PARAMETER ANALYSIS METHODOLOGY APPLIED TO PICO-HYDRO TURBINE:A CASE STUDY

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ABSTRACT:

In the present work, Parameter Analysis Methodology applied to Pico-Hydro Turbine. Design knowledge is a key asset for the prospect of the company specially under core arena but now a days many companies find it difficult to employ an employee of sound design knowledge. A systematic design through which PARAMETER ANALYSIS METHODOLOGY (PAM) is presented using a certain sequential model of conceptual design, where by function structures are established, solution principles sought, and then combined to form the product concept. In reality, design is seldom such a linear process, and that linear design process models may hinder creativity and innovation. So, a simple model that captures the nonlinearity is therefore more suitable for describing thought process of conceptual design which is done by means of the PAM. Through PAM conceptual design is reviewed through case study of pico-hydro turbine.

Keywords: *Conceptual design; Systematic design; Nonlinearities; Parameter analysis; Pico Hydro-turbine.*

I. INTRODUCTION

This Conceptual design, i.e., the activity of generating new design concepts, is considered as one of the most creative parts of designing. It typically occurs in the initial stage of a designing process, defining fundamental characteristics of the designed outcome and setting the goals for subsequent phases to implement [1-3]. Revealing the cognitive process of conceptual design activities can help to elucidate the nature of designedly thinking [4]. However, little is known about the cognition of how designers think during this key period of designing. Systematic design is a rational model of the engineering design process [5]. This model prescribes a sequence of major stages for the design process (clarifying the task, drawing the specifications, conceptual design, embodiment design, etc.), and offers various tools for each stage. To assist all designers in considering design principles, the Parameter Analysis Methodology [6] is carried out. Parameter analysis formalizes the "natural" way of thinking during design – repeatedly identifying dominant issues at the concept or idea level, implementing the concept as a configuration and evaluating the design.

The case study [7] of designing pico-hydro turbine [8] presented in this paper demonstrates the steps of parameter analysis that are required for the incorporation of a single design principle, in a similar manner.

Design Process Model

The failure of systematic design to produce potentially good conceptual design, is attributed to its non-linear nature, and in particular to two major aspects of non-linearity; the lack of functional reasoning through the conceptual design stage, and the possibility of deriving new concepts that are difficult than those identified initially. This design process model generates the thought process to tackle the above said two design__non-.linearirties.during conceptual design, which is called parameter analysis. Parameter Analysis was originally formulated as a methodology for dealing with the conceptual design stage. Parametyer Analysis is useful for future model analysis having design non-linearities.

II. PARAMETER ANALYSIS METHODOLOGY

The discovery of a few critical issues referred to as parameters at a time are emphasized_by the parameter analysis methodology, which calls for implementing these as configurations, and directs the designer to keep evaluating the evolving design to identify new,emerging, dominant issues. Parameter analysis is a systematic methodology for conceiving innovative ideas and developing them into workable designs. In this methodology back and forth motion between the two spaces of design knowledge takes place and the two spaces are known as configuration space and concept space. The schematic representing the two spaces are shown in Fig. 1. The name itself configuration space which suggests, that it consists of the descriptions of hardware, shapes, design tools and functional forms. The result of any design process is certainly a member of configuration space, and so are all the elements of the design artifact that appear, and sometimes also disappear, as the design process unfolds. Movement from one point to another in configuration space represents a change in the evolving design's physical description but requires conceptual reasoning, which is done in concept space. The concept space deal with parameters, which in this context are functions, ideas or concepts that provide the basis for anything that happens in configuration space.

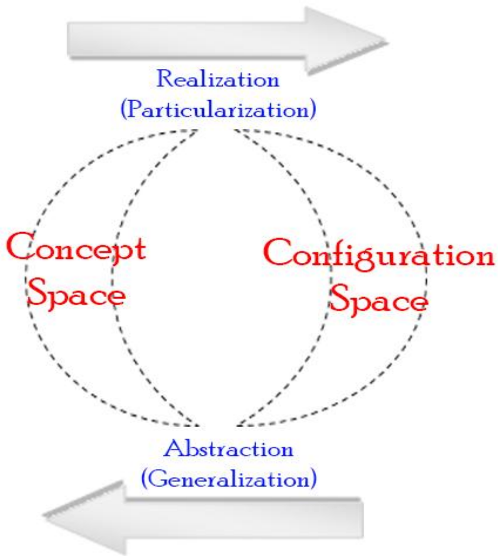

Fig. 1. Schematic of the two spaces used in the PAM

Repeatedly moving between concept and configuration spaces is carried out by breaking the thought process into three distinct steps: parameter identification, creative synthesis, and evaluation shown in fig.2. The three steps are applied time and again during Parameter Analysis, dealing with contingent, constantly evolving information associated with the design artifact. At each cycle of this process, the critical or dominating issues, configurations and results of the evaluations are different as are changing configuration and the results of the evaluation. Every design process must incorporate the three major stages (1) identifying and analyzing the need, (2) generating concepts to satisfy the need, and (3) evaluating the alternatives to select the best solution.

