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The Modeling Of A Conceptual Engineering Design System Using The Decision-Matrix Logic

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Abstract. Decision making a concept the optimal inside a concept engineering design (CED) is a job repeated. Decision matrix based method is the most popular concept selection approach used in engineering design. A matrix is an array that presents an axis of the alternate list being evaluated. The list of weighted criteria depends upon the importance of each of the final decisions to be taken. The decision matrix in this determined some weights and the rank as attributes to evaluate a total scores. Upon the weighting sometimes make the designer confusedly in determine variety. This paper described a decision making computer based, where a logic matrix decisions on a basis in the selection and evaluation. This model presents a logical procedure for concept evaluation considering the specified attribute. In decision-making this model is integrated and intended to improve the ability of beginners in designing.

1 Introduction

Engineering design process is a design planning in formulating solutions to assist a designer in building products with specific performance goals. In an Engineering Design Process (EDP) there are two main phases: initial design or concept and detail design. Techniques in drawing up Concept Engineering Design (CED) require information processing from a variety of sources that serve to meet the functional needs, operational constraints and evaluation criteria associated with the purpose specified. The ultimate goal of CED is to select the most desirable concept. The selected concept is then further developed in the detailed design phase.The conceptual phase broken down into four steps involving concept clarification, generation, selection and development are shown Fig. 1. Concept selection is one of the most critical decision-making exercises in a product-development process.

Concept engineering design has the main goal of determining the most desired concept. The designs that have been selected will be further developed beyond the design detail stage. The selection of design concept is one of the factors of decision making in product development. In this case, it is a recurring evaluation conducted to test the completeness

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and comprehension of requirements, which quickly identifies the strongest concepts. A common decision matrix approaches two major weaknesses; (i) some potentially optimal concepts may seem undesirable, since they never receive the highest total value, and (ii) general construction requires that decision makers determine weights and rankings that are not meaningful physically. More specifically, conceptual appraisal is obtained by using a random mapping process, in which the physical criteria value in the concept is mapped to the scoring space using a non-physically significant ranking structure, Messac[1].

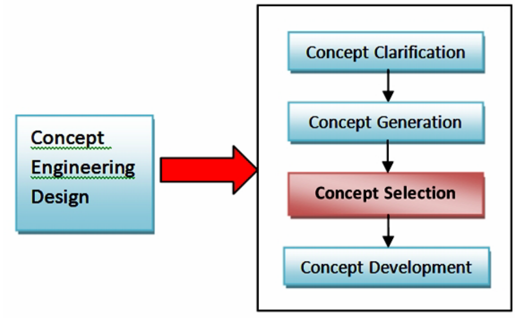

Fig.1. Phases of Conceptual Engineering Design

In the industrial world, there are several methods to do so. These methods include; Matrix decisions, feasibility assessments, intuition, cultivating, numerical and non-numerical charts, pair-wise comparisons, and prototype testing, Ullman [2], Otto [3] and Ulrich [4]. Screening and concept assessment is a popular variant of the matrix-based decision method, Ulrich [4]. The decision matrix method is the most commonly used to the concept of selection in engineering design practice, Mullur et al. [5]. This is an iterative evaluation that tests the completeness and comprehension requirements, which quickly identifies the strongest concepts. Typical versions are Pugh's method, Johnson technique and L-shaped matrix. Several versions of the decision matrix method have been refined for many different case studies. In the selection of suitable raw materials from several proposed feedstock alternatives, the matrix method for this case helps the selection of suitable and relevant material matrix decision ratings, Rao [6]. In addition, we present a theoretical framework for integration of methodology (LCC), Life Cycle Costing (LCC), and Quality Function Deployment (QFD) for selecting alternative product improvement strategies with consideration for Data Uncertainty The focus to the research is how manufacturing companies can be assisted in product design. Where the quality, environmental and cost (QEC) requirements of stakeholders in the life cycle stages within the product system are handled at an early stage where general data inaccuracy is prevalent. Considerations Of these three design requirements lead to multi-attribute decision situations, with respect to the selection of the concept of optimum product system improvement. Ratings of sustainable alternative options related to environmental, cost, and quality are also reported, Halog [7].

