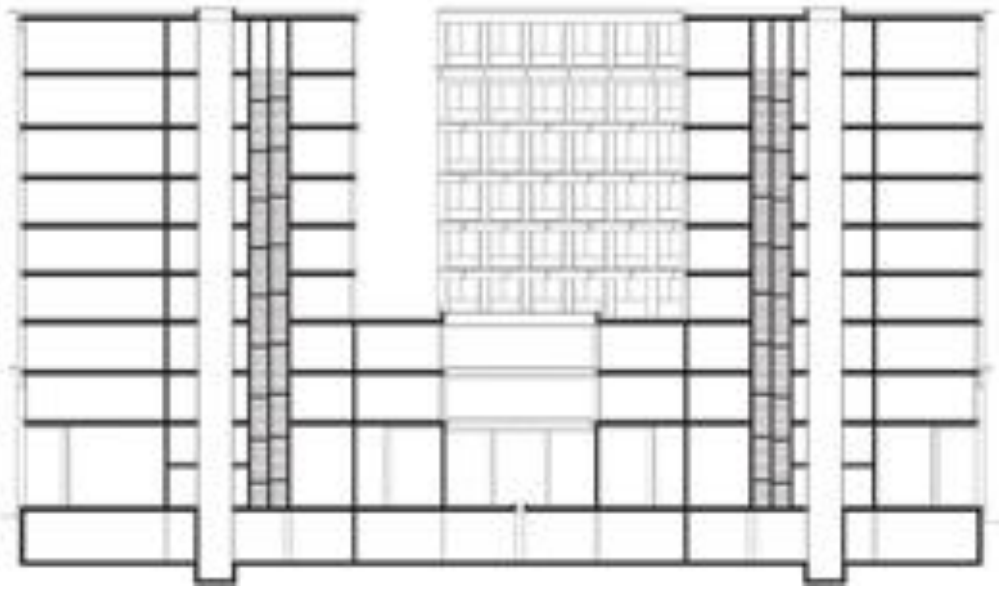
IBA Grundbau und Siedler, BeL Architekten, Hamburg

Potential

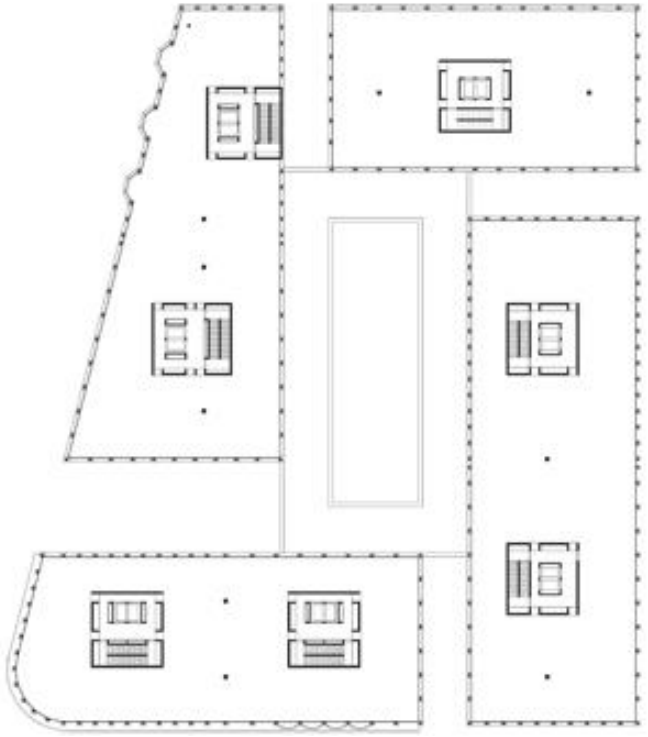
Passive capacity

Some buildings can adapt to changing needs.

Solids Ijburg - Amsterdam, NL



Adaptability is an indication of the extent to which a building can adapt to changing requirements or needs.



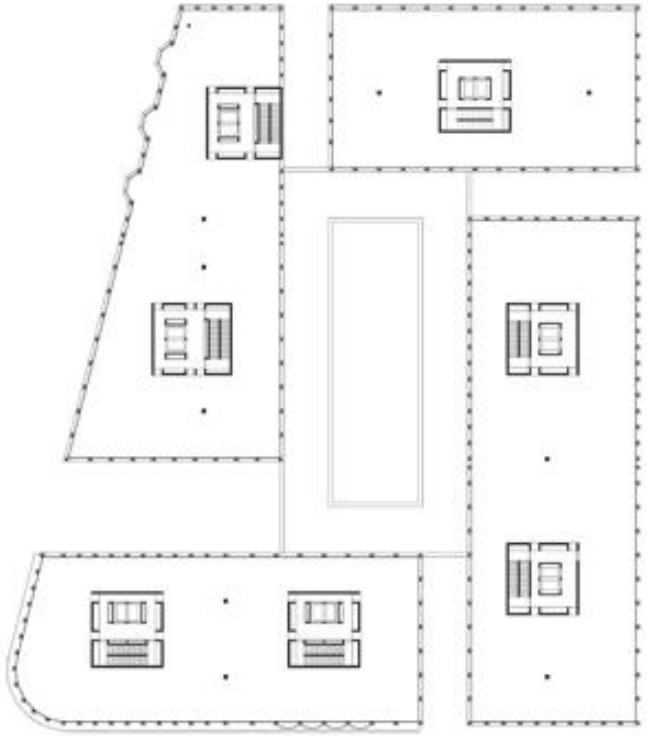
Solids Ijburg - Amsterdam, NL

Adaptability is an indication of the ease of changing sub-assemblies in order to increase functionality

Remove partitioning walls

Update building skin

Adaptability is an indication of the extent to which a building can adapt to changing requirements or needs.



Solids Ijburg - Amsterdam, NL

Ease if changing

Active capacity

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Concerns, mission, means

Develop a tool helping designers
to make ***better informed decisions***
directly from the first phases of the project.

