Playable Modeling: Interactive Learning Process in Science and Art

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Abstract. Models are simplified and idealized representations of everyday reality or imaginary truth. Scientists use all range of models to assume, analyze, simulate, as well as artists use them to imitate, imagine, query. No matter what the usage of models are, modeling would be a desirable working process and interactive media to interconnect and even interconvert in between science and art. Some models invented by the professionals but encouraging common people to manipulate and interact with them, they are mainly used for learning purposes. This paper will interpret the principles of several common playable models, such as Tangram and building blocks, and a new invented versatile model, Tangram Blocks, in order to analyze essential activity of interactive modeling process in these playable models, then use these models and their modeling methods to play with uncertainties and possibilities for future learning. This paper also will explore different formulas and approaches of modeling that can help people understanding science knowledge or art thoughts, especially in the museum and gallery context as an interesting, playful, interactive visiting experience. The playable modeling as a creative learning process could open participatory opportunities and led interactive co-operation for the scientists, artists and general public. It helps us to communicate and understand each other, then to stimulate imagination and variable future possibilities.

Keywords: Playable Models · Modeling Learning · Tangram Blocks · Museum Participatory Experience

1 Introduction: Modeling and Its Playable Possibilities

In science studies and artistic creations, even philosophy thinking, modeling is a fundamental methodology to simplify and analyze complex systems, in order to master the essences of things. On the one hand, models are abstracted from reality but beyond the real world, it functionalizes as bird's-eye view or the extracted quintessence. On the other hand, models have their fictional and suppositive nature that indicate uncertainties and unreality.

The development of science and technology as well as the division of social classes, it makes us living in a specialized world that's being sliced finer and finer. People are hardly to understand each other and common senses are difficult to reach. In other words, we can't see the wood for the trees. The harm of this subdivision tendency specially embodies in the learning process which is an essential living skill of human beings. When scientific

A. Marcus et al. (Eds.): HCII 2023, LNCS 14033, pp. 185–199, 2023.
https://doi.org/10.1007/978-3-031-35708-4_14

terminologies and contemporary art concepts are too obscure and unreachable to the general population, it stops us from interesting and approaching deeper knowledge and understanding in science and art. To resolve this learning crisis, could models, especially the interactive ones which allow people to play with, be useful to enhance intellectual curiosity? This paper would like to explore and discuss the possibilities of playable modeling as a powerful learning method and process for fostering and improving deeper understanding of complex issues. If this public engagement through interactive modeling could be established, it may in turn positively influence science and art development.

2 Modeling, a Creative Methodology in Science and Art

Modeling is widely used in most of scientific field to approximate represent real-world objects and phenomena in a logical and objective way, as well as arts and humanities consider modeling as props to "prescribe imaginings" and "generate fictional truths" [1]. The creativity of modeling builds on its suppositive nature, it is more like an ever-changing process rather than a given answer. Conceptual models help us to transfer complex nature phenomena into useable and apprehensible mental models, even we do not completely understand a complex system, we still can manipulate it through models. The scientists and designers' work is how to provide appropriate conceptual models for the people, for more complex system, models are more important. Some models are the result of researches, some are presented as an ongoing process that can be manipulating by the users. Modeling that can be engaged by most of people is full of adventures, serendipities and uncertainties, which is similar to create an artwork. How modeling works and processes creatively will be demonstrated in the following sections.

2.1 The Principal, Process and Purpose of Modeling

Every model for different subjects and purposes has its own formulation. However, there are some general principals within models. Models can be considered as outline and skeleton of things and phenomena; they omit the details and nonsignificant aspects. The modeling process could sort order in six stages as described below.

Observation. The modeling process starts from observation that looks at an object or event in both holistic and detailed ways, both objective and subjective aspects. If we can observe a phenomenon from reasonably wide areas as much as possible, the model we made will be more precise and representative. Anatomy and sampling in the science provide modeling details and data, observational drawing and sketching in the art give modeling materials to shape and generalize.

Simplify. After observation, we may recognize the complexity of real things and phenomena, too many of details and branches stop us to clarify the true features and core. Therefore, simplify is the very important juncture during the modeling process. For example, in data science, a model is a certain type of algorithm to analysis and summarizing huge amount of data, then to present them in a simple and clear diagram or chart.

People don't need to read all the data in the background, they can find the information they need directly from graphs of the models.

Abstraction. Simplifying and abstracting are commonly considered as an integrative process in the modeling. The creating process of Piet Mondrian's pure abstract painting could visualize how abstraction works. His use of vertical and horizontal lines to structure his painting, these lines are transferred from the real landscape drawing from step to step. In every step, his arrangement is reducing some contents of original observation drawing, until there are no clearly discernible concretes.

Visualization. After abstraction, the result will be presented as a model, which is a general shape object or a graphics.

Variation. The last two phases may not happen in every modeling process. Only the models allowed adjusting and manipulating can be varied. By repeatedly using a conceptual or fundamental model, more practical models can be derived from it.