This method evaluates and ranks the material and hence chooses the most appropriate material. The Multi Criteria Decision Making (MCDM) approach to review mobile phone choices with respect to a user personal sequence where the most prefer to feature affecting cell phone selections is identified through surveys conducted. Their article then application the Quantitative Strategic Planning Matrix, (QSPM), which is an analytical tool for formulating the strategy used, Gulfem and Gulcin, [8]. The QSPM framework for retail computer stores also highlights the advantage and limitedness of this important strategic planning analysis tool, Meredith, et al., [9]. The importance to the decision evaluation process as it plays a significant role in the flow of scenarios, because variants of the enterprise are interested in introducing new products within a short span of time, Green and Mamtami, [10]. This paper examines the disadvantages of its application over strategic planning techniques in manual form and explores in a typical decision-making approach that potentially effective and easy to use by presenting computer-based models for use in Conceptual Engineering Design (CED).

2 Methodology

2.1 Decision matrix based concept evaluation

A matrix is an array that presents an axis of the alternate list being evaluated. The list of weighted criteria depends upon the importance of each of the final decisions to be taken, Oladejo,et al., [11]. Table 1 shows a typically constructed decision matrix for a beam design problem. It shows beam concepts P^1,P^2, and P^3 rated against two design objectives (criteria); minimal volume and minimal deflection. A higher numerical rating indicates better concept performance. Each criterion is assigned a weight that is intended tocapture its relative importance with respect to the other criteria. For every concept, the weight of each criterion is multiplied by its rating. The summation of all such products is the total score for each concept. The concept that receives the highest score is typically preferred over other concepts, Mullur, et al., [5].

Table 1. Typical construction of a decision matrix, Mullur, et al., [5].

Criterion	Weight	P^1	P^2	P^3
Minimal Volume	0.6	2	5	3
Minimal Deflection	0.4	1	3	5
Total Score	-	1.6	4.2	3.8
Concept Rank	-	3	1	2

The following equation shows the mathematical simple formulation of the evaluation procedure, Mullur, et al., [5].

$$J^i = \sum_{j=1}^{n} w_i \, u_j^i \tag{1}$$

Where, j^i is the total score for concept i,
n is the number of design criteria,
w_j is the weight of the j^{th} criterion,
u_j^i is the rating of concept for the j^{th} criterion.

2.2 Development of computer application package

Computer modeling of dynamic systems is a very important tool for engineering analysis and design. This allows for an active experiment, design modification, and flexibility The model is developed on the Visual BASIC platform running on Microsoft Windows with a graphical user interface (GUI). The GUI determines how various elements look and work. Major activities involved in the development of the model detailed comprises of the design of the programmable algorithm are shown Fig. 2, selection of appropriate programming language, project development, project debugging, validation and implementation of the model.

