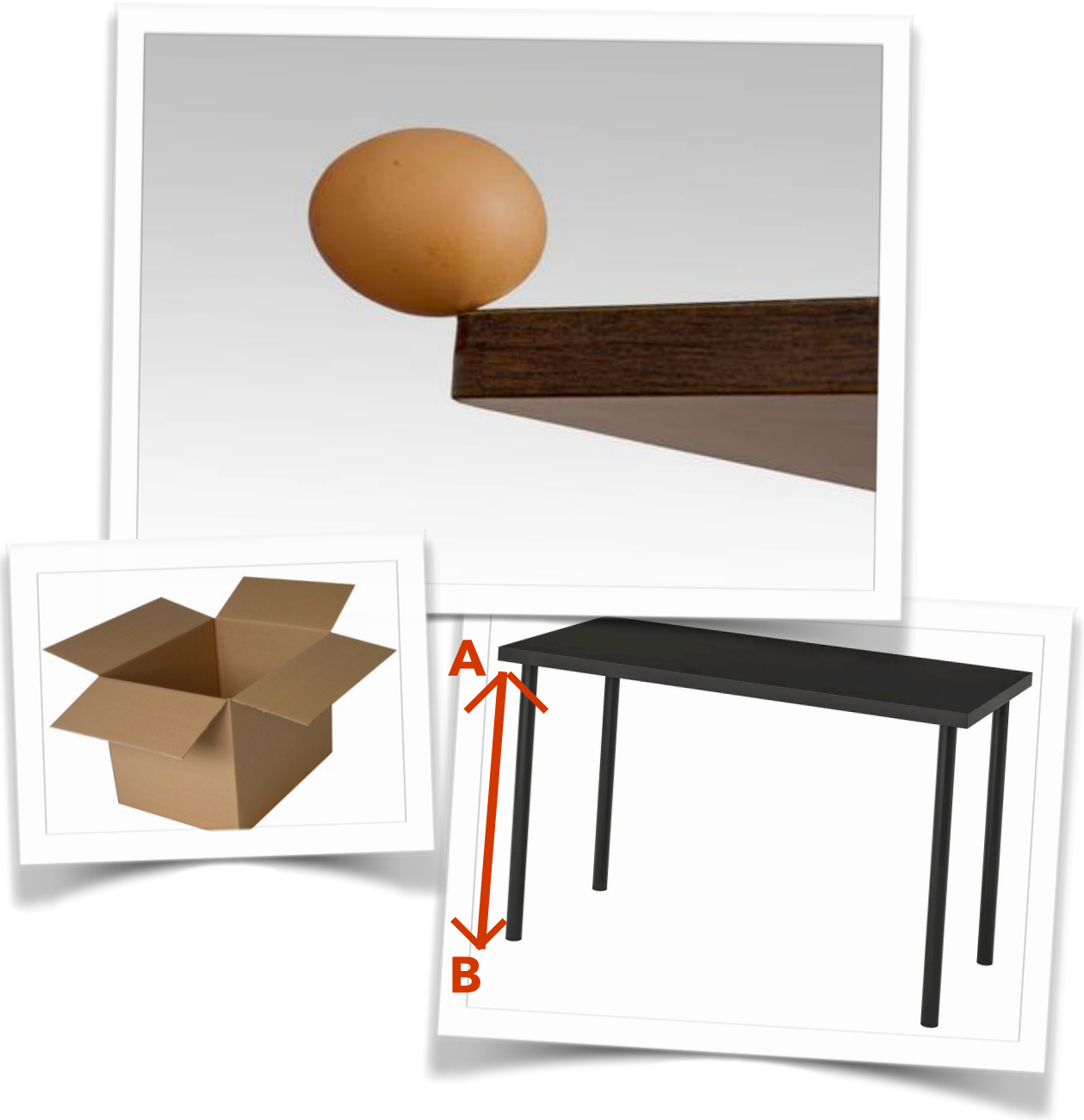
“ A table-based chain-reaction mechanism to move a chicken egg from A to B”



Cover

Creative Engineering Design (SOC-1020), Spring 2020 Conceptual Product Design Project 3 - Design Report

“ A table-based chain-reaction mechanism to move a chicken egg from A to B”

Team#9 “Fulmine”

Akhadjonova Gulkhayo u1910009 (003)

Abdrashitova Elina u1910025 (003)

Mirsaidova Dilnozakhon u1910042 (003)

Kamalova Malikabonu u1910273 (003)

May 8, 2020

Executive Summary

This report details a Product Design of **"A table-based chain-reaction mechanism to move a chicken egg from A to B"**. The main goal of this Project is to design such a mechanism and box that chicken egg will be moved without any leak and crack after falling to the floor.

Report contains and explains all steps of the Product Design processes:

- Gantt Chart
- VOC
- Design Parameters
- QFD Matrix
- Project Flow
- Conceptual Design Variables
- Decision-Making Matrix
- Final Design
- Prototyping and Testing
- Self-Evaluation and Conclusion
- References

Introduction

Current conceptual design and prototype aim to move a chicken egg from the point A, which is on the table, to the point B, which is on the ground, using mechanism with chain-reaction.

