

# **SIMPLE MOCKUPS - TOOL TO ENHANCE VISUALISATION AND CREATIVITY IN ENTREPRENEURSHIP COURSES**

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## **ABSTRACT**

The CDIO framework encourages us to work with prototyping during the conceive and design phases integrated into engineering education. At Linköping university, we apply prototyping and working with simple mockups in several entrepreneurship and innovation courses in order to stimulate creative thinking and experimentation. We have seen that through working with a joint prototype, the students increase their level of engagement and self-confidence while learning to know each other, both as individuals, and according to their skills and competence. Prototyping events are appreciated as learning activities, not least as they signal a culture of playfulness and unpretentiousness within a course. We have also seen that it is important to inspire the participating students to reflect on the event in order to complete the learning process. In the paper we analyse and discuss our experience regarding how and at what time in a course simple prototypes can be used, how workshops can be developed, and what we have learned.

## **KEYWORDS**

Entrepreneurship, project course, prototype, mockup, shitty prototyping, CDIO standards: 2 (learning outcomes), 7 (Integrated learning experiences) and 8 (active learning)

## **INTRODUCTION AND FRAME OF REFERENCE**

It has been stated that a picture tells more than 1000 words and whether this always is true can of course be discussed, but in most cases illustrations of various type enhance understanding, and this holds especially true for abstract or advanced items. This is probably why mankind has used sketches and models of different kind to explain things to each other for a very long time, from rock-carvings (see figure 1) and models in case of stones, sticks and cones to advanced drawings and 3D printed items. Recent research has also shown that visualization enhances creativity and learning (see e.g. Berglund & Leifer, 2013). Therefore, it is a worthwhile endeavour to integrate visualization into our learning activities and courses.



*Figure 1. The picture illustrate a wild boar hunting scene and the rock carving is to be found at Himmelstalund in Norrköping. Photo: (Theres Furuskog, Norrköpings stadsmuseum)*

Prototyping is an advanced form of visualization and it is highly relevant for engineering education that often involves product and concept development. The CDIO framework encourages us to integrate prototyping into engineering education, in particular during the conceive and design phases, see for example CDIO syllabus 2.0 subsection 4.4.1 where “Experimental prototypes and test articles in design development” are specified and “Modeling, simulation and test” in subsection 4.4.4 (cdio.org). Furthermore, recent technological developments such as CAD and additive printing/3D-printing have made prototyping feasible even with limited resources that often set the boundaries for what we can implement in our courses and their contributions to learning experiences have been highlighted in previous research (e.g. Chin Tiong et al 2016). However, even without access to such advanced tools, prototyping can be integrated into engineering education in structured but simple ways and in a variety of courses - as we will demonstrate in the cases below. The paper aims to share our experience regarding fast and easy prototyping, for example through creation of simple mockups.

Fast prototypes are already in use in various contexts, both in the industry and in the context of education. Berglund and Leifer (2013) lists several purposes where prototypes can be beneficial and among these the following could be mentioned: (1) guiding milestones, (2) demonstrating progression, (3) illustrating function and system integration. Furthermore, it is stressed that prototyping can lead to increased engagement; help students overcome “fear of design” and help them get rid of “solution looking for problem attitude” (Schultz, 1994, p 607). According to Berglund and Leifer (2013, p. 2) working with prototypes “unlock cognitive association mechanisms related to visualisation, prior experience, and interpersonal communication in ways that favour iterative learning between peers in the product development community.” Furthermore, prototyping also gives the students chance to experiment and improve in increments, i.e. they can make a prototype, test it, and then further modify and develop the next version. This learning-by-doing approach is also connected to entrepreneurial learning, which makes such approach suitable for entrepreneurship education (see e.g. Coope, 2003 and Politis, 2005). It is important to note that prototyping in an educational context should be accompanied by reflection in order to turn it into a fully-fledged learning activity (c.f. Shekar 2007).

The phenomenon of prototyping has not only several functions, it has also several names, e.g. rapid prototyping, mockups and what we, in this paper, name “shitty prototyping”. Rapid prototyping is commonly connected to industrial design and engineering (see e.g. deWeck et al 2005). Furthermore, artefacts such as Lego have also been used in engineering education for prototyping in the context of mechatronics and robotics for several years (Danahy et al 2014; Gomez-de-Gabriel 2011), however use of artefacts in other types of courses is less well-known and explored.