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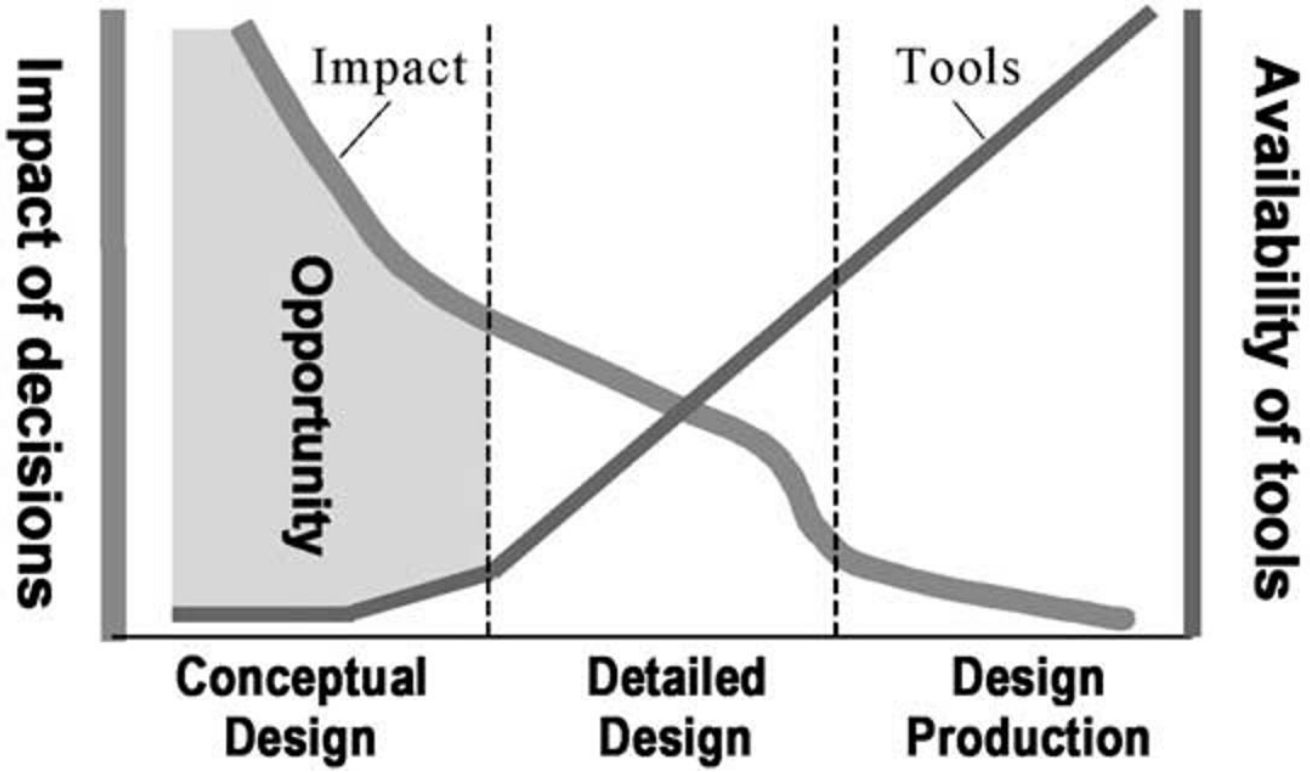
Concerns, mission, means

The tool

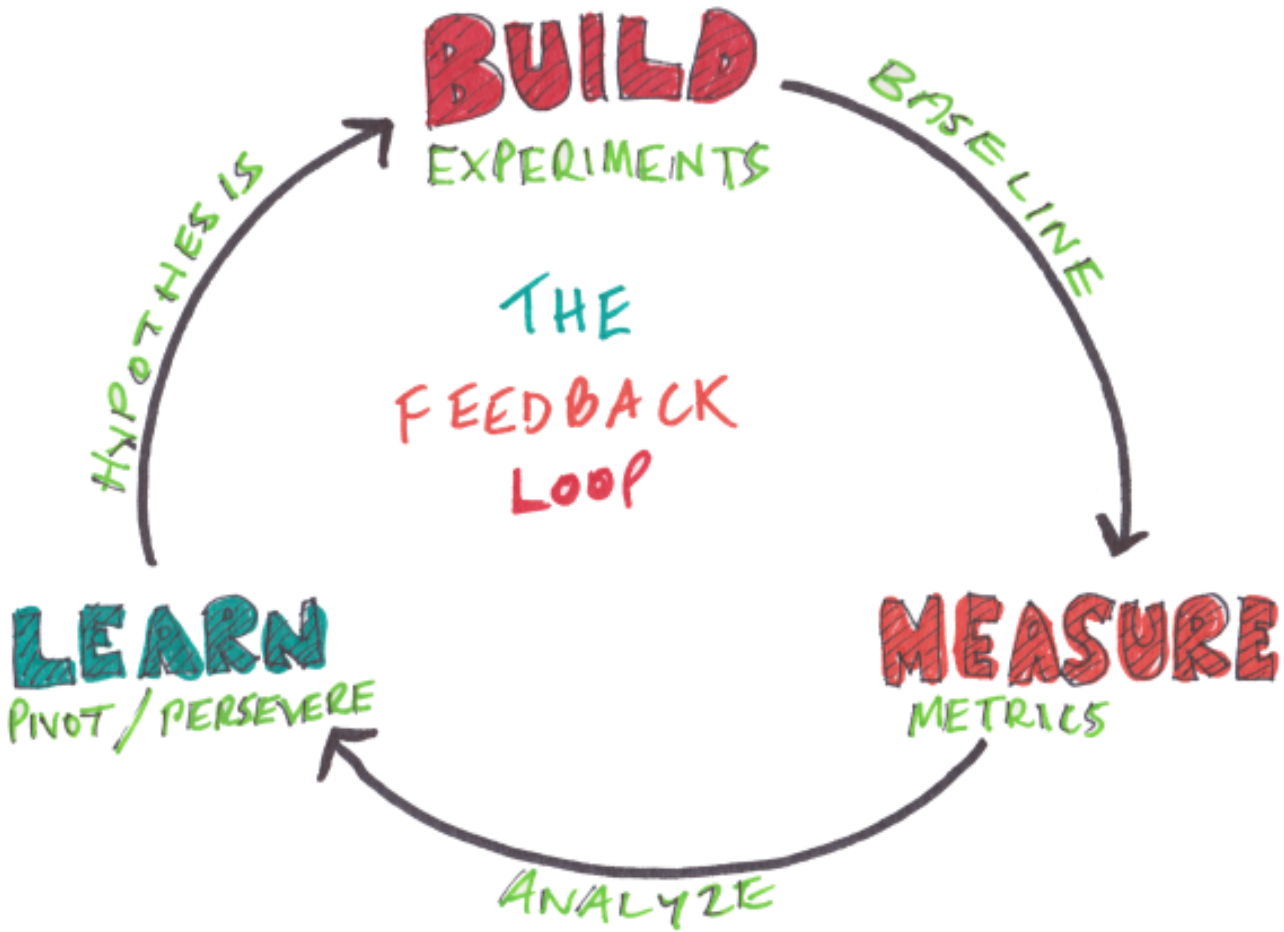
The parameters

There is an opportunity to develop tools supporting designer at the conceptual stage



Lihui Wang, Weiming Shen, Helen Xie, Joseph Neelamkavil, & Ajit Pardasan. (2002). Collaborative conceptual design-state of the art and future trends. Computer-Aided Design, 34, 981–996

