International Journal of Marketing Management

ISSN 2454 - 5007

www.ijmm.net

Email ID: editor@ijmm.net , ijmm.editor9@gmail.com

Int. J. of Mkt. Mgmt. 2022

International Journal of Marketing Management

ISSN 2454-5007, www.ijmm.net

Vol. 14, Issue. 4, Dec 2022

Development of products using knowledge organization and simulation modelling

Dr.S.Peniel Pauldoss[1], M.Vinay Kumar[2],lavuri Prasad[3],
Professor[1],Assistant Professor [2],
Student[3], Department
of Mechanical,
BRILLIANT GRAMMAR SCHOOL EDUCATIONAL SOCIETY'S GROUP OF INSTITUTIONS-INTEGRATED CAMPUS
Abdullapurmet (V), Abdullapurmet (M), R.R Dt. Hyderabad-501505.

Article Info:
Received: 16-09-2022 *Revised: 18-10-2022* *Accepted: 27-11-2022*

Abstract

In this study, we suggest a different strategy for developing simulation models, one that makes use of knowledge structures. Products that need to be rethought and updated to include modern technology are the focus. The primary goal of this strategy is to just create an analysis model for the new technology, and then to include that model into the old prototype using the connection parameters that have been defined by hand using the knowledge models. The development of a system iron for the future required this method. The approach's capacity to simplify product development was shown by its facilitation ofstraightforward data collecting and automatedmodel verification.

1. Introduction

Multidisciplinary characteristics are becoming more common in today's consumer goods. This adds complexity to both the design and production of these goods. In order to get a product to market quickly, design teams typically prioritize feasibility above optimization when considering multi-domain requirements. There is an obvious need to organize knowledge about the design process in order to enhance the product development process and reduce design timeframes. Designers and engineers are better able to organize, model, and solve design challenges when they have a high-level perspective (i.e., a knowledge structure) of the design artifact at hand. The Design Process Unit (DPU) is used as the foundation for the knowledge structuring work in this research. The DPU is a simplified model of the design process; it depicts the flow of data among the four stages of the procedure (synthesis, analysis, evaluation, and adjustment). The product development of the next-generation system iron is a showcase for the benefits of a DPU-based knowledge structure. Iron system design is a complicated procedure. The success of the product depends on its ability to adapt to changing customer demands. Typically, this entails constructing a product that is both smaller in size and more technically advanced than before. This paper will have the following structure. The principle of DPU modelling will be explained in Section 2. From a standpoint of design theory, Section 3 explains the specifics of the method. The system iron is used as a case study in Section 4. The design process unit (DPU) of the system iron will be shown. Section 5 concludes this research report by discussing its findings and offering some suggestions for further study.

2. Design process and knowledge structure

The design process shown in Figure 1 [1] is a widely recognized general paradigm. This theory proposes that a synthesis process should be used to first develop a prospective solution. The data is then assessed to see how well it performed and scored to determine whether the design should be tweaked (way 1), abandoned (path 2), or embraced (path 3). Both declarative and procedural forms of knowledge are used to facilitate these stages. Declarative knowledge defines unchanging elements, such as component types, parameter values, and relational structures. Dynamic processes, such as design methods and algorithms, are described by procedural knowledge. One the one hand, design procedures are context-dependent and need problem-specific expertise. Therefore, it can't be utilized to capture the heart of the design process. Declarative knowledge, on the other hand, is unaffected by the parameters of the requirements.Because of this quality, declarative designknowledge may be used with ease to generate generic models of design objects.

