

WHERE EMOTION MEETS FUNCTION: THE CONSTRUCTION OF AN ICONIC LEGO® MINIFIGURE THROUGH AN ORIGINAL AND ENJOYABLE DESIGN EXERCISE

María LONDOÑO and Alejandra VELÁSQUEZ

Universidad EAFIT, Product Design Engineering Department, Medellín, Colombia

ABSTRACT

In exploring new experiences in design and engineering education – specifically learning by doing – this paper aims to describe a creative learning activity for Product Design Engineering students based on an original and enjoyable design exercise, as well as to address the issue of how to keep current generations highly motivated in class. The project consists of making an exact replica of an iconic LEGO® minifigure of the students' choice in an augmented scale of 10:1, to learn model-making techniques by demanding, not only to work on the exterior appearance of the model, but also to construct it with different parts that can be assembled in the same way as a LEGO® toy.

The LEGO® figure-building exercise constitutes a starting point for students with no training in a workshop. A “maxifigure” will be built from the combination of different craft materials that allow traditional hand-tool methods to coexist with new technologies.

Considering the results of the projects found so far in the last two years, and the surveys carried out on students, the LEGO® figure-building exercise has become a significant experience. To sum up, this activity has also turned out to be: (a) an enjoyable practice that creates an emotional bond between the student and his work; (b) a fun exercise for stimulating and producing high motivation and commitment; and (c) a project which delivers great results and produces considerable satisfaction by achieving a high level of outstanding 3D models.

Keywords: Design and engineering education, learning by doing, model-making techniques, 3D models, LEGO® replica

1 INTRODUCTION

In the design area, education and training should stress the making of a physical model as an important skill for product designers. Then in that sense, a creative learning activity for Product Design Engineering students is presented by describing the methodology for making an exact replica of an iconic LEGO® minifigure in an augmented scale. In the process of building it, students learn modelling techniques, which will be explained further, and they accomplish the creation of a high-fidelity model with articulated parts, making it a very interesting and entertaining activity for them.

Why LEGO®? In the field of creativity and innovation, LEGO® has been the leader; just by adding one block to another one, a person can create something totally new. Options are unlimited and the product created has two great qualities: simplicity and practicality. Here is where emotion meets function because for the LEGO® figure-building exercise not only the functional part is considered, but also the bond or special attachment to a toy that makes students remember their childhood. They feel good, so they learn more and the results are even better; the feelings of happiness and satisfaction during the activity are remarkable.

By addressing a detailed description of the methodology and the techniques used, this activity will be presented with unique and original process, as well as the perception of the design exercise from the students' point of view, measured through a survey that was carried out during 2018 and 2019.

1.1 Product Design Engineering

Product Design Engineering is a five-year programme at Universidad EAFIT in Medellín, Colombia, where students design products that fit people's expectations, motivations and needs for society's current

demands. Therefore, throughout eight of a total of ten semesters, students fabricate models and prototypes for their projects in Design Courses, so they must learn how to build. Models is one of the practical courses that give students the construction skills needed at the beginning of their curriculum, and requires them to constantly make clean, organized and rational work. “When designing physical artefacts, perceptual-motor, cognitive and emotional skills must be available” [1], so we seek a pedagogical approach based on learning by doing; “I hear, and I forget. I see and I remember. I do and I understand.” (Confucius). The university is well known for having facilities with specialized workshops including wood, metal-mechanics, ceramics, and Computer Numerical Control (CNC). For this purpose, students work together with the supervision of technicians and professors to reach their objective. By the end of each term, a main exhibition takes place on campus, to share the results of all design projects with the entire academic community.

1.2 The importance of building 3D models

The construction of a LEGO® minifigure in an augmented scale of 10:1 - the final task of Models course - is a 100% learning-by-doing project that help students develop building skills and enhance their capabilities to represent three-dimensional shapes. As Hallgrimsson (2012) declared, the rich design tradition of developing sensibility to materials, manufacturing, and workmanship is based on the idea of learning by doing, which goes back to the beginning of industrial design. Because “learning results from what happens on the way of achieving our goals... and the most memorable way to learn is through experience: learning by doing” [2], this exercise constitutes a starting point in a workshop for students with no training. Developing manual skills and a hands-on experience in the tangible world is very important, not only for boosting common sense by determining the more suitable technique and material for each project, but also for training product designers of these new generations who are so digital. “By experiencing real materials and processes, the material qualities gain meaning” [3], and herein lies the importance of building 3D models. Rowena Reed Kostellow – an influential design teacher for half a century – was “especially concerned about the impact of the computer on the practice of three-dimensional design and cautioned against using the computer to do things that she believed only the human eye and hand could do.” [4] And according to Velásquez [5] within the process of designing a product, it becomes necessary to validate each decision the designer makes, and with hand-made models a design can be verified throughout the physical model. “Don’t forget people only react to physical samples,” a statement from an Adidas designer at the “Make Lab” at Adidas Headquarters, Herzogenaurach, Germany, 2020.

