INTERNATIONAL CONFERENCE ONENGINEERING DESIGN
ICED 05 MELBOURNE, AUGUST 15 – 18, 2005

DESIGN AN ANIMAL
ANALOGIES FOR THE DEVELOPMENT OF CREATIVITY

Chris Dowlen

Abstract

Following an introduction on the nature of creativity, the paper goes on to explain why it is necessary for life in general and specifically for students taking design degrees. The main thrust of the paper describes a specific project aimed at developing creativity in first year undergraduate students. This consists of a managed project approach, with students utilising specific creativity-building methods within the framework of a project to design an animal. These specific methods include such things as the inevitable brainstorming process, forced serendipity and morphological charts, continuing with affinity diagrams, copying, genetic developments, writing creative fiction and personal analogies. Students are introduced to embodiment processes such as structural and systems design and are expected to resolve the project as a model of an animal toy. A discussion of the value of the project forms the conclusion.

Keywords: Design Education, Creativity, Projects

1 Introduction

Teaching creativity is essential at the start of a design course. Design is about synthesis, which is unable to take place without understanding and experience of creativity. The thesis of this paper is that presenting creative methods and a framework for creativity is insufficient: students have to experience active creativity. The topic has developed from a paper presented to the ICED conference in 1995 [1], and from two papers presented to conferences and workshops on Design Education [2, 3]. The particular exercise languished after that for a number of years, and has recently been revived, as it was felt that without it students may have been missing out and were not able to develop their creativity well enough.

2 Creativity

> Creativity is a magical thing that you are born with. It presents itself early and like a virus is unstoppable.
>
> It inhabits the kids who daydream and are good at drawing, but not much else. If I knew where it came from, I would bottle it up and make a fortune.
>
> Michael Dempsey [4]

Not so much a definition, more of a description and a wish list. So what is creativity?

There have been many attempts at trying to look at creativity. One of the most useful treatises on the subject has been a text put together by Robert Sternberg in the late 1980s [5] in which he gathered writings from a significant number of players in the area who had developed

significant expertise and interest in the area over a number of years – some heading back to early developments in the 1950s. This group of people are quite clear that they didn't want the subject of creativity to become a tightly-knit academic discipline with strict codes of practice and processes such as the way they had felt research into human ability had moved into being concerned with psychometrics and the topic of what came to be known as IQ, but they rather wanted the subject to remain fluid and expandable, looking for a multiplicity of definitions for the term of creativity. This wish has meant that although it is easy to determine what creativity is, it can be deliberately expanded to become a many-headed and multi-faceted topic. Many writers on creativity do not seek to define it (such as Petty [6] and are more content to develop processes that render it visible. Concepts such as that of newness [7] or novelty appear – and others define it in contrast to the mundane [8] (actually defined here as mechanicalness). In this instance there seems to be a distinction between the normal way in which people create things and something that rises above normality.

Keeping the fluidity is important. But it is also useful to decide whether simple creation of something however banal still involves creativity or whether it can only be involved in the higher order of things. Although the jury is out, a working definition of creativity is more related to the act of creating than the quality of creating: the quality of creating determines the quality of the creativity rather than its existence.

2.1 Creativity is essential for life

As life unfolds we individuals go through it on a time line. We pick up sensations and information from our environment and distil it into our brains, providing our stimulation for living. As time unfolds, things change around us. This change is essential for our sensory stimulation and without it we would not be human, no matter how much we decided that we hated change. Each day is inherently different from the previous one and is essentially a new experience. This newness of each day and even each point in time can be technically described as novelty, although sometimes we don't feel that it is indeed this. Some of us hate change. Some of us court it. But it is a fact of life. And it is the creation of these changes – some small, some large – that constitutes creativity. Thus we could argue that creativity is essential to life.

It could be argued in a somewhat stronger manner that not only is creativity part of life that is unavoidable, but that we respond better as individuals to a degree of novelty and stimulation than we do to both a lack of novelty (in the limit this would be a zero stimulation so we would be unable to respond to it) or to an excess of novelty, where the complexity of the stimulation causes overkill and we are unable to perceive the newness of the change as the background is already too complex. In the limit this results in an active dislike of the complexity. [9]

Martindale [10] investigates the way in which artistic and cultural enterprise has developed over the course of the last two centuries or so, aiming to understand patterns of development and to analyse created works through that period. He identifies the principle of novelty as the major parameter in the way in which artistic enterprise develops through time.