The main goal of this prototype is to design such a mechanism and box that chicken egg will be moved without any leak and crack after falling to the floor at point B.

There are some requirements should be considered in Project:

Box

Designed box had to have a minimal size to contain an egg. Also it should have an appropriate opening to insert and remove egg, it means that BOX can NOT be a fixed wrapping containing egg.

Mechanism

Mechanism must be positioned anywhere on a standard kitchen table. The height from floor of T shall be in range 72-76 cm. Mechanism can contain any objects. It is activated by manual. The minimum number of chain-reactions steps is two. The initial position of the box shall be at any point on table top along table border.

Background

Nature has given the egg a natural package - the shell. Despite its relative strength, the egg is an extremely fragile product and even with the best handling methods, serious losses can result from shell damage. Economical marketing generally requires that eggs be protected by the adoption of specialized packaging and handling procedures.

Packaging is an important component in delivering quality eggs to buyers. It embraces both the art and science of preparing products for storage, transport and eventually sale.

Proper handling and storage help control moisture loss, but appropriate packaging may also help prevent it. Eggs also need to breathe, hence the packaging material used must allow for the entrance of oxygen. The material used must be clean and odorless so as to prevent possible contamination and tainting. Authentic egg packaging materials can be reused, but careful attention must be paid to possible damage, odors and cleanliness. The packaging must be made to withstand handling, storage and transport methods of the most diverse kind and to protect the eggs against temperatures that cause deterioration and humidity. Finally, consumers like to see what they are buying, especially if it concerns fresh produce. An egg package should be designed so that the customers not only recognize the product as such, but can also see the eggs they are buying.

Many factors must be taken into consideration for packaging eggs. It is important to obtain information regarding the necessary requirements for a particular market, such as:

- quality maintenance;
- storage facilities;
- type of transport;
- distance to be travelled;
- climatic conditions;
- time involved; and
- costs.

Team 9 decided to involve those above mentioned information about egg packaging in designing Box for egg.

