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Basic Schemes: Preparations for Applying Control Science to Sustainable Design

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Abstract

It is the ultimate goal for humankind to deal with various problems and achieve sustainability. Control science can be applied to all goal-oriented tasks and has already produced remarkable results. Accordingly, applying control science to the task of achieving sustainability is a rational and reliable approach. In order to apply control science to sustainability issues, our first study has shown the “basic control system for sustainability” as well as the “model of sustainability.” After that, in order to identify system components of practical control systems for promoting sustainable design, we have devised “two-step preparatory work for sustainable design.” The two steps of this preparatory work are “determining the relationships between the standard human activities and sustainability” and “sustainability checkup on human activities as an object.”

Keywords: control science, control system, model of sustainability, two-step preparatory work, sustainable design

1. Introduction

In order to develop a methodology for promoting sustainable housing design, we have applied the science of control. The reason is that accomplishing sustainability is regarded as the ultimate goal-oriented challenge, and control science is suitable for all goal-oriented tasks.

In order to deal with a variety of problems and achieve sustainability, “human beings must **control** their activities appropriately” [1], I wrote in my book, *An Introduction to Environmentology*, which was published in 1999. In 2001, I conceived the idea of applying the science of “control” to this ultimate challenge of humankind. “Control” is generally defined as “purposive influence toward a predetermined goal” [2]. Control science can be utilized for all goal-oriented tasks [3]. In fact, control science has been applied to various fields, including engineering,

medicine, agriculture, and economics; particularly, control engineering has a long history and has produced extraordinary results [3]. Thus, it is a logical and reliable approach to apply control science to the challenge of accomplishing sustainability.

Meanwhile, the application of control science to sustainable design has required us to develop basic schemes in advance for preparations. First, we have demonstrated the basic control system for sustainability as well as the model of sustainability, so as to facilitate the utilization of control science for various sustainability issues. Moreover, we have devised the two-step preparatory work for sustainable design. The following sections illustrate these basic schemes for applying control science to sustainable design.

2. Basic control system for sustainability

After starting research on applying control science to sustainability issues, first of all, we showed the basic control system for sustainability. Recently, we have revised it, based on the IPCC’s recognition, namely the necessity of adaptation measures for sustainability [4–6].

Figure 1 demonstrates the revised version of the basic control system for sustainability. “Controlled objects” are human activities which need to be controlled [7–9]. “Disturbances” are adverse effects on controlled objects which are caused by environmental, social, or economic problems [7–9]. Concrete instances of the disturbances include floods or landslides resulting from environmental destruction, harmful influences caused by environmental pollution, and a variety of impacts resulting from climate change [7–9]. Furthermore, “adaptation” has been added as the course from “disturbances” to “sustainability,” on the basis of the recent recognition of the IPCC [7]. “Controlled variables” are the variables that relate to the human activities and need to be controlled for primarily solving or preventing the problems or adapting to disturbances [7].

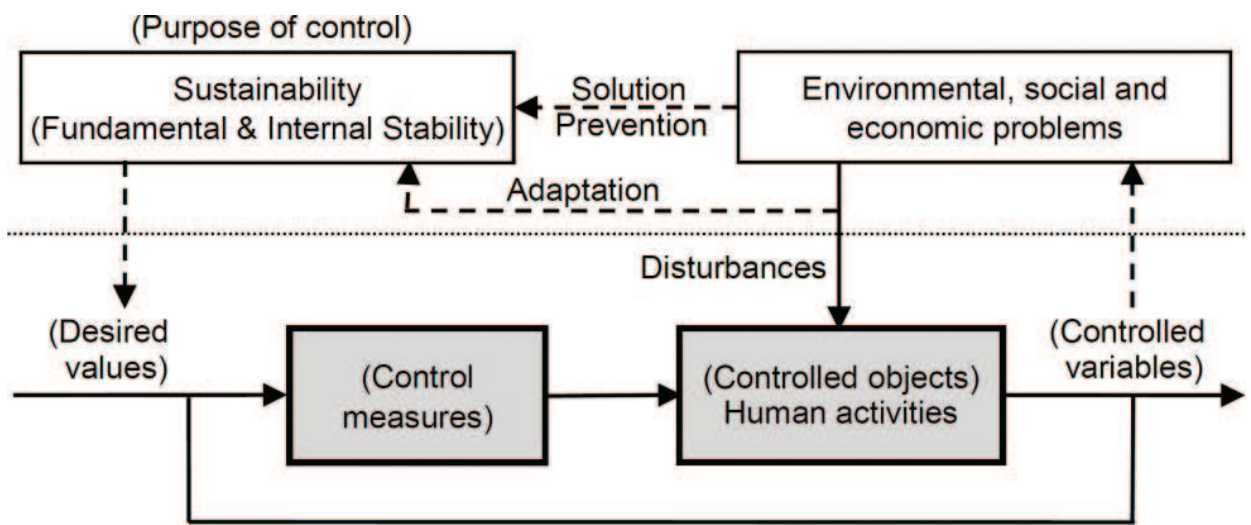


Figure 1. Basic control system for sustainability [7].