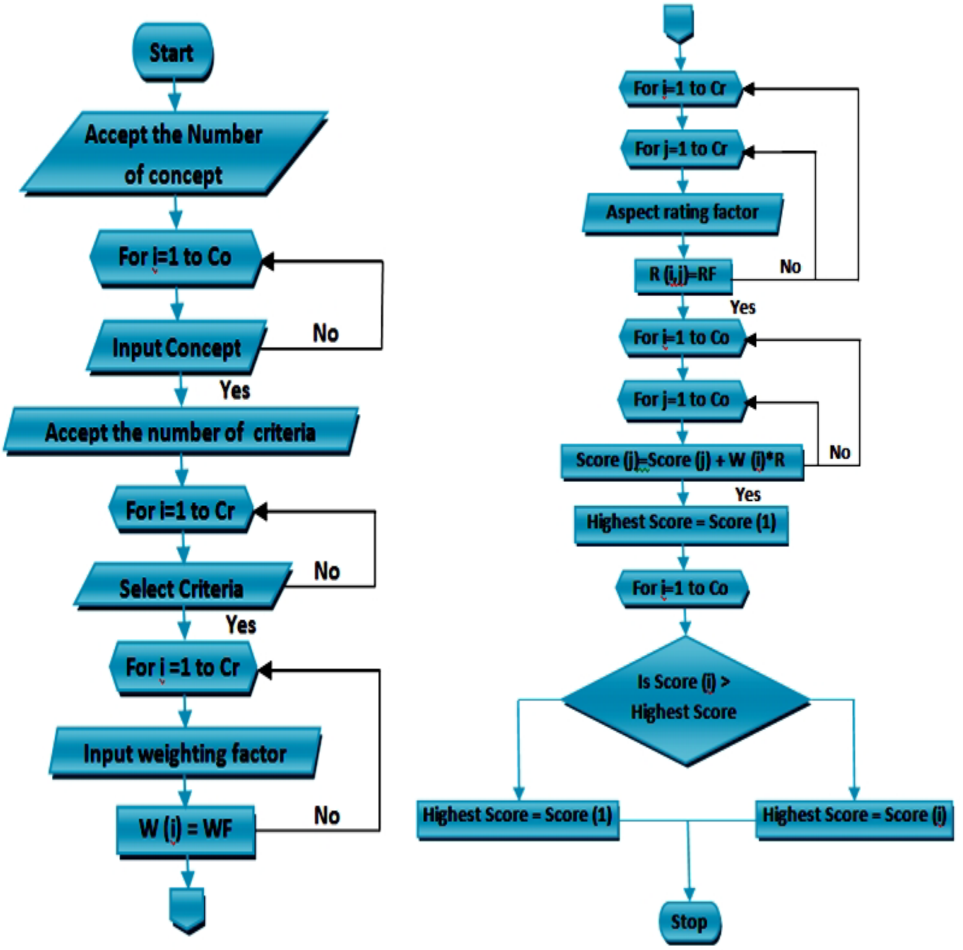

Fig.2. Flowchart of the package computation

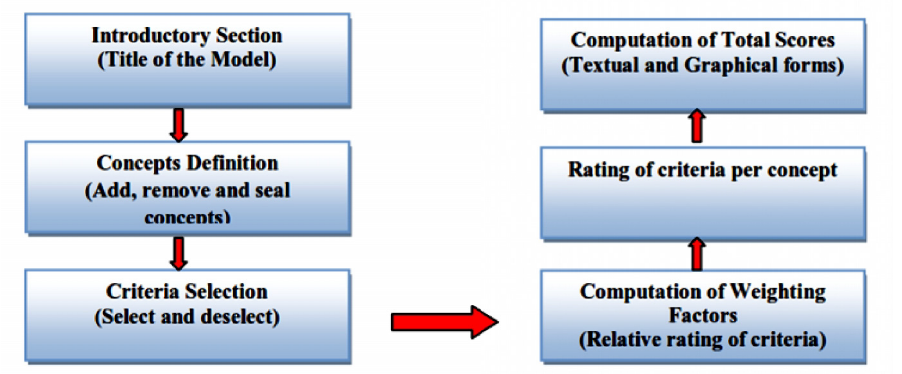

Fig.3. Major Structure of the Package, Oladejo,et al., [11]

The GUI itself consists of six main interfaces are shown Fig. 3, Oladejo,et al., [11]. Introduction Section; This section provides a brief introduction to the model, author and usability. Definition of concept; This section allows precise definition, by title, of all concepts that the model will consider. Selection of criteria; At this stage the designer is allowed to select related criteria from the set of attributes that the model will provide. Computation of weighting factor; The model calculates the weighting factor for each attribute. Rating of criteria per concept; The influence of each performance criterion of each individual concept, determined by the assessment of each criterion and concept. Computation of Total score per concept; The rating factor (RF), for each criterion and for each concept multiplied by the weighting factor (WF) to obtain the final weighting value for each concept. Each GUI is created using a three step process to plan the project and the process is repeated to create the interface. The three-step process involves setting up the GUI, defining properties, and then generating code.

3 Result and Discussion

The model can be used for any type of decision-making situation and has a manual method reference limit. Fig. 4 shows the interface for the designer to define the concept's alternative and criteria to be considered. The criteria is made available on the interface for the user to select. The list of criterion is developed from the engineering specification.

