

### LEGO - LEG GODT(DAN.) - PLAY WELL !

AN EXPLORATION OF COMPUTATIONALLY DRIVEN, GAMIFIED, MASS-CUSTOMIZATION AND PARTICIPATION ENABLING HOUSING DESIGN PROCESS - FOR HOUSING AFFORDABILITY, PERFORMANCE, AND FIT FOR PURPOSE DESIGN. REDEFINITION OF FRAMEWORK FOR 21ST CENTURY HOUSING DESIGN: FROM MACHINE FOR LIVING TO **A SYSTEM FOR LIVING**.

### PERSONAL INFORMATION:

Name:  
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### STUDIO INFORMATION:

Name of studio:  
Design tutor:  
Research tutor:

### CHOICE OF THE STUDIO:

Architectural Engineering studio has a potential of embracing the forces that will define the future of our profession - the automation of design and production processes. I always enjoyed working at an intersection of fields - being able to draw inspiration from various sources and I hope that the studio will enable an exploration in the merger of computation, system thinking, gamification and architectural design. And that this merger will prove useful in formulating foundations of my future practice.

### KEYWORDS:

Gamification, optimization, generative design, architectural configuration, space-syntax, voxelization, serious games, mass-customization, participation, democratization.

# GLOSSARY:



## GENERAL:

### AUTOMATED ANTHROPOCENE:

The Anthropocene is a proposed geological epoch dating from the commencement of significant human impact on Earth's geology and ecosystems, including, but not limited to, anthropogenic climate change. Most of the process that define the modus operandi of the system are automated with the means of computation.

### SYSTEM DESIGN:

Is the process of defining the architecture, product design, modules, interfaces, and data for a system to satisfy specified requirements.

### OPEN-SOURCE:

is a term coming from computer programming that characterizes decentralized software development model that encourages open collaboration. A main principle of open-source software development is peer production, with products such as source code, blueprints, and documentation freely available to the public.

### OPEN BUILDING:

is an approach to the design of buildings defined by John Habraken that takes account of the possible need to change or adapt the building during its lifetime, in line with social or technological change. Open building design seeks to co-ordinate inputs from different professions, users of the building, and other interests associated with the locality.

### LIQUID MODERNITY:

is defined by a chronic weakening of the relationship between labor and capital and the unleashing of capital's power to dissolve social and communal bonds. It is characterized by the pervasiveness in contemporary society of what Bauman refers to as the 'unholy trinity' of uncertainty, insecurity and unsafety.

### CONVERGENCE:

the tendency for different technological systems to evolve toward performing similar task. Convergence of evidence, or consilience, the principle that evidence from independent sources can tend to strong conclusions.



## FORMING & FABRICATION:

### KIT-OF-PARTS:

theory refers to the study and application of object-oriented building techniques, where building components are pre-designed / pre-engineered / pre-fabricated for inclusion in joint-based (linear element), panel-based (planar element), module-based (solid element), and deployable (time element) construction systems.

### CONFIGURATOR:

a digital interface that allows configuration - a specific case of design endeavour in which the final artifact is assembled from a fix set of units according to specific parameters and evaluation criteria.

### MASS- CUSTOMIZATION:

in marketing, manufacturing, call centers, and management, is the use of flexible computer-aided manufacturing systems to produce custom output. Such systems combine the low unit costs of mass production processes with the flexibility of individual customization.

### OBJECTILES:

is a generic object: an open-ended algorithm, and a generative, incomplete notation, which becomes a specific object only when each parameter is assigned a value. In the same way, a parametric function notates a family of curves, but none in particular.

### COMBINATORIAL CREATIVITY:

&

### ENUMERATIVE IMAGINATION:

similar concepts describing the idea of working with a limited set of units to create unlimited possibilities of configurations. The ideas relate to the concepts behind LEGO which as a toy provides a standardized unit and rules for possible connections and allows for an unbound process of imaginative creations.

### DIGITAL MATERIAL:

voxel or a unit materialized in from that has a limited set of rule based connections to other voxels. ( think lego )

### PRODUCTIZATION:

Productization involves taking a skill or service that has been used internally and developing into a fully-tested, packaged, and marketed product.

## INVOLVEMENT/PARTICIPATION:

### PLATFORMS:

A computing platform is the stage on which computer programs can run.

### THE COMMONS:

The commons is the cultural and natural resources accessible to all members of a society, including natural materials such as air, water, and a habitable earth. These resources are held in common, not owned privately. Commons can also be understood as natural resources that groups of people (communities, user groups) manage for individual and collective benefit.

### PROSUMER:

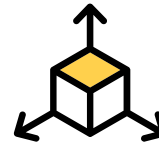
is an individual who both consumes and produces. The term coined by Alvin Toffler is a portmanteau of the words producer and consumer. Research has identified six types of prosumers: DIY prosumers, self-service prosumers, customizing prosumers, collaborative prosumers, monetised prosumers, and economic prosumers.

### PARTICIPATORY WEB:

also known as Web 2.0. Refers to websites that emphasize user-generated content, ease of use, participatory culture and interoperability (i.e., compatible with other products, systems, and devices) for end users.

### PARTICIPATORY DESIGN:

is an approach to design attempting to actively involve all stakeholders (e.g. employees, partners, customers, citizens, end users) in the design process to help ensure the result meets their needs and is usable.



## RELATIONSHIPS/GEOMETRY:

### TOPOLOGY:

In mathematics, topology is concerned with the properties of a geometric object that are preserved under continuous deformations, such as stretching, twisting, crumpling, and bending; that is, without closing holes, opening holes, tearing, gluing.

### MEREOLGY:

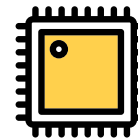
In logic, philosophy and related fields, mereology is the study of parts and the wholes they form. Whereas set theory is founded on the membership relation between a set and its elements, mereology emphasizes the meronomic relation between entities. Part-to-whole & part-to-part relationships.

### LATTICE:

In other words, for any basis of  $R^n$  the subgroup of all linear combinations with integer coefficients of the basis vectors forms a lattice. A lattice may be viewed as a regular tiling of a space by a primitive cell.

### VOXEL:

In 3D computer graphics, a voxel represents a value on a regular grid in three-dimensional space. As with pixels in a 2D bitmap, voxels themselves do not typically have their position explicitly encoded with their values.



## COMPUTATION:

### DISCRETENESS:

Discrete in science is the opposite of continuous: something that is separate; distinct; individual.

### ARTIFICIAL INTELLIGENCE:

Artificial intelligence (AI) is intelligence demonstrated by machines, as opposed to the natural intelligence displayed by animals including humans. Leading AI textbooks define the field as the study of "intelligent agents": any system that perceives its environment and takes actions that maximize its chance of achieving its goals.

### GENERATIVE DESIGN:

is an iterative design process that involves a program that will generate a certain number of outputs that meet certain constraints, and a designer that will fine tune the feasible region by selecting specific output or changing input values, ranges and distribution.

### MACHINE LEARNING:

is the study of computer algorithms that can improve automatically through experience and by the use of data. It is seen as a part of artificial intelligence. Machine learning algorithms build a model based on sample data, known as "training data", in order to make predictions or decisions without being explicitly programmed to do so.

### GENERATIVE ADVERSARIAL NETWORKS:

A generative adversarial network (GAN) is a class of machine learning frameworks designed by Ian Goodfellow and his colleagues in June 2014. Two neural networks contest with each other in a game (in the form of a zero-sum game, where one agent's gain is another agent's loss).

# INSPIRATION:

## WINSTON CHURCHILL:

We shape our spaces, thereafter **they shape us**.

## HENRY FORD:

The owner, the employees, and the buying public are all one and the same, and **unless an industry can so manage itself as to keep wages high and prices low it destroys itself**, for otherwise it limits the number of its customers. One's own employees ought to be one's own best customers.

## CHRISTOPHER ALEXANDER:

The designer becomes a **designer of generating systems - each capable of generating many objects -** rather than a designer of individual objects.

## IAN BOGOST:

**A world of unit operations hardly means the end of systems.** Systems seem to play an even more crucial role now more than ever, but they are a new kind of system: **the spontaneous and complex result of multitudes rather than singular and absolute holisms.**

## ALASTAIR PARVIN:

Traditionally, housing architects have aspired to work on one-off houses for wealthy clients, or large speculative developments for housebuilders. **It is time for redefinition. Be lazy like a fox. Coping is good.**

## BERNHARD HAFNER:

The network is a potential, which allows different solutions of filling. It **allows architectural diversity.**

## GILES RETSIN:

The discrete is willing to trade a **few degrees of resolution, formal differentiation and 'excitement'** for **scalability, impact and agency**, for example to rethink the production of housing.

## MOLLIE CLAYPOOL:

The role of the architect becomes one of **facilitation of a framework of production, linking the digital tools for design and fabrication** in a way that makes them accessible.

