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Function Innovation Design Model and Its Application in heating equipment

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Abstract. Function design is an important step in the process of product design. This article mainly focuses on process and realization of product function innovation. Function innovation and forecasting method is presented, and the product function innovation process model is proposed. Finally, the heating equipment is taken as an example to validate the effectiveness of the model.

Introduction

Product functional design is an important method for high-level innovation. First, the overall function is determined by user requirement. Then the overall function is broken down into a set of sub-functions and function units, and the function structure is composed of functions and flow of energy, materials, and signals. The principle solution is generated by the search for appropriate working principles and their combination [1]. The main focus of function design is function decomposition [1-4] and function-to-structure mapping [5-6] before.

Function innovation is the process of optimization, update and restructuring to product function structure by demand-pull and technology-push, including progressive function innovation and radical function innovation [7]. The goal of function innovation is to increase the level of ideal [8]. Sustainable function innovation theory and method is the current research focus [9-10].

Function Evolution and Forecasting

1. Function evolution analysis based on patent knowledge mining

Patents are the main source of knowledge innovation. Patent-based knowledge mining means the process of special relevance knowledge discovery from a large number of patents. Function lies in the state of evolution [10].

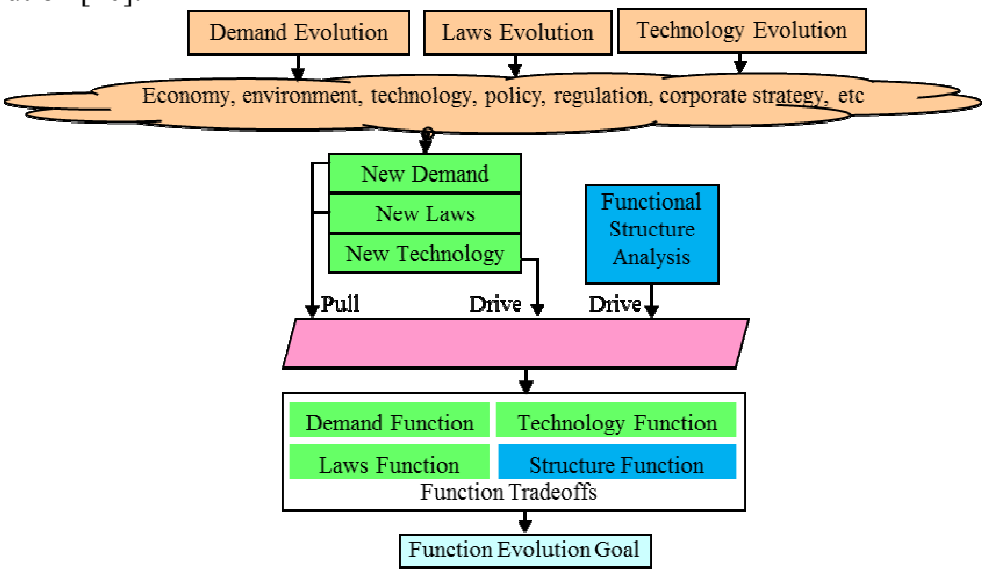

Fig. 1 Dynamics model of function evolution

2. Function forecasting based on function evolution

The laws of function evolution can point out the direction and approach of function evolution, which can be used to forecast the future function of product. There are two levels of function evolution goals, namely local idealization and global idealization. Choice matrix of the law of function evolution based on ideal level is shown in Table 1.

Table 1 Choice matrix of the law of function evolution based on ideal level

Laws of function evolution \ Function evolution goals	Local idealization	Global idealization
Laws of function organization	Law of functional completeness	
	Law of existence of links	
	Law of structure coordination	
Laws of function improvement	Law of specialization	Law of Integration
	Law of sustainability	Law of simplification
	Law of irregularity	Law of resource optimization
	Law of humanization	Law of dynamics
		Law of controllability
		Law of coordination

Process Model of Sustainable Function Innovation

By introducing TRIZ method into functional innovation, the process model of function innovation is formed, as shown in Fig. 2. The process model includes product demand acquisition, function modeling and optimization, function solving, evaluation, principle solution selection, and so on. The key is the introduction of functional modeling and function evolution to optimize the existing product function structure, and then sustainable assessment method is applied to improve the functional structure.

Case Study

CdTe thin film solar cell has become the new trends and hot spots in PV market. The heating equipment is critical equipment, but it is discontinuous, the efficiency of which is bad. In order to continuously deposit CdTe, it is need to separate heating substrate from depositing CdTe.