Neill, T. M., Gero, P. J. S., & Warren, J. (1998). Understanding conceptual electronic design using protocol analysis. Research in Engineering Design, 10(3), 129–140

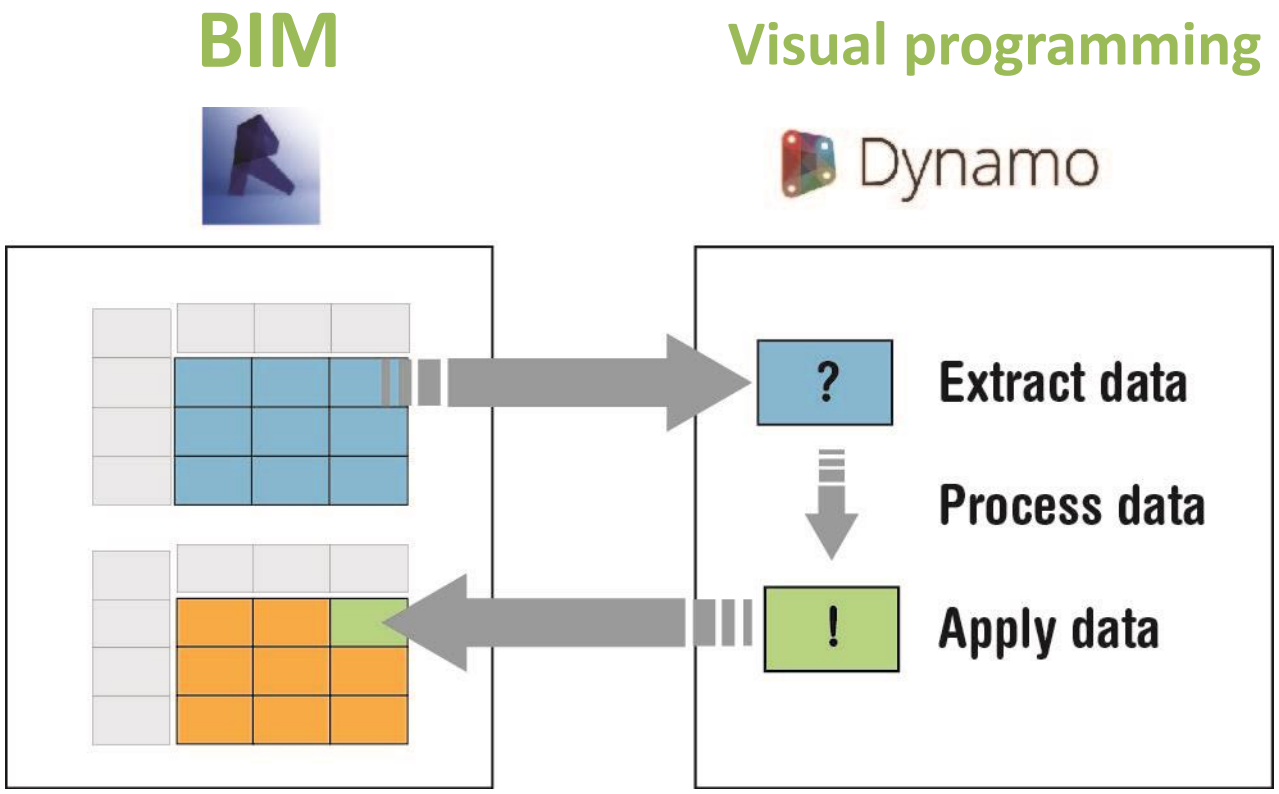

BUILD
EXPERIMENTS
BASELINE
MEASURE
METRICS
ANALYZE
LEARN
PIVOT / PERSEVERE
HYPOTHESIS
THE
FEEDBACK
LOOP

Towards a Transformable Architecture

Concerns, mission, means

BIM and its integrated management of **information** and **geometry** allow us to optimize and compare the ***passive functional capacity*** of a building or a concept.

There is an opportunity to develop a tool providing feedback from the “available” information.



Key strategies for Transformable Buildings

Towards a Transformable Architecture

Concerns, mission, means

The tool

The parameters

Towards a Transformable Architecture

Concerns, mission, means

What makes a space **polyvalent**?

What makes a space **comfortable**?

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Concerns, mission, means

Its spatial layout

Leupen, Bernard. 2006. “The Polyvalent Dwelling.” In Proceedings of the Joint CIB, Tensinet, IASS International Conference on Adaptability in Design and Construction. http://www.irbnet.de/daten/iconda/CIB10803.pdf.