International Journal of Marketing Management
ISSN 2454-5007, www.ijmm.net
Vol. 14, Issue. 4, Dec 2022

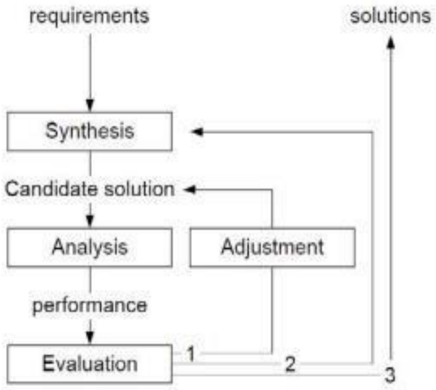


Figure 1: Overarching Design Model [1]

Embodied knowledge, scenario knowledge, and performance knowledge are the three primary forms of declarative knowledge involved in the design process [2-4]. Information about the object's topology and attributes, for example, are examples of embodiment. The scenario is associated with the group of things that characterize the energy, mass, or information flows to which the embodiment is subjected. The performance of an embodiment is what governs its behaviour in a given (set of) scenarios, and performance might be either energy quantities or attributes of physical objects. The interplay between these three domains of expertise changes depending on whatever stage of the design process (Figure 1) is being considered. Figure 2(a) depicts the synthesis phase, during which embodiment knowledge is described to match predetermined performance criteria for a certain situation. Using analytical equations, as seen in Figure 2(b), the performance of an embodiment under a specific situation may be measured and evaluated. When deciding what to do with a candidate solution that has already been developed, performances are used in the assessment step. Finally, the adjustment step makes minor tweaks to a few embodiment factors in order to fine-tune the solution's performance.

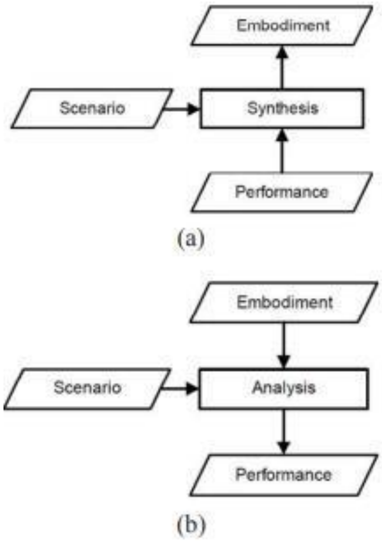


Figure 2: Knowledge structure in the analysis and synthesis process

2.1 The Analysis model

Declarative knowledge also includes the relations used throughout the synthesis, analysis, assessment, and adjustment processes. This is due to the fact that these relations apply for the design process regardless of the particular feature of the requirements, and hence do not specify design techniques as such. For instance, the procedural sequence in which a spring is created does not affect the equations used to determine the spring's deformation and stress. Similarly, rules of thumb for calculating the diameter of a spring during synthesis are not reliant on the particular approach that may be employed to create the spring. The quality of a design solution is decided by analytical relations, but just knowledge of these relations is necessary to complete the design process [2]. Here, we refer to the set of analysis relations utilized to measure an embodiment's performances as the analysis model. The amount of complexity and specificity in the design process is determined by the analysis model, which establishes the relationships between all key embodiment and scenario variables and performances. Because of this, factors related to embodiment and scenarios that were not included in the analytical model play no part in the design process and do not influence how well the solution is qualified.

2.2 Design Process Unit

For a design process to take place, it is necessary to have knowledge of three pieces of declarative information: the embodiment, the scenario, and the performance. In this study, we call this triad the

Design Process Unit (DPU) since it encompasses the fundamental information that must be collected or made accessible throughout the design process. A typical DPU used in the development of a mass spring system is seen in Figure 3. Embodiment (design) parameters include mass and stiffness, as seen in the picture. Power and frequency are considered in this case. Finally, the system's behaviour in a particular circumstance is specified by the performance parameter displacement. The analytical equation illustrates the connection between the variables under question. In this research, we visually represent DPUs in the order shown in Figure 3: embodiment parameters on top of the analysis model, scenario parameters on the right or left side of the analysis model, and performance parameters at the bottom of theanalysis model.