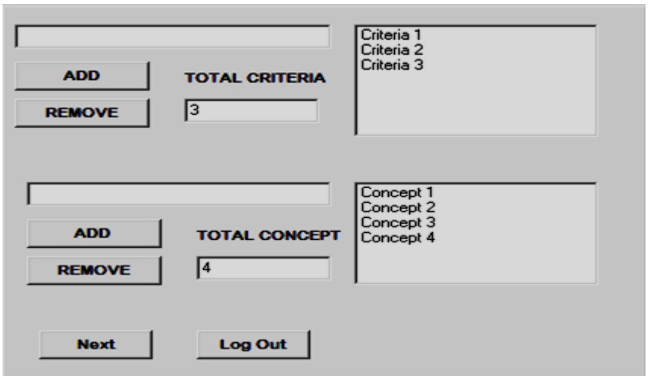

Fig.4. Interface to input the alternative concepts and criteria

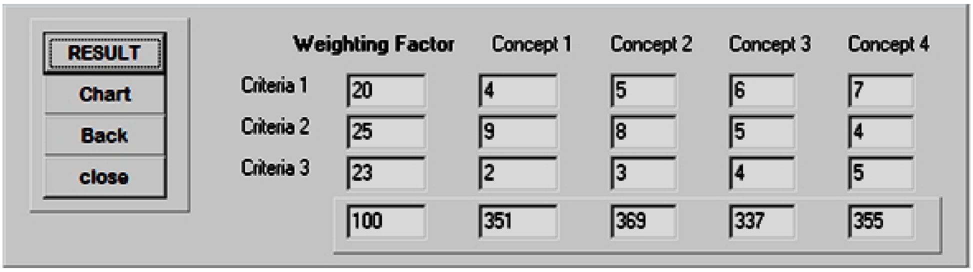

Fig.5. Interface to input the alternative concepts and criteria

Fig. 5 shows the interface for calculating the weight factor of each criterion. This involves the use of a comparison matrix in which all selected criteria are paired and then evaluated against each other in the order of relative importance listed earlier. The weighting factor at the interface is calculated by adding the number of times a certain criterion is selected according to the partner's criteria. The values obtained for each attribute are 20, 25 and 23, as shown in Fig. 5.

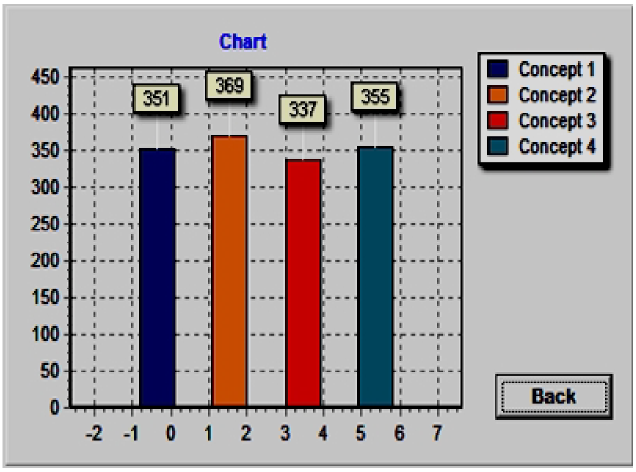

Fig.6. Chart of the concept score

This value is automatically moved to the next slide Fig. 6, where the ranking factor is selected to calculate the total score for each concept and displayed with a chart**.** In the graph is listed the highest score that is concept 2 with a total score of 369. The highest score or first rank on the graph is the chosen concept to be used.

4 Conclusion

This study presents an optimal selection of concepts developed through computer applications. The selection of the optimal concept comes from a number of alternative concepts available by using certain techniques in CED. The model was developed using matrix decision logic over the Visual Basic platform. The computer app device accepts the concept from the user, evaluates, ranks the ranking of concepts and presents the results in graphical form. This model can be used for all kinds of problem selection design concepts involving a number of attributes and can also serve as teaching aids in engineering design.

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