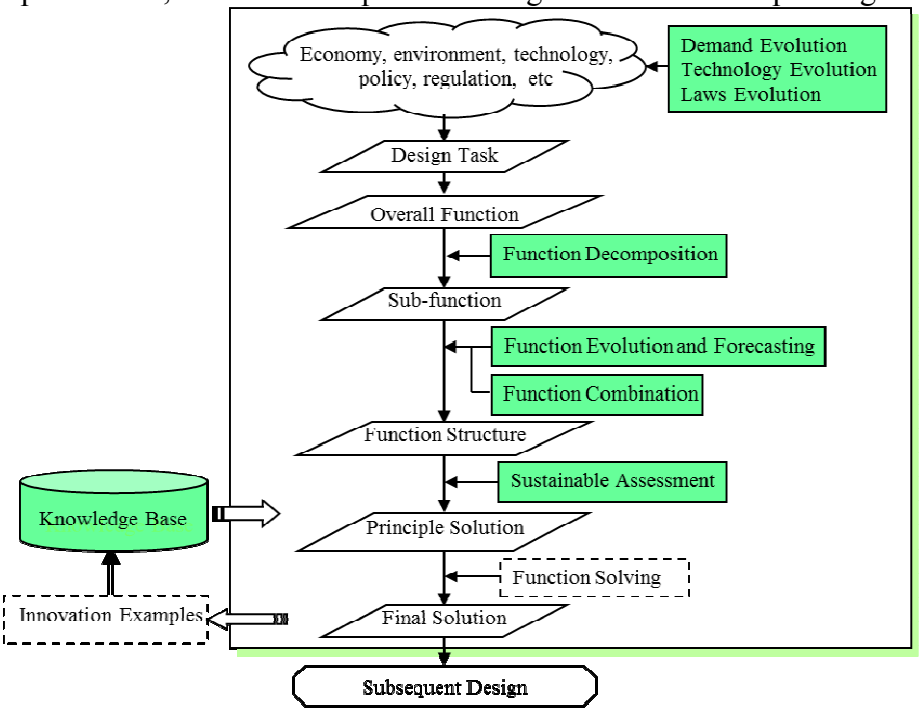

Fig. 2 Process model of function innovation

The functional structure is established and is divided into several modules, as shown in Fig. 3. Fig. 4 is the improved functional structure by function evolution and forecasting. Then confirm the principle solutions to sub-functions in function structure. The solution to heating equipment [11] is formed by connected the principle solutions to sub-functions, as shown in Fig. 5.