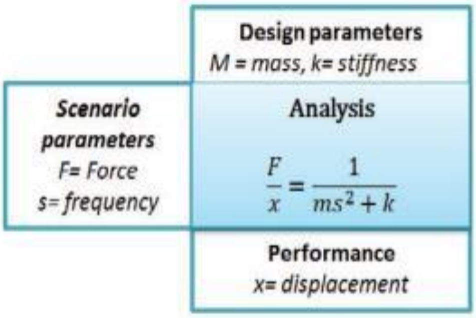


Figure 3: DPU of a mass-spring system

2.3.DPUs based knowledge structures

DPUs may be thought of as the building blocks of design knowledge, and a design artifact can be depicted as a network of DPUs expressing information at various granularities and for a variety of assemblies and subsystems. Artifact's component DPUs may be joined at the point of embodiment, scenario, or performance. Figure 4 provides a graphic representation of this. By creating DPU maps of an artifact's parts, one may see how many fields are represented and how the various pieces of information are related to one another. Product development methods, knowledge field interfaces, and build-up analysis models of theplanned artifacts may all be determined with the use of knowledge structure maps. When the analysis equations are unknown but the embodiment, scenario, and performance characteristics are known, an analysis model must be created before the design process can begin. When time or principal complexity prevent the development of a simulation or analytic model, an experimental set-up may serve as an analytical model. This is discussed further on.

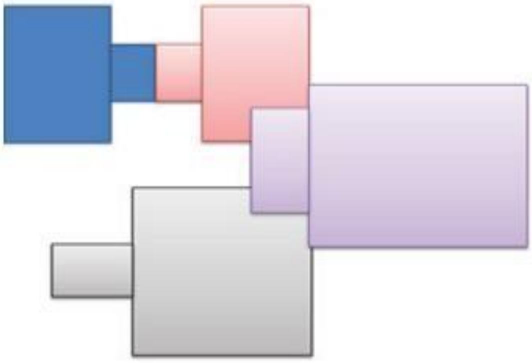


Figure 4: The framework of knowledge, with each hue designating a distinct DPU.

3. DPU based simulation modelling

3.1. The challenge

Redesigning current items to boost performance, raise market value, expand functionality, or any combination thereof is a prevalent technique in industry. When a product is redesigned by using cutting-edge technology, we have a case of innovative design. In order to incorporate new technologies, it is necessary to create new analytical models and verify them experimentally. Both analytical and simulated models fall within this category. In order to represent the temporal dependencies of a system, simulation models are recommended when dealing with dynamic behaviour. Creating such models is labour-intensive because of the need to include both legacy and cutting-edge components into a single analytical framework. It's also hard to keep tabs on model flaws since any one issue might affect any part of the product analysis model.

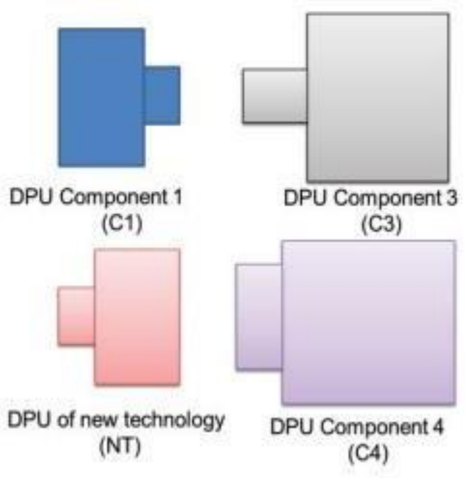
3.2. Approach rationales

This research presents a novel method based on DPU knowledge structures to reduce the time and effort required to construct simulation models for redesigned goods that include new technology. For this method, all that's needed is an analytical model of the new technology, which can then be combined with the current prototype by making use of the scenario and performance characteristics of the associated DPU. To do this, the prototype's measured variables are sent to the simulation model as inputs. The benefits of this approach are: - Decreased time spent on creating models Modelling within the constraints of the new technology makes tracking model faults simpler. - The real-world inputs to the system during the introduction of the new technology may be evaluated for their impact.

