Chapter 44
New Proposals for Sustainable Design: The Imitation Game as an Experience of Shared Co-design

Alessandro Rogora

Abstract The paper is related to the research *The Imitation Game* financed by the Politecnico di Milano. The Imitation Game is a serious game to drive design decision at urban scale versus sustainable scenarios, and it is currently under testing with the students of the Construction and Sustainability Design Studio. The hypothesis is to make the game available for citizens and designers in a coming future. The aim of the research was to define a simplified procedure to roughly estimate the effect of the behavior of people in a given area in terms of land necessary to support their lifestyle.

To calculate the amount of land required, all the consumptions have been converted into biomass (wood, biofuel, food, ...) and then into land surface to produce such biomass. Each player plays referring to a different census section of the town and has an amount of money related to the consumptions in the census section (heating, transportation, electricity, etc.). Players have the ability to modify their behavior that reflects people lifestyle, which means that any change in the player’s personal behavior affects the results of the play, as if a percentage of the population adopted that behavior. The Imitation Game was structured as a board game in which players (students) can gain extra points performing specific activities (i.e., reading books on the topic, performing activities), can play technological choices (available as cards in a deck of cards) and can modify their behavior to affect the final results. A Web site with the rules and examples for the Imitation Game has been prepared for the students.

Keywords Gaming for sustainability · Co-design for sustainability · Sustainable planning

44.1 Do You Like Gaming?

The application of gaming as a participatory approach not only develops the learning process but also gives the participants a better understanding of the explored
situation through interaction. Accordingly, games are viewed as realizing “real-world problem-solving” and educational tools, creating environments for achieving consensus, community interaction and learning [1].

To play is not a simple heritage of our childhood; to play is an experience forcing people to look at the way other players interact to each another. In a team play cooperation becomes a winning element. To play a game gives you the chance to combine strategy and intuition, as well as creativity and respect for the rules.

The term “gaming” initially appeared in quite few numbers of academic papers, related to business, political science and urban simulation [2] but in the 1970s, the work of Professor Richard Duke brought games into the urban planning arena and university context. This is considered as the starting point for today’s developments in the design methodology of simulation and gaming [3].

Yet, games are preceding phenomena, which have been applied from the late seventeenth century as a medium to search the world [4]; but is playing a game an effective option for sustainability? … and more: can we experience different options to choose consciously the most appropriate one between several? It is possible if we use games «designed with a purpose that goes beyond mere fun» [5].

The consequences of our actions are sometimes hidden or unknown, and the absence of tools to evaluate the effects of each single choice forces us to ignore these relationships. Role-play games can be helpful for the ability to jump from the virtual plane to the real one, making similar to “real” alternative options. In our mind, this opportunity is of the highest importance both for designers, politicians and administrative staff to experience different options and to drive decisions properly.

Gaming has been argued as an effective tool for participatory design, discussing an array of environmental games, their rules, concepts and methods, providing a guide to architects, researchers in the field and teachers [6]. We have examples of climate change games and research work by Reckien and Eisenack [7], and by Wu and Lee [8], but there is never a direct participation of the players who can modify the result of the game by changing their behavior. In the imitation game, on the contrary, the modification of personal behaviors is a key element for success in the play and the learning process versus sustainability. We are absolutely convinced that every sustainability strategy must include a necessary and profound reinterpretation of one’s personal lifestyles.

Citizens tend to delegate their representatives to institutions through the voting process of the Major, but after this, there is a sort fracture between citizens and politicians. A condition of dissatisfaction generally follows the delegation process, and this loop is both neither acceptable nor sustainable. To arrive at a more successful result in term of sustainability, people have to change deeply their way of life because sustainability does not allow delegation processes; everyone has to make his/her part, and everyone must act firsthand.

