OU/SERC DESIGN METHODS WORKSHOP
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SOME ISSUES IN ENGINEERING DESIGN RESEARCH

SUMMARY

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The overall aim of engineering design research is to develop knowledge which can improve the chances of producing a successful product. This aim raises a number of important questions: (1) What do we mean by a **successful** product? (2) How is a successful product **produced**? (3) How do we **improve the chances** of being successful? To answer each of these questions design research must be carried out. This leads to a further question: What **research methodology** should be used?

The first question leads to issues such as what **criteria** should be used to judge success; the second to issues such as what are the **influences** on success, how do these influences interact and how can they be measured; the third to issues relating to the development and validation of **design methods**. The question of a research methodology leads to issues of identifying **research areas** and projects within those areas, and selecting specific **research methods** to address the issues.

Problems in the selection of research areas include: the human element, the numerous influences and the interconnectivity between the influences.

Several research methods can be, and have been, used. A research methodology, i.e. a set of research methods and their links, is illustrated in Figure 1. A simple example will help clarify the methodology.

Example:

Criteria:	Increase of profit is identified as a criterion for success.
Description I:	A descriptive study shows that decreasing cost contributes to increasing profit.
Prescription:	A method is developed to decrease a particular cost element.
Description II:	The method is applied and a descriptive study is executed to validate the method. This includes two tests. The first test is whether the cost element has been decreased (a comparison with Prescription). The second test is whether the initial criterion has been realized, i.e. whether profit has increased (a comparison with Description I). There might be reasons as to why the second test fails, such as side-effects of the method which cause another cost element to rise.

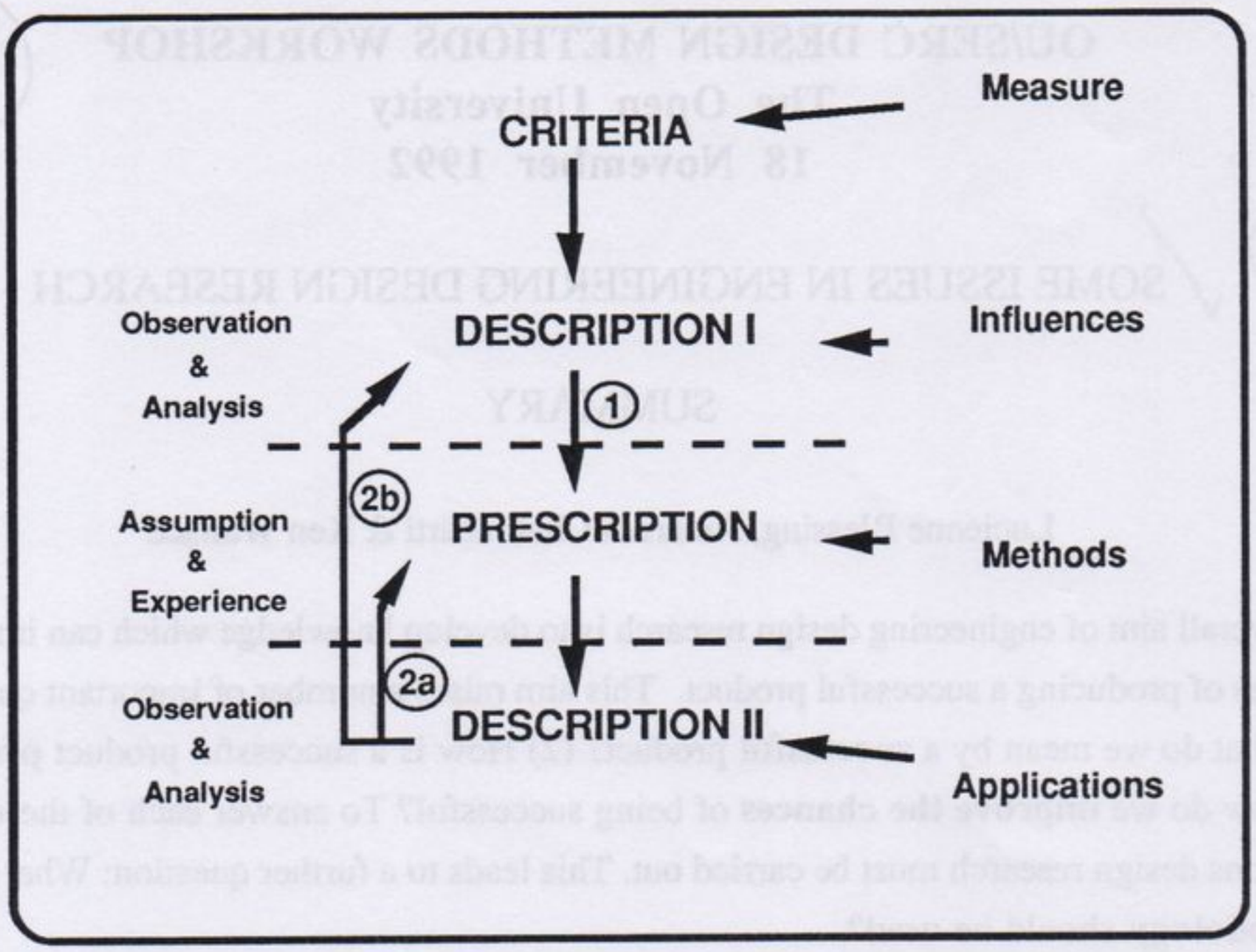

Figure 1 Proposed design research methodology
including currently missing links (1, 2a and 2b)

Most of the steps in this methodology have been addressed in design research, in numerous areas, using many different methods. The oldest area is the development of design methods (Prescription). Design methods are mainly based on assumptions and experience rather than on the results of descriptive studies. Descriptive studies of how designers design in the area of mechanical engineering (Description I) are relatively recent. Some of these studies focus on the influences that contribute to the success of a product. Two types of criteria have been applied (Criteria), depending on the context in which the research took place. In an industrial context, a common criterion is success in the market (sales, profit). In laboratory research, a common criterion is the fulfilment of technical requirements (good design). Some descriptive studies focus on processes in which a specific method has been applied. They can be considered as belonging to the Description II stage of the proposed methodology. However, comparisons of design processes applying a specific method and design processes without such a method have seldom been addressed explicitly.

Some key issues remain:

- the identification of subsets within each research area which can be investigated scientifically, and which will provide information for the development of practical design methods;
- the establishment of a link (link "1" in Figure 1) between the results of descriptive studies (Description I) and the development of design methods (Prescription);
- the validation of developed methods through the establishment of links between Description II and Prescription (link "2a" in Figure 1); and between Description II and Description I (link "2b" in Figure 2).