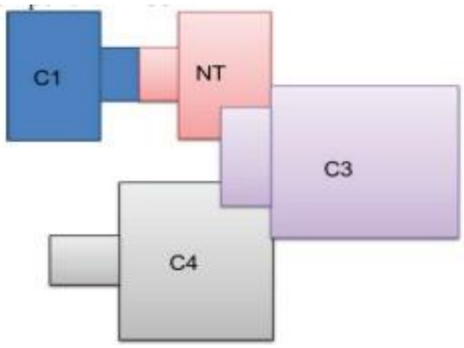
Since all models include simplifications, evaluating the performance of novel technologies is possible without the interference of models of other parts. In general, this method facilitates the targeted discovery of critical integration factors and tech habits.

3.3. Steps in the method

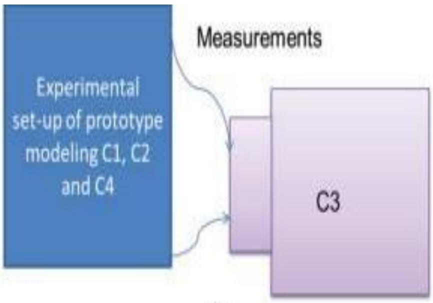
As seen in Figure 5, there are three overarching stages to the method. Figure 5(a) and Figure 5(b) depict the first step of modelling each of the necessary components as a DPU and combining them into a single overarching knowledge structure. Here, the pink DPU represents the cutting-edge innovation that has to be included. The variables that must be linked between the simulation model and the experimental setup may be identified with the help of the knowledge structure.



a) relevant component DPUs



b) combined general knowledge structure



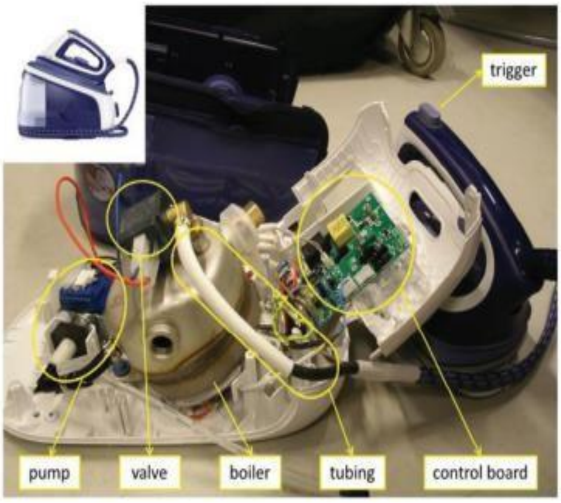
(c)

(c) figure 5. Schematic representation of the approach

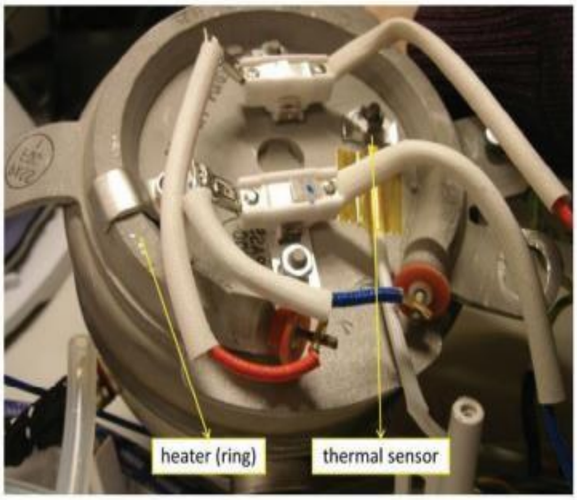
Finally, as illustrated in Figure 5(c), the simulation model and physical prototype are combined to form a coupled simulation experimental analysis model. Here, sensor readings provide a direct link between the experimental setup and the scenario parameters of simulation model C3.

