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FEWER CONSTRAINTS MORE CREATIVITY? INSIGHTS FROM AN EDUCATIONAL SCIENCE FICTION PROJECT

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Abstract: This article presents a case study of an experimental product design project in the context of design education. Short stories by Science Fiction writer Philip K. Dick were used as the source of inspiration for designing imaginary products within that narrative. Since the project was free of typical constraints, such as feasibility, cost-efficiency, material and production resources, the students had the possibility to try out extremes and push their limits. We present a description of the project frame, the resulting products, as well as an analysis of the case study. We believe that the work presented in this article demonstrates the impact of creative freedom on creativity and provides some insights for design educators how to trigger a creative leap within the students

Keywords: *creativity, science fiction, design education, Design for Film*

1. Introduction

Space… the final frontier. The voyages of Starship Enterprise have already demonstrated that Science Fiction can indeed have a visionary influence on today's products. Physicist Lawrence Krauss wrote a whole book about the physics of Star Trek (Krauss, 1995), and the X PRIZE Foundation launched a $10 million competition for the design of a medical scanning device based on the Star Trek tricorder (X PRIZE Foundation, 2012). Also other science fiction movies provided some cutting-edge ideas that later turned into actual products, such as the tablet shaped computer in Stanley Kubrick's "2001: A Space Odyssey" from the year 1968 that already showed astonishing similarities with Apple's iPad (Peralta, 2011). So, the question is not only, if existing Science Fiction movies can provide some inspiration for today's products, but rather whether we can generate ideas for innovative products via thinking in Science Fiction contexts? Is it possible that the limitless world of Science Fiction is able to unleash our creativity? When conducting a design project, you usually have a clear vision of what it is about. Either there is a precise briefing, or you are confronted with a clear set of constraints and restrictions (target group, available resources and materials, technological possibilities, budget, etc.). But what if there is no briefing, and there are no such constraints? What if you could do whatever you

want? Designing for Science Fiction provides the designer with such a freedom. Everything is possible, there are no limits—neither technological, nor financial, not even physical laws apply here. Is such a designerly freedom the chance for limitless creativity? Or do we actually need some constraints to come up with innovative solutions? This question leads us to our hypothesis, which states that *fewer constraints in a design project may lead to a higher level of creativity.*

In this article we present a case study of a Science Fiction design project, conducted in an educational institution. 14 design students were confronted with different short stories by Science Fiction writer Philip K. Dick, and the task to design a new object within that story that was not defined by the author. Confronted with only a few pages of text, the students had to come up with ideas for the main characters (how do they look like?), the environment, and finally with a new object that was not even described in the original story. The project TRANSFORMERS was conducted over a period of 12 weeks in 2011 at the Bachelors program of Integrated Design (product design, communication design, interface design) at the Anhalt University of Applied Sciences in Dessau/Germany. The project was a 'complementary project', taking place once a week for four hours. Among the 14 participants were four male, ten female, five in 2nd year, 9 in 3rd year. Each one was given a different short story by Science Fiction writer Philip K. Dick. After analysing the content of the narrative, everybody had to come up with sketches of the protagonists and the environment, as envisioned by the student. The original story had to be visualized in a storyboard aligned to a timeline. After that, each student had to invent an object (which was not existing in the original story), which would then modify the story and turn it into an alternative ending. This modified storyline had also to be visualized in a storyboard. Several interim presentations and group discussions provided the possibility to exchange ideas and get feedback. As a creative input there was a guest lecture given by a film and set designer. The results of the project were shown in a public exhibition.

This article starts with a description of the case study methodology, including the used data sources. The third section—the main part of this article—presents the results of the projects as well as an analysis of the data sources. In Section 4 we present a brief summary of our analysis, and we conclude by discussing possible implications for future design and design education.

2. Case study design

The presented case study tries to answer the following research question: How do students cope with relatively limitless design frames? And how does this stimulate or prevent the flow of creativity? Following Yin's Case Study Methodology (Yin, 2009), we based our case study on three data sources: 1) direct observations, 2) semi-structured interviews, and 3) the resulting project outcomes (artefacts).

The observations (1) were conducted by one researcher who was involved in the project as a lecturer and who provided the students with the whole project assignment and frame, and was able to extract first-hand insights through direct observations. After each session (once per week) he took notes about observed group dynamics or noticeable problems of particular students.

