Interdisciplinary nature, challenges and boundaries for research and teaching at TU/e-ID

1 Introduction

To describe the situation and ambition of our department it seems to be useful to have a paradigmatic view on our expertise, processes and structure. First we describe the three main paradigms: engineering (E), science (S), and design (D).

1.1 Some definitions

Science as an activity is the concerted human effort to understand, or to understand better, the natural world and how the natural world operates, with observable evidence as the basis of that understanding. It is done through investigation of observable phenomena, and/or through experimentation that tries to simulate observable processes under controlled conditions. The logic of modern science requires that observations or facts guarantee the validity of generalizations or theories. Science is not art; because art is largely an individual's effort to communicate his or her ideas or feelings in an implicit manner via artefacts. On the contrary, science is a group effort to explicitly describe and understand reality. Science is also not technology. Although science can lead to technology, and it uses technology, but it is knowledge by nature. We use further on the term 'scientific' like the German 'wissenschaftlich' or the Dutch 'wetenschappelijk', meaning 'according to sound academic standards'. We will use the term *science* to describe *science* in the positivistic paradigm only, and we will use the term *SCIENCE* to describe the whole.

According to Merriam Webster's online dictionary, *'engineering'* is defined as: (1) the activities or function of an engineer; (2a) the application of science and mathematics by which the properties of matter and the sources of energy in nature are made useful to people; (2b) the design and manufacture of complex products (e.g., software engineering); and (3) calculated manipulation or direction (as of behaviour). We will mainly refer to definition part (2a) and (2b) further on. *SCIENCE* consists of 'science', 'engineering', and other activities according to sound academic standards.

Paradigm is defined in the Kuhnian sense of a *disciplinary matrix* that is composed of those (a) shared beliefs, (b) values, (c) models, and (d) demonstrative examples that guide a 'community' of theorists and practitioners (Kuhn, 1962, 1974). Dorst (1997) introduced and discussed the two most influential paradigms for design: (a) *positivism* for 'scientific' research and (b) *phenomenology* for 'engineering' research.

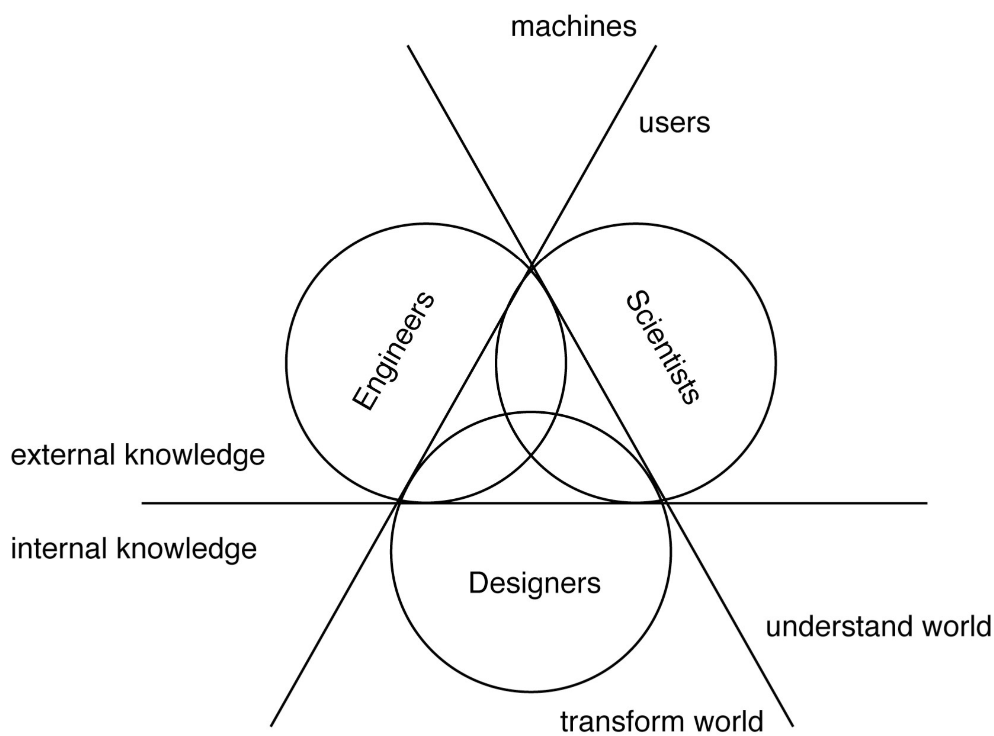

Figure 1: Paradigm model of designers (D), engineers (E) and scientists (S).

We hypothesize three barriers that can be used to distinguish the paradigms of the three different disciplines (see Figure 1): designers (D), engineers (E) and scientists (S, in particular social scientists):

(1) Knowledge representation: explicit (S, E) versus implicit (D)

(2) View to reality: understanding (S) versus transforming reality (D, E)

(3) Main focus: technology (E) versus human (D, S)

Barrier 1: Engineers (E) and scientists (S) make their results explicit by publishing in journals, books, patents or conference proceedings. Their body of knowledge is externalized and described outside of the individual engineer or scientist. These two communities revise their published results through discussions and control tests among peers. On the other side, the results of the designers (D) are mainly represented by their concrete designs as artifacts. The design knowledge necessary to create these designs lies within the individual designer, mainly as implicit knowledge (often referred to as *intuition*). To make better designs, the designer has to become more experienced. After gaining a considerable experience and intuition, designers tend to reflect (Schön, 1991) and publish their views on design, such as Dorst (2003). Still, the foundation of these reflections lay within the individual designer's experiences.

Barrier 2: Engineers (E) and designers (D) transform the world into preferred situations (Simon, 1996) while scientists (S) mainly attempt to understand the world through pursue of knowledge covering general truths or the operations of fundamental laws. This difference between (E, D) and (S) is of particular interest to our investigation since a preferred situation could also be ‘to know’ and since understanding also requires the use of synthesis. The following model illustrates the relationship between ‘abstracting’ from reality (for understanding) and ‘concretisation’ (for transforming reality; see Figure 2).

Barrier 3: Social scientists (S) and designers (D) are predominantly interested in the human targeted as possible users. Designers are interested in human values, which they transform into requirements and eventually solutions. Scientists in ID are typically associated with the social sciences. They are interested in the users' abilities and behaviours such as perception, cognition and action. Engineers (E) are mainly interested in technology, which does include software for interactive systems. They investigate the structure and operational principles of these technical systems to solve certain problems.

2 Design knowledge

The development and collection of *design knowledge* is the primary goal for the whole research line. This validated knowledge with high predictive power should be formulated in design theories based on high-level design principles, medium-level guidelines, and low-level implementation techniques (e.g., *metrics*). We propose that ID knowledge should be theory-grounded, and development of reusable ‘designer-digestible’ packets will be an important contribution in the future. We cannot expect industry to make very large big-bang changes to processes, methods and tools, at any rate without substantial evidence of the value derivable from those changes. This, accompanied again by the increased disciplinary maturity, has lead to a higher ‘validity’ barrier which research contributions must cross. It is readily observable, that research that proposes new frameworks, methods and processes are not accepted without positive evidence that they are of use rather than simply airy and unfounded speculation.

3 References

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