4. System Iron Case Study

Wrinkle elimination is the primary function of the system iron. People buy ironing gadgets in the hopes of quickly and easily ironing out creases. The system iron operates on the principle of producing high-quality steam (i.e., vapor at a minimum of 2 bar) in a separate unit and transporting it to a portable iron. Since the stream is produced elsewhere, the iron itself may be made incredibly lightweight and thin. In Figure 6(a), we see the inside of the system iron. It consists of the pump, heater, boiler housing, and valve essential to generate the necessary pressured steam. The latter is a user-activated electronic trigger. When the user pulls the trigger (opens the valve), the pressurized stream must instantly be released. A portable iron receives the steam through tubing. When the water level in the boiler drops below a certain point, the pump will inject (cold) additional water from the reservoir into the boiler to maintain a constant supply of steam (vaporized water). Figure 6(b) depicts the heater's installation at the boiler's base.A temperature gauge is also connected. The electrical control board then regulates the operation of the pump, heater, and sensors.



(a) system iron interior



b) the boiler's bottom Summary of Iron in the System, Figure 6

4.1. System iron knowledge model

Figure 7 depicts the iron system's newly applied technology's integrated knowledge structure of its primary DPUs. While maintaining the same boiler container and control system, the new iron increases performance by upgrading the heating element, pump, and valve. Existing components of the iron are represented by DPU-A (boiler material and geometry) and DPU-D (control system), while new technologies are represented by DPU-B (heater) and DPU-C (pump and valve system). Dissipation, or power dissipation, is both a measure of DPU-B's efficiency and DPU-C's physical manifestation. DPU-C's functionality and DPU-D's scenario both include the steam's temperature (Ten)and pressure (PS). Natural convection modelling is used in DPU-B analysis. The fundamental principles of this analytical model for DPU-C are the laws of conservation of mass and energy. To determine the equilibrium qualities of water and steam, engineers use steam tables. the analysis in DPU-C

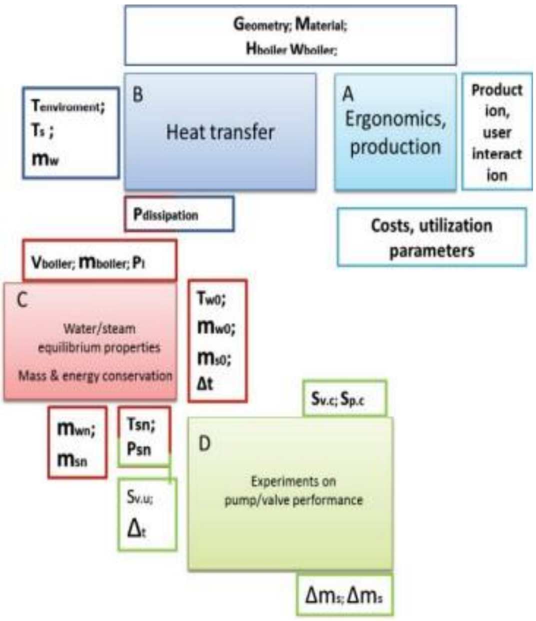


Figure 7: The iron heating system's knowledge architecture.

4.2. Coupled analysis model

DPU-D's prototype experimental setup is represented in Figure 9, and DPU-B and DPU-C's analytical models are shown in Figure 8. In Figure 8, we can see the fundamental concept behind the paradigm of linked simulation-prototype analysis. The Simulink version of this model has been created. As can be seen in Figure 8, the analytical model for heat loss from a hot boiler to a colder environment is split into three distinct sections, labelled B, C, and D to denote the DPU-B, DPU-C, and DPU-D, respectively. In Section B, we learn how to determine the equilibrium temperature and pressure using DPU-B. The entire input energy and beginning mass of water are used to apply the idea of mass and energy conservation. The thermal theory of natural convection is applied in the energy dissipation estimate shown in Figure 8's section C. The instantaneous dissipated energy for a given condition may be determined by knowing the material type of the boiler shell, the geometrical parameters of the boiler, and the temperature differential between the boiler surface and the surroundings. Part D of Figure 8 evaluates the control techniques' effect, allowing one to calculate the gain or loss in water mass and energy consumption.