Gantt Chart

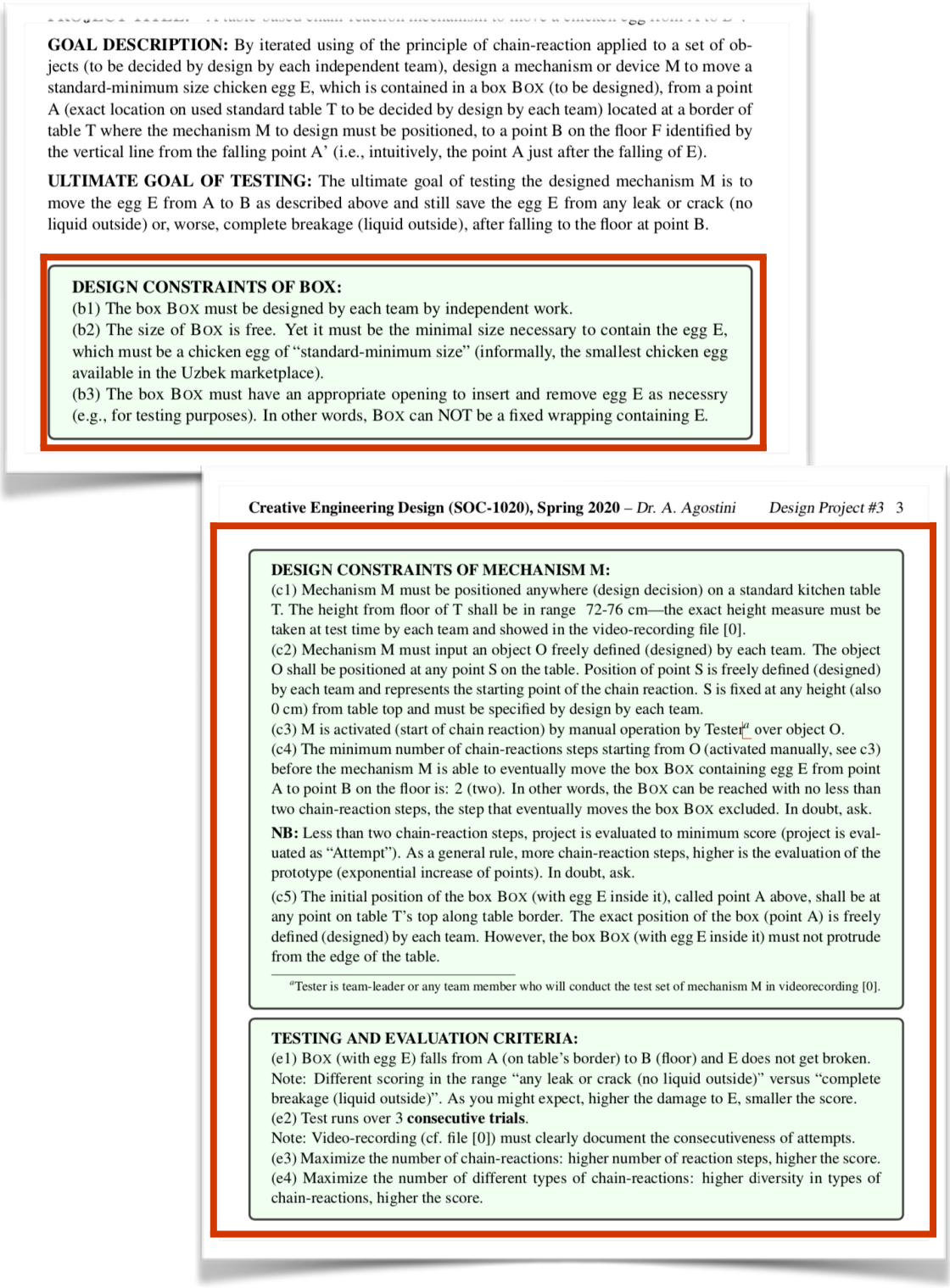
* Table 1

April 25	April 26-27	April 28	May 1	May 2	May 3	May 4	May 5	May 6	May 7	May 8
General Meeting		Meeting #1		Meeting #2			Meeting #3			Meeting #4
	*Survey & Internet Searches						Reports			
		QFD Analysis	Decision-Making Matrix				Presentation			
		Conceptual Design Drafts			Video submission				Video Presentation	
		Prototyping Testing								

* Due to emergency (COVID-19) all planned face-to-face meetings were transferred into online discussion/meetings (over Zoom and Telegram messaging)

Voice of Customer

As a "Voice of Customer" Team assumed the DESIGN CONSTRAINTS as defined in the official notification document.



GOAL DESCRIPTION: By iterated using of the principle of chain-reaction applied to a set of objects (to be decided by design by each independent team), design a mechanism or device M to move a standard-minimum size chicken egg E, which is contained in a box BOX (to be designed), from a point A (exact location on used standard table T to be decided by design by each team) located at a border of table T where the mechanism M to design must be positioned, to a point B on the floor F identified by the vertical line from the falling point A' (i.e., intuitively, the point A just after the falling of E).

ULTIMATE GOAL OF TESTING: The ultimate goal of testing the designed mechanism M is to move the egg E from A to B as described above and still save the egg E from any leak or crack (no liquid outside) or, worse, complete breakage (liquid outside), after falling to the floor at point B.

DESIGN CONSTRAINTS OF BOX:
(b1) The box BOX must be designed by each team by independent work.
(b2) The size of BOX is free. Yet it must be the minimal size necessary to contain the egg E, which must be a chicken egg of "standard-minimum size" (informally, the smallest chicken egg available in the Uzbek marketplace).
(b3) The box BOX must have an appropriate opening to insert and remove egg E as necessry (e.g., for testing purposes). In other words, BOX can NOT be a fixed wrapping containing E.

Creative Engineering Design (SOC-1020), Spring 2020 – *Dr. A. Agostini* *Design Project #3* 3

DESIGN CONSTRAINTS OF MECHANISM M:
(c1) Mechanism M must be positioned anywhere (design decision) on a standard kitchen table T. The height from floor of T shall be in range 72-76 cm—the exact height measure must be taken at test time by each team and showed in the video-recording file [0].
(c2) Mechanism M must input an object O freely defined (designed) by each team. The object O shall be positioned at any point S on the table. Position of point S is freely defined (designed) by each team and represents the starting point of the chain reaction. S is fixed at any height (also 0 cm) from table top and must be specified by design by each team.
(c3) M is activated (start of chain reaction) by manual operation by Tester[a] over object O.
(c4) The minimum number of chain-reactions steps starting from O (activated manually, see c3) before the mechanism M is able to eventually move the box BOX containing egg E from point A to point B on the floor is: 2 (two). In other words, the BOX can be reached with no less than two chain-reaction steps, the step that eventually moves the box BOX excluded. In doubt, ask.
NB: Less than two chain-reaction steps, project is evaluated to minimum score (project is evaluated as "Attempt"). As a general rule, more chain-reaction steps, higher is the evaluation of the prototype (exponential increase of points). In doubt, ask.
(c5) The initial position of the box BOX (with egg E inside it), called point A above, shall be at any point on table T's top along table border. The exact position of the box (point A) is freely defined (designed) by each team. However, the box BOX (with egg E inside it) must not protrude from the edge of the table.

[a] Tester is team-leader or any team member who will conduct the test set of mechanism M in videorecording [0].

TESTING AND EVALUATION CRITERIA:
(e1) BOX (with egg E) falls from A (on table's border) to B (floor) and E does not get broken.
Note: Different scoring in the range "any leak or crack (no liquid outside)" versus "complete breakage (liquid outside)". As you might expect, higher the damage to E, smaller the score.
(e2) Test runs over 3 **consecutive trials**.
Note: Video-recording (cf. file [0]) must clearly document the consecutiveness of attempts.
(e3) Maximize the number of chain-reactions: higher number of reaction steps, higher the score.
(e4) Maximize the number of different types of chain-reactions: higher diversity in types of chain-reactions, higher the score.