One of the factors required in conference papers of this sort is that they will demonstrate something that is new and that hasn't been presented in the arena before. A contribution to existing knowledge is required by PhD submissions – and this contribution to knowledge, in whatever form, is defined as being the novelty element. Without creativity this novelty element is not there – and as a result there is no PhD. In theory. So academic development relies on creativity: creativity of developing knowledge in a scientific area or creativity of the utilisation of the body of knowledge in an engineering or design area.

2.2 High quality creativity is useful in employment

Ken Robinson in his book *Out of our minds* [11] starts off investigating the rate of change in our culture and society and then compares what has been happening in society with what has been going on in education. He states

> Employers are complaining that academic programmes from schools to universities simply don't teach what people now need to know and be able to do. They want people who can think intuitively, who are imaginative and innovative, who can communicate well, work in teams and are flexible, adaptable and self-confident. (p52)

Intuitive, imaginative and innovative describe the people who they wish to employ to make a difference to their companies and to put changes into place that are going to be able to develop the companies significantly, making differences to, firstly, the bottom line of those companies and secondly, to the environment and society within which the companies operate. These qualities are significantly related to the quality and measure of creativity that they exhibit.

2.3 High quality creativity is needed in design

Design is at the cusp of human experience [12, 13]. It is the feature that turns people's dreams into plans and determines the way in which those plans turn into reality. The reality in this case is the reality of the man-made world, where raw materials have been shaped into products that are usually intended to have meaning in the lives of people who use them.

Without a means of developing those thoughts and ideas there would be no products, and without creativity there would be no novel – no new – products designed and manufactured. Designers need creativity in order to be able to propose the new designs. And when graduate designers complete their design courses they need to be able to demonstrate creativity.

What needs to be there are processes not just for developing new designs per se, but also for developing the best new designs possible.

Bob Gill, talking about developing graphic design ideas, says:

> The ideas you will have, which come from your personal take on every new job, every new experience, largely determine the quality of your graphic design.
>
> If your idea is boring, then chances are that your image will be boring. [14]

It is thus the task of those teaching design courses to, first of all, understand exactly how people develop new ideas, secondly to work out how these processes can be developed in students so that they can become part of the natural thinking processes of those students and so that they own these ways of thinking as their own. Not content with working out how to develop creative thinking, those of us in the teaching profession need to actually see our students develop the processes and utilise them in the ways in which they come up with ideas and develop them, first of all in their work as students and secondly as part of their way of life beyond the realms of University education – within the rest of life and within a long-term career pattern.

What makes up the contents of the investigative process and then how this is incorporated into a course is very much a matter of debate: no specific method is currently hailed as 'state of the art'.

3 How does creativity happen in practice?

3.1 Pointers for creativity

The real difficulty with it is that it is relatively easy to hypothesise after the event and to determine that such and such a logical process has taken place during a particular project. However, there are a number of pointers that can be clearly seen.

Petty [6] in his introduction says:

> Most people believe that being creative is what a few gifted artists, inventors or entrepreneurs do very occasionally. In fact we are all creative every day. Whenever a problem is solved or a difficulty overcome, whenever something new is made or something old is adapted, creativity has been at work. But being creative is difficult. (p13)

So he believes that creativity is a skill used on a day-to-day basis, but one that needs to be developed because although it is regularly used it is perceived as being difficult and inscrutable. He suggests that for gifted people it happens intuitively, but everyone else can learn creativity.

He suggests also that creativity is not a sudden flash of inspiration but a whole framework of persistent effort and steady improvement that takes place over a period of time. And that developing creativity is about managing that framework of persistent effort and steady improvement.

3.1.1 Practising creativity develops skills. [2]

The more people practise thinking in creative ways the better they are at doing them. It might seem obvious, but it doesn't always seem to be taken up. This means that if there is a specific length of time for a particular teaching programme, the larger number of exercises and small projects that students have to work on, the more exposure they will have and the more they will be able to develop ways of thinking into habits. Too much analysis without a lot of synthesis will similarly not develop the right sort of skills.