To favor appropriate engagement strategies, the use of serious gaming is considered an interesting option to give the change to experience and learn playing a game [8]. *The imitation game* is the ongoing result of a research financed by Department of Architecture and Urban Studies of the Politecnico di Milano University.
44.2 Methodology and Case Study

The game is structured into three parts related to:

- The definition of the impact of citizens behavior in term of land necessary to support the current lifestyle. The lifestyle was described using six sections and three sub sections, for a total of eight:
  - Nutrition food;
  - Moving transportation;
  - ResideHouse (three separate sub sections: heating, electricity, hot water);
  - Clothing clothes and shoes;
  - Socialize communicate, bar, restaurants, vacations;
  - Hobby well-being, culture hobby, sport.

A ninth section was introduced to consider the energy consumption related to the infrastructures, and the value of this last category is calculated as a percentage of the entire consumption of the previous eight [9].

- The definition of the available budget usable for technical transformation and the related effects in terms of reduction of land consumption;
- The modification of personal behaviors and the related effect in reducing the land surface to support the design proposal (Fig. 44.1).

We subdivided the energy consumption into eight + one sections that describe people's lifestyle giving a greater degree of detail to those sections in which it is possible to manage the effect of design decision [10]. Objective of the game is not to arrive at precise calculation of each section, but to give the player a comprehensive view of the problem of sustainability using the metaphor of surface of land to support the current lifestyle [11, 12]. The land consumption—compared to the available one—has a greater impact than to indicate value in MJ (that are not physically perceptible) or even with the surface per person that remains a meaningless number with no reference to a local situation. At the moment, “detailed” calculations are

Fig. 44.1 Distribution of the impact in term of land consumption for each section of the game at Rescaldina (MI)
used to calculate the energy consumption of buildings (heating, electricity and hot water) and transportation, while for the other sections values are based on average values. More precise calculation systems may be adopted in the future. For now, we are satisfied with a general, rough simulation useful to start playing.

The final result of the play for each team is described through a list of values (m² of land per section), a graph of the consumption for the current situation, the new design proposal and a reference sustainable behavior and a graph made of four concentric circles representing:

- the available land (in an urban area it will be the inner circle);
- The land consumption related to the current lifestyle (in an urban area, it will be the outer circle)—that represents the land surface necessary to support people living in the municipality;
- Two more circles that in an urban area, it will be in between: one is related to the final design proposal (due to technical modifications and changes in lifestyle) and one to the so-called strong sustainability (that represent an environmental oriented behavior of the citizens under 2000 W—[9]).

Three more indicators related to both current lifestyle, design solution and reference sustainable lifestyle are calculated. They are the population that can be supported with the available territory, the Regional Sustainable Index and the National Sustainable Index. These two indexes try to relate the adopted lifestyle at a regional and national level considering the amount of available land that can be used elsewhere [10] (Fig. 44.2).

In rural areas, the amount of available land could be higher than the one required to support current lifestyle, while—on the contrary—in urban areas the available land will be far from the necessary surface. Objective of the proposal is to reduce to the minimum the land consumption and to have NSI value higher than one that means to have a sustainable behavior at national level.

Each team—made of three students—plays with a different census section of the town, but the results per person are somehow comparable. The results of the different competing teams can be both compared to define the winner, as well as can be discussed between the players to find out a different mix of shared, appropriate decisions for the playground.

The first match was played in Rescaldin (a medium-sized town of about 14,000 inhabitants located in the north of Milan) by the students of the Construction and Sustainability Design Studio at the School of Architecture, Politecnico di Milano. The 34 students were divided into 11 teams, and each team played with a different census section.
44.3 Data Organization for the Play, Sustainability and Social Acceptability of the Design Proposals

A design choice must be sustainable, but has to be both economically viable and socially acceptable. The economic feasibility is given by the limited amount of money available for each player (or team), while the social acceptability is represented by the willingness of players to change their behavior for a significative period of time to make working the required transformation. The amount of money that can be used in the play by each team was originally set on 15 years of energy consumption calculated for the entire resident population; in the second play, the value of 15 was increased to 20 years. The “significant period of time” for the behavior change was set on the entire duration of the play (one university term). This is a critical issue, because one single term cannot be completely used to play. The first month is generally used by the students to calculate the values to start playing, and the three remaining months are a quite short period.

The most efficient use of the available money is one objective of the play, together with the definition of an acceptable pattern of behaviors. On the other hand, a deep modification of players’ personal behavior and social values is part of the learning process forced by the play.