2 FROM THE MINIFIGURE TO THE MAXIFIGURE

The construction of a maxifigure from the LEGO® minifigure is achieved by the combination of different craft materials that allows traditional hand-tool methods to coexist with new technologies that are very useful and effective when creating new shapes. Soft and smooth surfaces are expected in the model to offer a plastic and hyper-realistic appearance, like that of LEGO® products. Moreover, this project is intended for first-year students to learn proportion, detail design and the handling of tools and materials, as they are also encouraged to focus on their characters’ facial expressions. Students learn how to build each component separately to later assemble them, considering measures and tolerances to articulate the figure like a real LEGO® toy. Making the replica goes beyond the learning of model-making techniques by creating an emotional bond between the student and his work, and commitment within the activity. Besides the academic acquirements, this design exercise is a novelty in design and engineering education and it also has been considered a very original, enjoyable, joyful and creative challenge that everyone loves. Just as the founder of Frog (Hartmut Esslinger) once said: “I wanted to make people smile.”

3 METHODOLOGY: DESIGN EXERCISE

Building the maxifigure is a guided and structural process of an activity for four weeks, in which students work in pairs, giving them the opportunity to work with others. Sensibility and experience are accomplished from this process, and both are essential for training young designers. LEGO® minifigures are based on movies, sports, history, everyday life and almost anything; each figure is an original character that contains elements in the form of accessories or uniquely printed body parts and a black display base. There are at least 4,000 different figures with accessories such as *maracas*, microphones, guitars, and other elements as well as hair styles, hats, and helmets, giving the activity infinite, diverse possibilities, while – at the same time – having a fair way to grade students’ results with the same topic

and difficulty level. To describe the methodology, Figure 1 presents the Model Making Workflow, consisting of five steps:

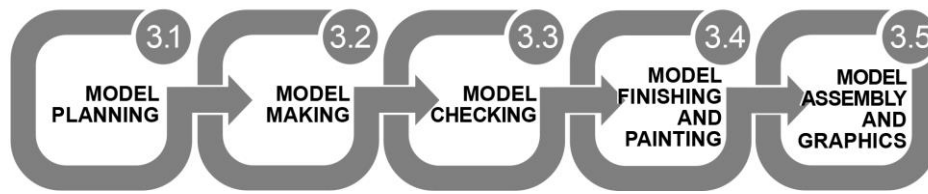


Figure 1. Model Making Workflow

3.1 Model planning

The success of the result depends on the planning; the process begins with: (a) choosing a LEGO® minifigure of the students' choice, (b) disassembling the character and its accessories, (c) choosing the most suitable material and technique for each part, and (d) drawing a 2D layout of full-scale templates 1:1. Accuracy of measurements is crucial to obtain a high-fidelity result.

3.2 Model making

Additive and subtractive are the two modelling making techniques. Through additive modelling, the material, such as gummed tape or clay, is added bit by bit; also, wooden shapes can be made and combined with other parts. Cardboard could be taped and glued together to create volumes and shapes, to join sections and surfaces. On the other hand, for making parts by subtractive modelling making techniques, removing material from a solid block is needed. Several examples are shown below:

- **Additive: Cut and build components.** For making the arms and legs, a laser cut machine is used. The cardboard is cut, folded and assembled to obtain three-dimensional components. The cutting and additive modelling construction technique is shown in Figure 2.

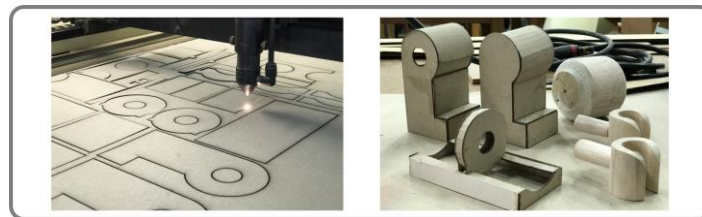


Figure 2. Additive: Cut and build components

- **Additive: Accessories and details.** Details, such as the hair, can be obtained by an additive modelling technique with the use of playdough or clay, which will then be covered with gummed tape, so the model housing can be un moulded. Figure 3 shows the replica of a dog made with glued layers of laminated cardboard.