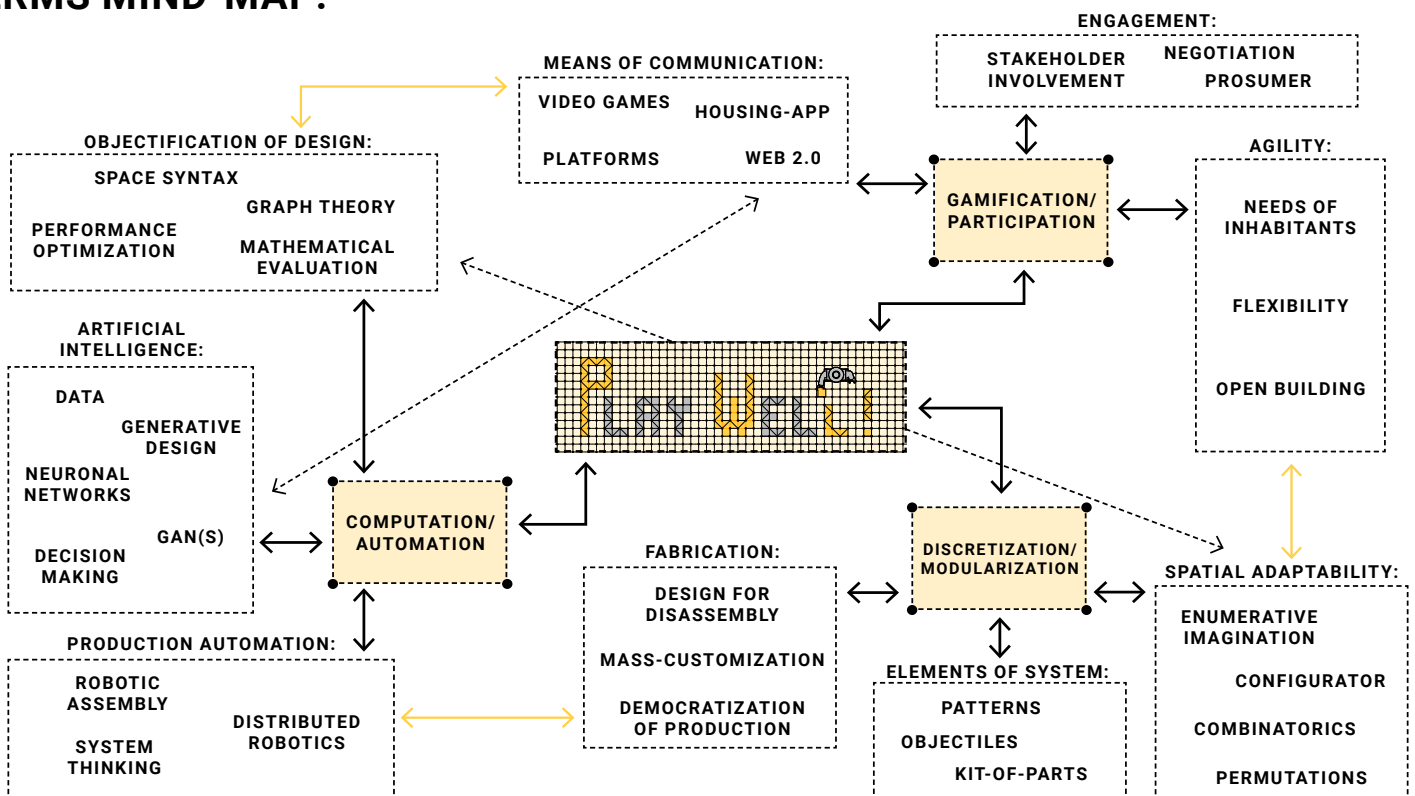
## BILL HILLER:

No idea in the theory of architecture is more seductive than that architecture is an ars combinatoria - a **combinatorial art**: the idea that the whole field of **architectural possibility might be made transparent by identifying a set of basic elements and a set of rules for combining them** so that the application of one to the other would generate the architectural forms which exist, and open up possibilities that might exist and be consistent with those that do.

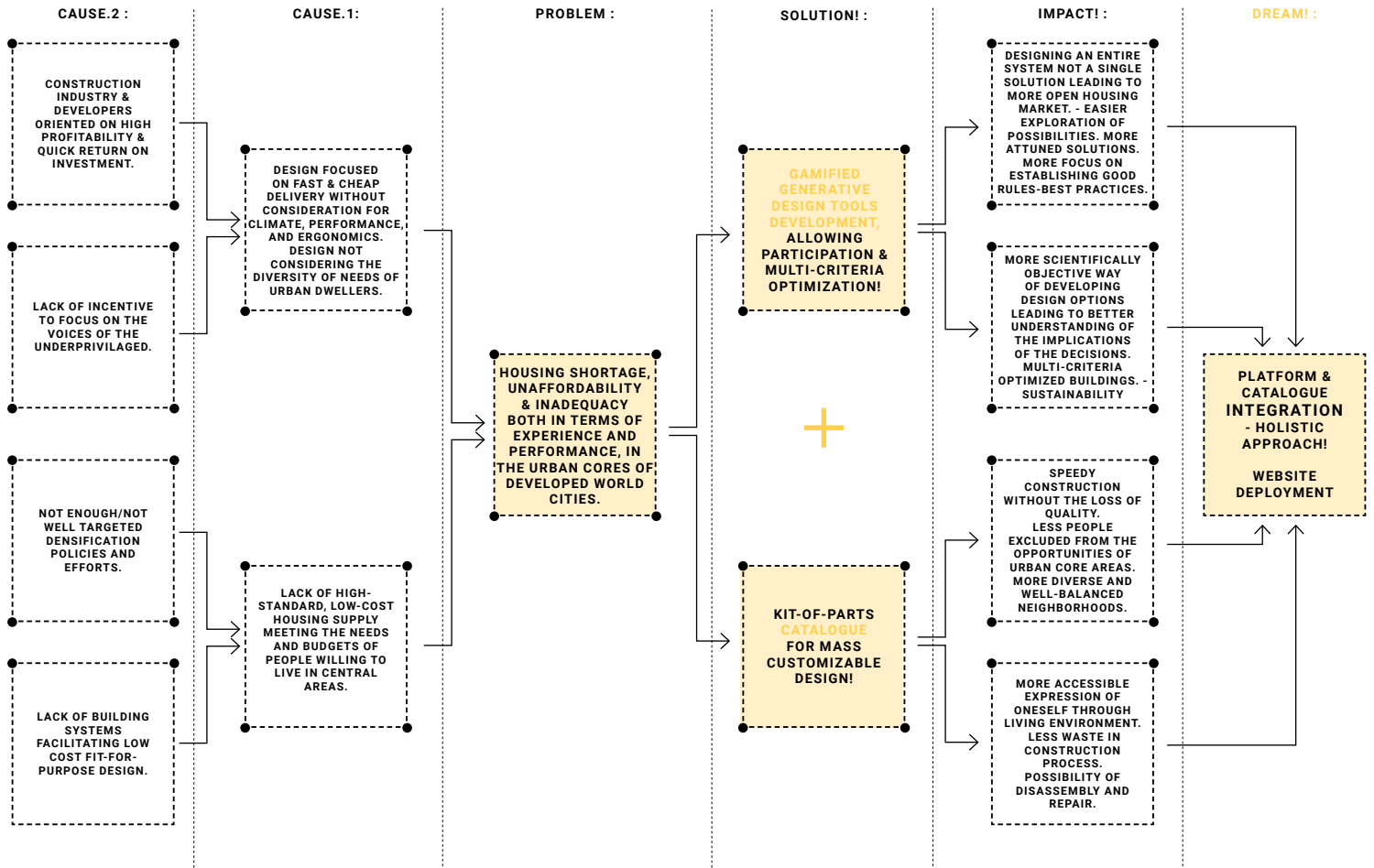
## KEVIN KELLY:

**Convergence** will be recognized as the **largest, most complex and most surprising** event on the planet.

# TERMS MIND-MAP:



# PROBLEM TREE:



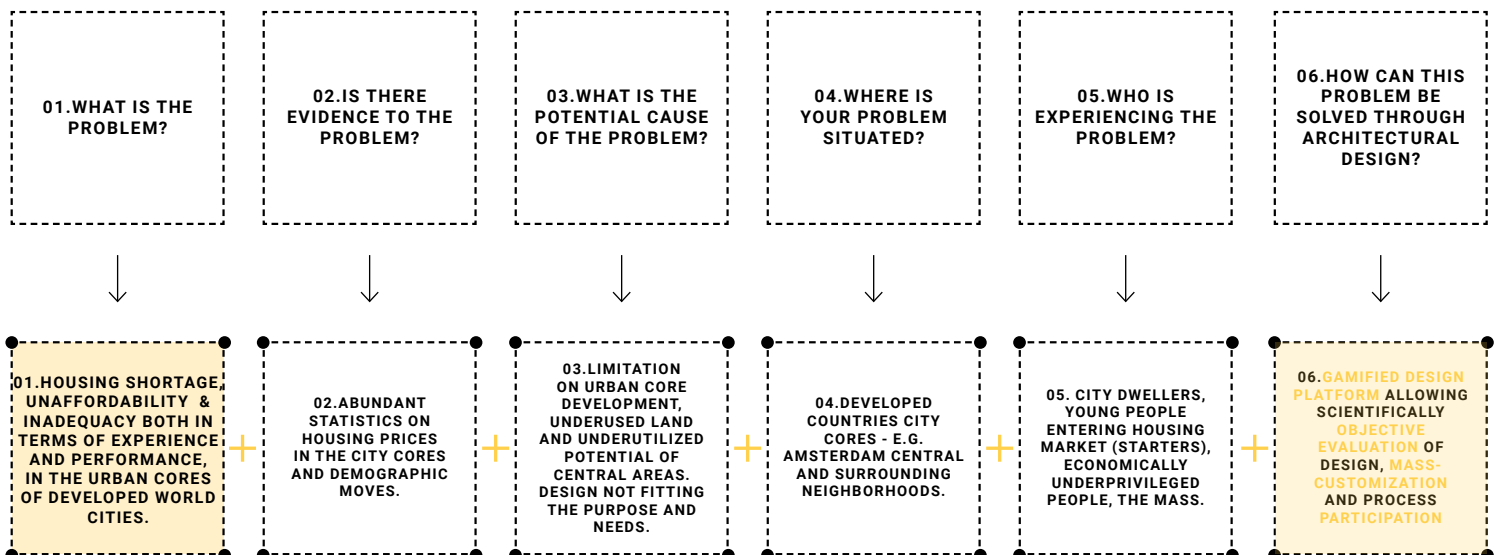
## PROBLEM STATEMENT:

Major cities around the developed world are under a considerable pressure when it comes to their housing policies. Housing shortage, unaffordability & inadequacy both in terms of experiential qualities and performance are haunting urban policy makers.