The semi-structured interviews (2) were conducted in week 11, prior to the final presentation, with 13 of the 14 students (one missing due to illness; that interview was caught up in week 13 after the final presentation). The interviews consisted of a prepared questionnaire with open and closed questions, which gave us the opportunity to evaluate the results quantitatively and qualitatively. During each interview—which lasted about 10 minutes in average—the researcher could clarify any occurring questions by enquiring details. Subsequently, we clustered the answers and collected those insights that were mentioned most frequently.

The artefacts (3) that resulted from the project were categorized according to their intended function and the respective levels of potential realizability. We distinguished between three categories—poetic objects, potentially realizable objects, and objects for virtual worlds or Science-Fiction movies. This classification was conducted by two researchers (raters), who independently assigned the projects to one of the three categories. The inter-rater agreement was measured with the Cohen's Kappa (Coeffient: 0,76, StdErr: 0,15). According to Fleiss (1981, p. 218) a Cohen's Kappa of 0.75 or more means excellent inter-rater agreement. For the two disagreements, the raters discussed their ratings and then came to an agreement. The two ex-ante disagreements were for the actifacts "Phoebe" (Figure 2, right), classified as poetic after discussion (before rated as poetic and virtual), and for the "Get-Ice-Cubes-Out-Of-The-Air-Racket", classified as virtual (before rated as virtual and real).

Finally, we did a cross-analysis of some of the data-sources, in which we compared the categorized artefacts with the answers from the interviews. This evaluation provided the opportunity to empirically test our hypothesis. The used data sources as well as their analyses are described in more detail in the following section.

3. Analysis

3.1 Observations

Since we were involved in the project as lecturers, we could directly observe the students' behaviour, as well as occurring problems. During the whole project we took notes about our observations and the students' progress.

Observation 1: Problem Solving Attempt. Most students had one initial idea, which would solve the main problem of the story (kill all the aliens or save the entire humankind somehow). They were suggesting an obvious solution ("silver bullet"), which would somehow resolve the problem within the story, but at the same time this would make it boring and destroy the dramaturgy. It was difficult to convince them that the better solution for this project was actually something that would cause problems, to make the story more interesting. We believe that an additional input into film dramaturgy would have helped the students to better understand the scope of the project. The lack of such information led to a major confusion among the students about what to focus on.

Observation 2: Science Fiction Experts. All students were Science Fiction fans, which made the whole process more fun, and everybody had a lot of input to give. On the other hand, most of them came up with ideas that were inspired by existing Science Fiction movies they already knew. It was difficult for them to design totally new worlds.

Observation 3: Ugly Design. Many students enjoyed the possibility to design "ugly" things. Usually designs had to be pretty, but in this case they were able to design really disgusting and yucky objects. Obviously they drew a lot of pleasure from this. The "Brain Worm" (Figure 4, left) is an example of an "ugly" solution.

Observation 4: Undirected Creative Energy. Some of the students developed a fascinating creative energy. They came up with a lot of creative ideas, which however didn't fit into the story or did not served the dramaturgy. This had to be guided by the instructors.

Observation 5: Phases of Creativity. Within the 12 weeks of the project, we observed that the mood of the students changed significantly. While in the beginning everybody seemed to be excited of their respective story and the visualization, the highlight seemed to be the input given by the professional film designer, which gave the students an idea of where this project could lead. However, after that there was a big decline of motivation and creative output, since most of the students were heading

towards a too simple solution (see also observation 1). Group discussions and individual consultations with the instructors seemed to help. In week 9 there was a kind of breakthrough for most of them, where they got really excited about their final ideas. In this week they presented the final ideas in an interim presentation and got group feedback. In week 11 there was another minor decline, which was probably due to time pressure towards the end of the term.

3.2 Semi-structured interviews

This section describes a summary of the outcome of the semi-structured interviews, as well as our analysis and interpretation. The first group of questions was about the project itself, such as the level of difficulty the students thought the project had, compared to other projects. We presented them a 5-point Likert scale (1 = very easy, 5 = very difficult), in which the average rating of all interviewees was 2.79 (standard deviation: 1.19, median: 3.00). Figure 1 (left) shows a violin plot of all answers. A violin plot is a combination of a box plot and a density plot. The black bar in the middle of Figure 1 is a box plot, representing the lower quartile, the median (white dot), and the upper quartile. The yellow (grey) part is a kernel density plot that shows the distribution of the answers.

Selected quotes from this group of questions:

> "It didn't feel like work, more like a hobby."
>
> "It was not difficult at all, because it was so much fun."
>
> "It was difficult to find the right material for prototyping the futuristic ideas:"
>
> "It was difficult to judge the results. You don't know what would be appropriate."