Creation. Especially in art, some versatile models can create multiple usage, such as human skeleton model in 3D modeling.

2.2 Modeling Types Allow Participating

Not all the models could be allowed people to manipulate them, some models are fixed by their creator as formulas, for example, the Pythagorean theorem; but some other models need people to involve, to change and to verify, such as Atoms and Molecules or Domino, the chain of conduction.

Modeling Atoms and Molecules. As atoms and molecules, can't be observed by naked eye, it is hard to describe their forms only by pain text and illustration. Thus, scientists had invented different types of models to represent molecular structures. Because of the variability of atoms and molecules, most of models are changeable, especially when the models are used as teaching aids.

There are 3 common molecular models: ball and spoke models, space-filling models and crystal lattice models [2]. Two of them have open structures, and the other one has designed both re-useable and permanent. Students could recognize how atoms bond together through composing ball and spoke models; and they can notice the size and shape of the whole molecule through adjusting the space-filling models; and then their teacher can demonstrate the spatial relationship of atoms by using the crystallographic models.

Developing and using models is an important practice at the middle and high school level, it helps students to understand more and more abstract contents of science. In this phase of learning, when the scale of physics and chemistry contents is much smaller or bigger than which we can directly see or touch or experience, modeling will be the most intuitional way to understand these topics.

Dominos: Chain and Relationship. Dominos is originally appeared as a family of tile-based games; but then people extend its cumulative effect to explain some chain reactions, literally as series of mechanical collisions and metaphorically as causal linkages and relationships within systems. Thus, dominos can be considered as a kind of playable models, using it and it variants can easily visualize the cause, effect and variate of an event or a phenomenon.

In the TV series "Genius by Stephen Hawking", the volunteers make an experiment with a domino installation called Machine of Life to demonstrate how the life comes from. Sustained by the correct input of energy and installing order, the machine transfers an impulse from one place to another. Each installation part moves following the laws of physics and together they keep the impulse moving as a chain effect.

3 Modeling as Learning Process

As a fundamental learning process, modeling help humans to understand the world and human beings from childhood to adulthood. Learning through modeling is not only suitable for the early childhood education, but also important for the advanced study continuing in our lifetime. There are mainly two kinds of modeling learning. One is to imitate models, such as people's activities or behaviors, it also called observational learning; the other is to form models, whatever it is physical or virtual model, conceptual or practical model.

3.1 Modeling Learning as a Social Behaviour

Modeling is mentioned in Albert Bandura's social learning theory as an interaction in between environmental and cognitive factors influencing human learning and behavior [3]. During the modeling, especially playable modeling process, children are observing, modelling, and imitating the behaviors, attitudes, and emotional reactions of each other. They are not only learning the knowledges through manipulating the models, but also learning how to communicate and socialize with others.

3.2 Set Model Learning as a Game

Learning as playing, there are a lot of participative models that set as toys and games. Puzzles, such as Tangram, an ancient Chinese puzzle, help people to understand the relationship in between shapes and colors, entirety and portion through placing. Building blocks, such as LEGO, in wooden or plastic materials set as toy modules to let people cognizing 3D shapes, extending their space perception and training their manipulative abilities through building. These puzzles and building blocks can be considered as playable learning media for children and students, their variable forms and extensions also can be advanced used in business strategies, art installation, scientist analysis and architecture or furniture design as prototypes or study tools for professionals and researchers.

Props and Toys. Props, are usually seen in the film and TV to simulate real world scenes, but they are also used as teaching models, for example, assembled plastic heart and head on the anatomy class. For the young children, toys can act as models to let children learning through playing. When we are toddlers, toys are simple-shaped and colourful, which help us to cognize the basic shapes and colours.

Recreational Mathematics. Recreational mathematics is mathematics hidden in the amateur activities, such as Sudoku and puzzles. It is not necessary to know the formulas and theorems; children or untrained adults can solve some maths problems by simply playing the games. So, it may can inspire them to seek for further learning about mathematics. Sometimes, professionals also use puzzles, Rubik cubes and other forms of play as basic models to deduce and predict.

Block Play. In our childhood, when we are playing the building blocks, we are having fun and we don't realize there is a process of learning involved in the playing. This open-ended and no-rules play is called Block Play; it was recommended by Friedrich Froebel in the early 1800s as an early learning strategy using wooden blocks play to help with child development [4]. To construct the blocks, normally made by wood or plastic, young children need to apply a range of abilities, such as mind-hand coordination, modeling ability, imagination and communication skill.

The physical movement and motor coordination abilities also can be trained through block play. Carrying, lifting, stacking and adjusting, these constructive actions involve both gross motor skill and fine motor skill, especially precise finger movements. We are always playing building blocks with our fellows, it is a common social event that happens at our early age. So, language skill, communication skill and cooperative skill can also be developed.