Figure 3. Additive: Accessories and details

- **Subtractive: Modelling solid parts.** As shown in Figure 4, to make a head, students use a wood-turning lathe, in which the material is removed gradually, by subtractive modelling. To make other parts of the body, a subtractive modelling technique is also used, either for cutting the wood with a paper template, or for carving it into intricate shapes.



Figure 4. Subtractive: Modelling solid parts

3.3 Model checking

Proportion, scale and verification of measurements are crucial to achieve an exact replica; it “... should be based on the perfectly proportioned human body where there exists a harmony between all parts.” [6] Fidelity is the degree of exactness with which something is copied or reproduced [7]. The model looks like and works like a LEGO® minifigure but on a larger scale, 10:1. Figure 5 shows students checking their model dimensions and correspondence with the original LEGO® minifigure.



Figure 5. Model Checking

3.4 Model finishing and painting

Different materials are used to look like plastic; in this case, wood is sanded until it has a smooth surface. Painting, for example, requires (a) colour selection, (b) type of paint, (c) surface preparation – with or without texture – and (d) paint application. “Preparation is the most important factor in a high-quality paint job.” [8] Figure 6 shows parts painted separately, one of the most crucial steps, before assembling.



Figure 6. Model Finishing and Painting

3.5 Model assembling and graphics

Graphic design is also an important part of the exercise. Figure 7 shows how high-quality appearance models will often incorporate graphic labels. Adhesive vinyl films can be used for characters’ facial expressions to add a final touch of realism to models.



Figure 7. Model Assembling and Graphics

4 RESULTS

Taking into account the results of the projects found so far in the last two years, and the surveys carried out on students, the LEGO® figure-building exercise has become a significant experience and has

achieved great results with outstanding 3D models. Figure 8 shows some examples of the high-fidelity models in 10:1 scale, called maxifigures, with the disassembled parts. There is also an example of the main exhibition that takes place at Universidad EAFIT campus.



Figure 8. Maxifigures

To measure the impact of the design exercise, a survey of student satisfaction was carried out during 2018 and 2019; all students enrolled were requested to participate. Survey respondents were asked to indicate on scale of 0 (very unsatisfied) to 5 (highly satisfied) their levels of satisfaction and learning with the activity being evaluated. Questions also included an open invitation to provide feedback on the major strengths and any suggested changes. A total of 133 Product Design Engineering students were asked to respond a survey with the following questions.

Figure 9 shows the question *How much did you like the activity and what did you enjoy the most?* in which 71.43% answered that they were highly satisfied. The right part of Figure 9 shows the six most enjoyable activities, being “the final result” the favourite one.

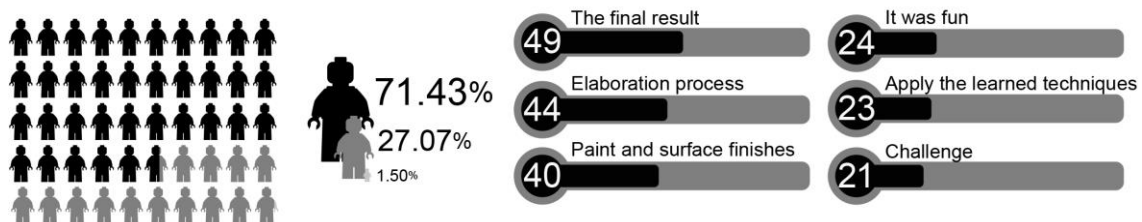


Figure 9. Results on “How much did you like the activity and what did you enjoy the most?”

Students were asked *How much did you learn with this activity and what did you learn?* Figure 10 shows that 88.72% highlighted the activity and graded it with the higher score, followed by 10.53% which answered that they were satisfied. The right part of Figure 10 shows the best representative lessons learned, with “surface finishes” and “construction techniques” the top ones.

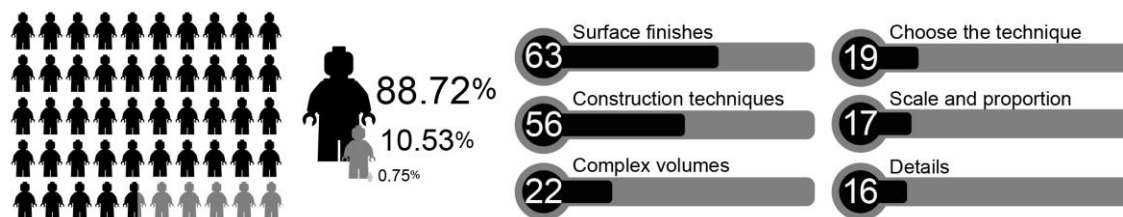


Figure 10. Results on “How much did you learn with this activity and what did you learn?”