The second group of questions concerned the individual level of creativity of the students, such as how creative they felt in this project. Again, we provided a 5-point Likert scale (1 = not creative, 5 = very creative). Here, the average rating of all interviewees was 3.46 (standard deviation: 0.69, median: 3.50) (see Figure 1, right).

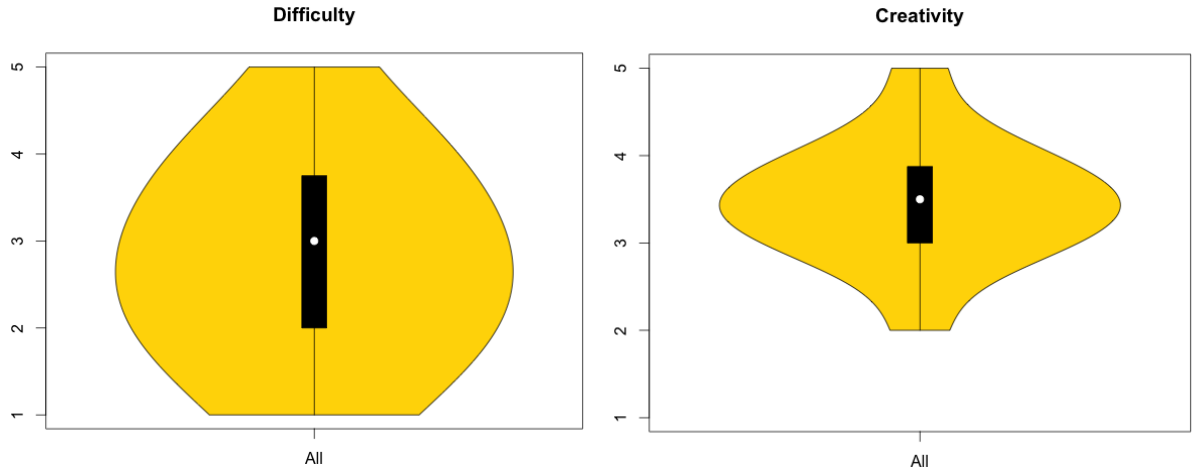

Figure 1. Left: Violin Plot of Difficulty (n=14). Right: Violin Plot of Creativity (n=14)

Also, we asked how they rated their level of creativity in this project, compared to other/previous projects (more creative, same, less creative)? The vast majority of the students (74%) felt more creative than in other projects, only one felt less creative (7%).

Selected quotes from these questions:

> "I felt far more creative than in other projects."
>
> "The endless possibilities triggered my creativity."
>
> "In the beginning it was difficult to turn off my internal censor how that might be realizable. But after that I could loosen up."
>
> "It was difficult to decide which idea to take, because I had so many."

The third group of questions related to the freedom within this project, specifically how the students experienced the lack of precise constraints or the possibility to design unrealistic, ugly or useless objects. From the 14 interviewees, 9 found the freedom positive and inspiring, two said it was difficult, and 2 said it was difficult in the beginning but later it was inspiring.

Selected quotes from this group of questions:

> "More constraints would have made it easier, but also more boring. I liked the challenge."
>
> "It was the perfect balance of freedom and constraints."
>
> "I would have preferred even fewer constraints and more freedom."

Finally, we asked some general questions about how they liked the project in general, what they did not like, or what was missing. The most insightful answers were about the multi-disciplinary approach of the project (there were sketching and illustration involved, as well as prototyping), and that the medium of the design was open (product, graphic, interface). On the other hand there were some complaints about the complexity of some of the stories.

Selected quotes from this group of questions:

> "I liked to manipulate the story, and that we had to design within that story."
>
> "I liked to design under 'pseudo-scientific' conditions. It didn't have to make any sense."
>
> "I didn't like the struggling at the beginning until I got my final concept."
>
> "My story was more difficult than most of the others' stories."
>
> "I had problems to understand the stories of the other students in their interim presentations."

3.3 Results (artifacts)

There was a great variety of different materials, styles, scales, and product functions within the resulting designs. Futuristic cosmetics or medications, therapy tools for depressed Aliens, Steampunk-style nano robots, ugly slimy worms, living and breathing lamps, ridiculous household devices (such as a futuristic sponge, a living trash can, or a tool to capture air humidity and turn it into ice cubes), and even dangerous viruses or DNA time capsules. Some of these things make sense and might be realized in the future, others are more like persiflage of our own living culture. The following section presents a description and analysis of the results.