4 Tangram Blocks: A Possible Versatile Model

Puzzles game and building blocks could be regarded as serial playable developmental models. They are invented by scientists, artists or designers for amusement or knowledge popularization purpose. Although these kinds of modeling games normally carried out as children's toy and endeavour for amateurs, actually, they are not as simple as that and they have more potentials. Deep ideas that are hidden in puzzles and building games, such as mathematics, cognitive science, logic, configuration management and communication. Various forms of play allow people to explore and understand these deep ideas in a voluntary and active way.

Therefore, there would be some possibilities to create and formulate a versatile model and its gamified modeling process which can suit for most of learning and usage scenarios. Extracting modeling methods and rules from Tangram and snowflake building blocks, next content will assume a new puzzle building game named "Tangram Blocks" that can be a tryout of playable model combining geometry, construction and fractals.

4.1 Tangram, the Chinese Wisdom in Puzzle Game

Tangram (Chinese: 七巧板; 'seven boards of skill') is a seven-pieces dissection puzzle originate from China, its history can be traced back to at least the first century BC. Scientific historian and biochemist, Dr. Joseph Needham, mentioned in the serial book "Science and Civilisation in China" that the Tangram is "one of the oldest oriental entertainment" [5]. Seven flat polygons, named *tans*, which can put together to form more than 1600 shapes, such as triangle, parallelogram, irregular polygon and all kind of figures, animals, architecture etc. The design and playing method are finalized around the Mind Dynasty (later 18th century) and then spread to American and Europe by trading ships in the same period.

Though Tangram's design is minimalism, it had created over 6500 different tangram problems, and the current number is ever-growing. Tangram is the best example of playable modeling for creative learning in both mathematics, shape recognition and art. Following, we will try to explain how Tangram as a playable model enlighten variable interactive learning process to achieve different educational aims.

Geometric Learning. The in-and-out complementary principle, established by Liu Hui [6], the third-century famous Chinese mathematician, is the main mathematics theory behind Tangram, when a 2D or 3D geometric figure to be divided to several parts and then to be displaced to the other positions, its total area or volume is invariant. Tangram could be considered as a square (sides 1, area 1) divided to 7 polygons, including 5 isosceles right triangles, 2 small ones (hypotenuse $\frac{1}{2}$, sides $\frac{\sqrt{2}}{4}$, area $\frac{1}{16}$), 1 medium one (hypotenuse $\frac{\sqrt{2}}{2}$, sides $\frac{1}{2}$, area $\frac{1}{8}$), and 2 large ones (hypotenuse 1, sides $\frac{\sqrt{2}}{2}$, area $\frac{1}{4}$); 1 square (sides $\frac{\sqrt{2}}{4}$, area $\frac{1}{8}$) and 1 parallelogram (sides of $\frac{1}{2}$ and $\frac{\sqrt{2}}{4}$, height of $\frac{1}{4}$, area $\frac{1}{8}$) (see Fig. 1). All 7 tangram figures can satisfy particular geometric properties, such as convex polygons. Using Euclidean isometries, tangram usually apply to form dissections of prescribed polygons in the mathematics classroom. According to student's level, teachers will ask them to arrange different prescribed polygons, for example, triangle, quadrangle, pentagon and hexagon. Students will learn geometric knowledge about the Pythagorean theorem (the *Gou-Gu* theorem in China), the in-and-out complementary principle, calculating perimeter and area through the dissection of different polygons.

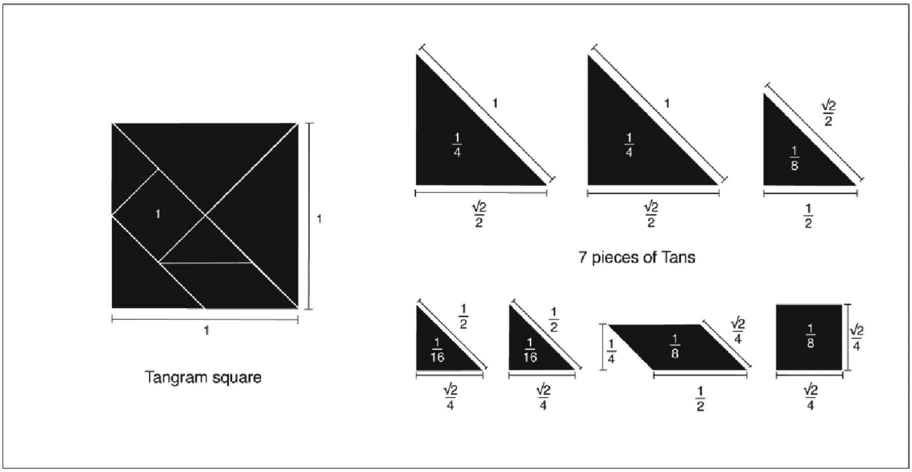

Fig. 1. Tangram set and its measurement.