Design Parameters

Table 2

Box	Mechanism
- **Size** (free, yet as small as possible) - **Functionality** (appropriate opening to insert and remove egg) - **Safety** (save egg from any kind of damage) - **Weight** (should be easily removable with egg inside)	- **Size** (the height in range 72-76 cm) - **Reliability** (should be strong to hold objects with any weight) - **Safety** (should safely move box with egg) - **Functionality** (as much chain reactions as possible)

Quality Function Deployment (QFD Matrix)

Box

	Size	Functionality	Safety	Weight	Σ
Must contain egg	3	2	3	2	**10**
Appropriate insert/remove	2	3	1	1	7
Safe	1	2	3	2	8
Easy to remove	3	3	3	3	**12**
Σ	9	**10**	**10**	8	

1 - not important
2 - medium
3 - important

Mechanism

	Size	Functionality	Safety	Weight	Σ
Height (72-75)	3	2	1	1	7
Strong	1	2	2	3	**9**
Safe	1	2	3	1	7
More chains	3	3	2	1	**9**
Σ	7	**9**	**8**	6	

According to Quality Function Deployment Matrix, the Box must have appropriate place for egg and should easily inserted and removed. At the same time, parameters such as Functionality and Safety require much attention in designing.

Mechanism, on the other hand, is considered to be reliable and contain more chains. As the Box, the Mechanism also needs more attention in Functionality and Safety.

It can be noticed that the main requirement of the current Project is to move the egg safely. That is why Team9 assumes that their QFD Matrix is evaluated correctly.

Project Flow

First step into project began with General Meeting, where tasks were divided for all team members, namely Reports, PPT Presentation, Tables, Surveys, and Final Digital Drawing.

The “Customer Voice” assumed to be the DESIGN CONSTRAINTS as defined in the official notification document. According to requirements and needs, the Design Parameters were chosen separately for Box and Mechanism (Table 2). For Box they were Safety, Functionality, Size, and Weight and for Mechanism: Safety, Reliability, Functionality, and Size.

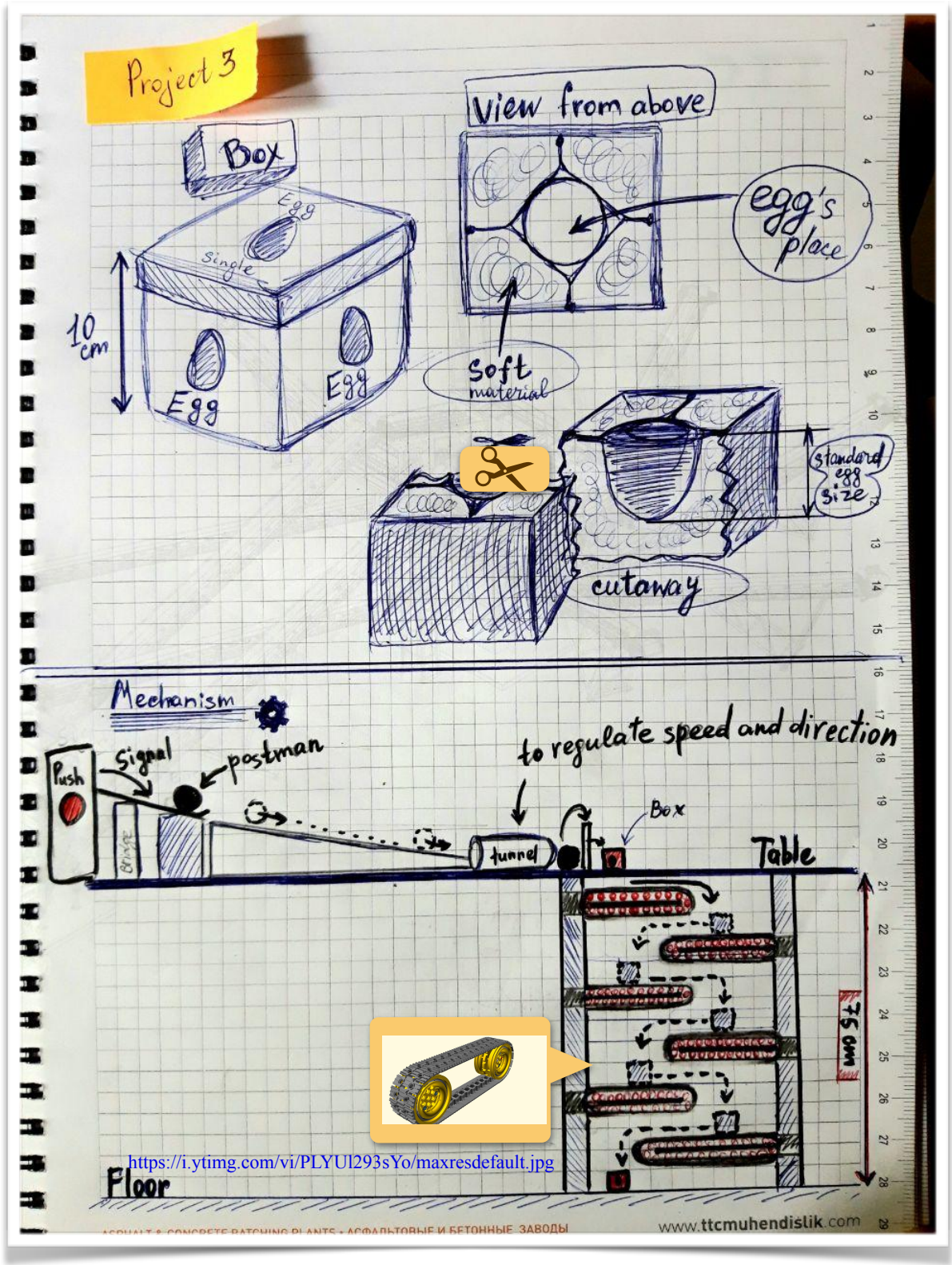
Next step was to make QFD analysis (Page 9). In the matrixes all design parameters and customer needs were included. To make comparisons and distinguish more significant parameters, it was chosen 3 scale assessment (1 - not important; 2 - medium; 3 - important). Scores were put according to the importance and suitability. As a result, Safety and Functionality in both cases (Box and Mechanism) received relatively high scores. Additionally, Box should be easy to remove and Mechanism is expected to be safe and have many chains.