Below we will share how we have worked with prototyping. We start with the case of Demola, which has been our role model when integrating prototyping into entrepreneurship education, and then give some examples from other courses where we have used “shitty prototyping” á la Demola. We have also used Lego for prototyping events in our courses, inspired by a workshop at the CDIO Conference in Turku in 2016.

## **SHITTY PROTOTYPING - THE DEMOLA WAY**

Demola is an international organization that facilitates co-creation projects between university students and companies/organizations, either locally or internationally. Demola is best described as a network organization that consists of various partners including universities, companies, local agencies and a growing number of Demola centers around the globe.

Demola is also given as an 8 credit university course “Demola - Cross disciplinary project” in cooperation with Demola East Sweden and Linköping university. The student teams in the Demola course work cross-disciplinary on real-life cases together with partner companies. For instance, teams create and refine business concepts, develop new products, deal with societal problems, or build demos and prototypes. Demola course projects are (at some sites) a part of the student's degree program and the student receives credits according to the course catalog regulated individually at each partnering University. The student team owns the IPR for the results of each project. The partner company can purchase or license the student team's creations. Partners may also want to continue the project for further development. The Demola course has been operated in collaboration with Linköping University since autumn 2012.

The Demola courses are student centered and the teams work with a high degree of independence. However, there are a few workshops included and one such workshop is named “shitty prototyping” and is run at an early stage of the course. The “shitty prototype” concept that we use in Östergötland is developed from the original Demola concept invented in Tampere, Finland. The workshop is mainly used as a tool to boost student teams' ideation processes, viewing from the student teams' perspective. For Demola facilitators the workshop is utilized as a way of detecting different personalities and roles within the teams, gaining an understanding of the groups dynamics and an insight of how to push the teams into new ways of approaching their challenge. After a completed workshop the facilitators are able to challenge and facilitate members within the groups individually based on their strengths, weaknesses and assumed roles. Gaining these insights is an important part of the facilitator's job to help the groups progress in their work.

### ***Practical setup of the workshop***

The workshop is run in four main blocks:

- 20 minutes of brainstorming, the wilder ideas the better!
- 30 minutes of building the prototype using craft materials and recycled junk
- 10 minutes of preparing an one minute elevator pitch that explains the prototype
- 20-30 minutes of reflection lead by the facilitator

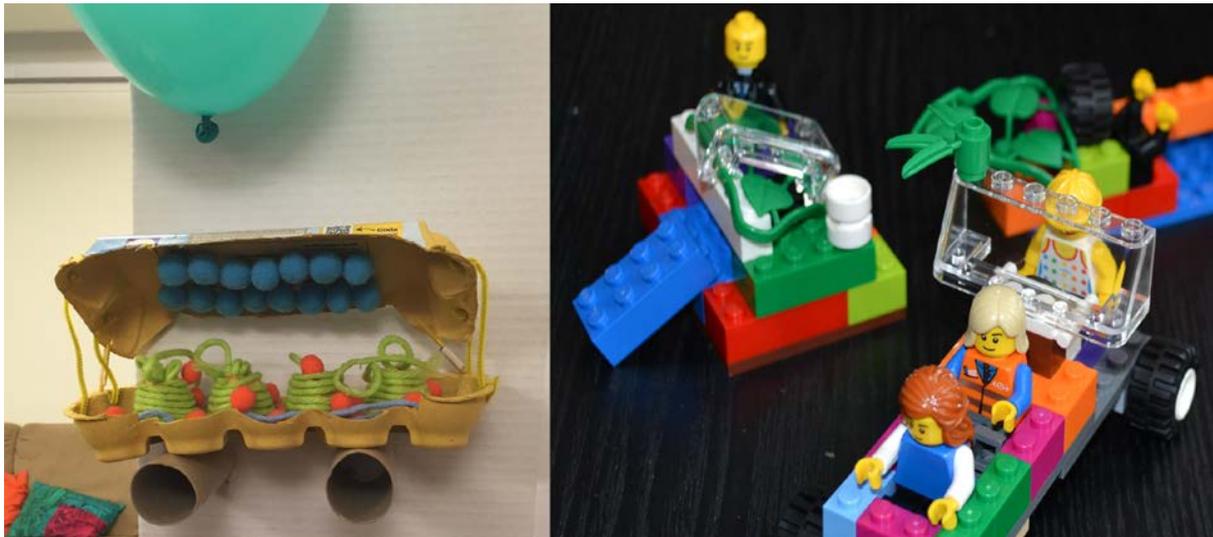
The workshop takes place about two weeks in the course. Firstly, the participants are divided into teams with three to six participant per team (unless they haven't already been divided into Demola teams) The teams are composed to be as diverse as possible to enable as many perspectives as possible. When the brainstorming phase starts a predetermined playlist is played, design to stress and calm the teams with fast paced and mellow music. When the brainstorming phase is over the teams start building their prototypes. The material available are both conventional materials as tools, paper, tape, glue, cardboard and more unconventional materials that shift from workshop to workshop for example paper rolls, curlers and scrapyard materials.