Tangram is widely used in the senior class of kindergarten and junior class of primary school to teach children of basic geometry. Tangram playing helps the young age students to stay focus and motivated thinking during the course learning. Rather than only listen to the teacher, students can hands-on composing the geometric figures and explore different solutions to geometric questions through numbers of trying. Under the instructions of teacher, the learning process using tangram could be set as individual activity or group work. Firstly, teacher can ask students to observe the relationship in between seven tans and try to piece together. For example, the 2 small isosceles right triangles can form the 1 middle triangle, or the 1 square, or the 1 parallelogram, then the 2 small triangles and the 1 middle triangle can form the 1 big triangle. Secondly, students can be divided to the groups, teacher can give each group an outline of a common convex polygon, such as triangle, square, rhomboid or trapezoid, let students to construct with all seven tans without overlap. If this challenge is easily solved out, teacher can upgrade the challenge to arrange pentagons and hexagons. According to Wang and Hsiung's research paper "A Theorem on the Tangram" [7], using all seven tans, there only exists 13 convex tangram configurations up to isometry. Thus, the convex tangram configurations of tangram are not too complex above the understanding of primary school students. Because of its simple and intuitional, tangram is a perfect playable model for basic geometric learning.

For the senior students in the primary school, tangram could help them to calculate perimeter and area of both convex polygons and concave polygons using the in-and-out complementary principle. If a complex polygon can be formed by tangram, students can dissect the complex polygon into tans, then recomposed the tans into a simpler sharp for calculating. There may exist more than one solution to the question, so playing with tangram could motivate students to find out different approaches as more as possible.

Training of Shape Recognition and Configuration. The common playing method of the tangram is to replicate patterns with given outline or silhouette using all seven tans without overlap. Gestalt principles are involved in the gameplay, for example, proximity, similarity, closure and figure-ground relationship, so, playing tangram is a training to strengthen our perceptivity and coordinate our mind and hand.

The accessary puzzle book of tangram normally put outlines/silhouettes of patterns in the front of a page and the schematic patterns to show how they are formed by tangram in the back. Therefore, we can play the tangram with the puzzle book in 3 degree of difficulties:

- Level 1: To configure the pattern according to the schematic pattern on the puzzle book. This easiest way is mostly for the young children aged 3–5, it helps them to cognize shapes and colours. Each piece could be considered as an abstracted part of a figure, such as a cat ear, a dog feet or a human face, arranging these seven tans can carry out different shapes of one figure. The learning process through this play is from abstract parts to configure the figural whole, then the parents or the teacher can guide the young children to link the tangram figures with the daily things.
- Level 2: To replicate patterns according to their outlines or silhouettes. This way of play requests the skill to dissect the figure into parts, it needs more imagination and numbers of try. Tangram can form more than 1600 patterns, there are many possible try-outs for the players. The pattern numbers vary from 100 to 1000 on the puzzle

book, which are aliened by difficulties of recognition and configuration. From front to back, the patterns are from simple to complex, from figurative to abstract, and could be divided into catalogues, including animals, humans, architecture and objects. The richness and various of tangram configuration makes it suitable for all range of age groups, and perfectly act as a family game.

- Level 3: To recognize tangram paradoxes. In the thousands of composed tangram patterns, some are paradoxes that two or more patterns look similar but have detailed difference. For example, the famous two-monk paradox [8] (see Fig. 2). Presents as two similar shapes, one has a longer body and the other one has one more foot. The subtly differences of two monk figures need the players to distinguish from the outline/silhouette, then use different composing to form two monks. Playing with third level of difficulties, the players could learn how to coordinate with higher visual acuity and multiple problem-solving thinking.

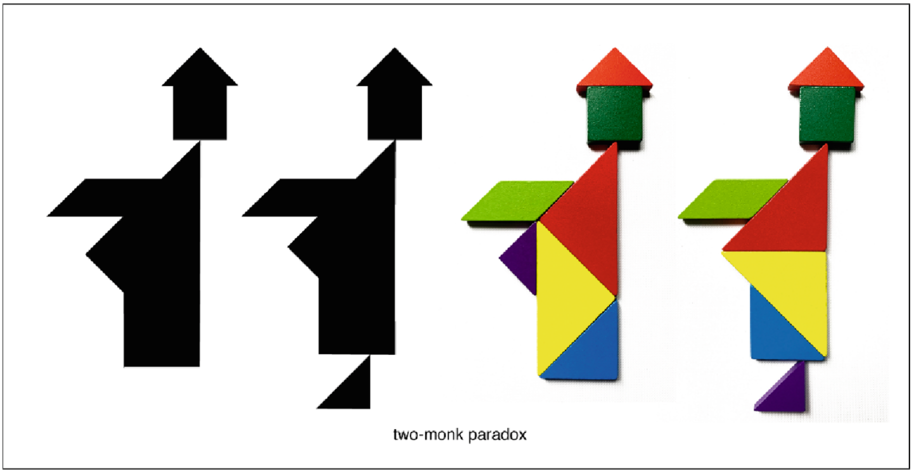

Fig. 2. Two-monk silhouettes on the left and their different tangram composing on the right.