Spatial connectivity influences the adaptability and the generality of a plan

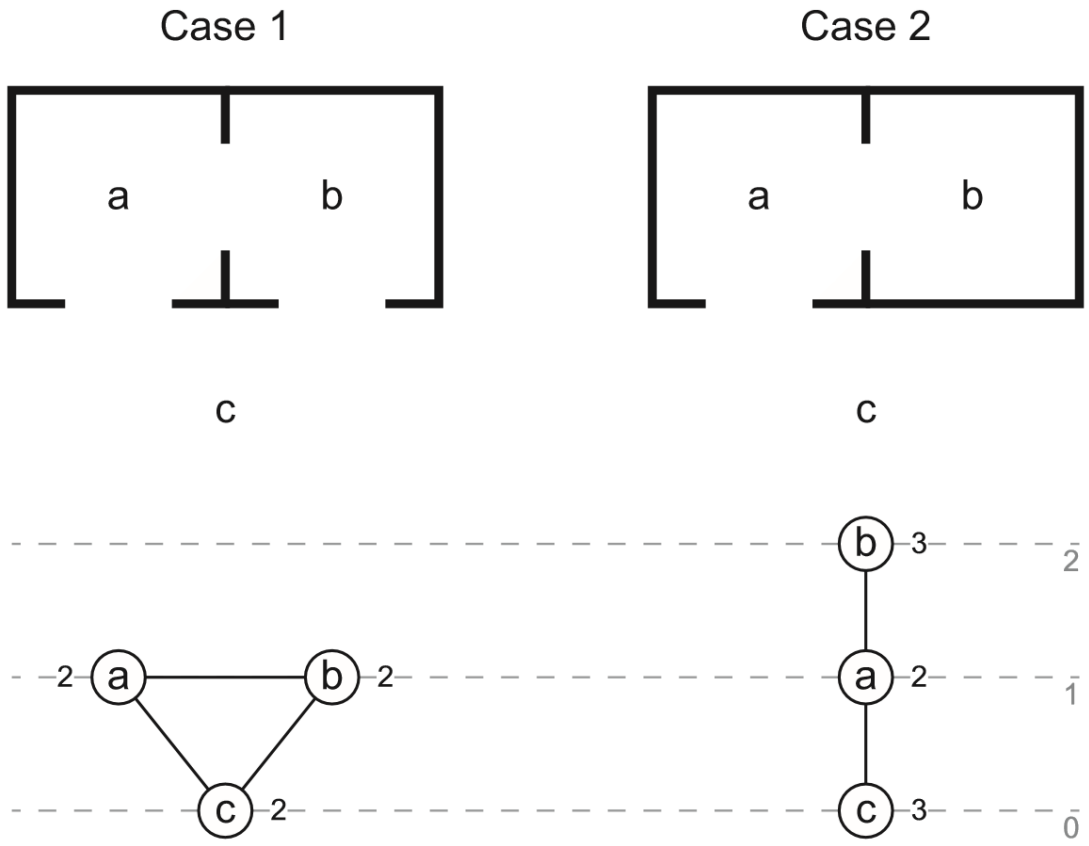
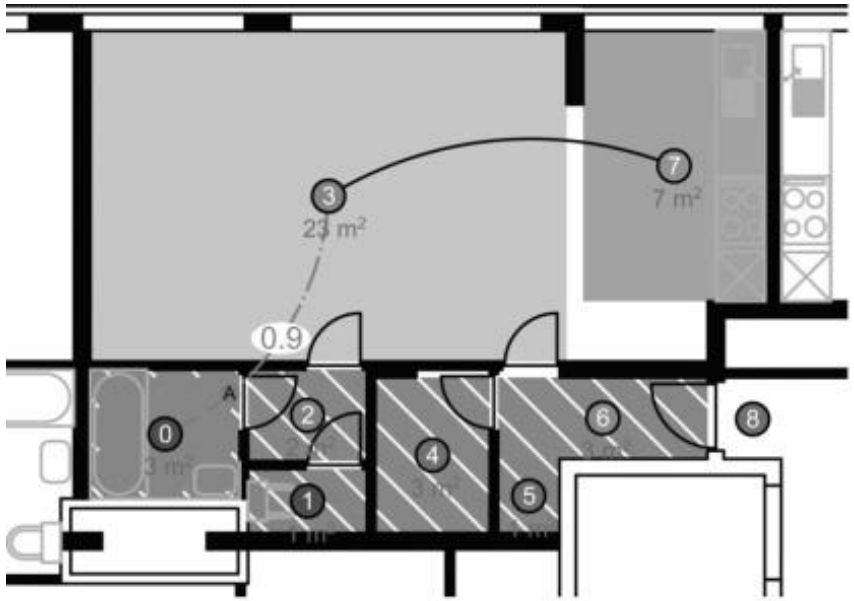


Figure 1.1: The relations between individual spaces (a, b, and c) affect the spatial configuration, as shown by the Justified Plan Graphs below each case. The Total Depth, listed next to each node, has higher values in the second case. (image adapted from Hillier, 2007, p. 24)

Accessibility
Connectivity

Pieter Herthogs, Niels De Temmerman, & Yves De Weerdt. (2013). Assessing the Generality and Adaptability of building layouts using justified plan graphs and weighted graphs: a proof of concept. Presented at the Central Europe towards Sustainable Building 2013.

Geometric tools allow to quantify and analyse the adaptability and generality of building plans



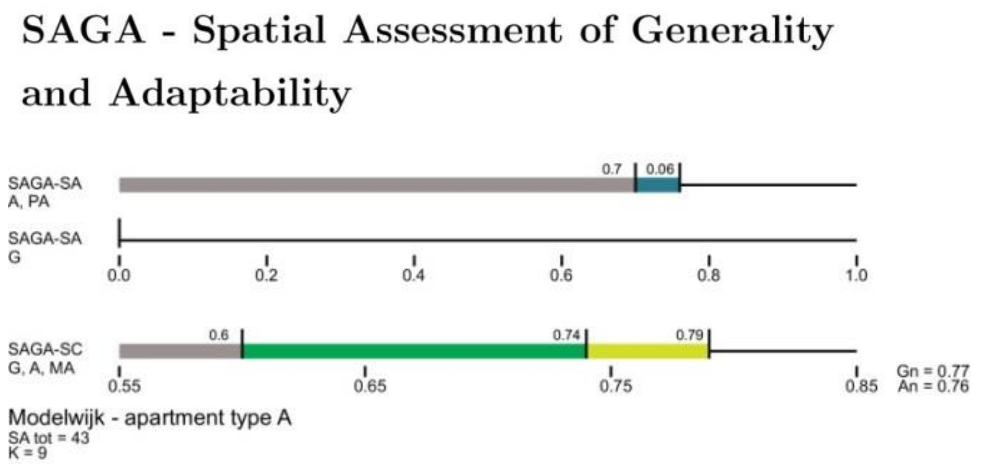
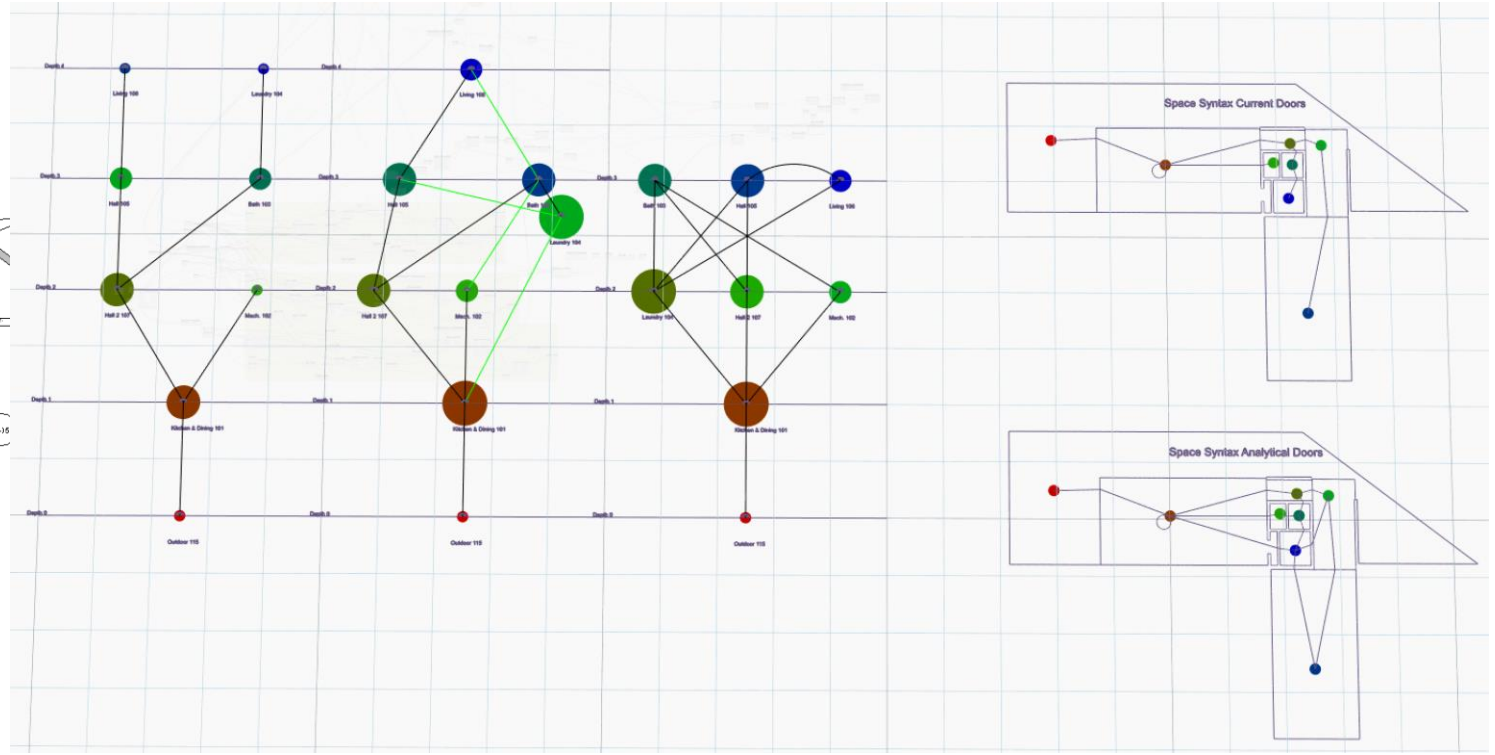