In the Figure 11 students were asked *Which ones do you consider more important? (Choose only 2)*, in which 80% selected “soft and smooth surfaces”, as well as 79% picked “combination of different techniques” as the two most important ones.

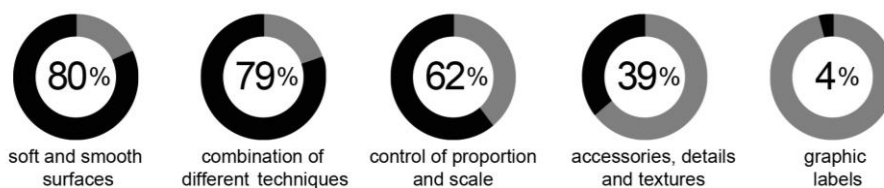


Figure 11. Results on “Which ones do you consider more important?”

In Figure 12 students provided feedback about the activity and their experiences:

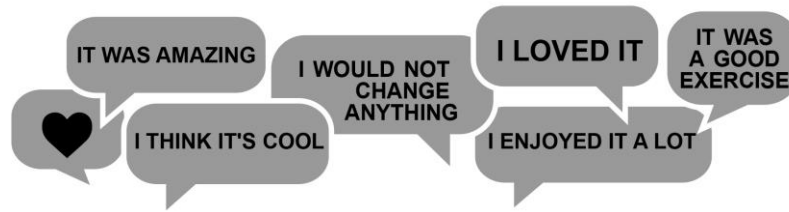


Figure 12. Student's Feedback

Despite all the positive comments, the pressure of other assignments, the crowded workshop spaces and the time-consuming activities of the exercise, were some weakness manifested, so students suggested that it might be necessary to have more time, and that Models course should have twice the curriculum credits. “The interest and value students attribute to the problem and elements in projects will affect how motivated they will be to engage in the project. Student interest and perceived value are enhanced when (a) tasks are varied and include novel elements; (b) the problem is authentic and has value; (c) the problem is challenging; (d) there is closure, so that an artifact is created; (e) there is choice about what and/or how work is done; and (f) there are opportunities to work with others.” [9]

5 CONCLUSIONS

The LEGO® figure-building exercise has become a significant experience for both students and professors; and it is a good example to share innovation and creativity in design and engineering education. Great results are accomplished by choosing a fascinating topic that catches student's attention and gets them excited with something they are passionate about; additionally, it stimulates them to excel in an assignment as challenging as this task. This activity remains one of the most fun exercises because: (a) the final maxifigure, (b) the elaboration process and (c) the painting of surfaces are the three highlighted aspects that students enjoyed the most.

Designers acquire valuable skills, such as construction techniques and surface finishes, through the possibility of materializing figures, reproducing them in the most faithful way and achieving a high level of comprehension with outstanding 3D models. This creative learning activity can be useful for other product and industrial design professors or students. Since it is a replicable exercise, it can be used to teach proportion, detail design and the handling of tools and materials for the construction of models... expertise that can be applied in future design projects.

REFERENCES

- [1] Singh, J., Warell, A. and Normank, J. *Designing with action layers – A bottom approach to explore product interaction for intuitive use*. E&PDE 20th. International Conference on Engineering and Product Design Education, London, 2018, pp. 104.
- [2] Schank, R. C.; Berman, T. R.; Macpherson, K. A. *Learning by doing*. Institute for the Learning Sciences at North-western University, 1982, pp. 172.
- [3] Hallgrimsson, B. *Prototyping and Modelmaking for Product Design*. London, Lawrence King Publishing Ltd., 2012, pp. 7.
- [4] Greet Hannah, G. *Elements of Design*. Princeton Architectural Press, New York, 2003, pp. 16.
- [5] Velásquez, A. *Técnicas de modelos: En el proceso de creación y diseño de productos*. Medellín, Editorial Eafit, 2018, pp.11.
- [6] Elam, K. *Geometry of Design. Studies in Proportion and Composition*. Princeton Architectural Press, New York, 2001, pp. 20.
- [7] Oxford English Dictionary.
- [8] Hallgrimsson, B. *Prototyping and Modelmaking for Product Design*. London, Lawrence King Publishing Ltd., 2012, pp. 155.
- [9] Blumenfeld, P.C.; Soloway, E.; Marx R. W.; Krajcik, J. S.; Guzdial, M. and Palincsar, A. *Motivating Project-Based Learning: Sustaining the Doing, Supporting the Learning*. The University of Michigan, Lawrence Erlbaum Associates, Inc. 1991, pp. 375.