Learning of Abstract Art and Story Telling. Tangram itself has inherent beauty of its composition with colored geometric pieces. Set of tangram in square somehow looks like a Mondrian's abstract painting. Mentioned in previous section, Mondrian created his paintings from the abstraction of nature; therefore, the tangram pieces could be excellent models to create abstract artwork. No matter you are child or adult, it can simply use tans as moulds to create a sketch of abstract painting by drawing the outline along the edge of tangram piece and tiling full of the paper or the canvas, then colours could be filled in different tangram triangles and squares to form a latticed abstract painting. Alternatively, to paint colour on the surface of tans, it can be used as stamps that allow children to imprint on different surfaces.

Visualized story telling also can be taught by playing tangram. Teacher can arrange students to use multiple tangram sets to compose figures, houses, animals and landscapes in the story. Then each student can move his/her protagonist around according to the plots, dubbed of dialogues can be finished in the same time. Setting up camera and lighting equipment, students even can make a stop motion animation with tangram composed scenes and figures. It will be a good interactive collaboration for the students to enhance their organizing and communicating abilities.

Art creations have no clear rules and regular process, the variability of tangram configurations gives the players endless possibilities to imagine, to create and to develop.

4.2 Snowflake Building Blocks, the Interlocking Blocks to Form Everything

Block play has been mentioned in the foregoing section of this paper as a gamified model learning process for training spatial skills, it is the earliest touch of modeling in our childhood. There are different types of building blocks, their functions and gameplays are not the same. For example, some are plastic-moulding building blocks, like Lego® bricks and Mega Bloks®, with concavo-convex dots on the surface connected each other by their dots, they can form solid and immobile structure; some are wooden building blocks having thick side surface, they are cubes, triangle blocks, rectangular blocks, arch blocks and semi-circular blocks that pile up to form constructions, but sometime the structures constituted by wooden blocks aren't well-knit and easy to push over.

Besides these common 3D block types, there are some other types of block play using 2D pieces to compose 3D structure. How could these 2D pieces link together and stand up to allow the 3D modeling? There are 3 common designs of the building piece that can achieve the goal:

- Magnet. 2D piece with magnet inside can attract each other to make up 3D space. The magnetic piece is easy to stick together, and hard to pull down, so, it is not easy to control the 3D shape.
- Tenon-and-mortise joint. Making the 2D piece edge tenon and mortise, thus, two pieces can conjunct together with their edges. Sometimes, it is a bit difficult to align all the tenons and mortises when more than two pieces to conjunct together.
- Grooves on the edge. Typically, the 2D piece in this type is in a snowflake shape, which is a rounded plastic piece with 8 grooves on the edge and a hole in the middle. Snowflake shape allows the 2D pieces joint each other from 8 directions, giving a lot of spatial developing potentials.

From variation and creativity aspect, snowflake building blocks is the most flexible and user-friendly design using 2D pieces to make 3D modeling. Because the snowflake pieces are quite small compared to other building blocks, it needs so many pieces to construct a 3D object. Playing with snowflake pieces has more challenge to the players, they need more patience to construct and more envision to imagine the final result.

4.3 Tangram Blocks, Gamified Model Combining Tangram and Snowflake Building Blocks

As tangram is very popular in both east and west for many years, variable game inspired by tangram have been invented and designed, some of them try to add a dimension on the tangram. For example, a 3D block game called "Pangram" using 7 volumes to form a cube, it develops polygons of tangram to polyhedrons by adding a height of $\frac{\sqrt{2}}{4}$ to each side of tans. The gameplay of Pangram is similar to wooden building blocks. Because the 3D shapes are directly pulled up from 2D shapes, there are total 7 slopes on the blocks. When the blocks stacked more than two layers, the slopes are easily slipping that make the 3D structure unstable and limit the configuring possibilities. Thus, to turn tangram into 3D in this way has its natural shortcomings.

Therefore, if we would like to apply tangram to 3D modeling, the better way is to use original 2D pieces to form 3D models. The main difficulty of this method is how to make a stable 3D structure. Discussed in the previous Sect. 3.2, the optimal solution is to cut grooves on the edges of a plate, then interlock each piece to form 3D structures.

The Design of Tangram Blocks. Inspiring from the design and its playing method of tangram and snowflake building blocks, there is a potential versatile model could be invented to accomplish both 2D puzzle play and 3D block play. The new designed playing model named Tangram Blocks, which make use of the original 7 tans and cutting grooves on their edges, then turning 2D tangram into 3D building blocks.