Further task was to start sketching design variables. Here it was decided to use the principle of CED class Activity (January 31, 2020) . There was given 2 hours to draw as much as possible design variable sketches and send it to Telegram group, where all members would explain the main features and basics of their own work. There were proposed 3 different options for the concept (Can be seen in the next section “Conceptual Design Variables”, p.12).

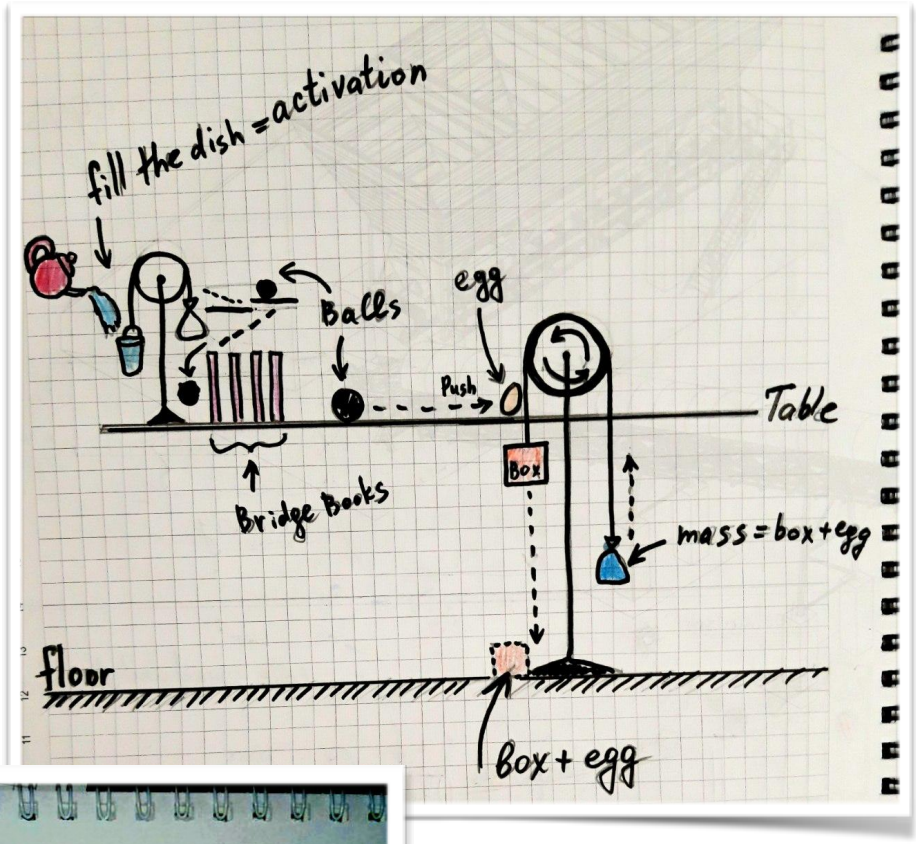
Evaluation and Analysis were done immediately and major parameters of Box and Mechanism were distinguished (Page 14).