Figure A.1: SAGA-SA analysis of Paduart's apartment type A. There are no general spaces (G_{sa}=0). Adaptable spaces (the living room and kitchen) cover 70% of the surface area (A_{sa}=0.70). These could be extended to include the bathroom (PA_{sa}=0.06).

Pieter Herthogs, Niels De Temmerman, & Yves De Weerdt. (2013). Assessing the Generality and Adaptability of building layouts using justified plan graphs and weighted graphs: a proof of concept. Presented at the Central Europe towards Sustainable Building 2013.

The transposition of this kind of tool in BIM allowed to automate the process and provide a feedback to the user

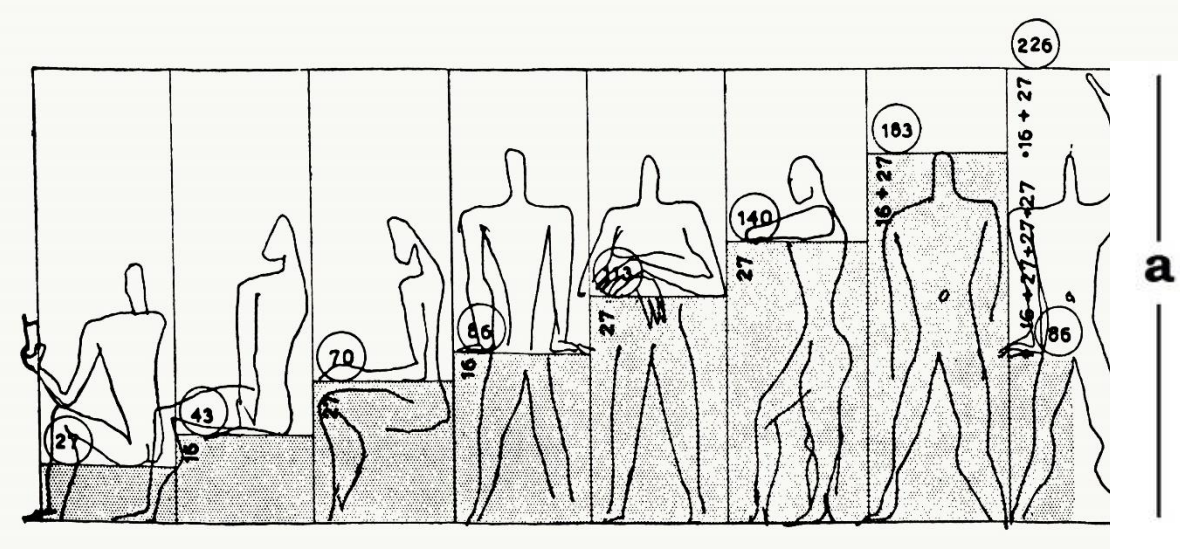


Towards a Transformable Architecture

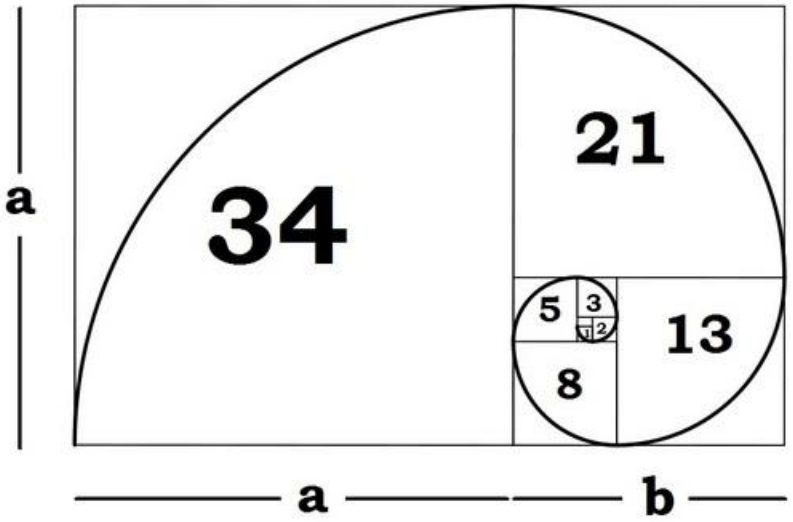
Concerns, mission, means

Its dimensions, its proportions