3.1.2 Developing creative skills early develops habits.

By the time Universities get students it is probably too late to develop new ways of thinking, but we can always try. Relate this to violin virtuosi: most of those touring the concert platforms started out playing at a very early age – commonly before they were at primary school. In Universities we don't have the ability to take in people starting out, but we can still start off creative thinking as soon as they came to us. In students' favour, this period of University education is normally one where they are making a significant number of adjustments in any case, so an extra one about how to think is probably not amiss.

3.1.3 Not having a stigma on failure is important.

Having the opportunity to do things wrong will develop skills in creativity. Initial exposure needs to be at a level where it doesn't matter whether the ideas succeed or fail. Normally, education does not have the same strict profit-based bottom line on it as industry does. Student achievement in the early years of a course doesn't normally get carried through to the final years as anything more than a pass – fail arrangement. At first year, introductory level, it needs to be emphasised to students that they are in a training situation and that the work they are doing at that point is to allow them to develop skills rather than demonstrate them. It doesn't always work and sometimes students are so wrapped up in getting what they perceive

to be a good performance that they end up playing safe, producing a series of things that meet the requirements of the letter and missing out on the possibilities of developing their creativity. A sad reflection, perhaps, on today's educational system.

3.1.4 Authentic assessment can be useful. [15]

Real problems need creative thinking more than invented ones do, as there is normally the opportunity for several unanticipated outcomes. Traditional assessment processes where there is a single correct answer to an invented problem are not very good at developing this kind of thinking.

3.1.5 Reflection and personal method are useful.

Getting some sort of personal documentation down will allow for reflection from students. To this end the recently compulsory addition of personal development planning into every UK higher education curriculum should assist the development of changes in thinking skills – including those to do with creativity.

3.2 Developing creative thinking in design courses

The first thing is probably the most obvious. Creativity is simply not something on its own. It needs to be developed by students so it can be used. In addition, creative thinking is only one type of thinking. Although Edward de Bono is very keen on developing creative and divergent thinking, his array of books indicates that he is not interested in developing lateral thinking at the expense of any other sort of thinking. In particular, his *Six thinking hats* technique shows that he appreciates other forms of thinking as well [16]. Petty suggests that creativity involves as many as six different phases, each of which is characterised by very different skills. It could be argued that some of these represent not creativity, but the way in which the creativity is managed in order to achieve real outcomes. Creativity needs to be harnessed. Creativity needs to be utilised usefully within design.

3.3 Ways of developing creativity

In earlier research [1], it seemed clear that most design courses need to use a combination of methods for developing creativity. In particular, it became clear that there needed to be a combination of specific exercises in creativity – perhaps a little like a creative toolkit – and that this needed to be seen within a creative environment, where the creativity could be incorporated within the framework of needing to be used in things such as design projects. Thus the way in which the creativity is utilised becomes as important as the techniques that are developed. Although in theory a set of exercises could provide benefit on their own, as could a series of design projects without a lot of specific tuition, maximum benefits occur when they are used in combination.

And it is clear that if both techniques are to be used, then the students' initial exposure to both design project work and to creativity enhancing techniques needs to be done at the start of the course.

3.4 Textbook approaches

Most design textbooks aimed at undergraduate design students contain a reasonable amount on the development of creativity. Baxter [9], for instance, one of the more popular texts in Britain, contains a chapter on the topic, its importance and ways of developing creativity. He summarises this usefully in some key concepts of creativity, and introduces as a toolkit of methods. This includes brain writing, parametric analysis, problem abstraction, collective notebook, orthographic analysis, SCAMPER, analogies, dot sticking, clichés and proverbs

and evaluation – PIPS. Otto and Wood [17] do not have a separate chapter, but deal with creative techniques largely in the chapter on concept generation. In their case they split the methods up into basic methods such as information gathering, mind maps and brainstorming and more advanced methods such as morphological analysis. They also introduce the TRIZ system. Because they have chosen to integrate the methods into the concept generation phase rather than extracted them as off-line creative techniques, they include a significant number of examples of how the techniques can be used in practice.

There are a number of texts that approach creativity outside the product design discipline, such as Geoffrey Petty's *How to be better at… creativity* [6] and older classics such as Roger von Oech's *A whack on the side of the head* [18]. Petty has some useful processes and ways of working that can be applied to many different topics and in different contexts. He presents a set of processes and explains how they can be utilised, and if an application text in the area is required, this is useful. Von Oech's approach is to have a series of wacky but disjointed methods to alter one's thinking processes so they become more creative. It makes for an enjoyable read but is less easily applied and is less useful as a textbook.