We distinguish between three categories of resulting artefacts: 1) poetic or philosophical objects, 2) almost realistic objects, which suggest cutting edge concepts that would actually make sense in just a

few more years or even today, and 3) objects that mainly make sense in the virtual world of a game or a Science Fiction movie. We describe the resulting objects according to these categories in the following section.

1) Poetic artefacts: Among the poetic objects were the brain massager that helps to overcome aggression (Figure 2, right), "Hasplexus", the hate-consuming virus that feeds itself upon the hate within humankind and finally mutates and turns evil (Figure 2, left), and "Phoebe", the breathing lamp that inhales air and exhales light, which gets frightened by an intruder and turns dark with shock (not shown).

Figure 2. Two examples classified as poetic. Left: The "Hasplexus" Virus, feeds itself upon the hate within humankind (scale 100,000 : 1). Right: "Phoebe" the living lamp.

2) Potentially realistic artefacts: Among the almost realistic objects were the nano-robot that purifies the body from inside (Figure 3, right), another microscopic robot that fixes damaged cells within the body (not shown), the DNArk, which preserve human genetic information in case the earth gets destroyed (Figure 3, left), the nano sponge that helps cleaning up stains (not shown), CalmCat 300—the digital pet (not shown), a futuristic communications device in the shape of a bracelet (not shown), and an intelligent robot that executes mine-working in contaminated areas (not shown).

Figure 3. Two examples classified as realistic. Left: The "DNArk": a sort of time capsule with human DNA probes to rebuild the destroyed earth. Right: The "Purification Nanit": cosmetics of the future—a nano robot that cleans up your body from inside (scale 100,000 : 1).

3) Artefacts for virtual worlds, games and Science-Fiction movies: Among the virtual objects that fit best into a virtual game or a Science Fiction movie were the brain worm to entertain you while you are in deep space hibernation (Figure 4, left), the carnivorous plant, which serves as a trash can for food leftovers (Figure 4, right), the "Get-Ice-Cubes-Out-Of-The-Air-Racket" to turn air-moisture into ice cubes (not shown), and the therapy device for depressive aliens (not shown).

Figure 4. Two examples classified as virtual: Left: the "Brain Worm" for deep space hibernation. Right: The "Carnivorous Plant": For disposal of food leftovers.

3.4 Cross-analysis of artefacts and interviews

Subsequently, we compared the answers from the interviews with the respective project outcome for each student. We wanted to test our aforementioned hypothesis that fewer constraints lead to more creativity. For that purpose, we compared the realistic results with the results that were classified as virtual or poetic (since the latter obviously had to cope with fewer constraints than the realistic results).

Figure 5 (left) shows the violin plot between the artefact category (1. poetic/virtual or 2. realistic) and the level of creativity the respective students indicated in the interviews. The plot shows that the mean of the creativity of poetic/virtual artefacts is higher than the creativity of realistic artefacts (poetic/virtual: 3.86 vs. realistic: 3.07). The difference is significant (t = 2.52, df = 11.7, p = 0.027).

Figure 5 (right) shows the violin plot between the category and the level of difficulty the students declared they had with the project. The mean of the difficulty of poetic/virtual artefacts is lower than the difficulty of realistic artefacts (poetic/virtual: 2.43 vs. realistic: 3.14). However, the difference is not significant (t = -1.14, df = 11.7, p-value = 0.28).