“Desired values” are derived from the purpose of control, namely sustainability [7–9]. The model of sustainability (**Figure 2**) shows that sustainability needs both “Internal Stability” and “Fundamental Stability,” in order to achieve the long-term well-being of all humankind, or ultimate goal, within the finite global environment and natural resources, or absolute limitations [7–9]. “Internal Stability” means social and economic stability; the conditions for Internal Stability are health, safety, mutual help, and self-realization, which are important for well-being of humans [7–9]. On the other hand, “Fundamental Stability” means environmental stability and a stable supply of necessary goods; the conditions for Fundamental Stability are environmental preservation and the sustainable use of natural resources [7–9].

The control objective of the basic control system for sustainability is to adjust the controlled variables to their desired values [7]. Moreover, the control system requires designing and implementing “control measures” or measures for attaining the control objective [7].

3. Two-step preparatory work for sustainable design

In order to identify a control objective, system designers must identify controlled variables and their desired values. Therefore, preparatory work for designing control measures is primarily intended to identify controlled variables and their desired values. This preparatory work con-

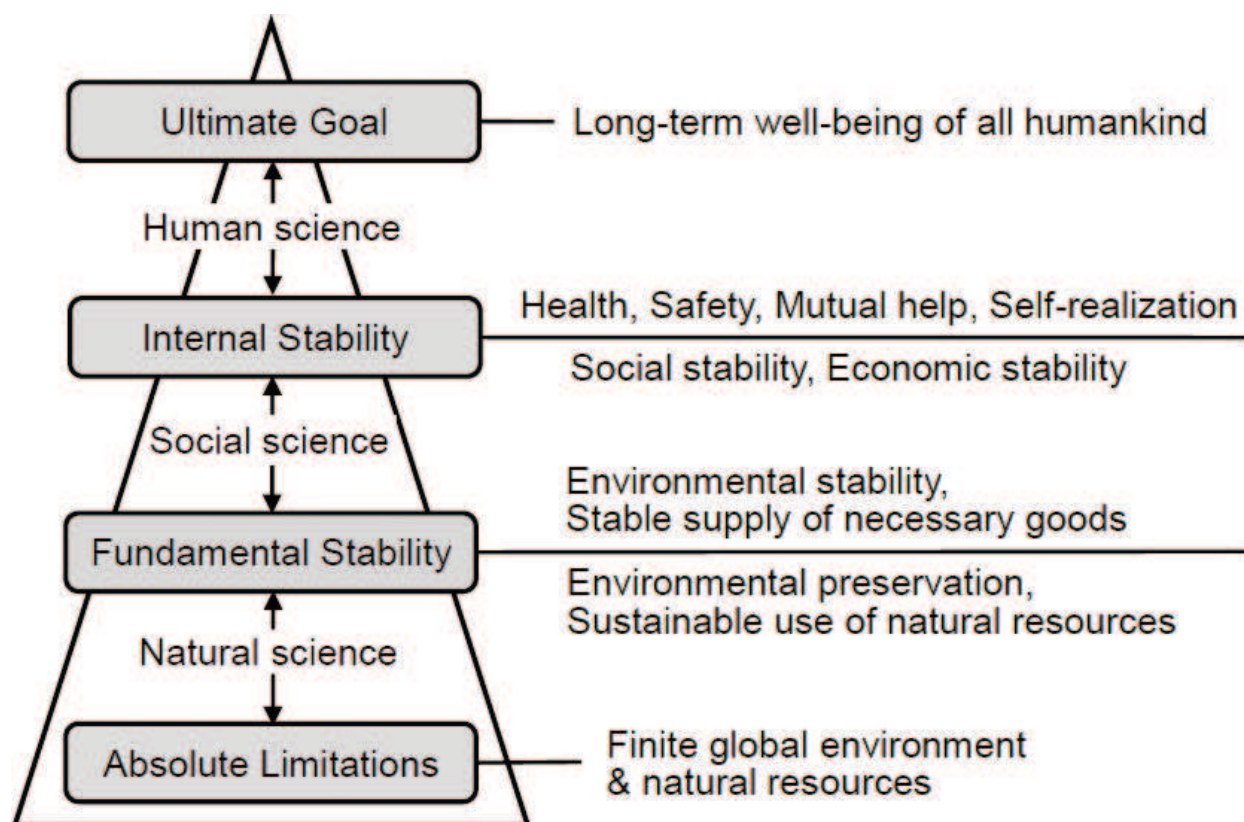


Figure 2. Model of sustainability [7].

sists of two steps: (1) determining the relationships between the standard human activities and sustainability and (2) sustainability checkup on human activities as an object [10].

3.1. Determining the relationships between the standard human activities and sustainability

The first step aims to comprehensively determine the relationships between the standard human activities and sustainability [10]. The standard human activities mean typical human activities among human activities which belong to one category. **Figure 3** demonstrates the concept of this step [10].