In order to balance weight and enlarge interlock area, the cutting grooves are better to be in the middle or to be symmetrized on the panel. The position and length of the grooves are the key points for the design of Tangram Blocks. For the 5 isosceles right triangles, 1 groove is cut in the middle of hypotenuse, groove reached the barycentre of the triangle, its length is $\frac{1}{4}$ of side length and its width as the thickness of the piece. While, it is to cut 2 grooves in the middle of the both long sides of the parallelogram and 4 grooves in the middle of each side of square, each groove's length and width equal to the small triangle's groove size. Because the large triangles have bigger area, they may have two symmetric grooves, as the same size as the middle triangle's groove, on the two sides to allow more interlocking modes and to support their own weight in the later constructing. (see Fig. 3).

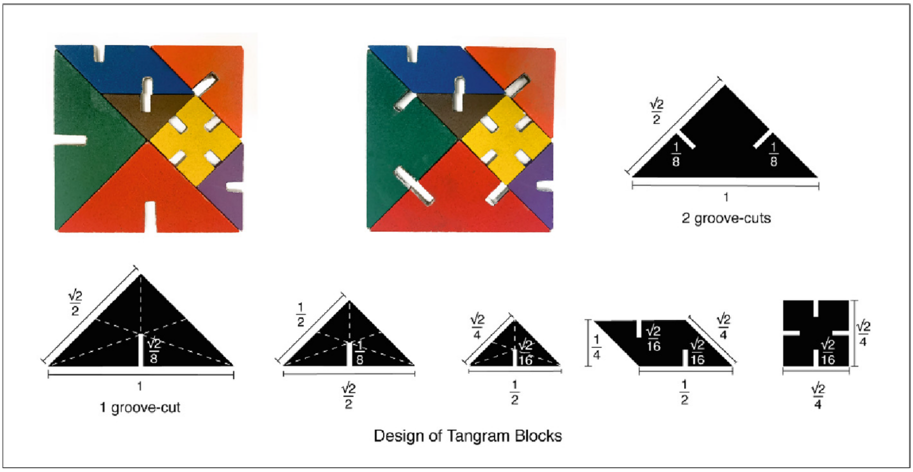

Fig. 3. Design of Tangram Blocks and two prototypes of different groove-cut design

The Gameplay of Tangram Blocks. Tangram Blocks is an evolutive Tangram that can be constructed in 3D space. It has all gameplay features that the tangram has, and that more gameplay only can be realized in 3D structures. For example:

- Geometric sculpture. The geometric shape of tan-pieces is convenient for making constructivism sculptures. Because of its abstract and minimal nature, this 3D format of modern art and design seems a bit hard to be understood by general public. Playing tangram blocks, people can be hands-on to compose the constructivism sculptures, to know how shapes and colours are related and jointed together three-dimensionally. During the constructing process, the players should look at the structure from different perspective, it is a different experience than playing tangram on a flat surface. (see Fig. 4 and Fig. 5)
- Tridimensional figure. In accordance with outline/silhouette on the puzzle book, tangram can form more than 1000 2D figures. However, to shape figures in 3D need higher spatial cognitive ability, as well as using 2D tan-pieces to form 3D shapes need to know how to balance weight and stand stable. Children, even adult would be benefit from playing Tangram Blocks as it is a thought-provoking figure modeling. (see Fig. 6 and Fig. 7)
- Shadow play. Sometimes, chaotic 3D objects can compose a whole clear shadow figure relying on certain kind of lighting and distance. Under the proper lighting, we can compose magic shadow plays with one or more sets of Tangram Blocks, we can change the model structure and position in order to form different shadow figures continuously. Thus, time has been involved in this creative playing, 2D is the shadow of 3D, and 3D is the shadow of 4D. Therefore, the players are not only playing a game, they are actually making a piece of art in time and space. (see Fig. 8)

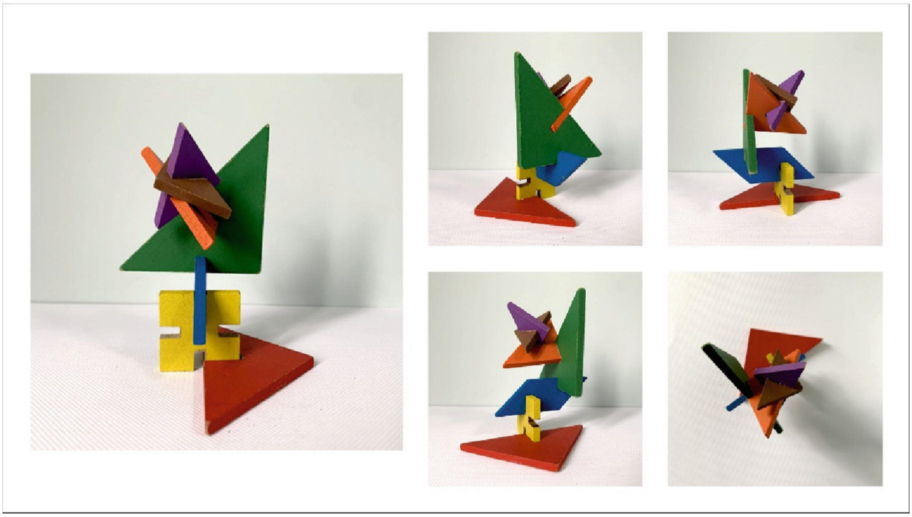

Fig. 4. Geometric sculpture made by tangram blocks.