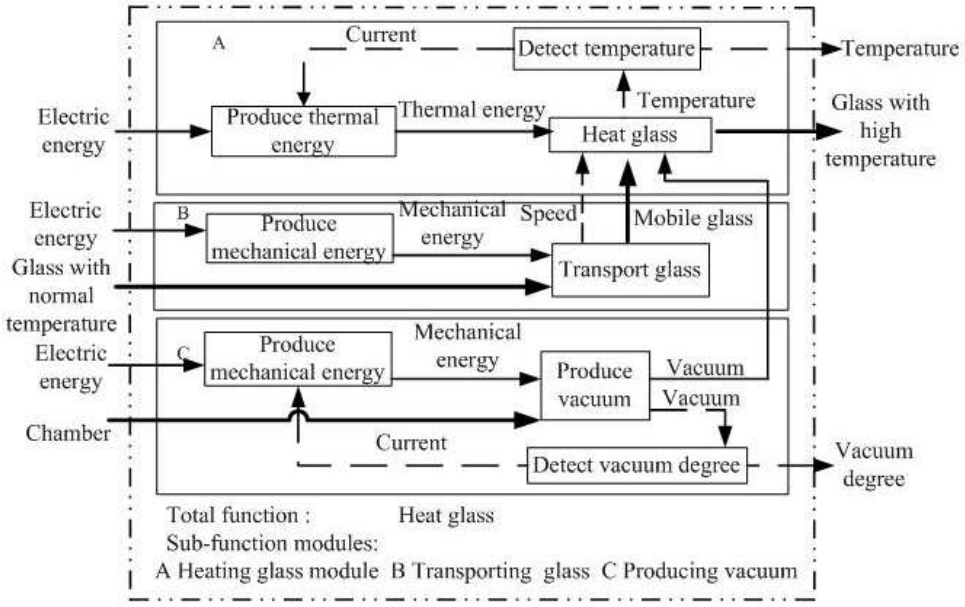

Fig. 3 Functional structure of heating equipment

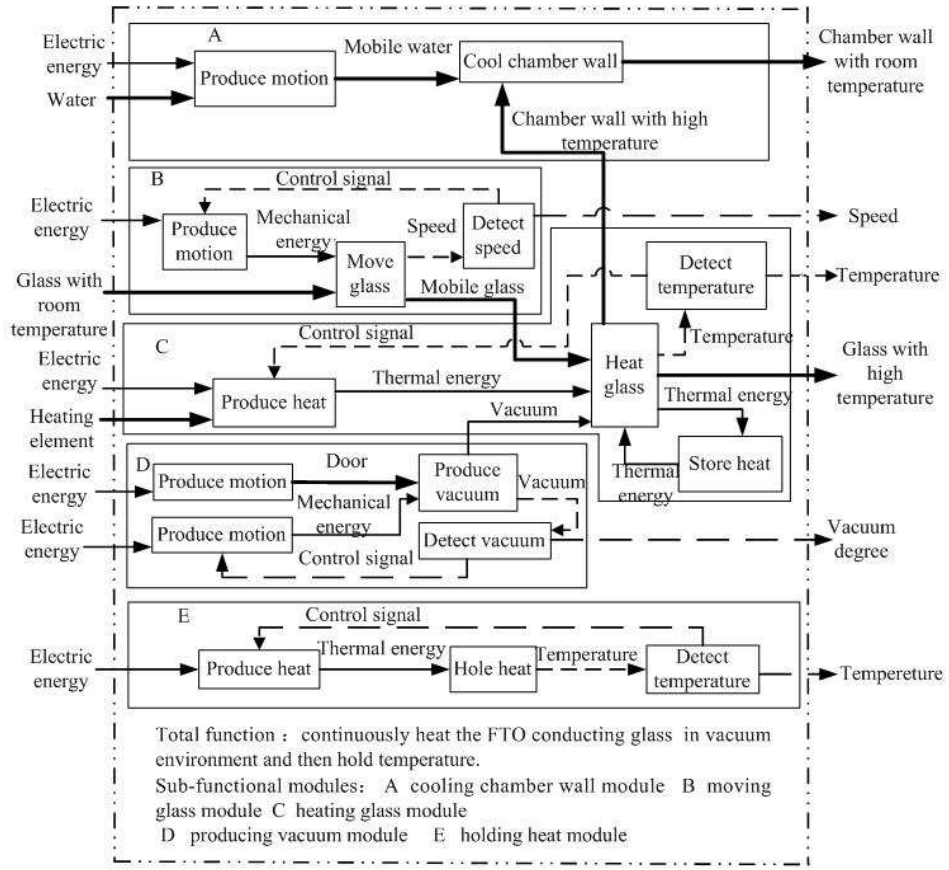

Fig. 4 The improved functional structure by function evolution and forecasting

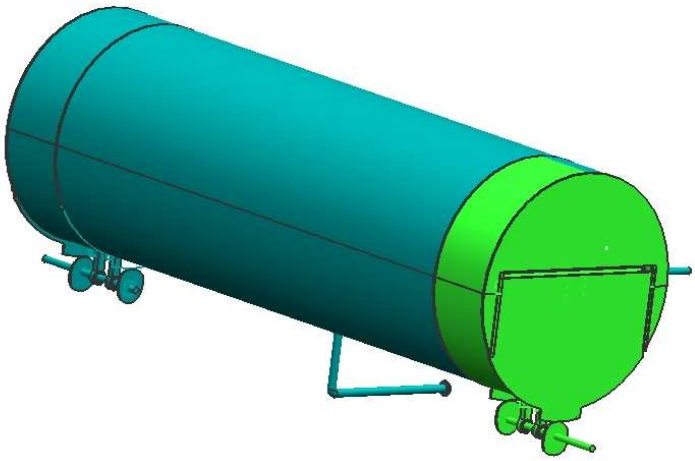

Fig. 5 Assembly drawing of heating equipment

Summary

The process model of for sustainable function innovation is proposed, which provides a systematic approach to product sustainable innovation from functional design angle, and the sustainable innovative of heating equipment in CdTe film solar cell production line demonstrates it is feasible.

Acknowledgments

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