4 The specific project

4.1 Project aims and objectives

The particular approach taken here uses elements from several of the approaches, and aims to do the following:

- Provide a creativity toolkit at the start of the degree course:
- Incorporate the theory within the approach of a managed project:
- Use a project vehicle that students may take in a slightly light-hearted way, but which nevertheless is trying to accomplish a serious purpose:
- Start students off with the process of using a design logbook for all their ideas:
- Include a variety of specific methods in a form that makes them transferable.

Students were at London South Bank University in the first term of a four-year sandwich degree in various product design disciplines and the project was one of three assessed parts within a unit that took up a quarter of one semester's teaching. The weight on the project, therefore, was insignificant in terms of the overall course assessment but it was designed to form a basis for working. Most of the students had come straight from a secondary school background, but there was a smattering of mature students within the group. Because the students were first year ones, it was thought more appropriate to insist that they used a series of processes in a particular manner within a prescriptive setting, so that they were not able to reject processes without having tried them first.

Specific objectives were that the students had to be able to apply a series of named creative processes in the context of a design project, and that they had to come out at the end of the project with an enhanced understanding of the processes of creativity. They would also be expected to be able to reflect on the way in which the creative processes were relevant to their own characters and to decide whether they were things that could be useful in the future.

4.2 Project choice

How exactly the choice of project came about is swathed in some mystery. A number of projects had been tried through the years, including the use of off-line discussion and warm-

up sessions on not very much (such as thinking of new uses for a bucket). These had not been very successful in terms of retention of the processes by students, and it was felt that providing a vehicle for the 'need to know' was important. Other important requirements were that the project had to be capable of interpretation in a multitude of different ways, and it had to be perceived as one which the students could use to let their hair down and behave in slightly weird, wacky and strange ways without being criticised for so doing. Conventional product design introductions such as simple toy design, whilst being useful, didn't seem to provide this sort of ability. After the animal design idea had become concrete, several other benefits came out of the woodwork, such as the ability to incorporate fairy stories, fictional product uses, genetic methods and structural and systems engineering without stretching the point too much. The term *embodiment* as used in Pahl and Beitz [19] could be used reasonably easily to mean the addition of flesh on the bones of an idea.

Fictional animals are being designed all the time: in literature, films, advertisements, toys and so on – because animals are part of our life, they are 'game' for being developed in our imaginations.

This project was designed to turn this process on its head. Rather than using imagination to develop animals, it was designed to use animals to develop imagination. Or more precisely, it was designed to develop the imagination of first year students through the process of using creative skills to develop fictional animals.

The choice of project used analogies from the beginning. Design of a product could be regarded as analogous to the design of an animal. In some areas it is easy to see analogies. Animals have structures that support them: if they are vertebrates, there is an internal bone structure: if insects and external carapace. Animals have operating systems. Animals have mechanisms. They have energy utilisation. They are complex chemical factories. Perhaps they are too complex, but in having their minds boggled by the complexity, students start to realise the importance of energy, of systems and of structures. Animals are related to humans. They are in the same world as we are, and interact with us. Many fictional animals are invented with anthropomorphic characteristics: they think, talk, follow daily routines and so on. And there are fictional animals everywhere. Many authors, filmmakers, toy makers and so on have created their own fictional animals and worlds. Hobbits, transformers, orcs, ogres, goblins, fairies, Loch Ness monsters have lives of their own within fiction. Other animals such as Winnie the Pooh, Piglet, Tom and Jerry, Mickey Mouse and so on have more than a passing relationship to the animals they purport to model but have their own distinct characteristics and ways of acting. Even if the animals actually existed we start to create fictional understanding of them – dinosaurs being but one example.

In some senses this was taken as a project slightly away from the reality of product design in that few of the students would actually be designing animals in their product design careers – although an approach was received from the Disney Toy company for a student placement in toy design, and some past student placements have been with Hasbro, the Jim Henson creature shop, Spitting Images and a few other similar companies.

4.3 The process

The overall work concept was that of a managed project. Students were provided with a time schedule and were told that they had to be using particular methods and to produce particular outcome using that method. The idea was to provide a prescriptive environment where certain methods had to be tried and tested without them being seen as off-line exercises. Students could then comment on how the processes had worked for them at the end of the project in a reflective manner.