It's very important that the facilitator is pushing the teams through each phase as teams generally tend to stretch the ideation phase. The teams should feel the right amount of stress that encourages them to not think through each idea to carefully. This forces the participant to "just throw the idea out there", which usually stretches the limit for what is realistic and not. During the building phase the facilitator keeps asking questions about the idea and in some cases encourage the teams to go further in the development with certain ideas. The teams will most likely, during this phase, come up with new purposes, features and implementations for their ideas which is encouraged. When the building phase is completed no more additions can be made to the prototype. Now the teams shift focus to constructing a sales pitch, the pitch should be around one-minute elevator style. Here the teams can take a step back from the intense building and starts looking down on what they created. When all teams have pitched their ideas all are gathered up for questions, conclusions and rounding up.

There could also be a second part of this workshop, when time allows. Basically one or two members from each teams are rotated and the teams have a 20-minute redevelopment phase. Focus then is on creating new input to the prototypes, taking the next step and determining what is realistic and not. Doing a redevelopment phase has shown that most prototypes end up fairly close to being realistic ideas that could well be developed in a near future.

A wrap up with reflection ends each workshop where the teams reflects on their experiences both as individuals and members of a team. Typical questions that are raised: "When did you feel stressed?" "Was the music distracting you?" "In what phase did you feel most comfortable?" "What findings did you see from the other students with different backgrounds?". The reflections give the facilitator information where the student is the most efficient.

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*Figure 2, A couple of “shitty prototypes” (1) is illustrating the hydro optic gardening system of “Vertical Garden”. The strawberries are grown indoors in hydro optic nutrition systems and supplied with LED-lightning. Through this system fresh strawberries can be produced in the neighbourhood and all year around. (Photo: Charlotte Norrman) (2) illustrates environmental problems connected to public transportation (Photo: Olof Hjelm)*

Inspired by the Demola facilitators and a Lego workshop at the CDIO conference 2016 in Turku we started during the autumn of 2016 to experiment with prototyping also in other courses. A small financial contribution from Region Östergötland made it possible for us to buy Lego building blocks and craft boxes.



*Figure 3, Shitty prototyping using arts and crafts material is going on!  
(Photo: Charlotte Norrman)*

We have used Lego as a tool for problem visualization and needs-based idea generation during a course in Environmentally Driven Business Development (see figure 2). In the course, Lego blocks were used to visualize problems that call for entrepreneurial solutions. We started by letting the students sit down in groups and then build and explain their individual view of a problem they have detected in the cleantech industry. Then the students merged their individual problems into a joint problem and then into a joint solution. We also used Lego in the same way in a national PhD student/practitioner course in commercialisation of biomedical engineering ideas run by Medtech4health. In this case the participants were divided into groups and their task was firstly to make an individual visualization of a healthcare related problem, and then, group wise create a joint visualization of a chosen healthcare problem.

The shitty prototype concept (facilitated as in Demola) has also been used three times in entrepreneurship courses (“Innovative Entrepreneurship”, see figure 2 and 3, and “Entrepreneurship and new business development”). But in difference to Demola, where the prototyping comes in at the start of a course, here it is used halfway through a course with the aim of acquiring feedback and further developing the group-work venture ideas. The prototyping was combined with a so called “Value Creation Forum” (VCF) feedback seminar - a method developed by Stanford. The seminar was arranged so that they made prototypes first and then presented them following the VCF format.

## **ANALYSIS AND CONCLUSIONS**

Both Shitty prototyping and Lego prototyping is playful and prestigeless ways of visualizing product ideas, concepts and problems. It does not require technological skills, but instead opens for creativity and playfulness and thereby helps students focus on function of the idea rather than on how the prototype should be constructed technically.