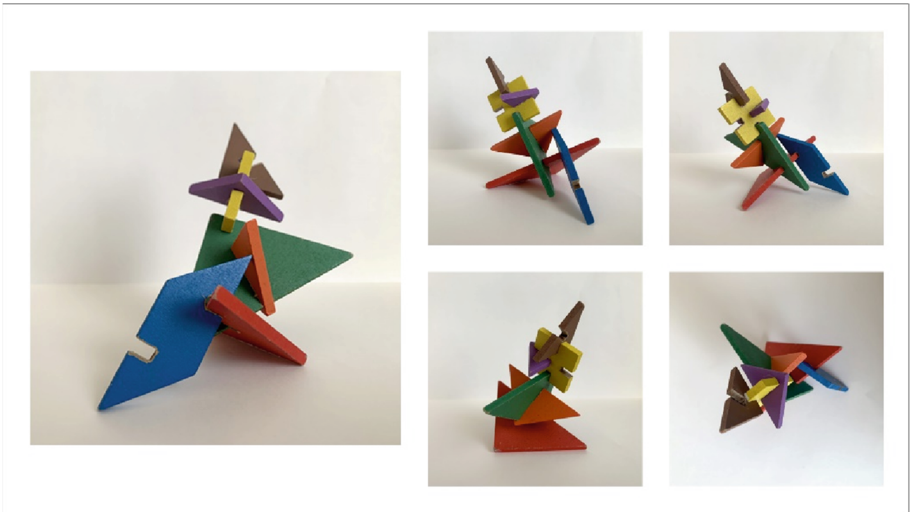

Fig. 5. Geometric sculpture can be looked from different perspectives.

As a 3D block play, playing with multiple sets of Tangram Blocks will have more fun, and the Tangram Blocks also has more room for interaction and collaboration than the Tangram. It is a full interactive process in between players and blocks, player and player. If creativity has no limit, the gameplay of Tangram Blocks could be expanded further, and it may even be considered as a playable development model that we will discuss in next section.

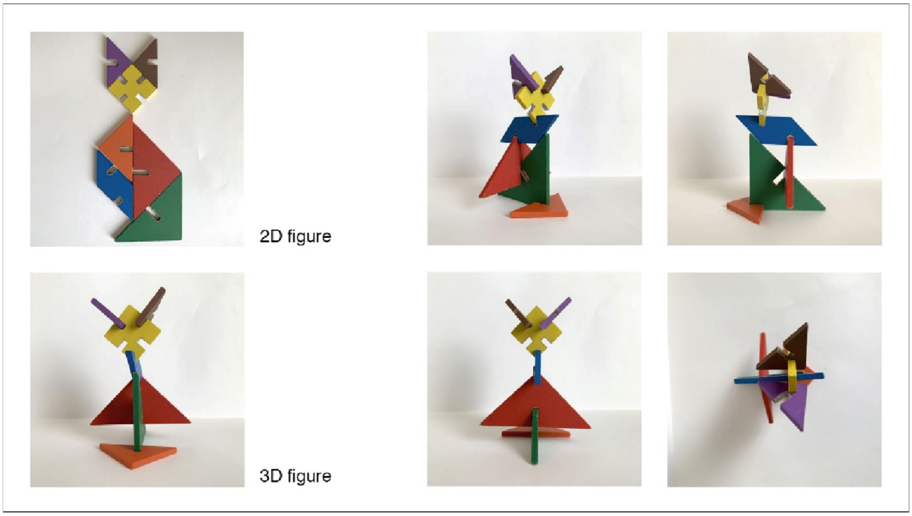

Fig. 6. A 2D cat figure can be transferred into 3D figure using tangram blocks.

