

between type fixation and token. In the case of intentional design, this is a convention, as can be seen from the code used to fix the type of a screw. In the case of biological design, this link will be, e.g., the genetic code, linking DNA structure to amino acid sequences. So even in the case of a non-intentional design process, here an evolutionary one, we may speak of design in the sense of type fixation. Therefore, conceiving design as the type fixation of a complex entity allows for a unified theory of design, applicable to intentional and non-intentional, i.e., biological cases.⁷ The non-intentional case is also relevant with respect to the design of societies, so I will come back to it in the fourth section of my chapter.

Let me point at the difference between a designed and a non-designed entity with respect to the differences in the way in which the components the entity consists of are assembled. A non-designed entity, if it has a stable structure like an atom or a solar system, comes into being by a process of self-assembly. All the components are in place because of their individual physical or physicochemical properties. We may therefore speak of property-determined components. In a designed entity, in contrast, the components are in place not because of a physicochemical selection for their individual properties in a self-organizing process, but because their type is fixed in a design. If the type of a screw is fixed as, say, M6x1x15 made of brass, the screw in the complex entity will be of this type because it was chosen according to the type fixation in the construction plan. Neither are the physical properties of such a screw sufficient to bring it in the place it fits into, nor would anything but the type fixation prevent a screw from steel instead of brass being mounted. In most cases, even a slightly longer screw would fit; hence it is not the individual properties of a component but the design that fixes its type.⁸

3 Design of Socio-Technical Systems, and Functions of Artifacts

I have introduced the concept of general design with reference to technical artifacts and, as an example for the non-intentional case, to the design of biological organisms. Now the question is whether the concept may be applied at the level of

⁷ A more detailed account of this concept of design is given in Krohs (2004; 2007).

⁸ There are many cases in which not all the parts of a designed entity are type-fixed. In addition to type-fixed components, such an entity may have property-determined parts, such as the molecules of the air in certain gas springs etc. Seventy-eight per cent of the gas molecules will be of one type, twenty-one of another, even without a type fixation. In many other cases type identity may occur without being a sufficient reason to ascribe type fixation. Some kind of sediment may consist of almost type-identical particles, but they accumulated just because of their individual physical properties that led to selective sedimentation under conditions that happened to occur. There was no design prescribing this type. The particles of the sediment are property-determined, not type-fixed.

social systems as well. Instead of considering whole societies, I will stick for the moment to the more clear-cut case of socio-technical systems. Besides being of interest in their own right, these systems may be regarded as a model of selected aspects of societies and form themselves components of societies. A socio-technical system may realize quite accurately the structure and functions that it was set up for. We may conceive such a system as being designed in the following way: The systems designers have fixed the types of machines that are used and have defined which qualification the individuals who are running the machines must have. Moreover, the designers have prescribed which communication- and decision pathways are to be used, etc. The components of the system are type-fixed: type-fixed devices, type-fixed man-machine interfaces, "type-fixing" jobs for workers (vacancies are filled only with persons of the qualification wanted), and type-fixed social institutions. Moreover, the proper arrangement of all these type-fixed components is laid down and may be used to set up, run, and adjust the system. This means that a socio-technical system is a designed entity as defined in the type fixation account of design presented above.

Type fixation within a socio-technical system occurs on different levels. On the highest level, the type of the system as a whole is fixed, e.g., being a certain type of coal mine or of a power plant. This involves a fixation of the types of the components of the system and of their arrangement. Some of these components are machines, and at least with respect to these, another level of type fixation is involved. They are themselves type-fixed complex entities and may be designed completely independently from their possible use in a certain socio-technical system.⁹ The question now is whether and how the design of the machines contributes to the design of a socio-technical system they are components of: Do the type-fixed parts of the machines themselves constitute parts of the socio-technical system? And if so, are they type-fixed components of it? First, the design of the socio-technical system usually will not explicitly fix the types of the components of the machines. It will fix the types of the machines only, and these, being designed entities, will have type-fixed components. With respect to the first question we should say that it is obviously impossible that a type-fixed subcomponent, i.e., a component of a component, of a socio-technical system is present only in the machine, but not in the socio-technical system the machine belongs to. So the part of a machine that is part of a socio-technical system is itself part of the system. But are these parts type-fixed components of the socio-technical system? The design of the socio-technical system explicitly fixes the types of the machines only, not the type of their components; but by this type fixation, we implicitly refer to the design of the machines. Without the design that fixes the types of their, the machines', components, the machines would not exist. So one can say that the design of a socio-technical system implicitly fixes the types of the components of its type-fixed

⁹I will stick to the case of artifacts since I am interested in the contribution of intentional design to the design of social systems. In addition, biological type fixation is to be found with respect to the individuals working in the system, in as far as they are biological organisms.