

# THE CREATIVE ENGINEER: SKETCHING FOR DUMMIES

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## ABSTRACT

Earlier studies demonstrate the importance of visualizing problems, and how the sketch manages to catch the ambiguity of the design process. It creates new ways for idea generation in an individual generate-interpret cycle, where the thought interacts with an external representation. The sketch enables an integrated group process by offering direct access to earlier and current ideas, and dialogues are better facilitated. Studies have also found strong correlations between the quantity of sketches and the quality of the result.

The mechanical engineering programs at LTU (Luleå University of Technology) did not have sketching courses, and to improve the students' creative capabilities sketching were added to their education. To accomplish this, the teachers at the Department of Innovation & Design, LTU, were contacted. The mission was to make success from only a few lessons, and to manage this a workshop was created.

Using this workshop, students will overcome the threshold of obstacles and misconceptions and make the sketch into an important tool in their creativity toolbox. The goal is to incorporate the pen in students' creative process and make them take advantage of the sketch when working in product development groups.

The results from this workshop proves that by simplifying the task and focusing on speed and quantity the sketch as a creative tool will be accessible for a wider audience. It has improved the outcome of students' projects, and shows the possibility to enforce the role of the sketch in future mechanical engineering education.

*Keywords: Mechanical, engineer, creativity, sketching, design*

## 1 INTRODUCTION

The importance of sketching in creative activities has been well investigated. Designers and architects have accepted that sketching facilitates creativity and have strong communicative qualities for representing thoughts and ideas. Earlier studies demonstrate the importance of visualizing problems, and how the sketch manages to catch the ambiguity of the design process [1]. According to Goel, sketches are inherent in the cognitive activities that facilitate concept generation, and Verstijnen [2] argues that combining and reconstructing in sketching is distinctly linked to creativity. A sketch is a partial image of the object, this creates freedom of interpretation stimulating creativity [3]. It creates new ways for idea generation in an individual generate-interpret cycle, [4] where the thought interacts with an external representation [5]. The sketch enables an integrated group process by offering a direct access to earlier and current ideas [4], and dialogues are better facilitated with physical representations to relate to and re-interpret [6]. Studies have also found strong correlations between the quantity of sketches and the quality of the result. According to Schütze et al [7], design solutions gained quality if the design team were permitted to sketch, and Yang [8] argues that the quantity of sketches used early in the design process strongly affects the design outcome. The sketch is also a way to store design ideas [9] so that it is possible to revisit them unchanged, something that is hard to do with ideas that was only expressed verbally.

Along with counting and speaking, sketching is a primary form of cognition and fundamental to human action. [10] We argue that sketching is an important tool not only to designers. According to McKim; to find innovative solutions it is necessary to be able to think visually [11]. It is not only designers who seek innovative solutions, this also apply to engineers, technicians, business developers,

entrepreneurs, well, everyone. The sketch is the key to visual thinking, and therefore we want to promote the sketch to a wider audience.

## **2 METHOD**

### **2.1 Background**

In the program IDE (Industrial Design Engineering) there is a long tradition of teaching students sketching skills to strengthen the creative process in project assignments, creative workshops and presentations. In these program courses students come from varying backgrounds and with varying skills. Taking an ordinary program sketching course means students have 30 hours of scheduled sketching and 170 hours to sketch on their own.

The ME (mechanical engineering) programs at LTU did not have sketching courses. The need to involve sketching classes first appeared with the introduction of engineering programs with industrial design content. In some project courses both IDE students and ME students were mixed, and one effect of this was that students from the ME program wanted sketching training since they saw the positive effects of the IDE students sketching and visualization abilities.

Staff from the ME program contacted the teachers at the Department of Innovation & Design, who were responsible for the sketching courses in the IDE program, asking for help with adding sketching to the actual project course in which also IDE Students were participating. Their idea was to train the ME students sketching skills making students from different programs being able to act in project groups on a more equal level when visualizing ideas. There was no tradition or experience of this in other programs than the IDE program at LTU. Because of this lack of experience and tradition the time offered to add this knowledge to the ME program project course was very short. The time offered was two half days, this means two times 3 hours. From their point of view it was at the time all they could spare for a sketching workshop. The idea of the content they ordered was also vague, they had seen IDE students work with industrial designer techniques, and this was what they wanted to have. Having 6 hours to teach sketching is a very short time to make a difference. IDE students have 200-400 hours of sketching courses in their program. They wanted these inexperienced ME students to learn as much as The IDE students do, but in a fragment of the time that the IDE students are offered. This was a huge challenge and of course impossible to fulfil.