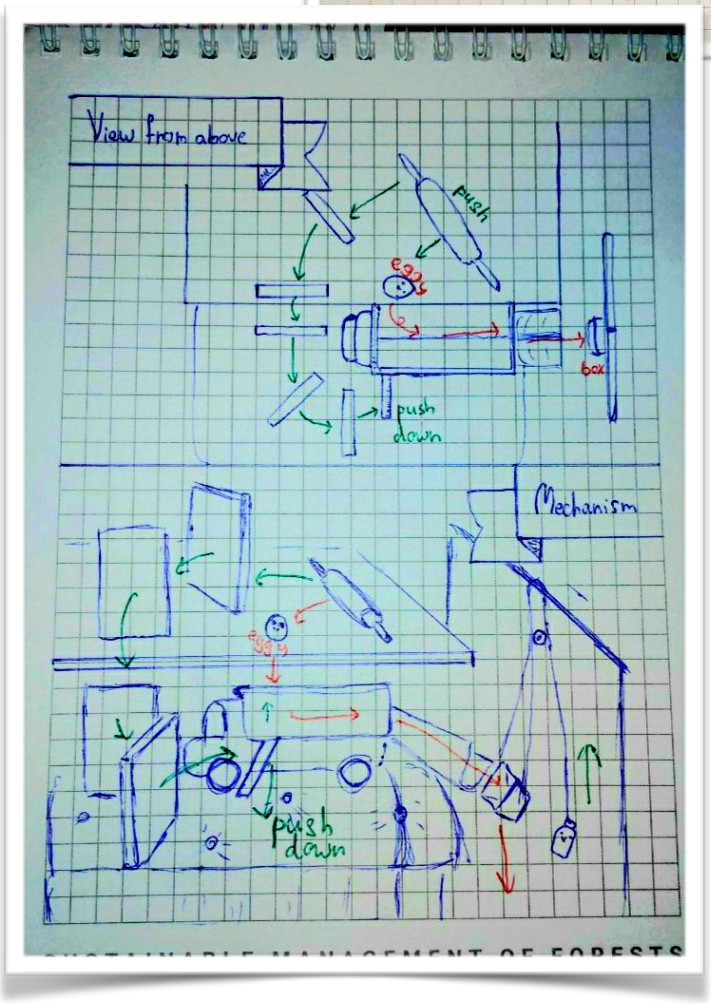
Conceptual Design Variables

Concept 1



Concept 2





Concept 3

Evaluation and Analysis (Decision-Making Matrix)

Box

Evaluation Criteria	Weighted Value (1-3)	Evaluated value		Weighted value * Evaluated value	
		Must contain egg	Easy to remove	Must contain egg	Easy to remove
Safe	**3**	2	1	6	3
Functionality	**2**	2	3	4	6
Sum		**4**	**4**	**10**	**9**

0 - not important
1 - medium
2 - important
3- very important

Mechanism

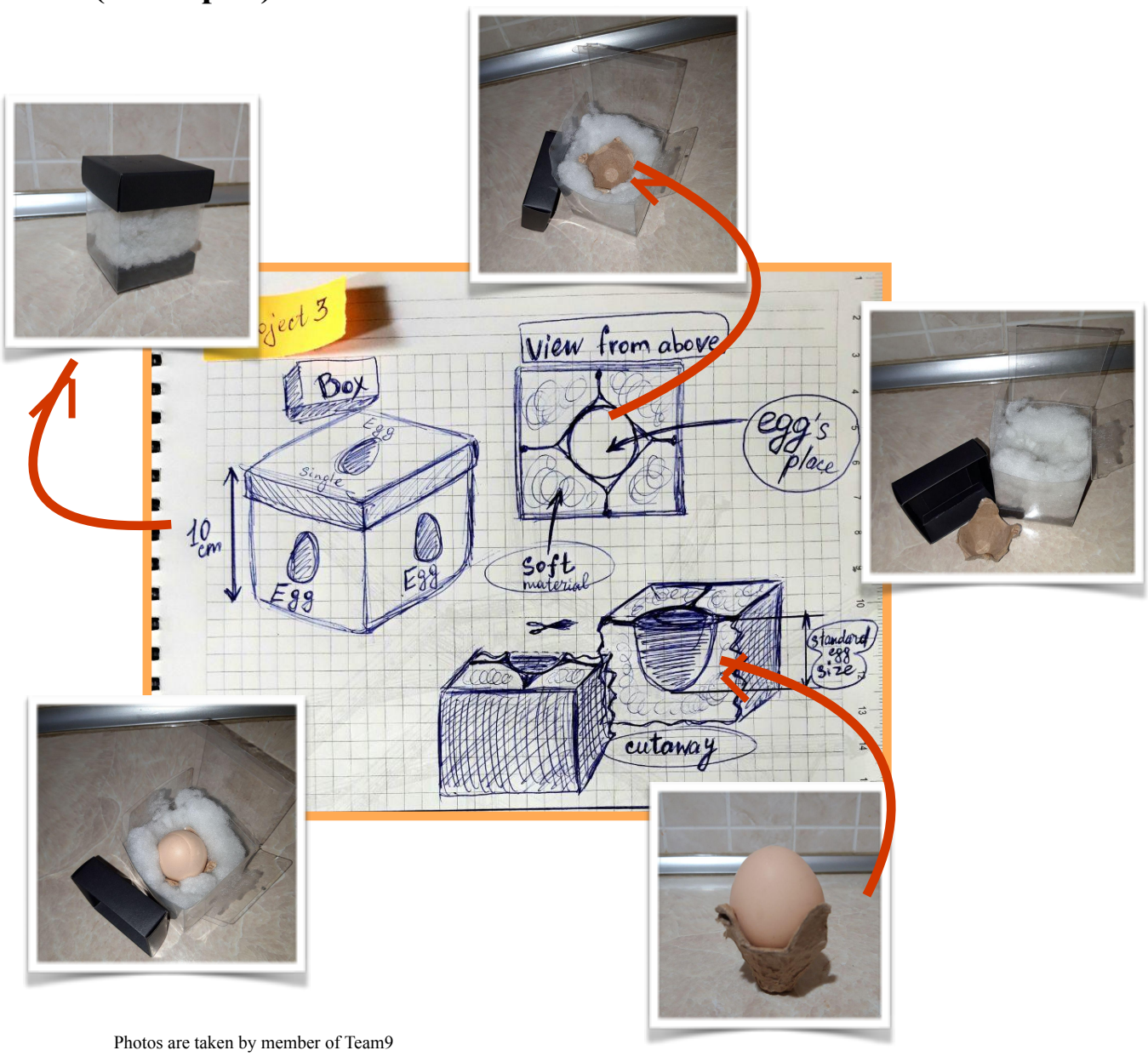
Evaluation Criteria	Weighted Value (1-3)	Evaluated value		Weighted value * Evaluated value	
		Strong	More chains	Strong	More chains
Safe	**1**	1	1	1	1
Functionality	**3**	2	3	6	9
Sum		**3**	**4**	7	**10**

