Gamification of Shape Grammars

Collaborative and Participatory Mass-Housing Design for Kashgar Old Town

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This paper describes the framework of an ongoing research, titled 'quasiGRAMMARS', seeking a participatory mass-housing approach. In the context of the city of Kashgar, China, where the convergence of Islamic-Chinese-Turkic cultures has been shaped within a unique style since the 10th century, mass-housing becomes a 3D puzzle that requires each piece to be placed with full of care, motivation, participation, analysis, strategy, art and finally design. Gamification is about designing collaboration and participation for mass-housing, whereas shape grammars are meant for analysis and design. This game finally turns into a strategic game to be scrutinised further in relation to game theory that is mathematically concerned with the economics too. However, the present study aims at proving a participatory design strategy that incentivises valuable action through gamification techniques. Focusing on its specific design development, it reveals some of these techniques to gamify mass-housing for Kashgar in eight steps. While unveiling gamification term for use in architecture domain, the paper discusses the limitations and future directions of the research.

Keywords: *Shape grammars, gamification, mass-housing, participatory decision-making, Kashgar*

1. INTRODUCTION

By the time, you have been reading this sentence, nearly 2 million messages was created and shared via WhatsApp (pennystocks.la). Of the available data in the world, more than 90% has been accumulated in the last two years, with the social media use being the most prolific data source (Hudson-Smith 2014, 42). And these figures were unimaginable only three years ago. Despite its fascinating speed, the consequences of lacking sufficient effort to take the straightforwardness of social media devices as an opportunity to make use of these data lead to information overload. Simply designed, a gamified platform can be a key to open up willingness for massive contribution. Gamification is a key to activate dynamics for a meaningful purpose and, in particular, with fun. *quasiGRAMMARS* is a research project looking for possibilities of such a scheme in mass-housing, and, at a

greater extent, in architecture (Lo et al. 2014).

This paper's definition, literally, is that gamification is to provoke and make use of higher-level intelligence via a collective manner that draws on big data available online through sharing. Through gamification, potentials of social network and fun-environments are utilised by designing collective intelligence for mass-housing instead of computationally expensive solutions. In other words, gamification plays the designed role of an ombudsman that is appointed to bring varying demands over a table based on voluntary and intrinsic participation.

More specifically, the underlying purpose of the present work is to introduce some of gamification elements in the context of the development of Kashgar's old-city. Starting with a brief introduction of Kashgar and its value in this research, the paper discusses the stages through which gamification becomes a diagram to map an open-collaborative system for mass-housing in Kashgar. Finally it presents a preliminary work which was conducted in an elective course with 15 students grouped into two.

2. KASHGAR: JEWEL IN CENTRAL ASIA

Kashgar, the westernmost city in China, is located where many different cultures and religions have juxtaposed thanks to its geographical position. The ancient city is described as "the heart of one of the most lovely and bountiful oases in all Central Asia (Starr 2013, 307)." Kashgar politically belongs to the Xinjiang-Uygur Autonomous Region whose capital, Urumqi, is the world's most landlocked city (Dong and Zhang 2011). This locational information concisely explains the environmental conditions that have formed the regional architecture.

Situated in the Tarim Basin in the periphery of Taklimakan Desert, Kashgar's enduring examples of Uygur, a Turkic people of Central Asia, architecture are threatened with oblivion and unbridled development which is invariably everywhere in China as a consequence of neo-liberal policies (Michell et al. 2008, 147; Florenzano et al. 2010; Aydin 2012). The historical urban fabric in Kashgar is "the best-preserved example of a traditional Islamic city to be found anywhere in Central Asia (Michell et al, 2008, 79)." And it is ironically the most-endangered one at the moment. Large-scale urban projects being implemented with the incorporation of local and central governments have already torn down nearly the two-thirds of the old-city. The ongoing project described as a 'precautionary' measure against earthquakes by the authorities is worth $4.39 billion, requiring 50,000 households, in other words more than 200,000 people, to be resettled (www.rfa.org).