The first layout of the workshop was to compress the basic IDE sketching course to a 6 hour workshop. By doing this we could say we had fulfilled the clients order. The students would be presented the techniques, the material and the theories in design sketching and all the training would be on their own responsibility. This was not a good solution but at least a solution. Students would know what material to use, where to seek for more knowledge and hopefully see the need for attending to a longer sketching course or practice on their own.

After five workshops we found that the outcome was not in level with the aim of the workshop:

- The students did not use the pen to take an active part in the creative work in their projects more than before.
- Their interest for attending a longer sketching course was low.
- They found it hard to link and implement the content of the workshop to their projects.

Still the students were positive about having a sketching workshop as part of the course, and they said it was interesting to try working with the correct materiel and techniques. The layout seemed to only stimulate surface learning, and the TLA (teaching/learning activities) [12] was very teacher-oriented where the students just mimicked the things that the teacher presented without any reflection. The value in the workshop was mildly intrinsic, they found it inspiring to see things happening on their papers, but without any deep learning activities they cannot put their experiences into action in a different context after the workshop.

### **2.2 The new approach**

Besides the problem with having very short of time, the teachers know from experience that there is not only the skill training that is a problem. There are also obstacles to overcome regarding the students attitudes. These attitudes can way to often be “I cannot draw”, “sketching is a gift which I do not have”, “I am not an Artist” etc. Considering the results from the previous workshops it was obvious that it was more important to work with the students’ attitudes rather than giving them a line-up of tools and techniques.

The problem is to make students understand that they do not need to be skilful, artistic or have a divine gift to make it possible to use sketching as a tool in their creative toolbox. This was one of the most important changes to deal with in the new workshop layout. Since Yang [8] argues that the quantity of sketches is what matters; it is not artistic skill that we need to focus on but rather making the students sketch at all. The important thing was to make them sketch, not to make them good at it.

The conditions for the workshop were the same as before; the same time frame, the same students. To reach the intended learning outcome the layout of the workshop had to be remade from scratch. Instead of focusing on perspectives and rendering techniques the focus was shifted towards doodling, speed exercises and simple visualizations with no need for artistic qualities. The value of the course towards the students had to be improved, and surface learning had to be replaced by deep learning so that the students would be able to implement the content of the workshop into their projects.

According to Biggs [12] there are three levels of thinking about teaching. In order of abstraction: Level 1; the teacher presents information, the student absorb it. How much they absorb is up to the students' abilities. Level 2; the focus is more on what the teacher does. To be able to explain concepts and facts the teacher needs different skills. Level 3; the focus is on what the students do, that they involve themselves in the learning activities. The teachers' role is to encourage them. Level 3 is, according to Biggs, the key to good teaching and a way to make students use a deep approach in learning. To achieve this the workshop, that in its first iteration was mainly a Level 1 activity, needed more peer- and self-oriented instead of teacher-oriented activities.

Value, how do we motivate the students? Biggs defines four motivational categories: Extrinsic motivation, what the outcome produces, Social motivation, what other people value, Achievement motivation, ego-enhancement, and Intrinsic motivation, the process of doing it [12]. It's fun to sketch when you see improvement, so the intrinsic motivation is built into the workshop as long as the learning activities are inspiring. The extrinsic motivation must be strengthened, and this can be achieved by activities that show the positive effects of sketching in situations that are familiar to the students.