The proportion and the shape of spaces influence the building's versatility



Le Modulor - Corbusier

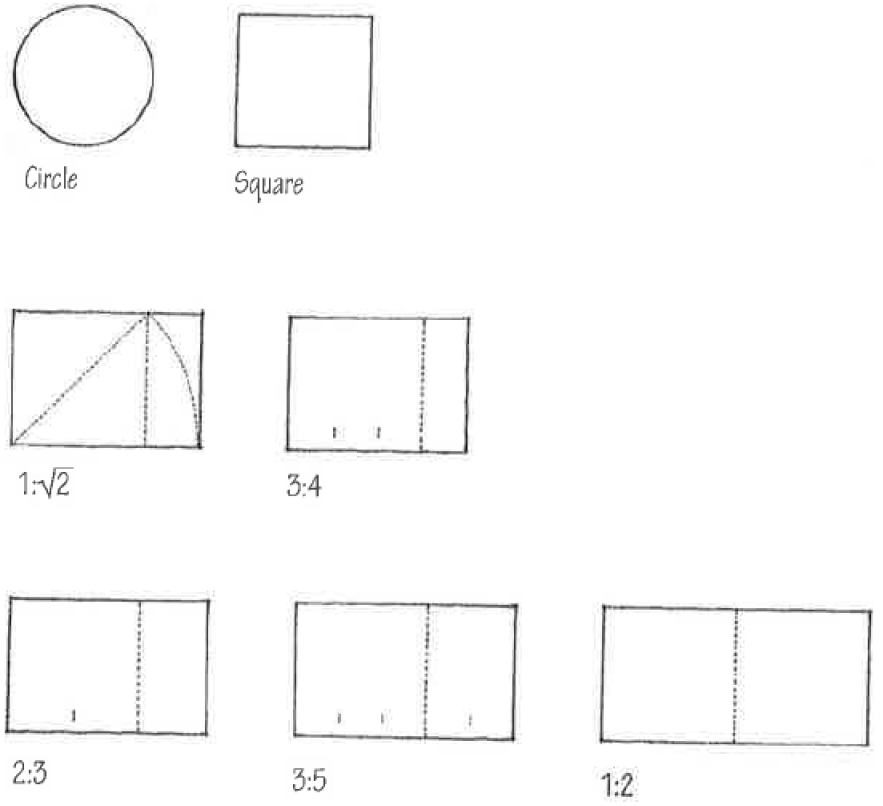


The Golden number

Ching, F. D. K. (2007). *Architecture: Form, Space, and Order* (3rd Edition). Hoboken, N.J: John Wiley & Sons.

The proportion and the shape of spaces influence the building's versatility

Andrea Palladio - *Seven Ideal Plan Shapes for Rooms*



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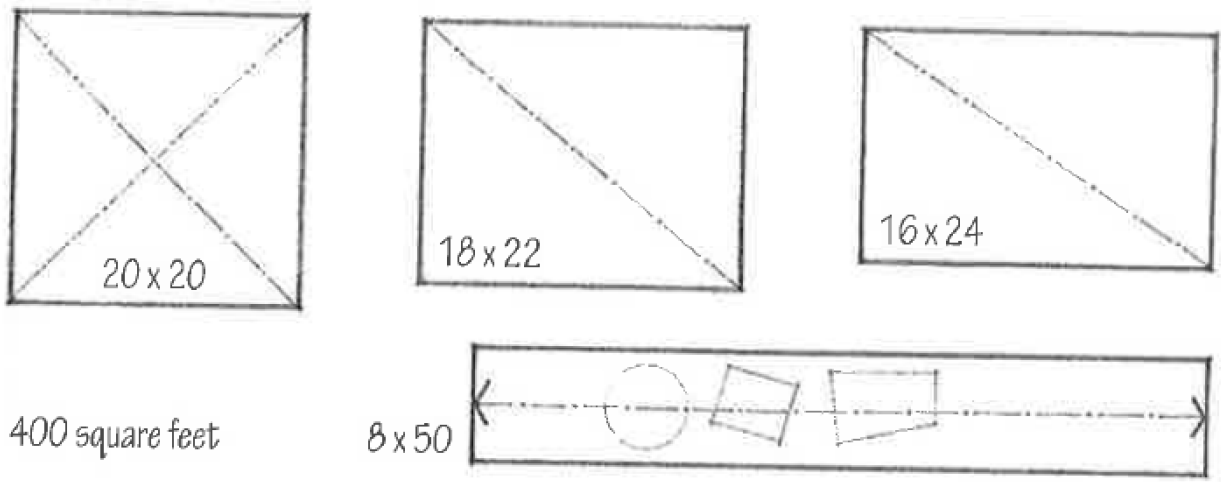
The proportion and the shape of spaces influence the building's versatility



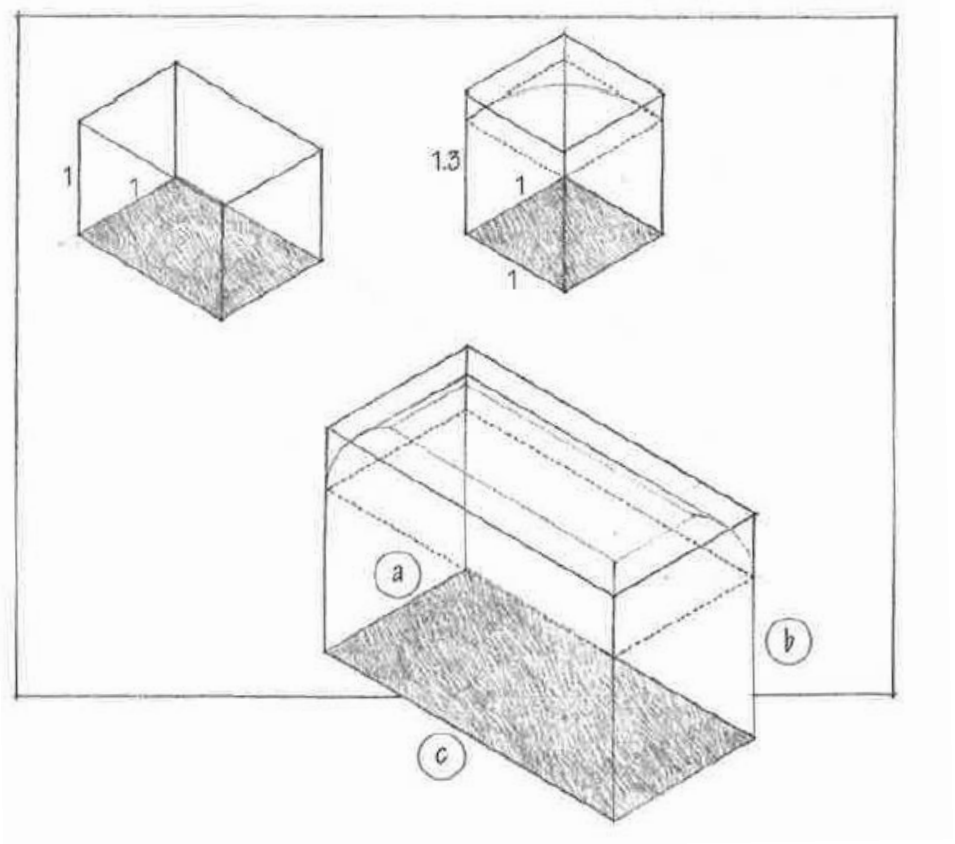
A streched space is more dynamic

A compact space is more static

Ching, F. D. K. (2007). *Architecture: Form, Space, and Order* (3rd Edition). Hoboken, N.J: John Wiley & Sons.