Students were split into groups, but they were working in the groups for some of the time and were working individually for some of the rest of the time, eventually producing an individual piece of work. This enabled them to relate to a small group of students (four or five) at the start of the course but not have to rely on them entirely to achieve results: it also enabled the students to experience particular group processes such as brainstorming, combination animal games and affinity diagrams where the group contribution is important.

4.4 The schedule

The whole project was not supposed to take very long. It took five weeks of work at four hours a week for the whole project. Students had two sessions a week of two hours each due to timetable arrangements. These were spilt with a tea break between them.

Putting flesh onto the schedule would be useful.

4.4.1 Before the project

Students were given a questionnaire to put themselves into groups. The questionnaire is not exactly very clever, being a series of 'breaking the ice' questions to determine some personal preferences such as what television programme is their favourite, what car they might aspire to and (crucially) what is their favourite animal. It is this last question that determines student group membership, although the jury is still out as to whether it is better to have all the tigers together or one dog in each group!

Students are also asked to find animal pictures as homework and to bring them in so they can discuss them. These should be animals that they have some sort of emotional attachment to – ones they dislike as well as ones they like.

4.4.2 Week 1 Creative methodologies: initial exposure.

This topic was designed to provide an outline of what was expected of the students during the project and of how they were expected to work. It produced the ground rules they were expected to follow and indicated why they were expected to play their full part in the project and, in particular, to attend the classes as they would not be able to have the particular experience without this attendance. During this period, students were also put into temporary groups, because a significant number of creative methods have been developed in a group situation – although in most cases in the literature, the advice is to make the composition of the group as broad as possible

Once in the groups, the students are asked to own the groups by inventing a group name, which is then pinned up on a suitable display board. They also discuss the homework pictures: what it is about each of the animals that they like or dislike and what their emotional responses are to them.

Animal consequences

The next task, still of an introductory nature is for each group to play an *animal consequences* game. This involves each student starting to draw an animal by doing the head first: these partial drawings are then hidden from view and passed around, with the next student completing the body and front legs, next one the hind legs, next one the tail and then the last one hiding the whole lot and inventing a name for the poor as yet unseen creature.

What they have actually been doing with this game is starting off the process of designing several group animals, none of which have ever been seen before and all of which normally generate immense mirth and get the students into a suitable mood for the next part of the process.

Brainstorming

This process is well known, although the term is now supposed to be out of use because of its connections with epilepsy. Students were asked, in their groups, to get as many ideas as possible in a short time, with each idea as exotic as possible, and on a separate sheet of paper obeying the 'shoelace rule' (you can read it from standing when you put it on the floor).

Forced serendipity.

At some point in the process a random word generated from a dictionary is thrown into each group and they are asked to continue to develop at least twenty ideas based on that particular word.

Affinity diagrams.

In the second session students take all these ideas and pin them up anywhere on their pin boards. The process is then to move the sheets around into positions so they relate to their neighbours. It is a process to cluster design elements according to intuitive relationships such as similarity, dependence, proximity, etc. This method is a useful way to identify connections between issues and reveal innovation opportunities [20].

Copying to effect

As all the ideas are up on every group's boards, students are encouraged at this stage to size up the competition. In particular, they are asked to note down and build on any promising ideas that other students have. This process is designed to get the students to assess other people's work and to see what it is that makes for good work – without necessarily understanding at this point what the criteria are. The process of blatant *copying* of work is encouraged at this point, because by doing this students are likely to improve the quality of work of the cohort as a whole [21].

Morphological charts [22, 23]

These are also introduced to the students as a quick and easy method of combining partial design solutions to produce a multiplicity of solutions. It is a method they can apply quickly and relatively easily and probably produces the largest number of solutions with the smallest possible effort. If students do not have time to do these in the session, then they are asked to complete the chart as homework.

4.4.3 Week 2.

Use of selection processes – in particular NAF.

This is a process that is able to be used quickly and easily by most students. What is required is that the vast number of animal ideas is reduced quickly to a manageable number – ten is the suggested one. They have to select six ideas that are Novel, three that are Attractive and one that is Functional. Hence NAF. The emphasis is on novelty, as it is far more interesting to add functionality and beauty to something novel than it is to develop novelty out of something where it is inherently missing. There is pretty design and there is clever design. Students should above all be learning how to do clever design. Pretty is window dressing and flower arranging (but is still needed).