International Journal of Marketing Management

ISSN 2454-5007, www.ijmm.net

Vol. 14, Issue. 4, Dec 2022

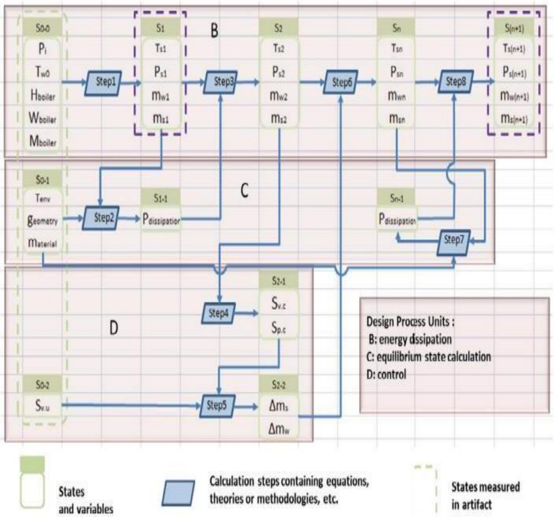
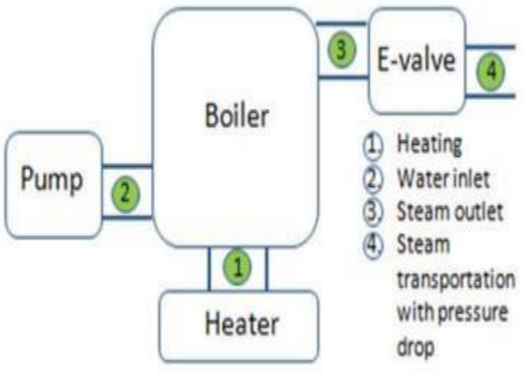


Figure 8: Contextual Analysis of a Heating System

These values are calculated precisely by utilizing real-time data from the experimental setup representing DPU-B and DPU-C, eliminating the noise introduced by modelling mistakes in the simulation model. The findings also allow the simulation model built for the new technologies represented by DPU-B and DPU-C to be verified in real time



Schematic representation of the Simulink model's components and interfaces, shown in Fig. 9.

5. Conclusion

Three benefits above traditional modelling techniques have resulted from using knowledge frameworks for developing simulation models into the design of a new system iron system. To begin, it is simple to get the necessary data for constructing the simulation model by processingthe actual trials. Second, the simulation model allows for far quicker iterations of design testing than were possible before. Third, it is possible to do autonomous experimentation and quickly compare performance data by combining the simulation model with the experimental setup. This allows for more effective performance comparison andsolution revision iteration work. This makes it possible to use a synthesis strategy to streamline the design process and provide optimal results for goods with dynamic customer needs.

References

[1] Tomiyama T, Gul P, Jin Y, Lutters E, Kind Ch, Kimura F (2009), Design methodologies: Industrial and educational applications. CIRP Annals, Vol 58(2). pp. 543-565.

[2] Schotborgh WO, McMahon CA, van Houten FJAM (2012) A knowledge acquisition method to model parametric engineering design processes. Int. J. Computer Aided Engineering and Technology. (paper accepted for publication).

[3] McMahon CA (1994) Observations on modes of incremental change in design. Journal of Engineering Design, Vol. 5(3). p.195. Taylor & Francis Ltd.

[4] Weber C (2005) CPM/PDD – an extended theoretical approach to modelling products and product development processes. Proceedings of the 2nd German-Israeli Symposium on Advances in Methods and Systems for Development of Products and Processes. pp. 159–179. Fraunhofer-IRB-Verlag, Stuttgart.

[5] Jauregui-Becker JM, Tragter H, van Houten FJAM (2009) Structure and models of artifactual routine design problems for computational synthesis. CIRP Journal of Manufacturing Science and Technology. Vol. 1(3). pp. 120-125.