The first step starts with selecting important elements from the standard human activities [10]. Human activities in one category include almost the same elements. Therefore, at first, system designers select such common elements from the standard human activities [10]. In this connection, if one or more factors which influence the selection can be found, the selection process will become more efficient [10]. In addition, the elements which are considered to be closely related to sustainability should always be selected as important elements, no matter whether they are common in the present situation [10]. For instance, when “home” is

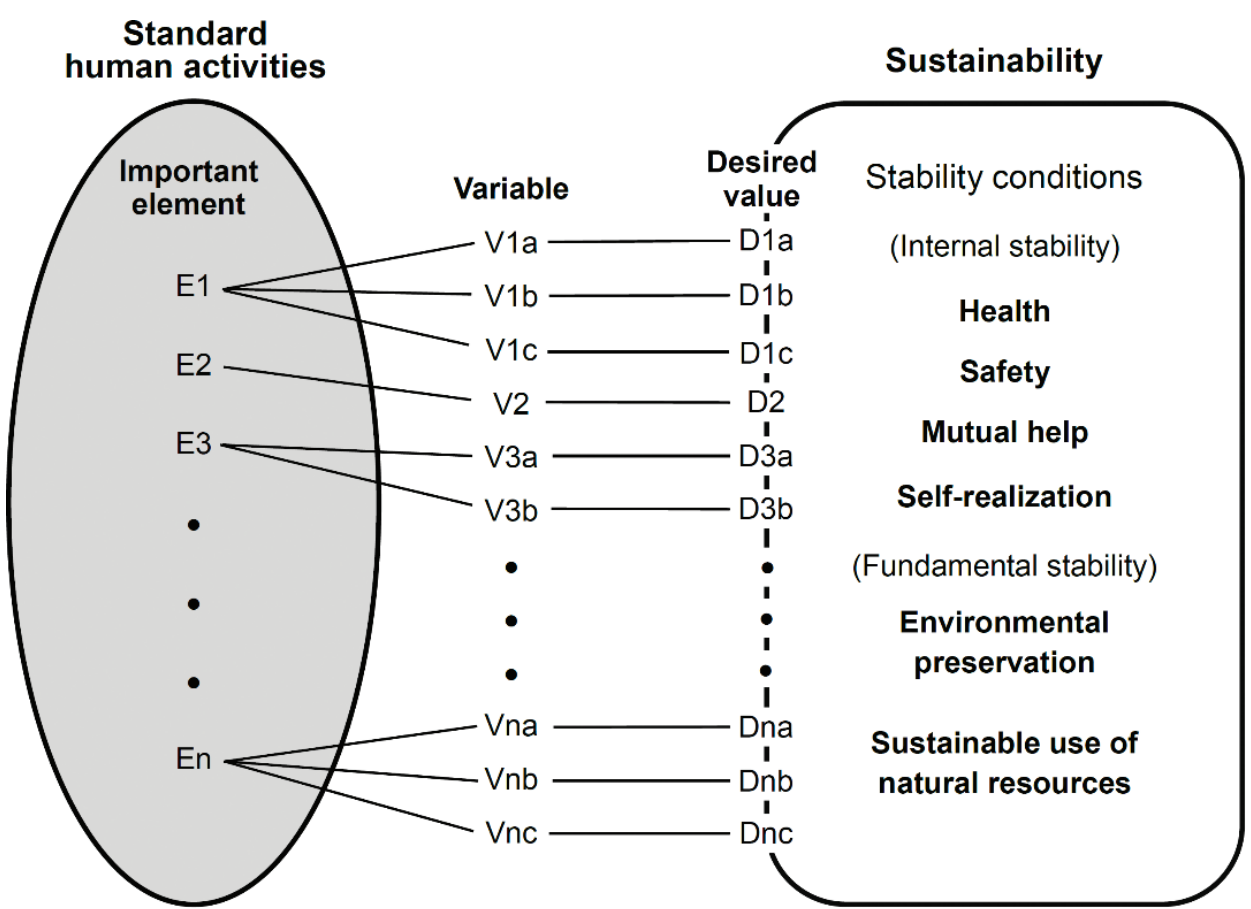


Figure 3. Concept diagram of determining the relationships between the standard human activities and sustainability [10].

chosen as a category of human activities, “equipment for rainwater use” need to be selected as an important element, even though it is not common in current ordinary homes [10].

After system designers select important elements, they determine the relationships between the selected elements and sustainability [10]. This work is composed of three processes: (1) considering the relationships between each element and the stability conditions for both Internal Stability and Fundamental Stability, including health, safety, and environmental preservation; (2) identifying variables which can indicate the degree of stability; (3) setting the variables’ desired values that can meet relevant stability conditions [10]. As demonstrated in **Figure 3**, the number of variables that connect to one element is not necessarily one but can be many [10]. In addition, system designers need to identify variables and set their desired values, based on the most recent technology, scientific knowledge, and social conditions [10].

3.2. Sustainability checkup on human activities as an object

The second step is “sustainability checkup on human activities as an object” [10]. The second step starts with the measurement or estimation of the above-mentioned variables of human activities as an object [10]. Subsequently, comparing the measured or estimated values with the desired values, system designers assess the degree of stability [10].

After the comparison and assessment, the variables that fall below the desired values are necessary to be identified as “controlled variables” [10]. In addition, human activities as an object that includes controlled variables are naturally identified as a “controlled object” [10].

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