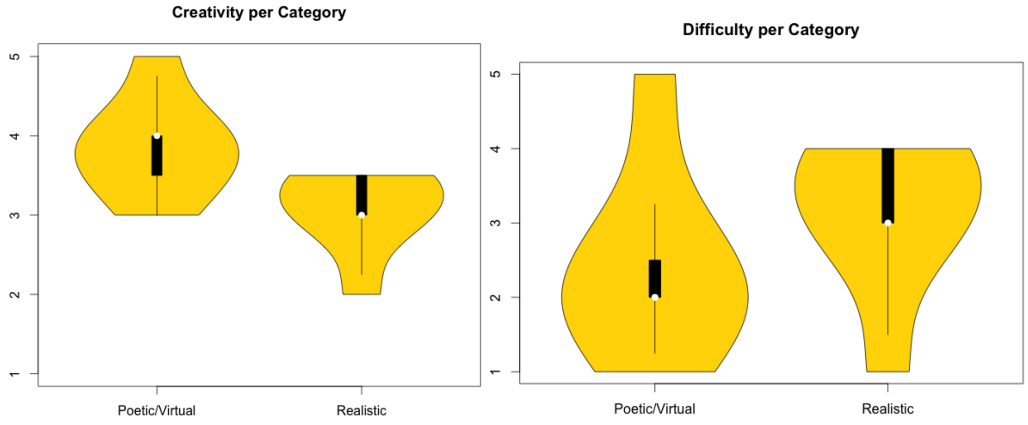

Figure 5. Left: Violin Plot of Creativity per Category "Poetic/Virtual" and "Realistic" (n=14). Right: Violin Plot of Difficulty per Category "Poetic/Virtual" and "Realistic" (n=14).

This leads us to the following conclusion: The more the students were able to ignore realistic design constraints (feasibility, logic, physical laws, etc.), the more creative energy they were able to generate, according to their self-evaluation. This supports our initial hypothesis that a limitless design frame in educational project work is able to foster creativity within students.

4. Summary and discussion

This article presents a case study of a Science Fiction design project in an educational context. Our initial hypothesis claimed that a limitless design frame with lots of freedom might be able to trigger creativity. We used three data sources to evaluate our hypothesis: direct observations during the project, semi-structured interviews with the participants, and the actual results of the projects (artefacts). This section provides a brief summary of our findings and the respective analyses. From the actual results of the project—the artefacts—we distinguished between three types of artefacts: poetic objects, potentially realizable objects, and objects for virtual worlds or Science-Fiction movies. From the observations and semi-structured interviews we could extract six key insights that seemed to have a positive influence on creativity, in the context of this Science Fiction project.

The following aspects had a positive influence on the creative output:

1) Few constraints, freedom, anything goes

2) Mix of different media (illustrative, sculpting, writing)

3) Possibility to design something weird and ugly (doesn't have to make sense)

4) Personal interest in the Science Fiction topic

5) Group discussions and external input (such as guest lectures)

6) Last but not least the story itself, which provided an inspiring playground

At the same time we could identify several aspects that seemed to restrain the creative flow. The following aspects had a negative influence on the creative output:

1) The lack of dramaturgic understanding

2) The challenge to realize "unreal" objects (finding the right materials for modelmaking)

3) The internal impulse to check the ideas for feasibility

Our main insight was, however, that those students, who decided to design an almost realistic object that might be realizable in the near future, felt significantly less creative than those students, who designed something really futuristic or poetic. Also, the students with the more realistic approaches indicated that they found the whole project more difficult than those, who designed fantastic and unrealistic products. You could also say, that those who focused on the "Science" part within this Science-Fiction context developed less creative energy than those who focused on the "Fiction" part.

Of course, the analysed case with 14 students provides only a narrow perspective on the impact of creativity. Also, we did not analyse the reason why some students decided to design more realistic objects, while others were able to get rid of the constraints. This may have been caused by the different stories each student received, which may have provided some constraints in itself. But this does not change the outcome of the analysis, that those who designed more realistic objects felt less creative than the other two groups. However, another limitation of our finding is, that they rely on a

self-reported measurement of creativity. Future research should evaluate the creative output independently.

We derive the following recommendations for educators, who want to trigger a creative leap within their students: Encourage wild ideas and allow experimentation with ugly or unrealistic concepts in order to trigger creativity. It will always be possible to reduce those wild ideas down to a more realistic setting, later on. Also, provide students with a playground—an inspiring context with "safety nets" (where everything is allowed and can be tested), where they can push their limits. The challenge will probably be to find a means to switch off the internal quality control of the students. This problem may be addressed in further research.

The question remains, whether such a fictitious project setting makes any sense at all, since the results were either too cutting-edge for today's technologies, or even completely unrealistic. Of course, we cannot know by now, if the ideas in this design education project will turn out real within the next years or decades. Maybe there will be a vegetable device that eats our food leftovers, or a nano-robot that purifies our skin, or maybe this will remain just Science Fiction. However, we believe that this article indeed demonstrates the positive influence of such limitless projects on our creativity. Moreover, there is definitely a market for such wild design concepts in the areas of film or game design. It is a fact, that more and more things in our world become virtual—for example there are about 80 times more virtual farmers, playing the online game "FarmVille", than there are real farmers in the US (Cohen, 2011). This demonstrates the huge potential for designing fictitious products for film, games or other virtual worlds. We believe that the work presented in this article demonstrates the potential of a loose design frame with a lack of constraints to unleash creative energy.

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