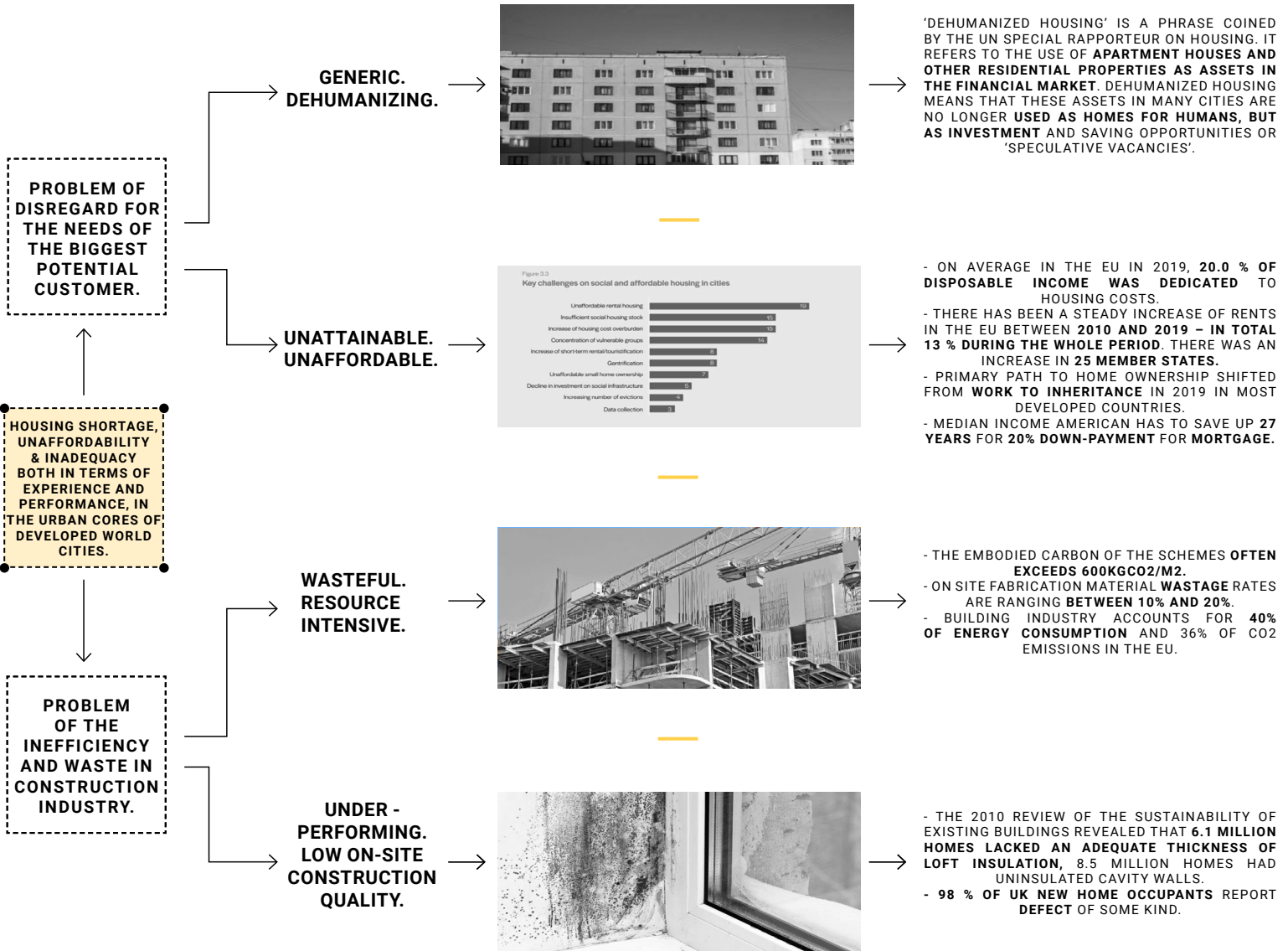
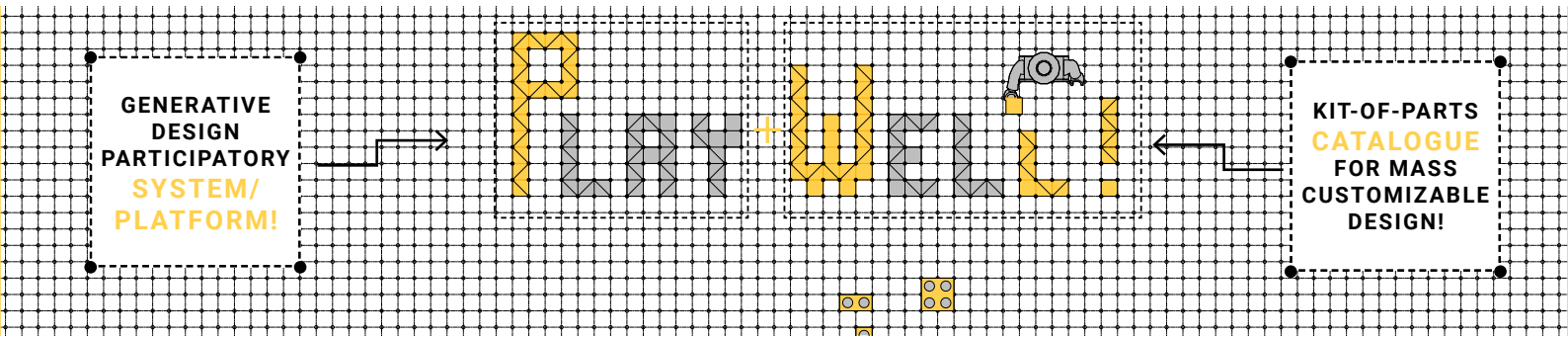
When designers and investors are focusing either on high-end tailor-made solutions to the 1% of the population or on creating generic one-size fit-all schemes that are purely calibrated to maximize financial profits of the developers the problem is exacerbated even further.

And when flats cease being places to live and become objects of market speculation we find ourselves in a recipe for disaster. Underprivileged families, young people hoping to enter the housing market, and many other social groups are finding themselves pushed-out of the vibrant environments of the urban cores, deprived of both economic and social opportunities.

Many of the housing schemes that are being offered sell out even before the beginning of construction which aberrates the system. But what if there was a potential there to be harnessed as force that helps both developers and people in need...



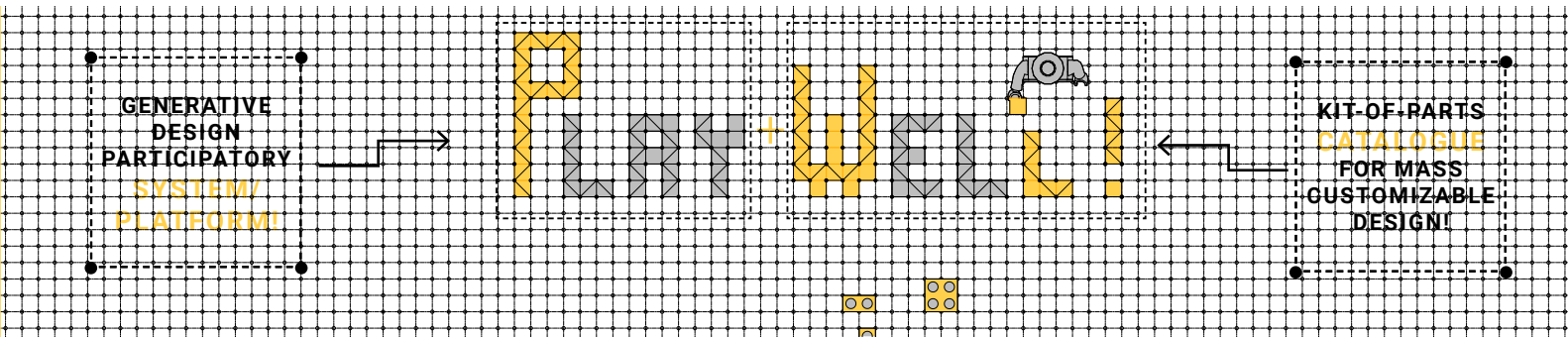
# PROBLEM EVIDENCE:



# HYPOTHESIS - SOLUTION:

...what if instead of starting from one-size fits-all approach the designs started from a deep understanding of the needs of the future inhabitants? The running hypothesis of the Play Well project is based on a notion that the combination of generative design and mass-customizable system thinking could have a potential to cause disruption in the built environment industry. This combination could be with bringing a modular and adaptable world in which designers have the possibility to empower the future building users to influence the design process to perfectly match those needs without limiting the possibilities of the future generations. (Both in terms of reconfigurability of the schemes and their sustainability) The haute couture for the masses - affordability and tailor-made design coming into one.

# HYPOTHESIS - SOLUTION:



## OBJECTIVE:

The end goal of the research project is to create elements of the housing design system that could be used in participatory generation of housing schemes. The overarching ambition is to, during the research period, establish best practices in terms of modular design (kit-of-parts catalogue), participation empowerment (design games understanding), and to create a set of computational/generative tools (building performance and configuration) that will all later be used in the design stage to formulate optimal design proposal.