Finally there is also the expectancy-value theory of motivation to relate to. If the students do not expect to succeed, there will be no motivation to get involved. [13] In this case there are a lot of students that arrive to the workshop with a firm belief that they cannot sketch, and that this is a permanent fact. The sketching education at the department of innovation & design builds on two standpoints that are based on a decade of observations of results from sketching courses: 1; everyone can draw. 2; everyone can improve. This is something that needs to be communicated to the students in order to inspire them. But it is not possible to just tell them, the learning activities must support it. First of all there must be a progression in the exercises where the students can see that their abilities are making an impact on the results. There is also the ego-boosting Achievement motivation factor, or rather its negative counterpart, to consider. If there are large differences in the skill level among the students, the inexperienced students will more likely feel inferior then inspired by the more experienced students work. The learning activities must therefore focus more on production and outcome then on artistic expressions, and level the field so that the students are working on even terms. This can be hard since it is not a good idea to put a leash on the experienced students, but by putting the emphasis on creative outcome the artistic level in the sketches become less relevant.

### **2.3 Setting up the workshop**

To be able to get the focus more on the students' activities and less on technique presentations the amount of equipment used in the workshop was cut down. The only thing the students need to bring with them is a simple ball-point pen, preferably black. Pencils are not allowed for several reasons: Pencils are weak, pens give stronger lines and works better in group activities. Pencils have an "undo-function" since they can be erased, and this becomes a crutch that low skill sketchers are keen to embrace according to our observations over the years. They become anxious, they draw the same line over and over getting more and more frustrated. It slows them down and makes them lose focus on what they are doing and instead get them caught up in *how* they do it.

In the workshop they are provided with white A3 copy paper. The use of cheap common copy paper has the effect that students always have it near and they can use it at once when needed. No wasted time to find paper and no excuse to not draw. There is also an assortment of markers, post-it, sticky tape and other useful things that the students can borrow if they want.

The workshop builds on five main steps:

1. Warm-up
2. Speed exercises
3. Readability
4. Creative exercise
5. Reflection

**Step 1:** The workshop begins with simple warm-up exercises; different ways of drawing straight lines, circles, simple primitives etc. This is mostly to make the students start getting things down on paper and break the anxiety that a blank sheet of paper can induce in an inexperienced sketcher. This is also a good opportunity to break the “I cannot even draw a straight line” attitude and show that straight lines are overrated; it is the combination of lines that is interesting not the straightness of each individual line.

The warm-up is combined with basic information about how to use the pen, how they relate to the classroom, the table, the paper and the pen, and also how the body works in the sketching context. The outcome of this basic knowledge is creating security among the participants. By starting at the very basic facts about how to use the pen to visualize everyone can feel secure because everyone starts at the same level. This first step is fairly teacher-monitored to get the students started; the teacher shows them examples and the students then does it on their own while the teacher is there for feedback and support.

**Step 2:** Speed exercises. The reason for this is that learning to draw is a process that needs time, but in this case we only have 6 hours to succeed. One way to handle this is to increase the amount of drawings made by each participant. To make this possible the drawings must be very simple with low demands. The focus must be on producing and not impression. The speed exercises can be performed in many ways, but the simplest and most effective from experience is to just shout out objects with an interval of about a minute up to 3 minutes. The students are forced to visualize the objects quickly.

The outcome: They have no time to scribble, they see that their class mates, because of the short time to act, are at the same level as them and they can start laugh about it, proudly showing their weird interpretations of the objects to each other. There is no need for knowledge about perspective rules or lighting. Most students just do simple 2D thumbnail sketches leaving out detail and focus on the important features to be able to get something down in time, and this puts the emphasis on productivity and descriptiveness instead of artistic expressions. This exercise also focus a lot on what the student does instead of having the teacher telling them, and it creates an open atmosphere with peer interaction since it triggers discussions and communication.

**Step 3:** After the speed exercises the students are instructed to make the sketches more readable by strengthening important lines, adding simple depth and a simple light setting, and use color and annotations to highlight and enhance the message. For the depth we use simple isometric/parallel perspectives where a feeling of 3D is added to the doodlings, but true perspectives are of course allowed. The model used for lighting is a simplified light setting, where a shadow direction is defined by picking a set of surfaces that faces the same direction and hatch them with the pen.

The papers are then rotated so that everyone has someone else’s sketches in front of them. The task is to highlight or comment in text parts of them that are not understandable, it can be shapes or features that are unclear. The papers are then switched back and the original artist have to make them understandable by refining the sketch, adding annotations and colours. This emphasizes the communicative aspects of the sketch, the fact that others must be able to discuss and reflect on what they have drawn. Since they are interacting with their peers they get more involved in what they are doing, and because of the direct feedback they will automatically reflect on their work and use a deeper learning approach.