Figure 1
The satellite map of Kashgar old-town which undertakes a major urban renovation project requiring nearly 200,000 people to be replaced (Google Earth).

The process of the resettlement is oriented without an inclusive decision-making process. Families are compelled to move in identical units 'prefabricated' for efficiency and affordability. Since they are not involved in decision-making, the projects cast doubts though, allegedly, legalised by the Chinese government on the basis of earthquake safety. And therein lies political and ethnic tensions between the local Uyghur people and the Han Chinese who dominates the Chinese state that wants to have more authority over its gateway to Central Asia. Unlike political/ideological problems, Kashgar's richness lies underneath its distinct Uygur identity which is a multifaceted composition of Islamic, Central Asian, Middle Eastern, Chinese, Mongol, Tibetan, Persian and

even Indian influences. Therefore, mass-housing in Kashgar gains a methodological peculiarity akin to an open-ended 3D puzzle game demanding manifold means for an inclusive optimised solution.

In addition, the vernacular organisation of architectural and urban space in Kashgar is worth mentioning. The houses in Kashgar's old town invariably have a courtyard regardless of the householder's social or financial statue. Accessed via narrow lanes, the courtyard typology, by which vertical and horizontal allocation of different functions are composed, displays variation based on affordability. As a religious condition, which is prevalent in other Islamic historical cities, the balance between privacy and sister/brotherhood defines visual and spatial permeability in the old town via courtyards and lanes. As a consequence the old city is a product of interwoven arrangements, whereas strong social relationship is fundamental for its agglomeration that grows from the mosque as a de facto standard.

Apart from the data gathering and design aspects of this research, the third focus is Kashgar's digital heritage by making use of gamification techniques. Considering that large-scale projects under construction, it is a bit late to save Kashgar's architecture in real terms. By digitally recording and displaying its history through different media, *quasi-GRAMMARS* is projected to bring out creative presentation and exhibition means via gamification. But this aspect belongs to the proceeding stages of this research.

3. GAMIFICATION AS A MEANS FOR USE OF SHAPE GRAMMARS

3.1. What gamification is not

The term of gamification might sound novel however its use dates back to the beginning of the last century. In 1912 *Cracker Jack*, a snack brand, started to give toys as a gift in their boxes. Although gamification in this research is meant to be 'collectively productive', with this instance its focus might seem on the marketing domain that is to encourage for more 'consumption'. However, by and large, gamification is described as the use of game design elements in non-game contexts (Deterding et al. 2011). Depending on familiarity, there are varying common assumptions towards gamification. The following paragraph informs us on what gamification *is* and *is not*.

First of all, gamification is not turning everything into a game. The purpose of gamification is not to pull us out of reality but rather finding what is not boring in an activity that usually requires collaboration and engagement. This is neither to say that they are 'serious games' which are used as training and learning environments such as in military and education. The focus of simulations in serious games is on testing the abilities of learners and on improving their skill sets in a virtual environment similar to real conditions. On the other hand, game theory is to mathematically analyse decision-making 'strategies' or individual 'choices' (Kelly 2003, 1), whereas gamification may be helpful to improve collaboration for 'a choice' and encourage involvement in 'a strategy' (Kapp 2012, 9). Also, points, badges and leaderboards (PBLs) are irrepressibly penetrating into every aspects of our daily lives in tandem with the growing use of social media. PBLs are one of the most common game elements however they are not sufficient with regards to what games and game design can provoke. We can gamify a situation by thinking like a game designer, which is different than being a game designer. With gamification, we break down games into elements that are explained below.

3.2. Game elements: How?

The largest LAN (Local Area Network) party with around 11,000 participants was recorded at DreamHack Winter 2007 in Sweden (www.guinnessworldrecords.com). What is intriguing about it is that the focus is on "everything you can do with computers" combining fun activities with learning and sharing, such as gaming, communication, programming, designing, music composing, etc. (www.dreamhack.se). Admittedly, games play a major role in societies being shaped by the 21st century culture of gadgets and devices. Use of on-

line games is constantly in increase as a business and marketing strategy to motivate people in engagement and sharing (Zichermann and Linder 2010, 47). Huizinga's description names the boundaries of engagement in play and play environments as the *Magic Circle* in which once you enter, "it is sacrosanct for the time being", i.e. the game rules matter most not the real world (Huizinga 1955, 77).