## OVERALL DESIGN QUESTION:

DESIGN - MAIN QUESTION:

How can housing schemes become more attuned to the needs of the future occupants? Is there a way for designing with kit-of-parts systems to be combined with generative tools to unlock the hidden potential?

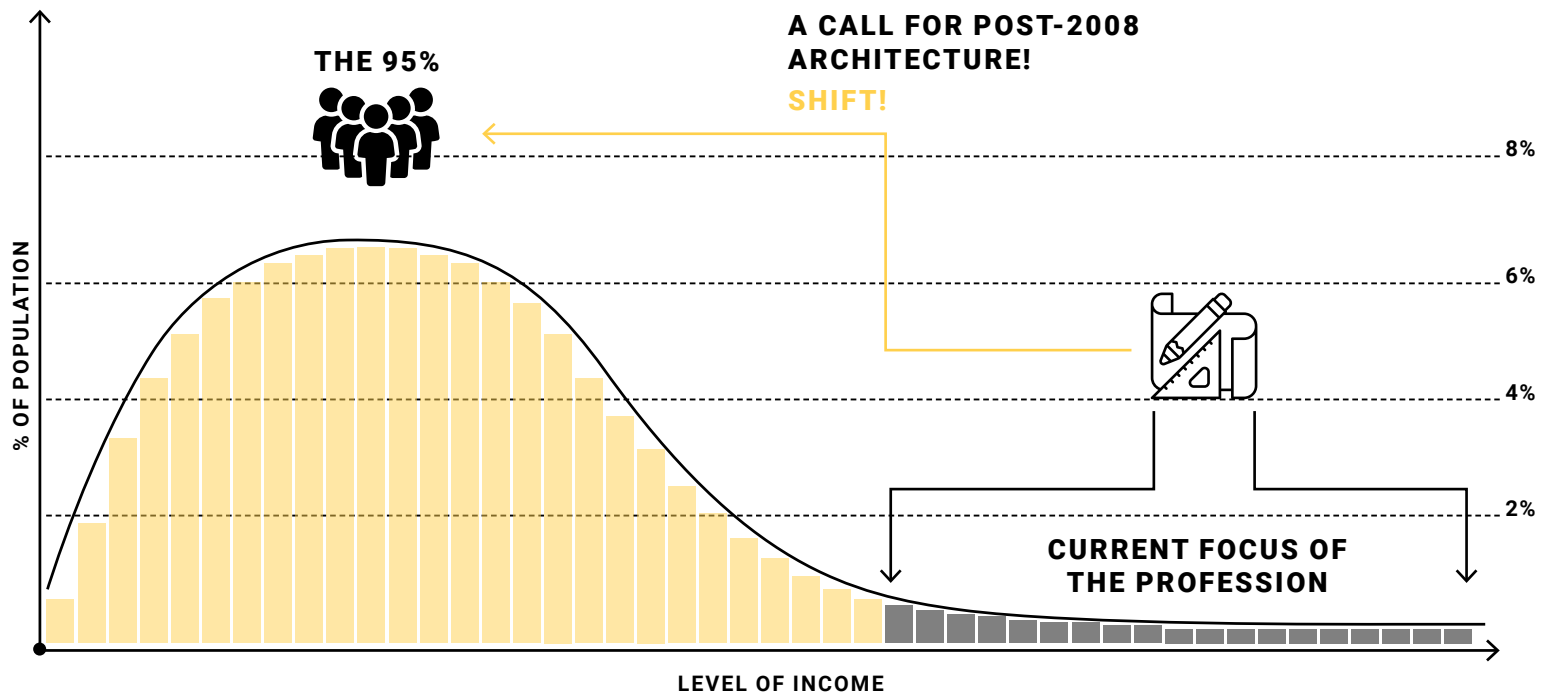
## THEMATIC RESEARCH QUESTION:

RESEARCH - MAIN QUESTION:

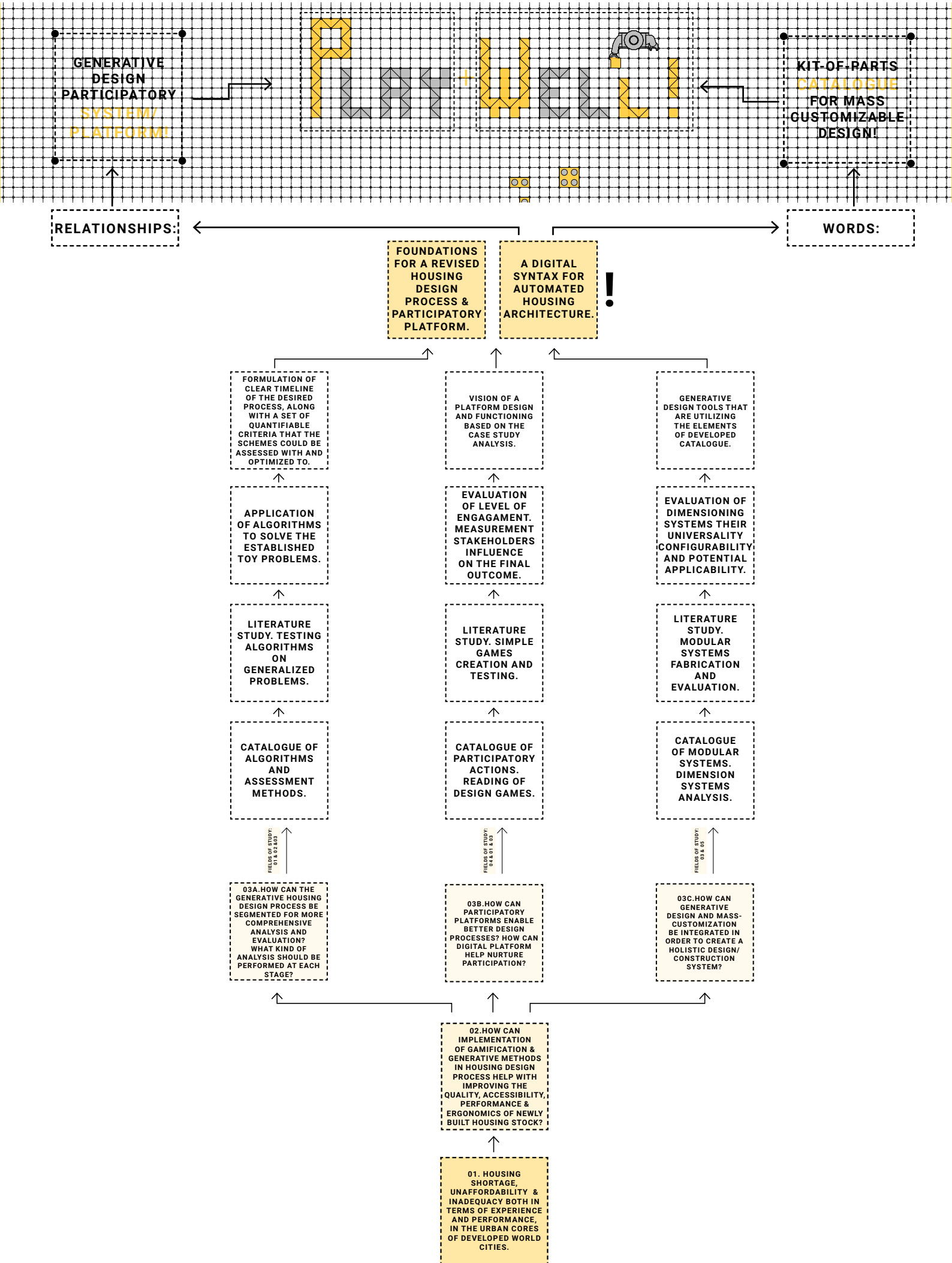
How can **implementation of gamification & generative methods in housing design process** help with improving the quality, accessibility, performance & ergonomics of newly built housing stock?

RESEARCH - SUB QUESTION(S):

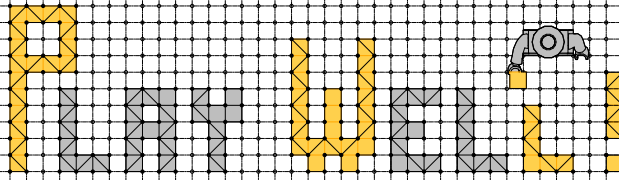
01. How can the generative housing design process be segmented for more comprehensive analysis and evaluation? What kind of analysis should be performed at each stage?
02. How can participatory platforms enable better design processes? How can digital platform help nurture participation?
03. How can generative design and mass-customization be integrated in order to create a holistic design/construction system?



