

The Universal Design Project

Carsten Wulff, 2014

Abstract—Can we make a design project to cover all courses. Can a design project, the same design project, be used over five years in 40 different courses? Well, we think so. Maybe not all courses, but many. The trick is to find the right project.

WHAT is the virtue of a design project? It's an essential ingredient of engineering education. It's used to shine a light on the challenges of building real systems. It should motivate students. They should enjoy it. It should inspire them to reach higher. The design project should through practical experience enhance learning and give students a more intuitive understanding of the subject at hand. At least, this is what we want it to do.

Design projects are, in most cases, complex systems, too complex for any person, regardless of intelligence, to completely grasp in a few hours. Into this highly complex system we throw our students and expect them to complete the final piece that makes the system work. We may add a sound-bite like "This system is used in all cell phones" or even worse, we say "This system is an essential part of a improbability drive" — whatever that may be — which might not motivate as well as we'd like.

This is a bit unfair. Not all projects are like this. But why are some difficult to comprehend? It is a byproduct of the inherent complexity of real-life systems. Real systems — be it cellphone or digital camera or iPod's — are difficult to build. They are complex systems that require experts of many disciplines, from metal machining to power amplifiers, from signal processing to device physics, from industrial design to chemistry. A cellphone may take months, even years, to design, assemble and test. If the design project is to be a reflection of reality it will be complex.

*

We teach complex systems by abstraction. We begin with a piece small enough for the students to fully understand. When the students understand — or usually just before — we add another, and another, and another, until they are well versed in the subject at hand. Demanding subjects must be broken into small, comprehensible pieces. Some subjects are too tough teach in a single course, and must be broken into multiple courses. Maybe

we should do something similar with the design project? Could we make a universal design project, one to cover all courses. Could a design project, the same design project, be used over five years in 40 different courses? Well, we think so. Maybe not all courses, but many. The trick is to find the right one.

Criteria for the universal design project

The universal design project must be exotic. It must be instantly recognizable as a difficult and complex system, but at the same time understandable, at least what it does. It must be something that our students want to understand. The first piece we teach — the atom of the design project, the indivisible piece — should be so easy to understand that the student can go home and explain to grandma, with a sincere amazement, what wonderful things they will learn at IET. At the same time, the last piece — the piece they will learn in the fifth year — must be so complex that they still struggle and feel a sense of achievement after completing it. The student should delve deeper and deeper with each passing year, and discover the beauty of complexity. They should be amazed at how much knowledge is necessary to understand the universal design project.

An example of a universal design project

Say that an STM is our universal design project. The first design lecture we teach our students that an STM is a Scanning Tunneling Microscope and that best STMs can resolve one thousand millionth of a meter, almost individual atoms. Then we tell them that they are going to build one, and that they will learn what goes into building one. The first year they will start by assembling pre-built black boxes into a complete STM and take some pictures to show to grandma. The second and third year they learn about the contents of the black boxes. In the fourth and fifth year they will develop and improve the black boxes, and when we send them into the world they will be able to build an STM from scratch. If you have doubts that an STM is a feasible design project, just google "STM DIY".