In order to invite the player into the Magic Circle, game elements should be designed properly to prompt engagement together with aesthetics that contributes to the whole experience which we look for. Game elements are classified differently but we use here the one (Werbach and Hunter 2012) which separates them as dynamics, mechanics and components. It does not necessarily require using all elements but integrating ones that will be most efficient in motivating player engagement. Mapped as a pyramid, dynamics are placed on top while mechanics and components step behind them respectively. A list of dynamics may include constraints, emotions, narrative, progression and relationships (Werbach and Hunter 2012). This paper further looks into dynamics as a map to use in explaining a conceptual framework for gamifying an open-collaborative design systems based with shape grammars. Further studies will look into mechanics and components under which the number of elements is higher.

3.2.1. Game elements for mass-housing in Kashgar. As a designed constraint, shape grammars are the rules of the design game. Participants are given priorities once they make a decision which conform predefined criteria relying on Kashgar's grammar. The game is open to changes, i.e. new shape grammar rules can be added to generate different results. However, the more resemblance to Kashgar's character, the more priority is given to get involved in new decisions. This is also constrained by a voting system guided by environmental evaluations such as daylight and wind. At the end of the game, those who lead the leaderboard pay less since their collaboration points are high. Though risky, creative ideas that lead to innovative design alternatives can also be gained through design rules not alike the initial.

Notice that the concept of this proto-game includes at least three game elements which are external rewarding, feedback and cooperation. Besides, we could add a time constraint, levels and storytelling which would be related to intrinsic rewards that has authentic meaning behind. Intrinsic motivators have a more significant place in gamification, e.g. saving the character of a historical city, participating its development and contributing to its digital heritage. Game elements, such as badges and points, do not inherently become external or internal motivators. Instead the context makes the distinction, e.g. feelings gained from mastering a challenge that causes increase in self-confidentiality. Gamification explains intrinsic reward structures by means of self-determination theory (Deci and Ryan 2000). Autonomy, competence and relatedness are the elements of self-determination theory. Autonomy is corresponds to the feeling of doing something meaningful, while competence means mastery from achieving a seemingly difficult task. Relatedness is anchored to connection and interaction within social circles (Werbach and Hunter 2012). Through social connection, designing for such a collective intelligence has the same goal as many other complex systems such as ant colonies which nestle individual actions of many agents in order to harness the best or most relevant outcome (Porter 2008, 128).

Gamification in the Kashgar project works for data collection via social media on which there is a lot of Kashgar photos and individual stories waiting to be identified. They contribute to knowledge in analysing Kashgar and its recent past to understand the pattern of urban life that is often both personal and impersonal. Therefore, it is such a gamified platform that uses the potential of game elements to collect these data in order to expose hidden values and meanings into decision-makers' attention, i.e. the citizens, designers, planners and developers.

3.3. Gamifying Shape Grammars

Based on Kashgar's case, this research seeks a narrative articulation of mass-housing design with enhanced participation. Inhabitants' involvement is complemented with alternatives in the design stage. To produce these alternatives, this research uses shape grammars which are invented by Stiny and Gips (1972). For many, shape grammars obstruct creativity because of its rule-based approach. However, it is widely acknowledged that shape grammars are exceptionally potent when the problem needs pedagogical, historical, synthetic and/or analytical design solutions. Given that mass-housing projects in historical towns require retrospective and tactful solutions, analysing Kashgar Old Town with shape grammars is particularly important to attain a contextual end-product with which the local can identify.

Recent works (Beirao and Duarte 2005; Benros et al. 2007; Aydin and Schnabel 2013) examine shape grammars to achieve a flexible urban design tool focusing on both descriptive and generative sides by taking advantage of their parametric essence. The research of City Induction (Duarte et al. 2012), and the City Maker thesis (Beirao 2012) provide rigorous insight on the problem of city planning, the lack of flexible design tools and integration of shape grammars in urban planning.