Final Design

Concepts 1 and 3 were chosen as the Final Design and Prototyping was started immediately (as submission of Prototype Video was announced earlier). For that reason, Team9 decided to assume concept sketches as final design (recognizing that it does not meet Designing Process requirements, sketches were drawn as precise as possible). The Final Design can be considered as built prototypes.

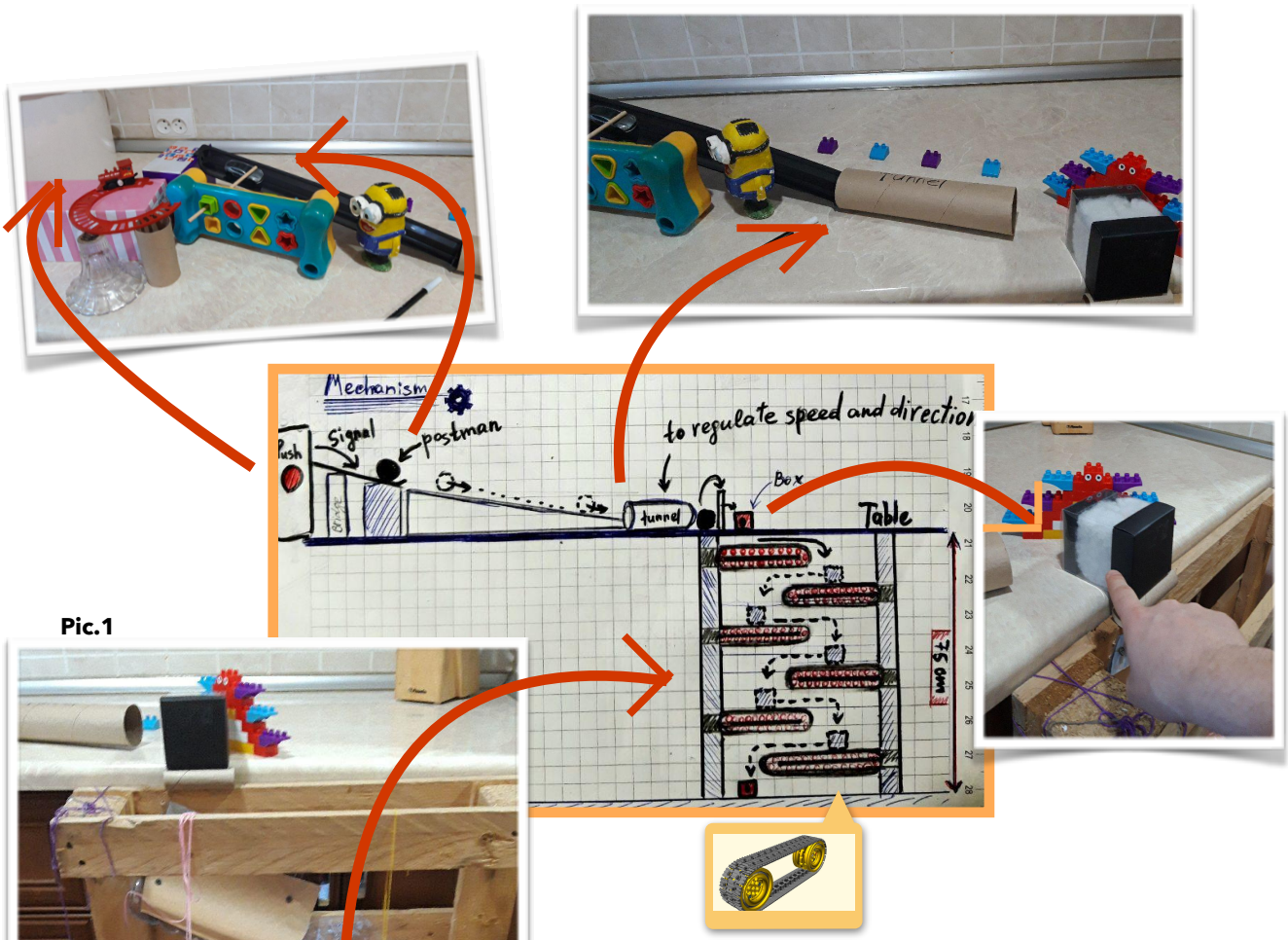
Prototyping and Testing

Box (Concept 1)