We decided to play using census sections because census section is the minimum information unit for which to have specific available data from National Institute
of Statistics (ISTAT). The organization of the original information was in charge of the *Magister Ludi*\(^1\) that made data and drawings available to the players. When possible specific local data have been used, in case of missing information, regional or national data have been used to simulate the current lifestyle in term of (land) impact.

For each of the eight sections, the specific consumption was calculated (e.g., energy consumption for space heating or kms per year per person); these values have been then translated into m\(^2\) of land using appropriate conversion factors [10]. The surface of land to supply food depends on the personal diet; in the game, the evaluation is direct: for example, a Mediterranean diet weights 1.800 m\(^2\) of land, a meet-based diet weights 2.200 m\(^2\), while a vegan diet is only 808 m\(^2\). For other areas of consumption, the calculation is more sophisticated and detailed: for example, the space heating depends on the building typology (building shape and building technology) [13]. The energy consumption is translated into the amount of biomass (wood) to burn to obtain the required thermal energy, and from this, a land surface can be obtained. To calculate the land surface to support mobility, it was decided to consider the production of biofuel and the related land surface to grow sunflower.\(^2\) More detailed evaluations methods are expected (and welcome) in the future with contributions coming from specialists and researchers of different fields of knowledge (the focus of the game is for architects and urban designers).

Nine datasheets have been prepared: one for each section (or sub-section) and one main datasheet (named game) where all the results coming from the eight datasheets are imputed and stored (Fig. 44.3; Tables 44.1 and 44.2).

\(^1\)The name Magister Ludi—Latin for “Master of the Game”—comes from the book “The glass bead game” by Herman Hesse. The Magister Ludi is not necessarily a single person, but defines the group of people that prepared the data and the information for the play. In the Construction and Sustainability Design Studio, the Magister Ludi was represented by Prof. Alessandro Rogora, Prof. Alessandro Trevisan and Arch. Ilaria Belotti.

\(^2\)Values of land production are referred to conventional agriculture that is considered largely unsustainable; values for biological production in agriculture are expected to require greater land surface. The working team is debating whether to use this value in the next release of the game.
As previously reported, the amount of money that can be used by each player (or team) in the first play was originally set on 15 years of energy consumption. After one play, the hypothesis was to increase to 20 years of savings and to add both the costs for buildings maintenance as well as the money saved adopting specific strategies or behavior (e.g., biking causes less accidents). This will produce a significant increase into money availability to play the next play and will refer the timeline to the conventional 20 years of payback time used by most Italian Energy System Company.

### 44.4 The Game and the Simulation

The complexity to analyze the entire town of Rescaldina (14 211 inhabitants at May 2020) and the necessity to keep the appearance of a classic board game—where luck can play a certain role—forced us to give each player (or team) a different census section to work with, a population between 300 and 600 persons and a number of buildings between 100 and 250. It means that each team will calculate different consumptions, will receive a different amount of money and should adopt different strategies to get the best possible result because of the difference in terms of building typologies, construction period and technology, as well as the different family compositions of the census section [14].

To make the final results more comparable between one another, the evaluation was weighted on the population of the census section; it means that we have a consumption pro person and the original impact depends on the section analyzed. To define the winning proposal, we decided not to use the raw land impact, but to calculate the ability of each player to decrease the original impact in percentage. Using a percentage, the result is a bit easier to compare, while the land surface could be strongly dependent by specific conditions that affect energy consumption (e.g., old cottages instead of recently built multi-story buildings).