Being developed as an urban modelling tool at ETH Zurich, CityEngine is used for the research (Halatsch et al. 2008; Parish and Muller 2012) on quick visualisation of urban geometries derived from built-in and customisable shape grammar rule sets.

Marrakesh (Duarte et al. 2007), Porto (Coimbra and Romao 2013) and Maputo (Barros et al. 2013) are amongst the historical cities that are analysed and/or modelled via shape grammars. These works heavily rely on site analysis to understand their unique architecture style to propose further urban development, whereas Pompeii work (Haegler et al 2009) is a procedural modelling of an ancient city that is visualised as a means of digital heritage. To highlight the Marrakesh work (Duarte et al. 2007), its resultant shape grammars are evaluated in response to energy efficiency based on evolutionary optimisation techniques such as genetic algorithms (Caldas and Santos 2012).

One common aspect of these works is that they point out the strength of shape grammars in being generative and descriptive, and more importantly that their shape grammar use is in parallel with procedural information and evaluation. This research takes shape grammars for granted because they are so practical in solving the complexity of mass-housing projects.

The creativity diagram correlates creativity and designing to playing through copying that is summed up by two activities; recursion and embedding (Ham 2013). The diagram's focus is on learning for beginners who are, without exception, asked to be creative as soon as enrolled for architecture or design education. This is not always easy for a designer who is constantly pushed for time to finish a project on time. However our focus is on a novel mass-housing design workflow which necessarily needs playing designed with gamification techniques.

Two earlier scientific projects use gamification techniques to predict possible protein combinations (fold.it) and DNA sequences (phylo.cs.mcgill.ca). Enabling for a meaningful contribution, Foldit targets to identify new proteins that could help prevent and treat important diseases by crowdsourcing the research through a puzzle game. Aiming at discovering DNA sequences, Phylo is a research in molecular biology to identify new genes. In this puzzle, the players are asked to make multiple sequence alignment so that the research team could decipher the data driven from a heuristic algorithm to be used for the research in genetic disorders like cancer. By making use of collective intelligence, both research benefit from game design since it is computationally expensive to achieve an optimal solution. In spite of a cumbersome process, the two studies integrate a novel approach that is based on the potentials of data collection and management via willingness and fun activities. In other words, it is literally a win-win game connecting instantly available data with scien-

tific studies.

Similarly, the potentials of shape grammars are to be tested with this research gamified pattern which describes the connection between the participant and the rules and tools. In a sense, this pattern is the gameplay of quasiGRAMMARS, to be designed in a narrative way (Aydin and Schnabel 2014). Exploring a new way of story-telling for mass-housing projects, it demonstrates the flexibility of shape grammars as well as their readability by lay-persons. The levels of 'gamification of shape grammars' are as following:

1. **Context**: A design without context loses significance. As a design research, this research starts with the gathering of contextual information. The designer does not have to be on site to collect information but a gamified social web-platform enables everyone who is concerned with the social aspect of the design to contribute to constant data collection. The context of the Kashgar study is its old-town which is a very popular destination for the adventurous. Massive information is to be easily identified through the contribution of these people who are concerned with saving Kashgar as well as their still-fresh stories.

2. **Site Analysis**: This research is about mass-housing design proposed to be as transparent as possible. Apart from narrative and photographic dataset collected through its online platform, the research requires analysing the site more precisely. The site is already under demolition, whereas the fifteen per cent of the old-town is planned to remain as an open-air architectural exhibition. Site analysis is to aggregate on the content collected at the previous step so that a feedback cycle can be parameterised inside the loop.

3. **Shape Grammars**: Having collected various data sets, shape grammar rule sets are to be defined in this stage. The end-target is to achieve three types of shape grammars; anticipated, possible and unanticipated (Knight and Stiny 2001). The first is meant to be a result that is reached with pre-defined rules while the possible shape grammars refer to as the use of additional rule sets. And the last one, the unanticipated shape grammars, is to search new designs that do not necessarily rely on the site analysis, thus rule sets.