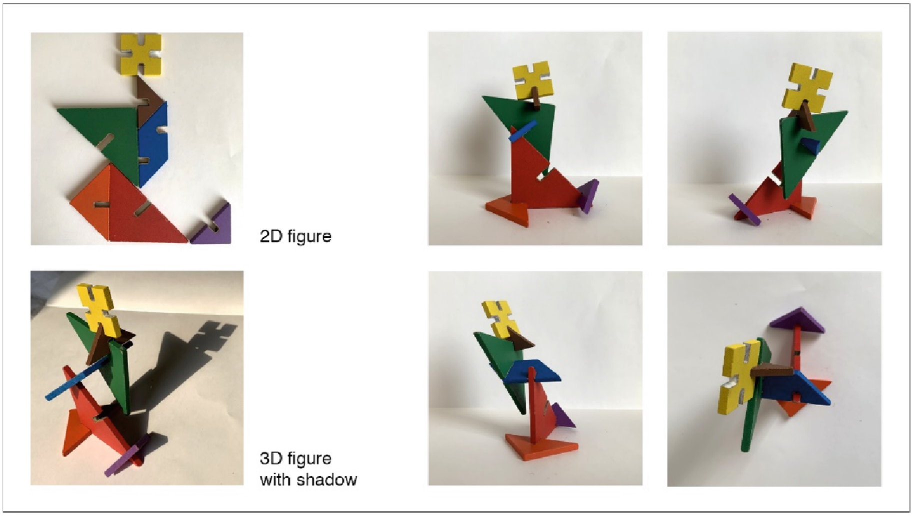

Fig. 7. The 3D human figure's shadow is similar to the 2D figure.

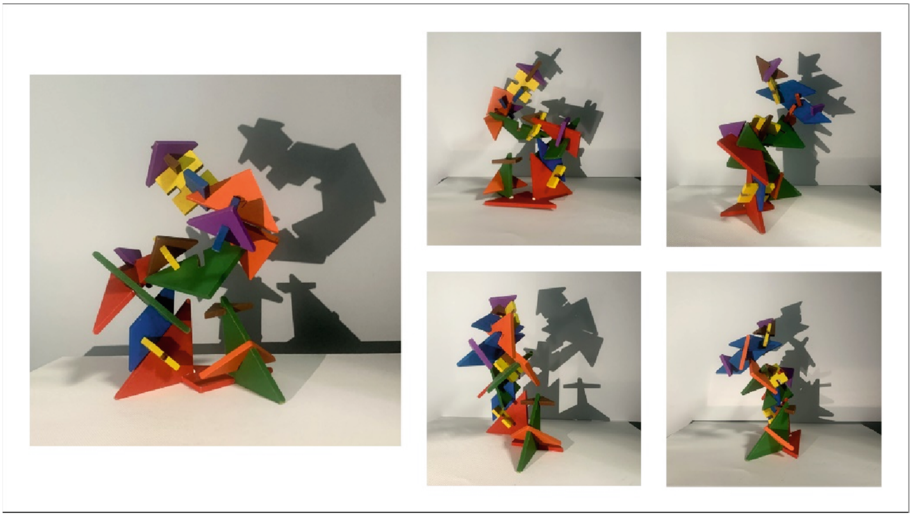

Fig. 8. Three sets of tangram blocks in different lightings and positions compose various shadow plays.

5 Implant Playable Modeling into Museum Participatory Experience

Today, museum does not only function as a place to collect antiques and cultural relics, but also as a creative and exchange venue. Quoted by sociologists Daniel Aaron Silver and Terry Nichols Clark, "Amenities" are the syntagmatic and unique scenes that give us meaningful city life, participatory experience and emotional resonance [9]. As a kind of amenities, museums and galleries now more focus on people's visiting experience and process rather than the static objects and collections.

Therefore, playable modeling seems to be an excellent new presented formats and interesting activities for museums and galleries to explore and enrich visitors' exchange and communication. Transferring passive watch to hands-on positive activity, modeling bring us together to engage with the ideas and disciplines shaping our lives, not only in science and art but also in fields such as politics, literature, environmental protection and economics. Paola Antonelli, senior curator of design at MoMA, suggests "museums can become laboratories for rethinking society, places for showing not what already exists, but more important, what is yet to exist" [10].

Playable modeling can address an interactive museum user experience by promoting enjoyment in science museums and enhancing participatory experience in art museums and galleries.

An interactive art installation Domino Effect presented by Ingrid Ingrid in the 9th 'Luminothérapie' event in downtown Montreal. 120 giant dominos with LED lights and sensors inside had distributed across six stations. When people pushed over the domino piece, the light color of domino is changing and fair-sounding music is following by the kinetic potential of tumbling dominos. Domino as a playable model inspired the artists to enhance interactive experience in between people and artwork, and among each other.

"It's rare that people can really play with art installations like our dominos that you can manipulate with your hands. That's what drove us to come up with the idea of using dominos," says the studio's creative director, Geneviève Levasseur [11].

6 Conclusion: The Development Prospect and Future of Playable Modeling in Learning Science and Art

Playable modeling will be an evolvable active learning methodology in the nearly future, this paper already provides some evidences to prove its feasibility and possibilities. Tangram Blocks, the new versatile gamified model, will be developed as both a physical model and a mixed reality game. It could be developed as a good example and realizable model of playable modeling in learning science and art.

Play, its concept, however, is much more than an activity related to the games, it can be a learning process involving spontaneous and joyful interaction. When we learning by playing, we can motivate our self-enhancement drive and creativity. It is a real freedom to understand the world by our hands-on modeling process. Playable modeling, an adventure to observe, to act, to explore, to discover orders and meanings in a brand-new world.

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