Genetic processes.

After using the NAF technique, each group should have ten ideas to develop. These are now used as their breeding stock of animals. They need to use these to breed the animals for several generations in the most promiscuous way possible, and ignoring whether the animals

in question would be able to breed in practice or not. They have to realise that morality and even practicality don't stretch to animal design methods. At this stage, students are not doing this in a particularly structured way with genetic algorithms and severe conditions, but simply using the process in a loosely structured manner.

Imaginative composition

In the second session of the week, students are working on their own. They start to use *imaginative composition* about a particular animal, having made a personal selection. It needs to be clear that this is supposed to be a fictional story: the animal is allowed to have a name and to think quasi-human thoughts about how it is going to behave. Fairy stories, poems and stories of a day in the life are typical outcomes. They need to be able to answer what the animal likes doing and how it reacts with other animals.

Personal analogy

They also are expected to use a *personal analogy* to describe what it feels like to get inside the animal's skin and to impersonate that animal for a day. Then they are allowed to change and develop the animal so that the weaknesses they have found in the process can be overcome.

4.4.4 Week 3. Development of ideas

Structural design

This week is concerned with development rather than with the creation of ideas. What the students are trying to do is to develop the animal ideas they have had and try to understand how the animal goes together and how it works. Interestingly, the animals have been formed so far without consciously resolving such aspects – students effectively 'discover' these aspects of the ideas that they have already had at that point. They need to give names to the various parts (this is relatively easy with animals: harder with other products), work out where the parts are, how they stay together and are attached to each other. Then they go on to look at the sort of skeleton and loads that need to be carried and flesh out the animal.

Systems design

They also need to do some systems design, asking questions like, "How does the animal work?" "Eat?" "Breathe?" "Procreate?" "Think?" "What happens to matter and energy?" This last can be very complex as far as animals are concerned, but students are asked to have a go.

These processes are akin to animal (product) embodiment.

Specification writing

In the second session in week three students are told that they are not designing a real animal, but have to turn the work they have done into an animal toy. The first job they need to do is to define the toy properly, producing a design specification.

Detail design

They then have to work out how all the bits of the toy have to work and how they all have to go together.

4.4.5 The last two weeks. Product modelling and presentation

The last two weeks are used to develop the toy as a model and to invent some form of stage-set packaging for it. Students are not taught model-making processes at this point in the

course and they simply need to find ways of demonstrating how their intentions can be communicated effectively in two and three dimensions.

5 Results

5.1 Immediate Results

Figure 1 Animal examples

Figure 1 shows models that students have made as the final outcome of the project. It has to be remembered that this is a first year project and that eight weeks earlier these students were enjoying the relative freedom of summer vacation and had not started a design course at all. In particular, they had virtually no training in model making. It is clear that a number of these students found some difficulty coping with the transition to an animal toy. This was not the case for all students: Figure 2 shows some examples where the toy element is stronger and where this difficulty is not so apparent.

The animal on the left is a flying pig – yes, in green with yellow spots: that on the right has been turned into a child's first vacuum cleaner. The humour in this creature comes across – the nose is the vacuum hose: the ears detach to form dusters: pulling the tail acts as the on-off switch with its end being a feather duster – and the air exits from its backside.