4. **Initial Design**: In order to initialise the game, a seed is required. Initial design is provided by the designer who is in charge of the shape grammar analysis.

5. **The Game**: Engagement, motivation, decision-making, negotiation and anything that may be possible in participative mass-housing design take place in this stage. Gamification elements are exploited at upmost but efficiently. The actual framework of this section is the focus of the next stage in this research.

6. **Optimisation**: It is a genetic algorithm that maps the optimisation of decided plans with a pareto algorithm. In order to test the potentials of collective intelligence, this stage can be further developed in a way optimisation can be searched by contribution via an extension of the game.

7. **Last Decisions**: At this stage the game privatises itself only for the dual discussions between its designers and future-users.

8. **Evaluation**: Further evaluation is meant to list the performance of the overall product(s).

4. PARTICIPATORY MASS-HOUSING

Mass-housing projects are carried out for the society native to complex relationships from economical level to aesthetical. Yet, the AEC industry is globally in such a top-down manner that the occupants of the society are mostly limited to participate only in the marketing stage. They can only choose from what is predefined and select the one that is hardly suitable indeed. Instead of what a family may need, it

is at the moment the other way around where families have to adapt to the units usually far away from dealing with family-specific demands. The ideology of 'having a house' has changed from planning and designing the house to fit the individual families to choosing the 'container' units like a product in a mall that the family could best adapt to. By adopting such an open-source system and open-collaborative design strategy, this research examines the need to develop a platform for a relatively bottom-up design approach that allows the participation of its inhabitants giving most of the control back to the people.

Open Building is an approach for building design that was promoted by John Habraken (1961). Habraken proposed two main domains of actions - the action of the community and that of the inhabitants. Without the individual inhabitant, the result is usually uniform and brutal, which we can see in most mass-housing projects nowadays. On the other hand, the community is necessary however, without a design control mechanism, resultant spontaneous decisions may be chaotic. Use of shape grammars offers a control mechanism by means of which participants contribute without knowing how it is run but with a feeling of high-autonomy. Therefore gamification breeds fun, engagement and motivation insofar as to design a platform that increases intelligence by using the power of collective working, like a win-win game.

The Ökohaus (Eco-home) is a project conducted by Frei Otto and Herman Kendell in 1988 for the Internationale Bau Ausstellung (IBA) exhibition (www.laciudadviva.org). It is a collective housing which exercises user participation and open design. Frei Otto sees this as an opportunity to consider new ways of living in high-density urban context. Occupants are selected only if they are willing to spend the time and effort to participate in the design process. In exchange, the cost of the unit are much lower than an average house in the city.

Next21 (Kim et al. 1993), is an experimental housing project that consist of 18 individual housing units. For this project, the focus is more on the building system itself instead of the collaboration process as compared to the previous example. Specific design strategies are generated from the framework of two principal concepts, the system building and the two-stage building. In 1996, they did an experimental remodeling of one unit with the participation of its residents and it was a great success (Sasakura 2005). This provides precedence for the possibility of a participation/collaboration design method and also flexible building system for collective housing.

From the two examples, the participatory process is made possible not only by the designer but also the habitants themselves. The architect prepared the framework or infrastructure for the participation and provide incentives to attract habitants to contribute willingly. In the case of Okohaus, Frei Otto only gave two simple rules, the design had to incorporate greenery and that every space must have enough sunlight. Next21, on the other hand, had unit elements such as facades and partitions set for the habitants to mix and match. The gamification is actually happening in a disguised form which can be improved to enhance the engagement.

5. PRELIMINARY WORK: GAMIFICATION WITH QUASI-GRAMMARS

A preliminary work as a part of an optional course with fifteen MArch students was conducted to see different attitudes in such a "game" without the constraints from the "Gamification of Shape Grammars." A design environment was set up, examining the results that granted significant findings for the framework of this research (Table 1).