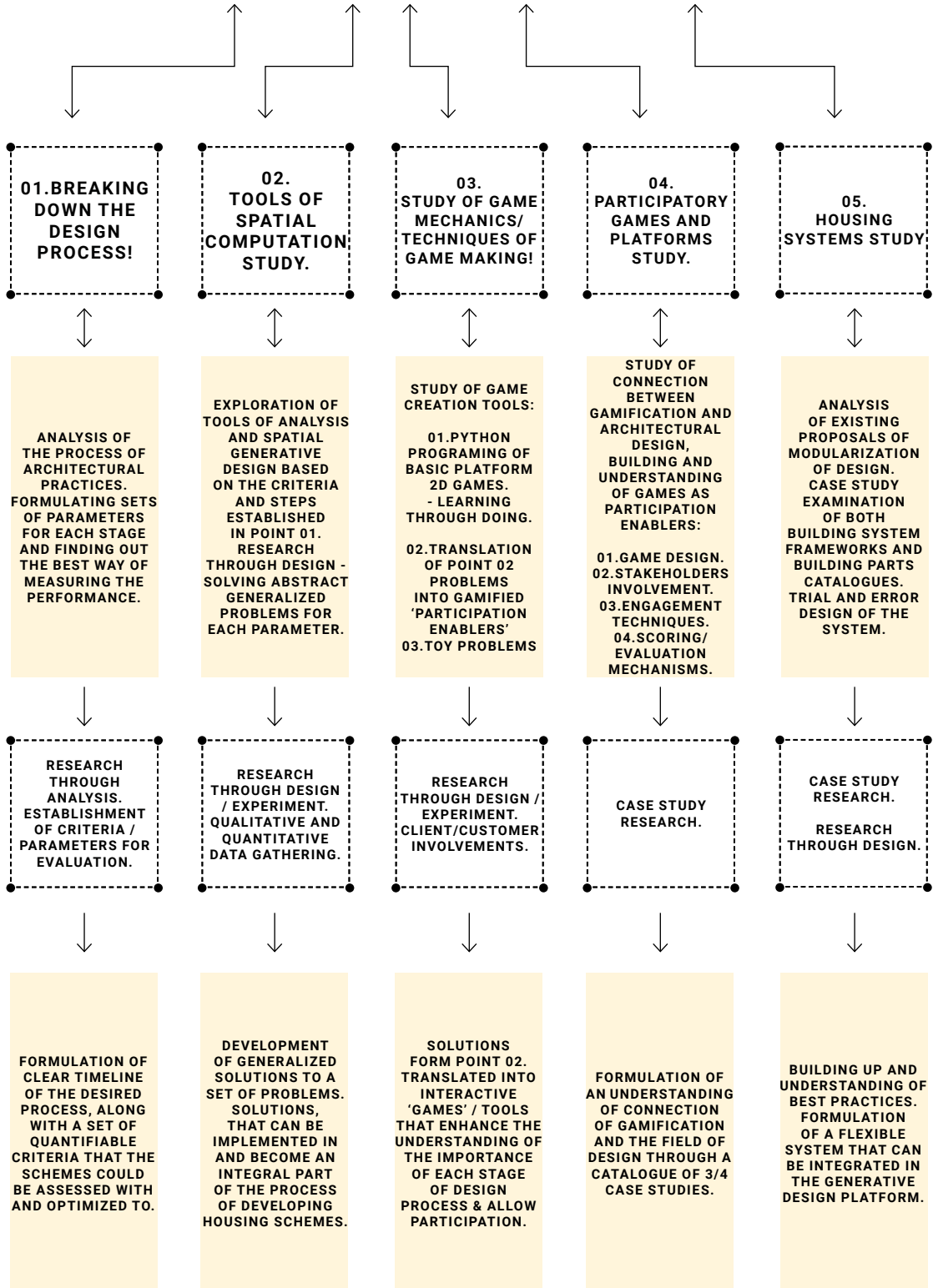
# OBJECTIVES / GOALS:



# METHODOLOGIES - PROCESS:

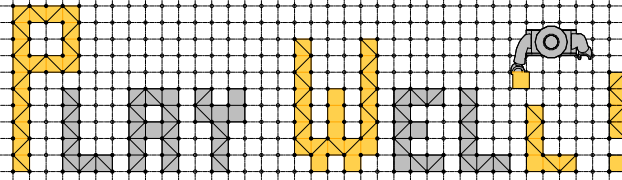


## FIELDS OF STUDY:

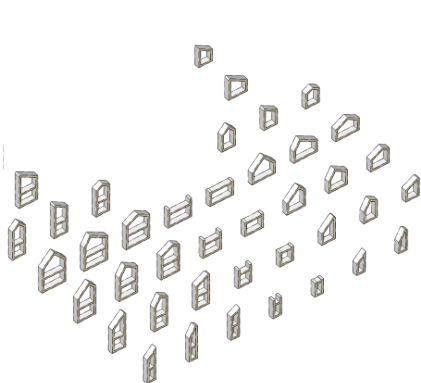
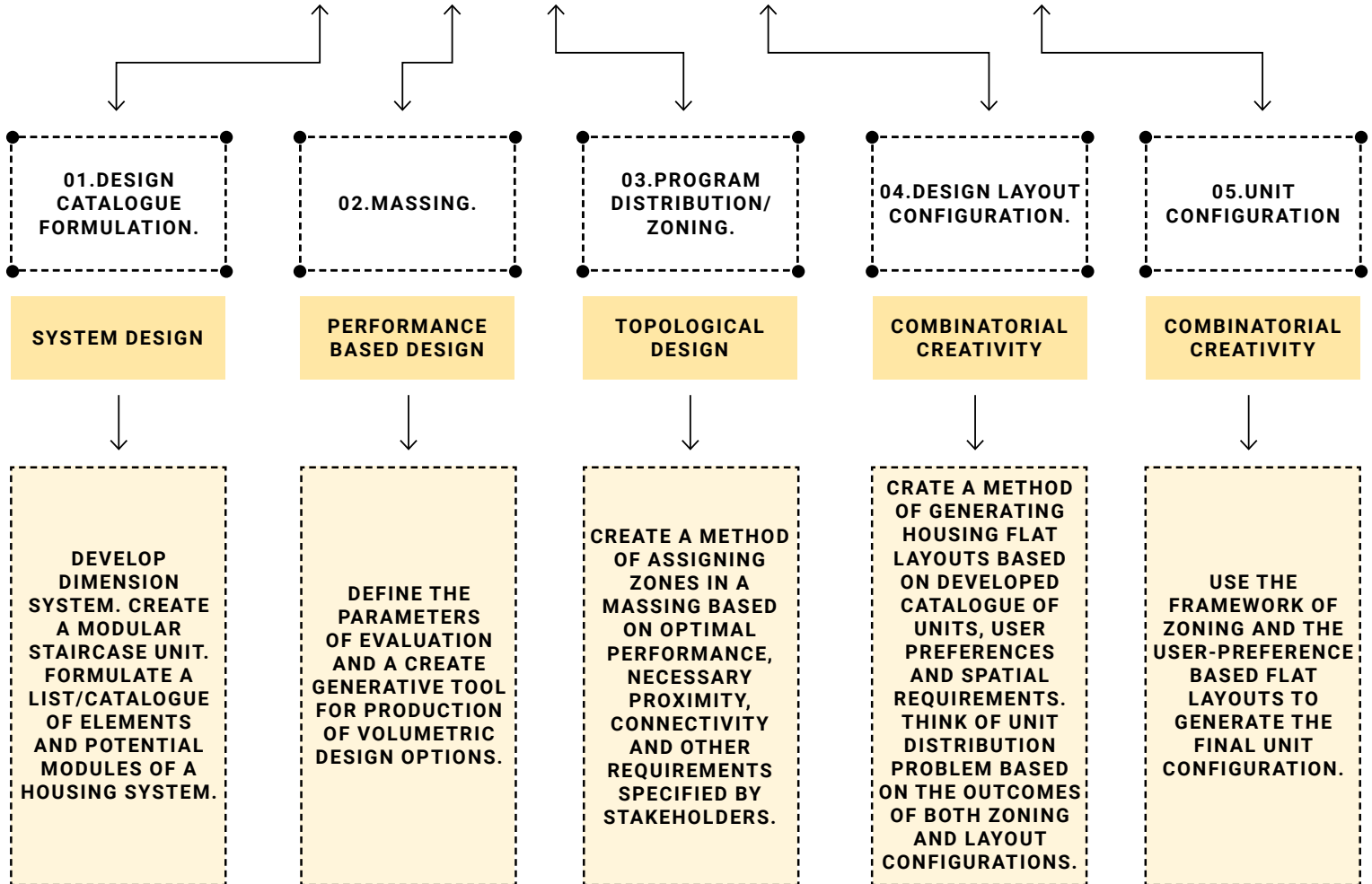




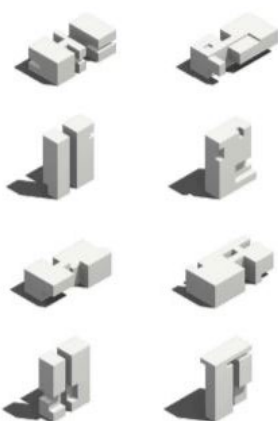
# METHODOLOGIES - TOY PROBLEMS:



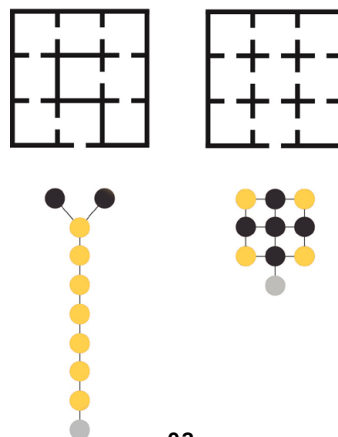
## TOY PROBLEM(S) DEFINITION:



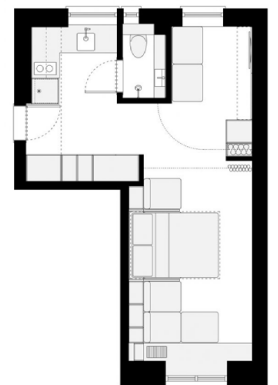
01.



02.