In the Demola-course shitty prototyping have been used several times since the course started in 2012. The experience from the facilitator's own experiences give ahead that reflection is of high importance, e.g. it is important to sit down and discuss what parts of the shitty prototype that can be further elaborated on. Questions addressing how the problem was regarded, who is the customer/user etc are important. Through the prototyping event the students have been learned a method that can be picked up later on in the development process, and this is of high importance. The workshop shows upon the possibility to go from idea to prototype in about one hour and to know this can add confidence to the students in their development process. Another benefit is that the workshop helps strengthening the group and builds fellowship between its members, especially if the group members represent different disciplines. Finally, we have recognized that the workshop is disarming and lowers the prestige among the group members and has proved to be an important tool to track group dynamics.

Regarding the use of Lego we observed that in both cases the Lego prototyping served as tool to increase creativity. It also served as mean to let everybody in the group contribute and say what was on their minds. A third observation was that when the individual prototypes was joined together they contributed to give a more complex picture of the problem, including several dimensions. If we only had let the participants discuss, there is a risk that only the most influential ideas would have become accepted. Instead it seemed that Lego contributed to more democratic generation of results.

For the entrepreneurship courses, a preliminary evaluation shows that the prototyping events were appreciated, not least as they added a culture of playfulness and unpretentiousness to the courses. During the spring of 2017 the shitty prototyping event has been run in two courses, one with 25 students and the other with about 50 students. A small survey showed following results: in the small group (12 respondents out of 25 participants and 1,5 months after the event was run) 7% answered that the event was “very good and useful” and 83% that it was “good”. There were four alternatives for this question and no respondent selected “rather bad” or “real bad and waste of time”. In the larger group the evaluation was made directly after the event (33 respondents out of 50 participants). 45% of respondents found it “very good and useful”, 45% “good” and 9% “rather bad”.

We also asked the respondents for short comments. Here a few examples of the answers are given:

- *“Good with tempo in every step - we had to focus on practice, not on thinking”*
- *“Nice event, an opportunity to realise both product and demo for the others”*
- *“There was too little time and it was stressful, otherwise good for realisation of ideas”*
- *“Smaller groups would be better so people stayed excited”*
- *“Would have preferred to have more time before for planning of one’s idea”*
- *“Very good to hear others’ opinions of your idea”*

From this we draw the conclusion that the “Shitty prototyping” works well in education contexts, it is fun and it helps the students to develop their ideas. Large groups - e.g. over 50 are not optimal as the presentations take long time and the group tends to lose energy with time. About 30 students is probably the best group size.

Comparing the different type of prototyping events, we can conclude that Lego is a fast and easy way to run a creative event. This is not least since almost every one has played with Lego when they were kids. The building blocks allow the participants to express and visualize their ideas and concretize vague thinking into concepts that can be shown to others and communicated around. On the other hand, the familiarity can act as a constraint and make people “path dependent” and make them return to previous forms of creation. A drawback, especially when used by “grown ups” is that some individuals regard Lego as kid’s toys and therefore are not willing to participate. This was experienced during the MedTech course where the participants were between 25 and 70 years old.

Shitty prototyping requires more preparation and more equipment. The workshop is also more time consuming. Benefits are instead that the creation is more free than when using ready-made building blocks, such as Lego. There are no defined modules or paths to follow. For some people this stimulates creativity and for others it is a barrier. However, since the shitty prototyping is done in groups, the members can compensate weaknesses of each other and benefit from each other’s strengths.

Comparing with the previous studies presented above, we agree that prototyping is a good way of concretizing and illustrating ideas, as was argued by Berglund and Leifer (2003). We also agree that it aids students to overcome fear of design as proposed by Schultz (1994) as the prototyping events tend to lower prestige and promote playfulness and team spirit. Prototyping also facilitates experimentation and iteration, irrespective of what method is used. Both Shekar (2007) and the experience from Demola leads us to conclude that reflection is crucial - otherwise there is a risk that prototyping just becomes a fun event and learning opportunities are missed.

What we have realised is that engineering students are, normally, not used to creative or divergent types of teaching methods. Therefore it is important to explain carefully what will happen during a prototyping event so that students feel safe in that the teacher is in control of the overall process. Another finding that we have made, and which is interesting from a CDIO-perspective, is that especially the shitty prototyping event can be used as a tool to enhance group dynamics. During a prototyping event it is easy for a facilitator or a teacher to observe interactions and engagement in the process. Based on this knowledge groups can be coached in order to reach better group dynamics (see e.g. Schutz, 1958) and thereby also perform better.

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