The objective of this studio was to observe the struggle between flexibility and control, the conflict of the top-down versus bottom-up approach. To limit the variables, this studio addressed only the collaborative design amongst different designers and users rather than the involvement of the users and the stakeholders. The aim was to investigate the possible problems faced when a group of collaborators come together to design a part of the building.

The purpose was to create an environment that

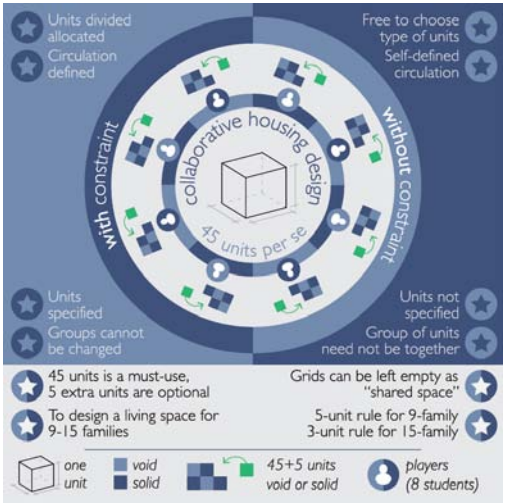

Table 1
Constraints given to participants.

each individual designer would imagine herself or himself living in. Under the condition of a fixed plan layout by the main architect, the designers were each given a number of unit cubes to fill up the plan (Figure 2). Each cube did unnecessarily function as a specific unit, thus being a public space, a void or a green plot. The designers then worked together to generate a circulation such that each space would be accessible. Together with the cubes this rule defined the quasi-grammars in this work. The main architect would then collate the data for the designers to move to the next stage of planning. As they went into details, they would realize some problems and would need to shift their cubes around, which would then require further discussions. After a few rounds of discussion, the designers had discussions about the building outlook, i.e. façade. The main architect collated the plans and models to check if there are problems with the overall model.

The 'grammar' of the building in this case is set by the main architect (the cubes) while the façade is set by the designers themselves. However, every façade design has to follow a main theme set by the main architects which is 'verticality'. The outcome of the final product is a collage of unique façades yet they are following the required rule.

The final designs were evaluated with respect to the quasi-grammars. As the design process was very open ended, the designers could change the constraints as long as the whole group agreed and the main architect's confirmation was given.

By comparing the process and outcomes with the quasi-grammars, we realise that instead of giving specific parameters, it will be more efficient for the main architect to just provide general guidelines and limitations. However, this would also need the main architect to keep close inspection of every designer so that they do not divert too far away from the main objectives.

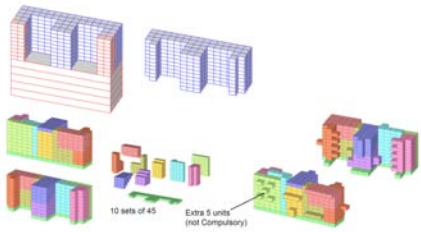

Figure 2
Building broken down into units.

Figure 3
Final product.

6. CONCLUSION

Kashgar's vernacular architecture, its cultural context, local demands, development, political sensitivity, harsh environmental factors and so on, they all comprise a complex intricacy to design a large-scale mass-housing. 'Gamification of Shape Grammars' takes the advantage of each of these attractors within a gamified environment where a participatory and collaborative design strategy is sought so that everybody wins. Gamification is nothing more than a means compared to the design aspect of this research. Efficiently designed, gamification techniques will be subtly integrated into the loop in which standard and non-standard information types will be parameterised with each other. Though predicted, limitations of gamification such as 'pointsification' will be explained in detail in future works. Briefly, it is to say that the design of gamification elements play a major role in creating an engaging experience which is the aim of this project. Another of most significant targets in *quasiGRAMMARS* is to contribute to digital heritage studies in the context of Kashgar. Through gamification techniques, novel presentation methods will be produced. In this paper, the framework of the *quasiGRAMMARS* project is presented. A preliminary study is conducted to draw a draft for the next stage in Kashgar mass-housing research. Proceedingly, an online platform for data gathering will be initiated and field-trips will be carried out as a part of site analysis in Kashgar.

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