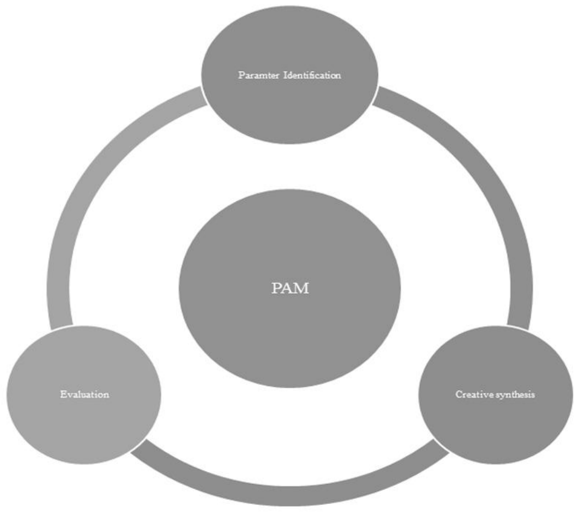

Fig. 2. Schematic of the parameter analysis methodology with three repeated steps

A. *Parmeter Identification*

The parameter identification, consists primarily of the recognition of the most dominant issues at any given moment during the design process. The term 'parameter' specifically refers to issues at a conceptual level. These may include the dominant physics governing a problem, a new insight into critical relationships between some characteristics, an analogy that helps shed new light on the design task, or an idea indicating the next best focus of the designer's attention. Parameters play an important role in developing and understanding the problem as well as pointing to potential solutions. The parameters within a problem are not fixed; rather, they evolve as the process moves forward. Theoretically, the most significant conceptual issues – the dominant parameters – are identified early in the design process, and as we proceed downstream, we encounter and handle in more detailed way. Fig. 2 shows schematic of the parameter analysis methodology with three repeated steps.

B. *Creative Synthesis*

The second step in parameter analysis is creative synthesis. This part of the process includes the generation of a physical configuration based on the concept recognized within the parameter identification step. Since the process is iterative, it generates many physical configurations, not all of which will be very interesting. However, the physical configurations allow one to see new key parameters, which will stimulate new directions for the design process. Parameter analysis shifts the burden of truly creative activity from creative synthesis to parameter identification, the creation of new conceptual relationships or simplified problem statements, which lead to desirable configurationally results. Thus, the task of creative synthesis is only to generate Configurations by means of which, through evaluation, will enlighten the creative identification of the next interesting conceptual approach.

C. *Evaluation*

The third part of parameter analysis is the evaluation step, that facilitates the process of moving away from a physical realization to practicability sense. Specifically, as one must consider the degree to which a physical realization represents a possible solution to the entire problem as well as highlights the weaknesses of the configurations. The main purpose of evaluation in parameter analysis is not to find fault but, rather, to generate constructive criticism. A well-balanced observation of the design's good and bad aspects is crucial for pointing up possible areas of improvement for the next design cycle. The extent to which the configuration succeeds in achieving the desired effect constitutes a useful criterion for evaluating and/or comparing design alternatives. The designer should systematically identify and map various transmission paths of forces and moments in the evaluation step. This activity provides critical insights into 'when,' 'where,' and 'which' transmission paths are critical. First, a relevant principle is chosen and, together with a concept for its realization, it becomes the temporal parameter. Next, a configuration is created to embody the parameter, and finally, an evaluation is carried out.

III. Case Study

In the parameter identification (PI) step, the relationship between the head, discharge and flow rate (creative synthesis, CS) of a fluid is identified. In the evaluation (E) step the recognized facts are that the configuration did not lend itself to compact packing (inspection of flow rate with respect to pressure). Note that this parameter combines three functional issues- providing suitable head, diameter of runner and being simple. The configuration proposed for realizing the aforesaid last concept is shown in fig.3.

Fig.3. Proposed conceptual design of Pico-hydro turbine

IV. Results and Discussion

Case study of Pico-hydro turbine design is applied to the parameter analysis methodology. The computational fluid dynamic analysis through ANSYS (FLUENT) results is given in table I & II.

Table 1 Static Analysis

S. No.	Descriptive of Results	AK Stainless Steel 341	ASME SA 516
1	Coefficient of Lift	0.05	0.01
2	Coefficient of Drag	0.001	0.009
3	Total pressure (Mpa)	1.28	0.507
4	Turbulent Kinetic Energy (m^2/s^2)	6.68e1	3.148e1
5	Turbulent eddy Dissipation (m^2/s^3)	3.56e4	9.28e4

Speed of turbine: 1200rpm
Inlet flow velocity: 15 m/s
Factor of safety = working Stress/ Yield strength of the material.
Yield Strength of material for AK Stainless steel 341= 241 Mpa
Working Stress for AK Stainless steel 341= 288.68 Mpa

The working stress is >> yield strength of the material

In above case the Pico-hydro turbine not withstand for power enhance up to 20W.
In case of ASME SA516 Gr.70 Material
Yield Strength of material for ASME SA516 Gr.70 Material = 260 Mpa.

Working Stress for ASME SA516 Gr.70 = 124.74 Mpa
F.S = 124.74/260 = 0.479

In above case the F.S of material is above 0.3 so this pico-hydro turbine is withstand for power enhance up to 20W by using ASME SA516 Gr.70 Material.

TABLE II STATIC ANALYSIS

S/No	Material	Equivalent von-mises stress (MPa)	Total Deformation (mm)
1	AK Stainless Steel 341	288.68	0.13839
2	ASME SA516 Gr.70	124.74	0.25372

V. CONCLUSION

The parameter analysis was proposed as an effective methodology to help designers gain crucial insights into the problem, thereby aiding them to reformulate the problem. Further, it does not force the designer to completely specify the functional requirements. Thus, Parameter Analysis offers the designer a practical means for handling the nonlinearity of the design process using repeated application of three steps.

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