Photos are taken by member of Team9

Mechanism (Concept 1)

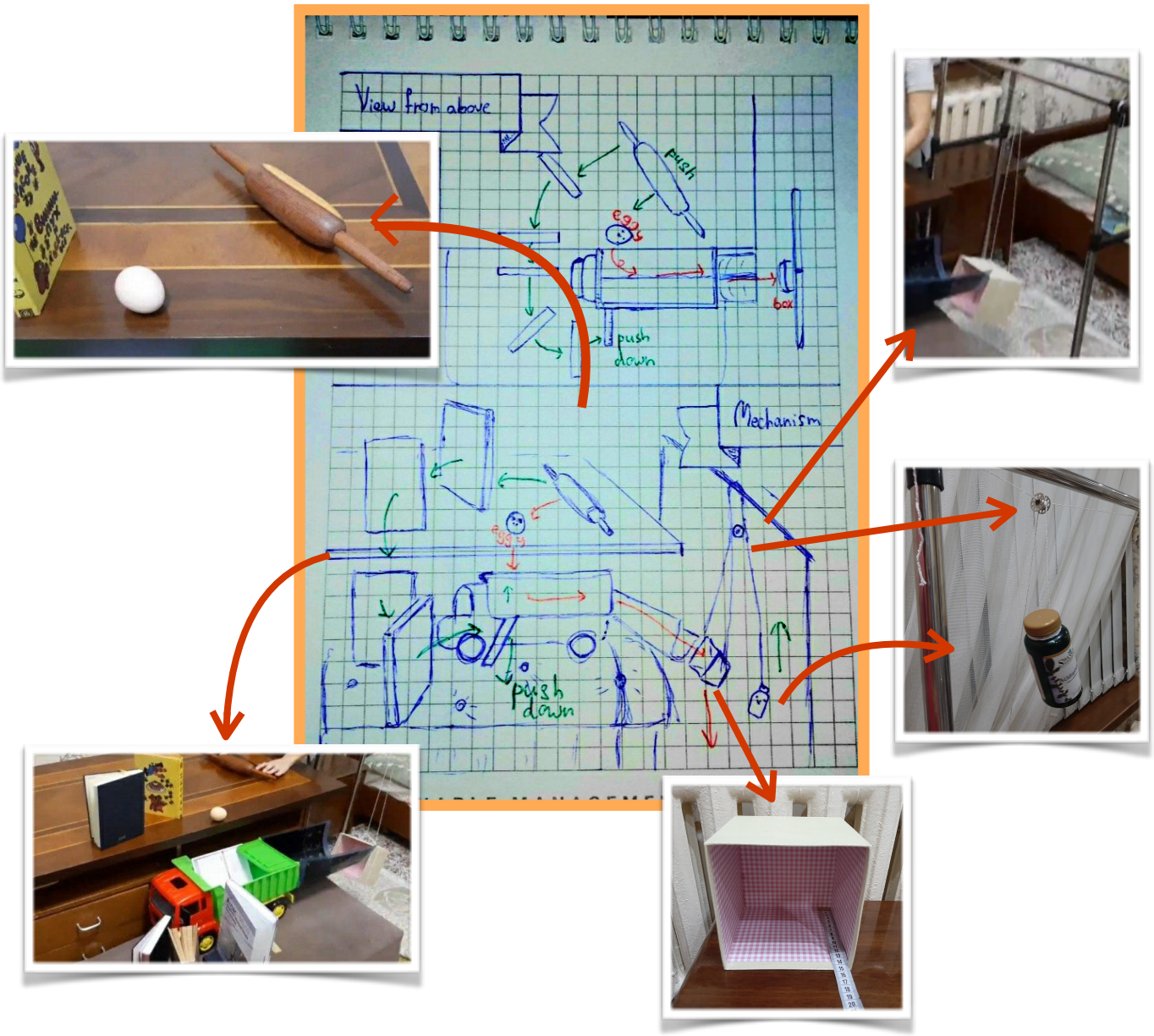


Pic.1

In picture (Pic.1) can be seen that plastic bottles are used instead of track loop wheels just for prototype test. (Learnt in Videos about Rendering and Prototyping provided in lectures)

Photos are taken by member of Team9

Box & Mechanism (Concept 3)



Photos are taken by member of Team9

Self-Evaluation and Conclusions

= **Done**

Purpose:

- *To design such a mechanism and box that chicken egg will be moved without any leak and crack after falling to the floor*
- *Box should have appropriate size and structure*
- *Mechanism should contain more than 2 chain reactions*

In conclusion, Team 9 could reach its goal and constructed Mechanism to move egg from table to floor in designed Box, applying chain reactions. Besides some designing and prototyping processes were comparatively difficult and a bit challenging for Team consisting of only girls, whole procedure was really interesting and full of amusing experiment.

Team 9 hopes that the current design or processes/reactions in design can be implemented in food factories, chicken farms, kitchen, and in other industries in near future.

References

Page 5: **http://www.fao.org/3/Y4628E/y4628e05.htm**