Figure2: Animals toys

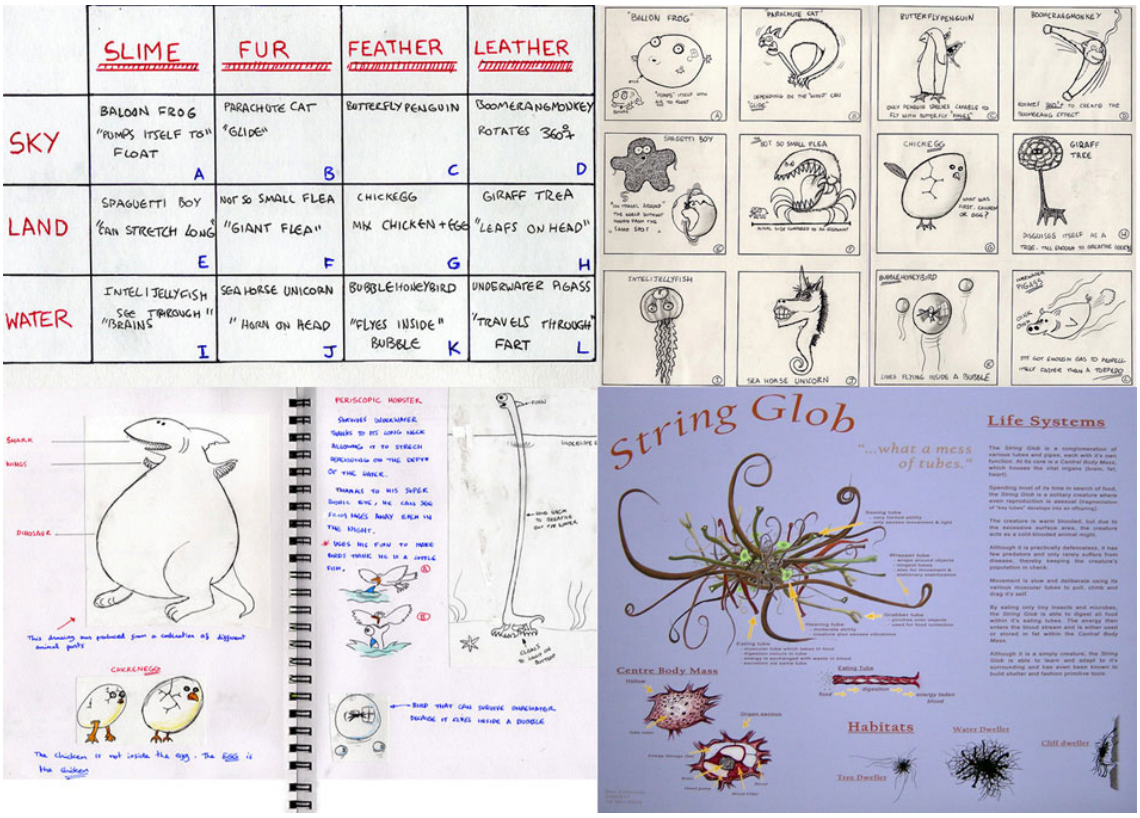

Figure 3: Back-up work and results of some exercises

Figure 3 shows results of some of the exercises and some of the back up work. The upper right is a re-invention of the idea of the morphological chart, producing only twelve variations: the upper right drawing shows a series of animal developments which were used later as a basis for selection: bottom left shows two pages from a developmental part of the logbook and the lower right illustration is of a final development – the animal has become an edible pasta toy!

5.2 Student feedback and comments

How successful has the project been? It has been carried out with six groups of students so far. The project is particularly ambitious in getting the students to carry out a huge number of techniques in a relatively short time. The initial response is that it is significantly different from what they were expecting on their courses, and produces a certain amount of surprise in

them. As they continue with the project, they generally become engaged with it, although they find that their brief encounters with systems and structural design quite difficult. After undertaking the project, the general feeling is that they understand what they have been doing, and frequently they seem to have developed significant methodological skills that they may have had difficulty in acquiring in other ways. The project has been run in two modes. The mode described could be called the 'short fat' mode: in the 'long thin' mode students have twice as long to assimilate the techniques and it may be an improvement to return to this mode in the near future.

5.3 Other possibilities

What other sort of project could produce a similar or better result? That question is difficult to answer, as there are an infinite number of possibilities for developing this sort of thinking in students. Arguably any other brief could have been used for it. One that is closer to the day-to-day work that product designers carry out in industry might have increased relevance, although some of the processes such as genetic development and personal analogy would have been more difficult to incorporate

5.4 Longer term results

Figure 4 Lonely creature

Longer-term results are also hard to quantify. It may be easier to describe some specific examples rather than generalisations. During the period the project was not running there was a gentle complaint from one of the teaching staff that the second year students seemed to have missed out on developing their creativity and didn't seem to have a set of tools to develop ideas properly. Later in the course the student who had produced the child's first vacuum cleaner in figure 2 wanted to take the product on and develop it as a final year project, but in the end found something more suited to the company he had worked with during his industrial placement. The student who produced the animal in Figure 4 – the lonely creature – later said that the idea of a creature being very lonely and missing the ark haunted her for some considerable time – and during her industrial placement she obtained a placement with the Jim Henson Creature Shop – the special effects company that had made the original Muppets. She continued working with them when she first graduated.