The adoption of specific behaviors by the players produces the most effective results and with almost no cost. On the other hand, biking instead than using a car, or to cultivate a vegetable garden is easy to declare, but far more complex to live, that
is the way students are “obliged” to adopt the behaviors they declare for the entire period of the play (one university term).\textsuperscript{3}

We experienced that a small modification of personal behavior is easy to obtain, while significant variation can be difficult even during the play. To make the game more effective as a training experience and closer to reality, each player represents a percentage of the population of the census section, and to affect a larger percentage of the population, players need to convince more people to adopt sustainable behaviors. One player adopting a behavior represents 20\% of the population, two players 35\%, the entire team (generally three players) 45\%, but to arrive at 80\% of the population (we assume that 20\% will never accept the behavior or could not adopt it because of physical problems or similar), it is necessary to convince 14 people to adopt such behavior for the entire play. During the first play (October 2019–January 2020), this was a really great and hard work, and only very few of the eleven teams could convince relatives and friends to share their behaviors (Figs. 44.4 and 44.5).

To promote students’ training in sustainability, we adopted the idea to give some bonus to the players both to enliven the play and to increase awareness and to spread the themes of sustainable living among people. Bonus is related to activities of: self-training, information and practice. The self-training activities include reading books, attending seminars or online training on local sustainability issues, participation in courses for artisan training (weaving, carpentry, cooking, sewing, etc.) or artistic (singing, music, dance, painting, etc.). The information activities include the

\textsuperscript{3}The COVID-19 pandemic forced us to modify the rules for the second play running during the Spring Term 2020 because people had no possibilities to modify their behavior with reference to mobility. For this play, we decided to exclude this category from the evaluation of the design proposal.
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The 10 selected buildings showcase the variety of buildings in:

- floors (1-3)
- footprint [0-100m²; 100-300m²; 300-600m²; more]
- built period (1930s-40s; 1950s-60s; 1970s-80s)

**Fig. 44.5** Selection of reference buildings to calculate energy consumption (heating, electricity and domestic hot water)

organization of social activities, promotion and dissemination via the Internet, the creation of blogs, the promotion of craft and/or artistic activities, etc. Practice activities include soft gymnastics (Qi Gong, Yoga, Tai Chi, Nordic walking, etc.) meditation, bike fixing, craft and artistic activities (painting, sculpture, music, theatrical activities), etc.

The list of different practices and the related effects is recorded in a dedicated database available to the players and can be downloaded by the ImitationGame Web site [15].

### 44.5 Conclusions and Further Development of the Research

The academic discussions as well as the recent contributions of experts in the field not only reveal that three applications of games as “tools for design; for teaching/learning; and for research” are still identified, but also some new games serve dual or even triple aforementioned purposes, at the same time [3].

Our experience of the use of gaming in teaching is positive, even if we had some problems in fixing the rules during the first play and the COVID-19 pandemic made difficult to play properly the second play.

The second play is currently running (Spring Term 2020) at the Politecnico di Milano University. Now, the rules of the game have been tested (and partially fixed), and it means that the students can be more concentrated on the play. The calculation datasheets work better, and the results of the second play are easier to compare with each other.
Students prepared and shared a deck of playing cards with all the technological solutions that can be used in the play; at the moment, we have about 70 cards, but new ones can be added during each play if needed. The cards are related to technologies like wall insulations, PV panels, electric vehicles, etc., but also to less usual solution like sun ducts, solar cooking, passive greenhouses, hydroponic pots, etc. Each of these has a cost and an average effect, and it means each solution can be used for a better design proposal in terms of reduced land impact.

In the second part of the term, all the teams moved to the building scale. The idea was to use the same approach in the retrofitting of an existing building of the early 70s (destination: social activities + two apartments). The proposal was to estimate the land impact of user’s behavior at the building scale using the same procedure adopted for the urban proposal but increasing the detail of specification. This experience is running in these days, and our hope is that the final results will be as interesting as the evaluation at the urban scale.

The next step of the research will deal with the migration of the game into a dedicated software, and the hypothesis is to start working on the evaluation of “social happiness.” Basic biological needs could be satisfied to survive, but humans look for more than mere physical survival. They need a safe, healthy and pleasant environment in which to live safely with loved ones, having enough food to eat, clothes to be dressed, time and support to socialize. If our ambition as designers is to give humans a positive environment where to live, the simple evaluation of energy consumption—as well as related land surface impact—is important but not satisfactory to define if a design solution is appropriate or not and which one is the preferable option between two that are quantitively similar. This is an objective far from the solution, but for sure an interesting topic to work on.

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