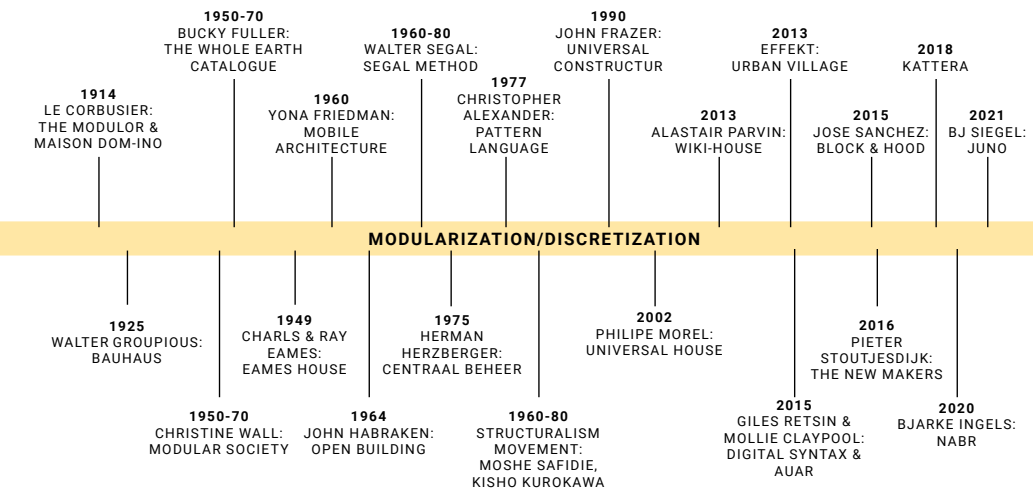
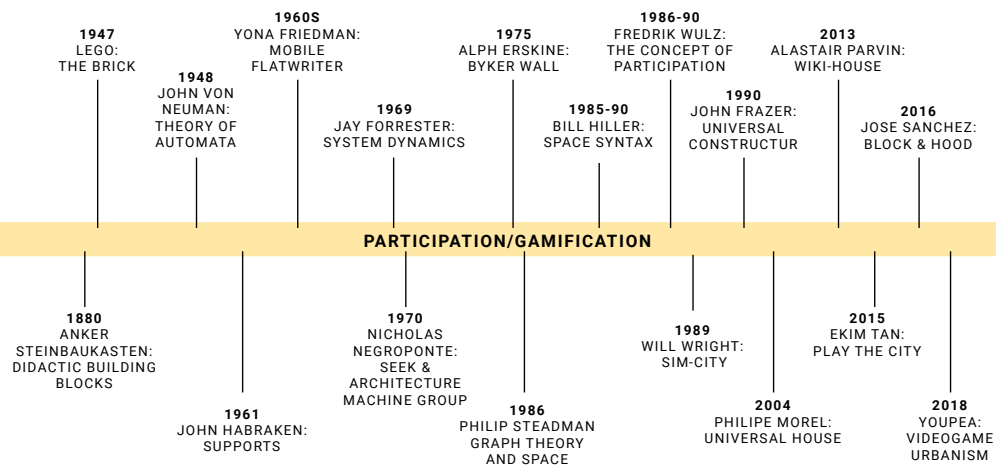
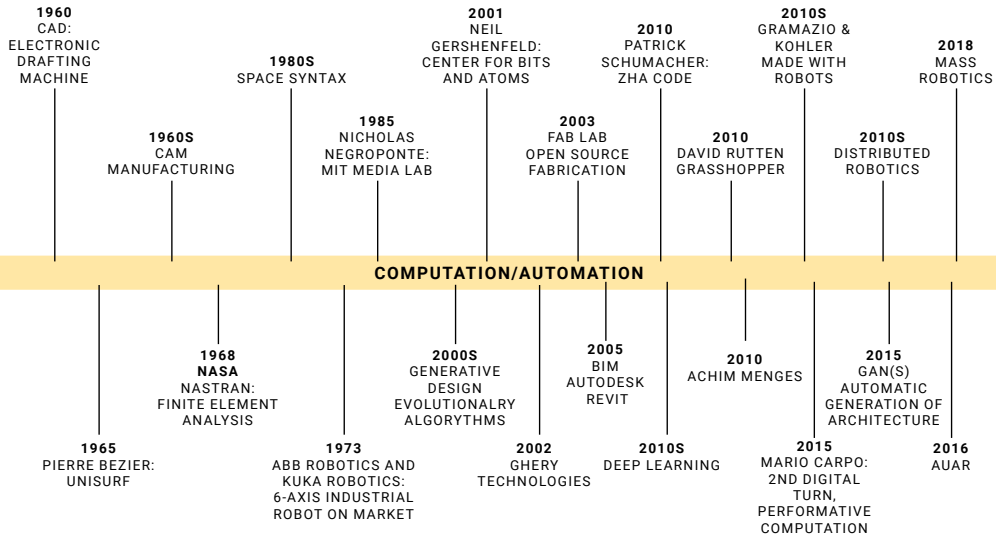


03.



04.

# THE PLACE IN HISTORY:

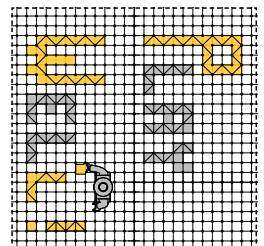


MODULARIZATION/DISCRETIZATION

COMPUTATION/AUTOMATION

GAMIFICATION/PARTICIPATION

CONFIGURATION/SPACE SYNTAX



## STATE OF THE ART:

The state of the art appraisal could be divided into two major categories that relate to the planned extents of my thesis, namely gamification/generative design & mass-customization/system design. I tried to formulate an understanding of both.

### GAMIFICATION/GENERATIVE DESIGN:

- + Pirouz Nourian & Shevrin Azadi - Genesis Lab.
- + Ekim Tan - Play The City.
- + Stanislas Chaillou - ArchiGAN.
- + Plethora Project - Block and Hood.

Researchers were able to create generative design systems that automatically formulate housing plan layouts based on training datasets. (Chaillou) Many solutions for automatic spatial configuration and performance assessment have also been developed. (Nourian & Azadi)

### MASS-CUSTOMIZATION/SYSTEM DESIGN:

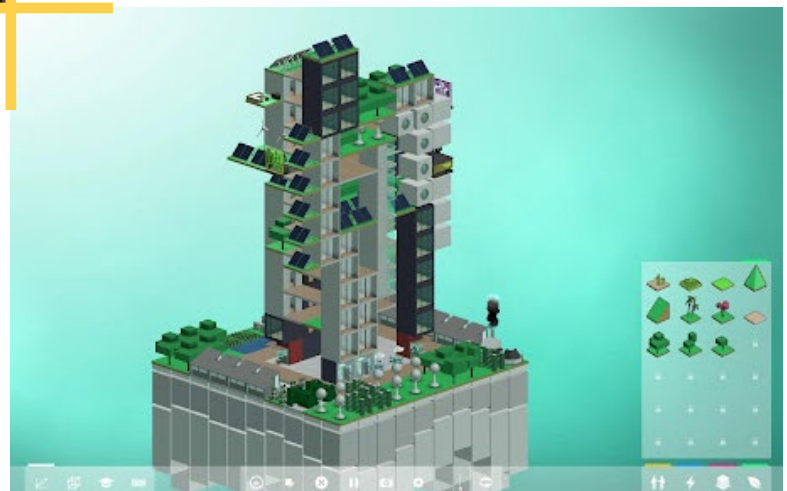
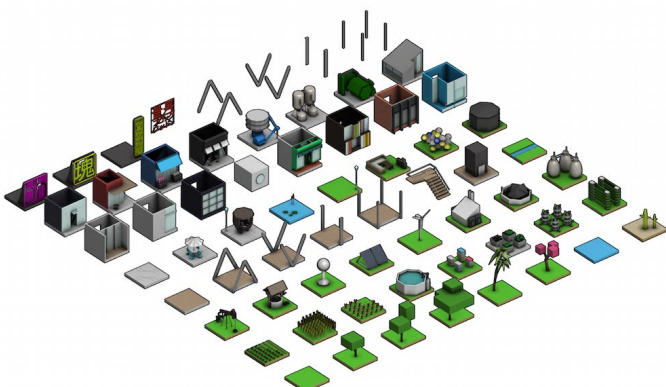
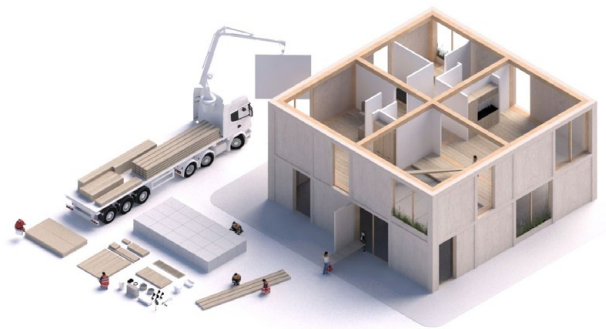
- + THE NEW MAKERS - Pieter Stoutjesdijk.
- + Open Systems Lab - WikiHouse.
- + SPACE10/Effekt - Urban Village.

Researchers were able to formulate design principles for unitized building systems that enable mass-customization of elements within a modular framework. (Stoutjesdijk) Some of the solutions have been made publicly available via open source platforms. (Open Systems Lab)

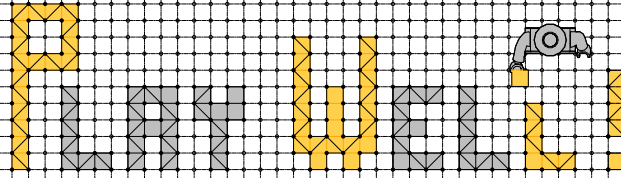
The current (publicly available) state of the art in housing design does not involve solutions that combine generative design and modular system thinking. I believe that in order to create great design solutions that are in sync with the 21st century needs a knowledge of both fields is critical as one could immensely benefit from and inform the other. Helping to devise more attuned and well performing buildings.