The proportion and the shape of spaces influence the building's versatility

Andrea Palladio - *Determining the Heights of Rooms*



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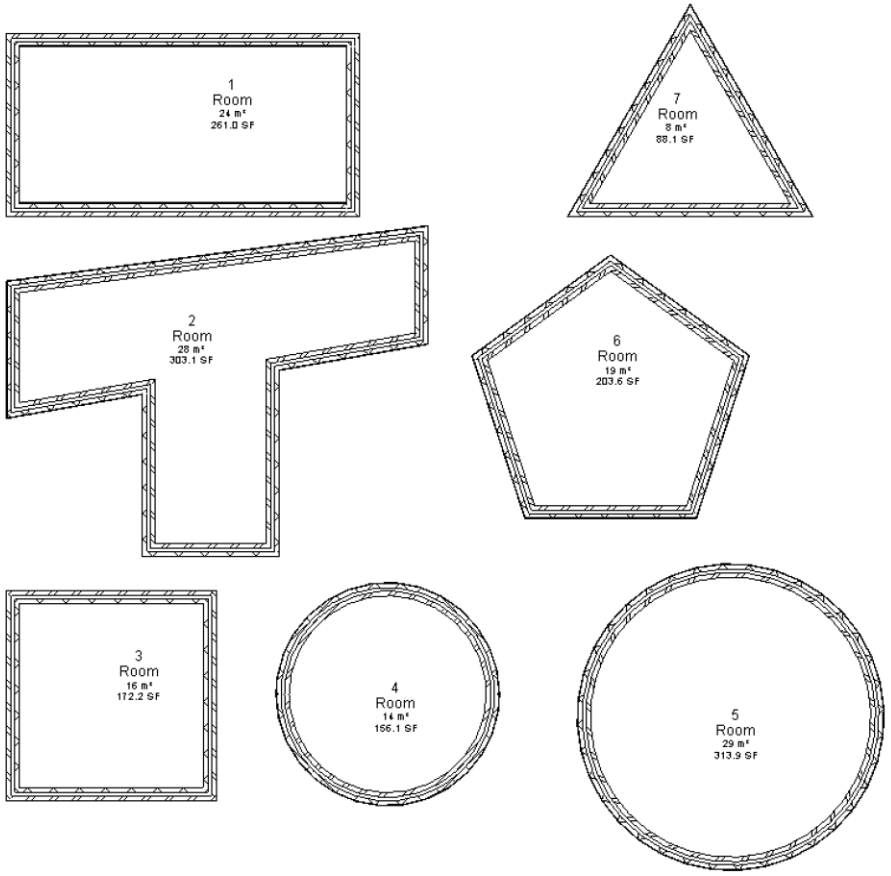
The proportion and the shape of spaces influence the building's adaptability and generality



Length/ width ?

Perimeter / Area

P^2/A = ratio

Dimensions
Proportions

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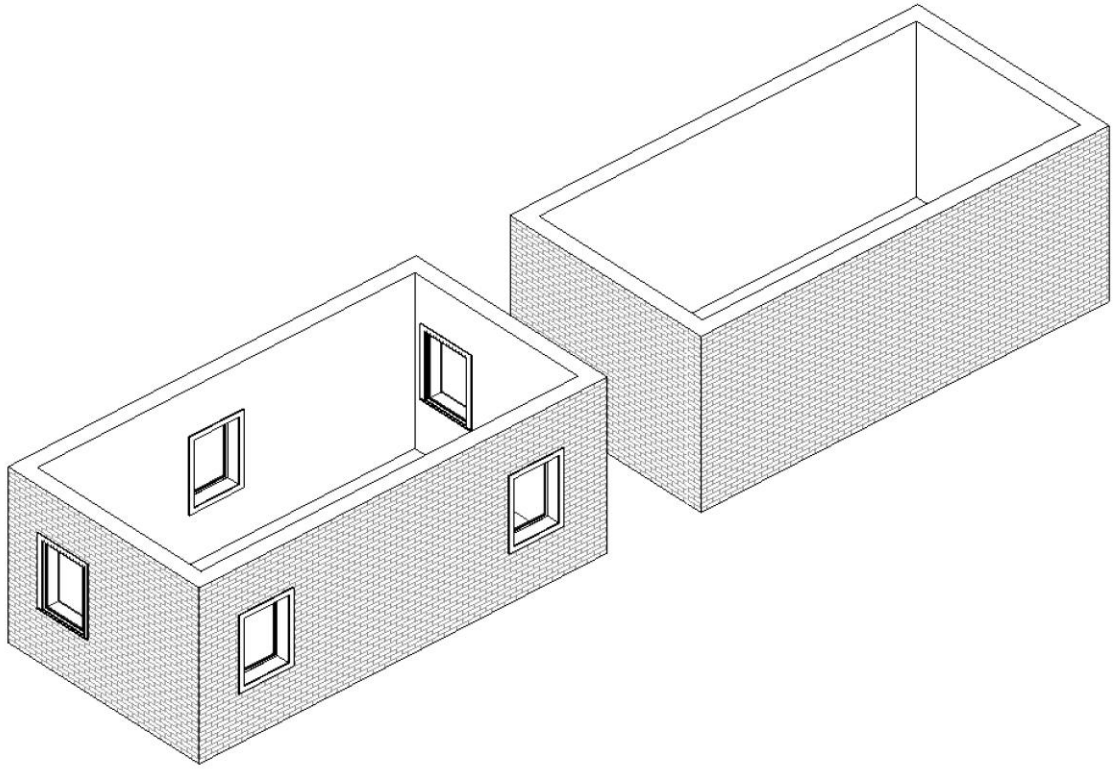
Concerns, mission, means