6 Conclusions

Creativity is an essential feature of design students. Teaching them creativity is not an option, but descriptions of creative processes without a context cannot generally be assimilated.

The project leads to several conclusions. It has produced results that indicate, at least superficially, that students benefit from the process in later parts of their courses. Creativity needs to be applied throughout design courses, however, not just at the start, and as students' understanding of design develops they are able to take on board developing views of creativity: a different, more analytical approach appears to be more successful for experienced design students. There is significant evidence that they have taken on board various creativity principles by the final year of the course: when undertaking what was essentially a computer-based embodiment exercise included a significant amount of creative thinking that wasn't necessarily expected [24]. By this time a brief refresher is useful, and the students generally have the confidence in their design abilities to work with a less prescriptive set of methods.

The managed project approach is one that ties a specific set of experiential learning objectives clearly to a project context, thus ensuring that although students may not have absorbed everything they have covered, they have certainly experienced it. It is a useful technique to use in the context of other design projects.

References

1. Dowlen, C., K. Hurst, and I. Gilchrist. *Creativity in engineering design; can it be taught?* In *ICED'95*. 1995. Prague: Heurista.
2. Dowlen, C. *Developing the creative environment for engineering design*. In *Engineering Design and Creativity*. 1995. Pilsen: Heurista.
3. Dowlen, C. *Teaching creative thinking to first year students: A report on a specific experiment*. In *Product Development in Engineering Education*. 1994. University of Limerick, Ireland.
4. Dempsey, M., *Creative accounts. In creative survey*, in *Design Week*. 2002.
5. Sternberg, R.J., *The nature of creativity: Contemporary psychological perspectives*. 1988, Cambridge: Cambridge University Press.
6. Petty, G., *How to be better at ... Creativity*. 1997, London: Kogan Page.
7. Torrance, E.P., *Creativity as manifest in its testing*, in *The nature of creativity*, R.J. Sternberg, Editor. 1988, Cambridge University Press: Cambridge.
8. Bohm, D., *On creativity*, ed. L. Nichol. 1998: Routledge.
9. Baxter, M., *Product design: Practical methods for the systematic development of new products*. 1995: Chapman & Hall.
10. Martindale, C., *The clockwork muse*. 1990: Basic Books.
11. Robinson, K., *Out of our minds*. 2001, Oxford: Capstone.
12. Dowlen, C. *Development of a cognitive framework for design science*. In *International Conference on Engineering Design, ICED'97*. 1997. Tampere, Finland: Heurista.
13. Dowlen, C. and M. Atherton, *What is design?*, in *Nature and design*, M.W. Collins, M. Atherton, and J.A. Bryant, Editors. 2005, WIT Press: Southampton. p. 1 - 16.
14. Gill, B., *Graphic design as a second language*. 2003, Mulgrave, Victoria: Images.
15. Wiggins, G., *The case for authentic assessment.* Practical Assessment, Research and Evaluation, 1990. **2**(2).

16. de Bono, E., *Six thinking hats*. 1990, Harmonsworth: Penguin.
17. Otto, K. and K. Wood, *Product design: Techniques in reverse engineering and new product development*. 2001: Prentice Hall.
18. Von Oech, R., *A whack on the side of the head*. 1990, London: Thorsons.
19. Pahl, G. and W. Beitz, *Engineering design*. 1984: Design Council.
20. IDEO, *Ideo method cards*. 2004.
21. Dowlen, C. *Copying: A constructive process*. In *IE&PDE 2003*. 2003. Bournemouth: Professional Engineering Publications.
22. Cross, N., *Engineering design methods: Strategies for product design*. 3rd edition ed. 2000, Chichester: John Wiley & Sons Ltd.
23. Walker, D., B. Dagger, and R. Roy, *Creative techniques in product and engineering design*. 1991: Woodhead.
24. Dowlen, C. *Teaching and learning in the real world: Computer modelling as part of the product design process*. In *E&PDE 2001*. 2001. Derby: Derby University.

Chris Dowlen, Department of Architecture and Design,
London South Bank University, Borough Road, London SE1 0AA, UK
+44(0)20 7815 7609 Fax +44(0)20 815 6134 chris.dowlen@lsbu.ac.uk