## RELEVANCE:

The thesis hopes to operate at an intersection of field of spatial computational and system design. I am planning to embrace the state of the art techniques and findings in all the respective fields and combine the methods and tools in order to create a more holistic approach to design process and its problems. I strongly believe that in the 21st century environment the convergence of various processes is an absolute key to solving problems of complex and fluid nature. The thesis will operate in the context of a major housing crisis in developed world cities and try to address its challenges through building up from an existing knowledge base.



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## **CHAPTER 00 : INTRODUCTION - RESEARCH FRAMEWORK.**

- 0.1.ABSTRACT.
- 0.2.BACKGROUND.
- 0.3.MOTIVATION.

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- 1.1.PROBLEM STATEMENT.
- 1.2.HYPOTHESIS - GAMIFIED + DISCRETE / SYSTEM + CATALOGUE / RELATIONSHIPS + WORDS
- 1.3.RESEARCH METHODOLOGY.
- 1.4.SCOPE & LIMITATIONS.

## **CHAPTER 02 : THE MODULAR & THE DISCRETE.**

- 2.1.LITERATURE & HISTORICAL REVIEW.
- 2.2.CASE STUDIES.
- 2.3.DIMENSION SYSTEM, DESIGN ELEMENTS & CONNECTIVITY/INTERFACE.
- 2.4.KIT-OF-PARTS CATALOGUE.

## **CHAPTER 03 : PARTICIPATORY DESIGN & GAMIFICATION.**

- 3.1.LITERATURE & HISTORICAL REVIEW.
- 3.2.CASE STUDIES.
- 3.3.STAKEHOLDER INVOLVEMENT & RULES OF THE GAMES.
- 3.4.HOUSING PLATFORM FRAMEWORK.

## **CHAPTER 04 : COMPUTATION IN DESIGN PROCESSES.**

- 4.1.LITERATURE & HISTORICAL REVIEW.
- 4.2.DESIGN PROCESS BREAKDOWN.
- 4.3.TOY PROBLEMS FORMULATION.
- 4.4.TOY PROBLEMS ALGORITHMIC SOLUTIONS.
- 4.5.EVALUATION AND IMPLEMENTATION.

## **CHAPTER 05 : CONVERGENCE: THE NEW HOUSING SYNTAX.**

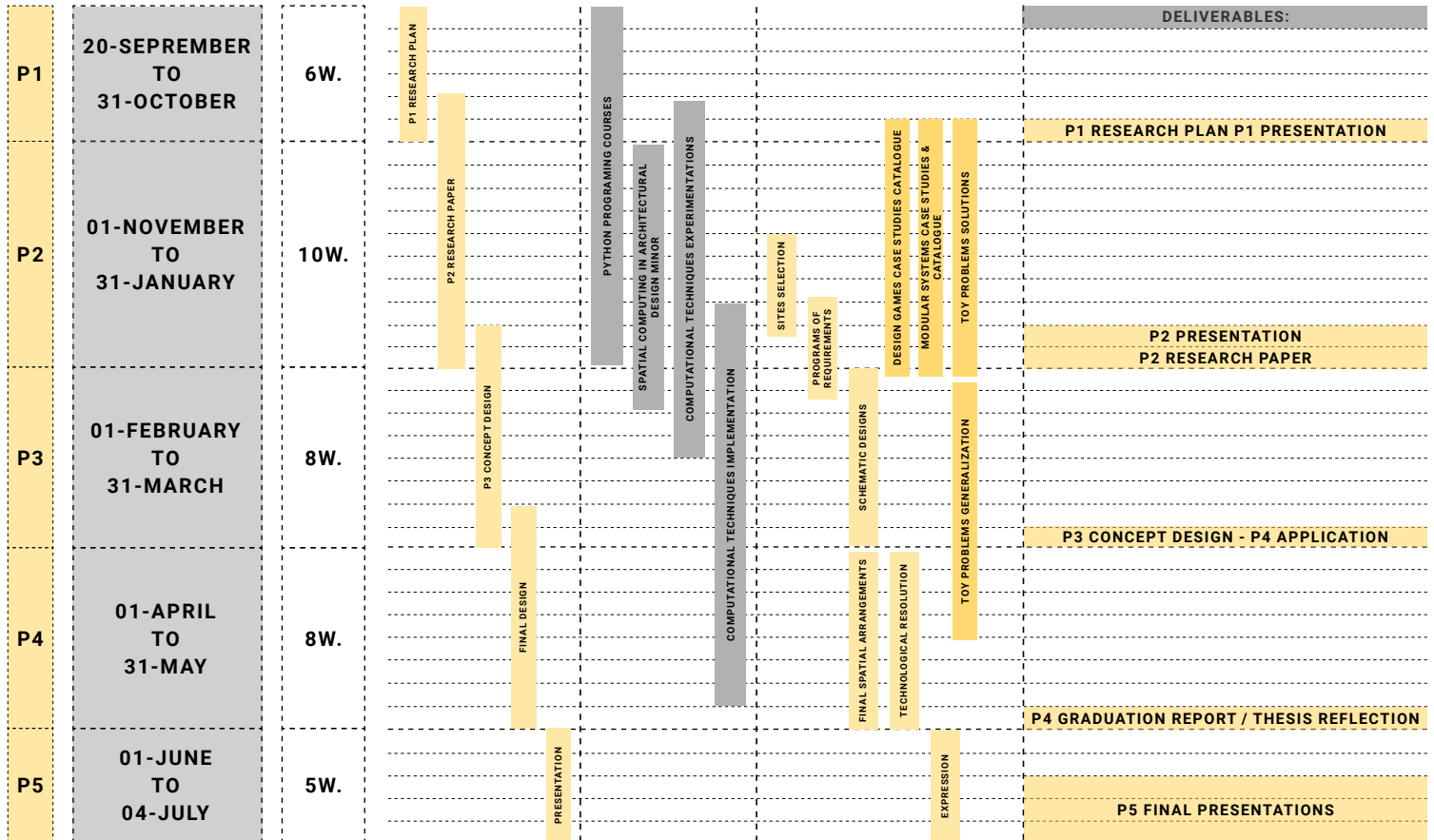
- 5.1.THE REDEFINED PROCESS.
- 5.2.NEW HOUSING SYNTAX.
- 5.3.PLATFORM DUMMY PROPOSAL.

## **CHAPTER 06 : CONCLUSIONS & REFLECTIONS.**

- 6.1.PROCESS CONCLUSIONS.
- 6.2.REFLECTIONS.
- 6.3.FUTURE DEVELOPMENTS.

