Chapter 15
Materials as a Bridge between Science, Engineering, and Design

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ABSTRACT

This chapter explores the idea of using the topic of materials as a bridge between three fields of knowledge: materials science, mechanical engineering and product design. It discusses ways in which the teaching of materials to diverse student audiences can be enhanced. For example, how a course is to be taught by materials scientists to product designers where the instructor has a fundamentally different notion of what materials are compared to the students' perception of what materials are and how they can be used in their future profession. A broader vision of what the materials discipline means needs to be acknowledged in order to build a common materials education thread. The chapter presents the visions of three common materials user groups – materials scientists, mechanical engineers, and product designers – and highlights the differences and similarities amongst them in the context of developing further materials knowledge and education.

INTRODUCTION

It sometimes feels like materials scientists, mechanical engineers and product designers live on different planets. They usually study in different departments often located in different buildings and campuses. They use different technical languages, have different learning and academic styles and their materials courses have different areas of emphases. This chapter argues that these professionals are all a potential part of the same team and need similar skills, albeit disguised under different roles. Each group works within a design context, whether it is designing the latest new material or experiment or manufacturing process or the latest electronic device. Each party has a contribution to the process of making life, easier, more pleasurable and increasingly more sustainable. The work of each also acts as inspiration and a source of innovation to the others.

DOI: 10.4018/978-1-4666-8183-5.ch015

New materials enable game changing products, while new products demand new and optimized materials.

Students of each engineering discipline need to be able to move seamlessly between the world of creating, building and testing, and the hypothetical world of models, design requirements and equations. Materials scientists tend to start at the microscopic level and work up. Product designers tend to start at the macro level and work down. Engineers are in the middle, needing to understand both heat treatments and macro structures for example. Everyone needs to learn how to navigate the Design Cycle - conceive, design, implement, and operate - not just theoretically, but also taking stakeholders into account and working in teams (Dym, Agogino, Eris, Frey, & Leifer, 2005; Silva, Pereira-Medrano, Melia, Ashby, & Fry, 2012).

The overall vision of the importance of materials in today's economy should be present in the education of future scientists, designers and engineers; especially in general materials courses taught to non-materials specialists (see Figure 1). They will often be responsible for selecting materials for various products/systems and need to be able to grasp the economic, social and environmental implications that their decisions may have in the future, as practicing engineers, scientists or designers.

Teaching materials within a design context has been shown to provide a strong motivation for both students and teachers (Silva, Fontul, & Henriques, 2014, in press; Silva, Fry, Arimoto, & Ashby, 2012). This design context/approach helps in engaging students in meaningful discussions and in establishing connections between science, engineering, design and society. A common education platform is suggested in this chapter as an enabler for the interdisciplinary systems thinking required to support these discussions.

BACKGROUND

The subject of materials can be traced more than 4000 years back in history. The discipline has a

Figure 1. The past and present of materials, from alchemy, tradition and empiricism to materials science and engineering