**Step 4:** The students have to put their sketching skills in use in an arranged creative group exercise. This exercise should, if possible, be connected to their ongoing projects. If there are groups already set up for the participants they can work in those, but a good idea is to mix them up. It is good to use an exercise that focuses on the sketching activity rather than the actual outcome of it, and where visual thinking really makes a difference. Customer journeys [14] for example are excellent since they focus more on experiences and services rather than artifacts. Other options are brain-writing sessions or a fictive service concept generation project if there are no ongoing projects to use.

The exercise is built up in two parts; first, a session of idea generation, and then a session with idea refinement. In the idea generation part the goal is quantity, that a large mass of ideas to work with is

generated. Depending on the experience of the students the task can be very free. Engineering students usually have experience of group projects and creative sessions so they know what it is all about and can get started without detailed instructions, but if the creative exercise is new to them it is good to provide them with some reading material before the workshop. The important thing is to let them set up their work on their own as much as possible since it requires that they discuss and together come up with a game plan. Even if the work flow is free, to make a quick-project like this the frame for the exercise must be clear. For example task, time for presentation and goal. It is also important that the teacher is present to answer questions or look for groups where the dynamic is lacking. Activity and participation is the key.

In the second part the goal is to make something interesting out of the ideas generated in the first part and present it to the rest of the class. The work flow is still free, but a wall or board is assigned to each group that they can use to display their concepts during concept evaluation. This is usually all that is needed to push them into discussions about and around their visualizations. A second doodling and sketching session comes natural when they together start to narrow their ideas down towards a final concept, but sometimes some groups need to be guided in the process.

The presentation can also be held in a simple manner: They are instructed to visually present their concept to the rest of the class. A random person that is not part of the group that is presenting is asked to explain the concept for the rest of the class. Doing it this way the strengths and weaknesses of the visual presentation becomes obvious, and it also involves the whole class in another way since the presenters are suddenly a part of the crowd. The group is then asked to describe the process and how they worked with the assignment, and feedback is given.

**Step 5:** The actual workshop ends with the presentation, but there is one more task for the group: A short reflection must be handed in after the workshop where they describe their work in the creative group exercise together with their own reflections on each step. The reflection is important since it stimulates deep learning [12] and helps with processing the activities the students have experienced during the workshop. It can be very simple and be predefined like; how we decided the main concept, how we refined the main concept and so on. The hand-in should be individual so that each participant gets a chance to reflect on their work and even assess their own contribution to the result.

### **3 OUTCOMES AND CONCLUSIONS**

The teaching staff could notice a significant increase in drawing activity, and a larger amount of students show drawing activities in the discussions and creative work in project groups. There have also been students from the workshops showing interest in taking the basic sketching course in the TD program. This type of very simplified drawing lessons where drawing is more like doodling have been used in other courses to warm up in beginning of creative work. This warming up sessions has been successful to speed up activity in project groups.

This indicates that the new layout of the workshop gives a higher value to the students and stimulates a deeper learning approach. There is a higher grade of extrinsic motivation since they feel they can use the knowledge to contribute better in their projects after the workshop, and the intrinsic motivation is higher also for the less skilled students thanks to group activities. The TLA is more learning-by-doing oriented and peer-directed because of the group interaction, something that the previous iteration lacked. The teaching method is also more student oriented then teacher oriented since the students themselves are active and take part in the planning of their work, and the lecturing is cut down to a minimum.

The initial warm-up and speed exercises and the simple materiel seem to have a good effect when it comes to counter the fear of failure. The activity level and participation is high in the whole group when the creative group exercise is initiated. They also support the expectancy of success for the low skill students by keeping the whole class on the same playing field and rewards action more than artistry.

This was a workshop with students from the ME Program. Drawing as a creative tool presented this way can be useful for many other groups and not only for these students. Companies, local authorities, consultants and others where there is a use for creativity and creative methods when solving problems could use this to speed up the process and increase individual activity.

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