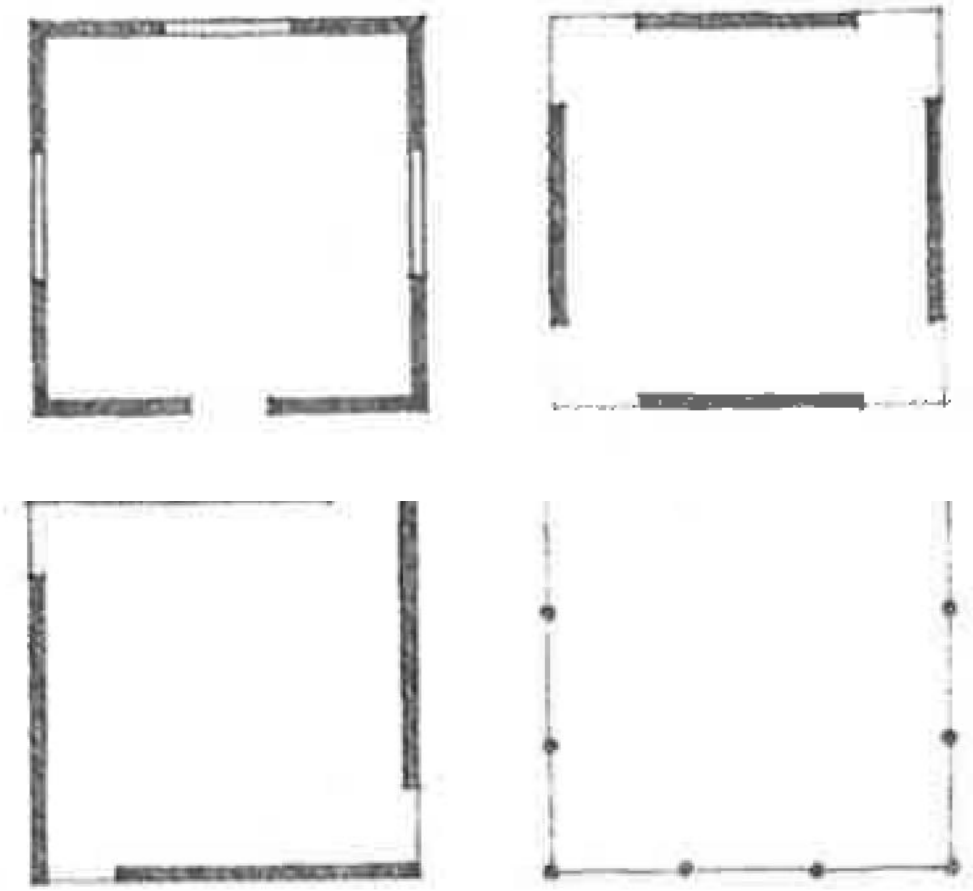
Qualitative potential

Quality and comfort of a space influence the versatility of a building



A **qualitative** space is more likely to be preserved or reused

Quality and comfort of a space influence the versatility of a building



Qualitative potential

Conceptual phase

Rules of thumb

Ching, F. D. K. (2007). *Architecture: Form, Space, and Order* (3rd Edition). Hoboken, N.J: John Wiley & Sons.

Towards a Transformable Architecture

The tool will allow to **assess** and **compare** a project (its spatial layout, dimensions and qualitative potential) and to determine its **versatility**.

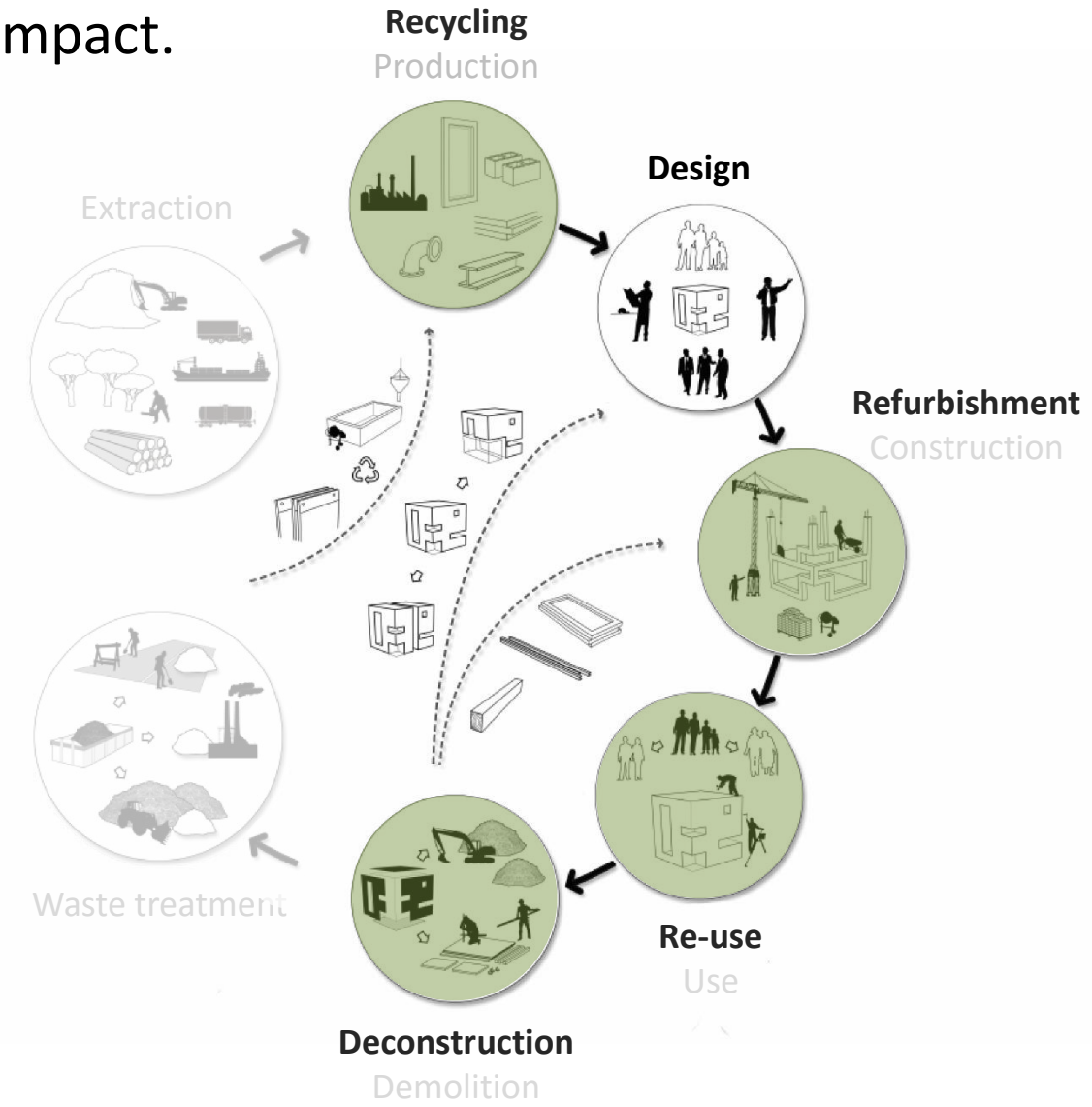
Towards a Transformable Architecture

Once, the passive qualities of the building developed, the designer can decide to go further and increase the potential of **adaptability** or **transformability** of the building.

Towards a Transformable Architecture

Using information that is already implemented in the BIM to provide feedback to the user and allow him to make « **Better Informed Decisions** »

Therefore, buildings are designed to
allow change and reduce their future impact.



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Towards a Transformable Architecture

« Your task is not to **foresee** the future, but to **enable** it.»

Antoine de Saint-Exupéry