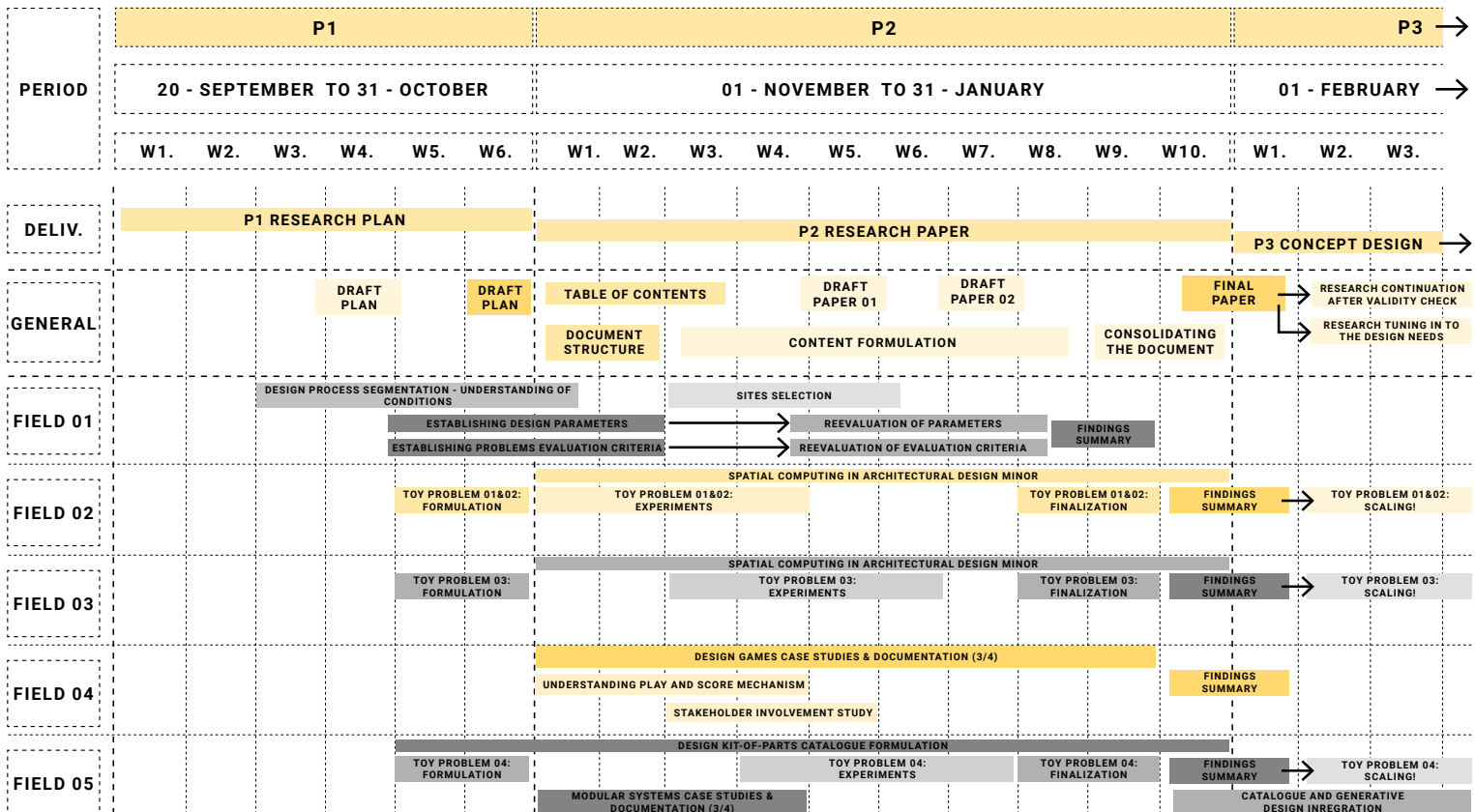
## **APPENDIXES & BIBLIOGRAPHY**

# PLANNING - GRADUATION PLAN TIMELINE:

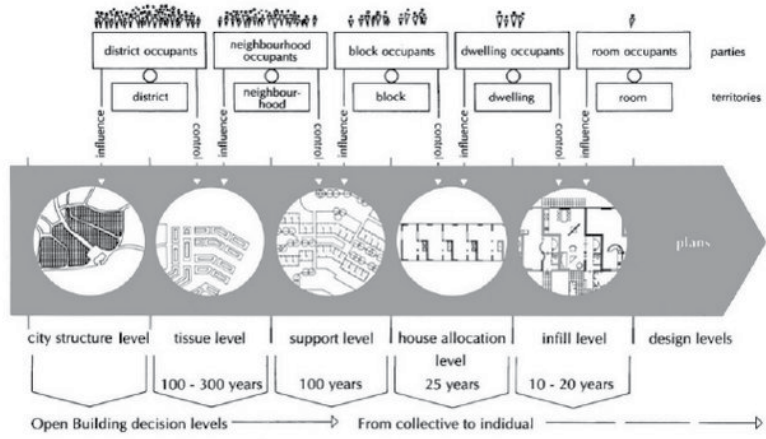


Research plan is divided into 5 fields of study that correspond with the ones defined in the methodology section of the document. Within each category there are specific tasks and goals set to be completed before the paper hand-in. The research will be mostly done through case study analysis of the state of the art solutions in gamification and modular system design and through experimentations that will be trying to address the established toy problems. Solutions to those are meant to later be scaled and implemented in the process of formulating the final design project.

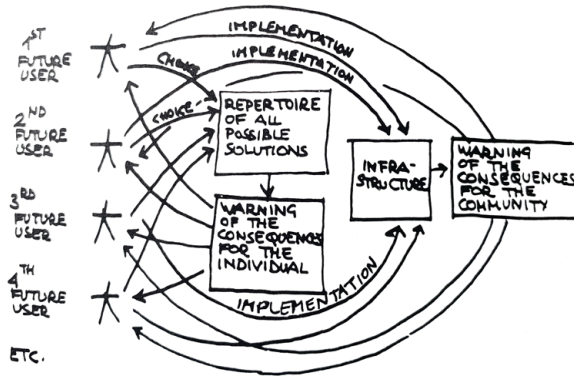
# PLANNING - RESEARCH PLAN TIMELINE:



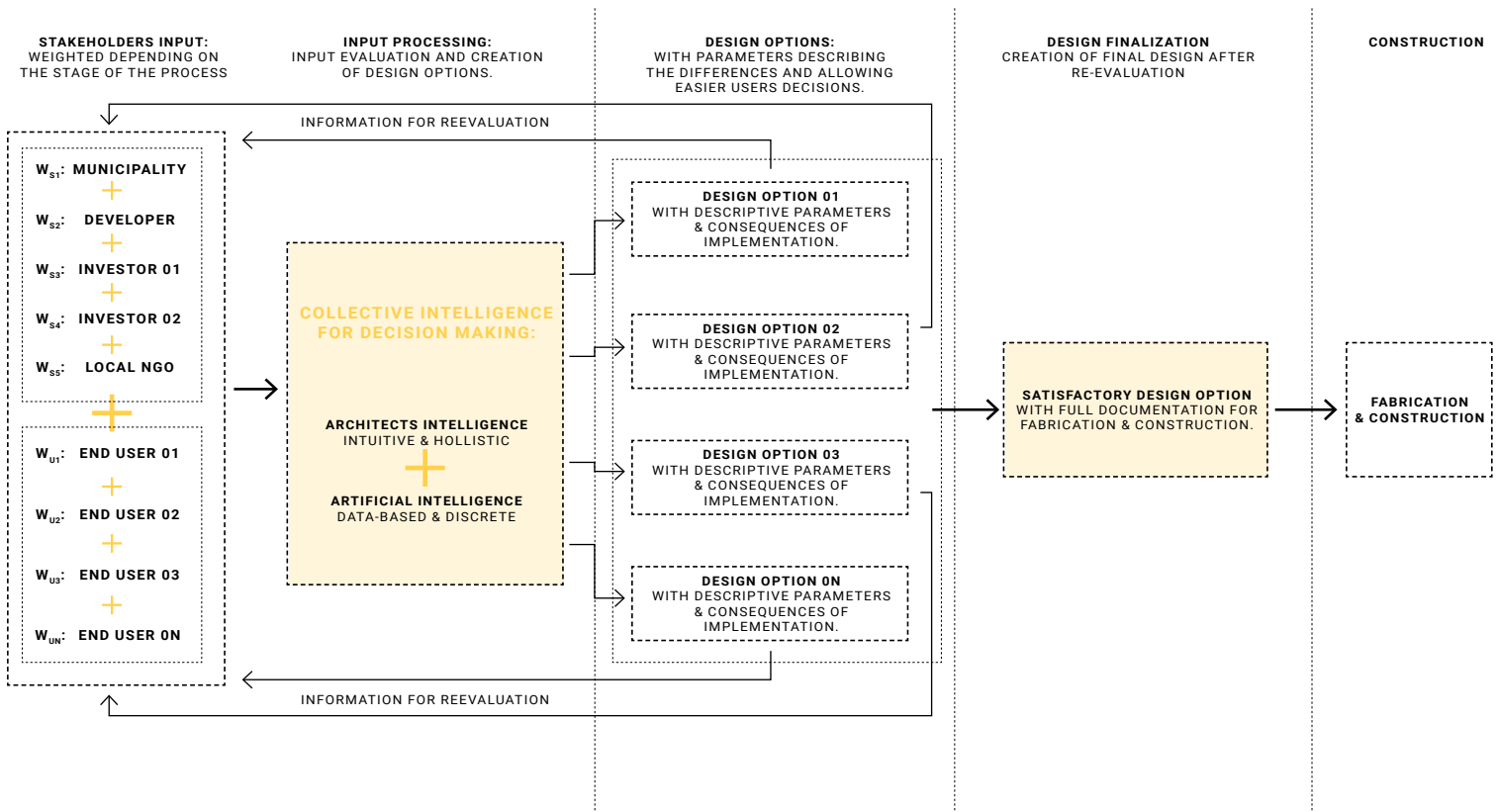
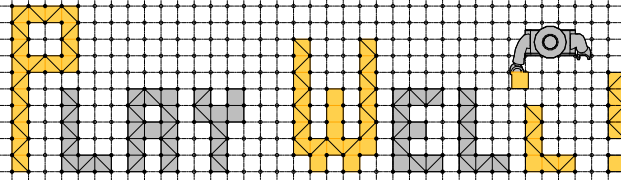
# PLAY WELL - DIGITAL SYNTAX DESIGN PROCESS:



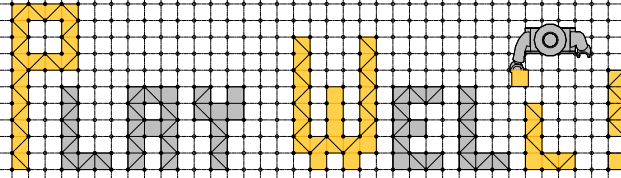
## JOHN HABRAKEN - OPEN BUILDING



## YONA FRIEDMAN - FEEDBACK SYSTEM



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## GAMIFICATION:

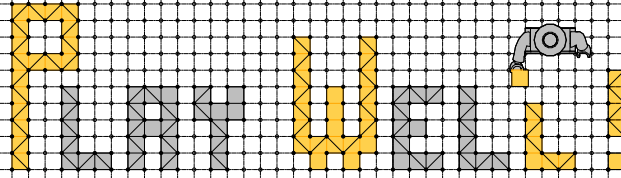
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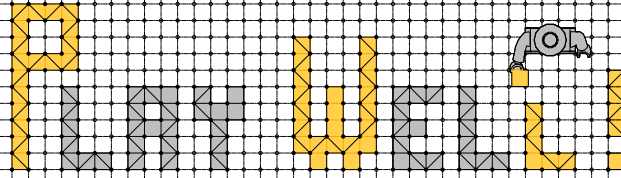
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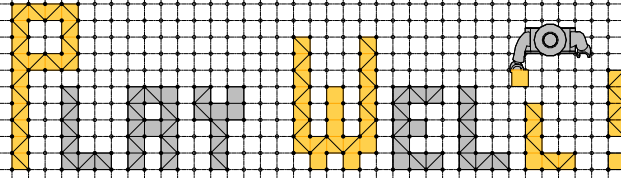
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