



# A case-based reasoning system for using functional performance specification in the briefing of building projects

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## ABSTRACT

Functional Performance Specification (FPS) is a structured requirement analysis process, in which client requirements are firstly defined with functions and relevant evaluation criteria – functional performance. This paper describes a Case-Based Reasoning (CBR) system recommending functions and functional performance to facilitate the use of FPS in the briefing of building projects. It begins with an introduction to the briefing practice and the problems of using FPS in briefing, followed by proposing a structural job plan of FPS. Next, the CBR system design is described and how it supports the use of FPS is illustrated. Finally, the competence of the system is evaluated with two experiments, which demonstrate that the CBR system is a highly promising tool for facilitating the use of FPS. The future research work concerning addressing the shortcomings of the CBR system identified in the experiments is also noted.

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## 1. Introduction

Case-Based Reasoning (CBR) utilizes the specific knowledge of previously experienced, concrete problem situations (cases), thus a new problem is solved by finding a similar past case, and reusing it in a new problem situation [1]. CBR has been widely applied to a variety of tasks. Concerning applications in the A/E/C industry, we can cite construction negotiation [2], wall selection [3], bid decision making [4], construction safety planning [5], procurement selection [6], construction planning [7,8], bid mark-up estimation [9], subcontractor registration decisions [10], value engineering [11], and construction hazard identification [12].

Due to the success of CBR in suggesting solutions based on similar situations, the study described in this paper aims to introduce CBR to support the use of Functional Performance Specification (FPS) in the briefing process of building projects. The strategy we take is to design a CBR system that retrieves similar cases (textual functions representing client requirements in the form of ‘verb + noun’ enable semantic search) responding to the new event (keywords related to requirements that the user concerns), and then recommends solutions (relevant functions and their functional performance) to the selected returned cases.

The paper begins with an introduction to the briefing, followed by the discussion of the problems encountered in using FPS in it. After that, a structural job plan of FPS is proposed. Next, the design of the CBR system is detailed, including how it supports the use of FPS in the briefing. Finally, we evaluate the competence of the system within two experiments.

## 2. Functional Performance Specification (FPS) for briefing

Briefing (also known as ‘architectural programming’ in the US) is a process through which a client informs others of his/her needs, aspirations, and desires for a project [13]. A brief is the document that defines client requirements for a building. Defining the requirements and communicating them to other stakeholders are crucial to the successful delivery of a project [14,15]. With consideration of the critical influence of briefing on the whole building delivery process, Value Management (VM) exercises are expected to be conducted at the earlier stages [16–21]. In Hong Kong, the Environment, Transport and Works Bureau requires major projects (those with an estimated project cost exceeding HK\$ 200 million) in the subordinate departments to conduct VM studies [22]. The Construction Industry Review Committee also recommended that VM should be used more widely in local construction, because it can help the clients and the project team to focus on the objectives of the project and the needs of all stakeholders, both long and short term [23].

### 2.1. Value management

VM is concerned with defining what ‘value’ means to a client within a particular context by bring the project stakeholders together and producing a clear statement of the project’s objectives [16]. An essential feature of the VM approach is expressing client requirements as functions. In terms of VM, a function is referred to as the specific purpose or intended use of a project that makes the project sell, produce revenue or meet requirements.

Function analysis is one of the key components of VM methodology, which distinguishes VM from other cost reduction activities [23]. Charles Bytheway developed a concept and named it FAST (Function Analysis

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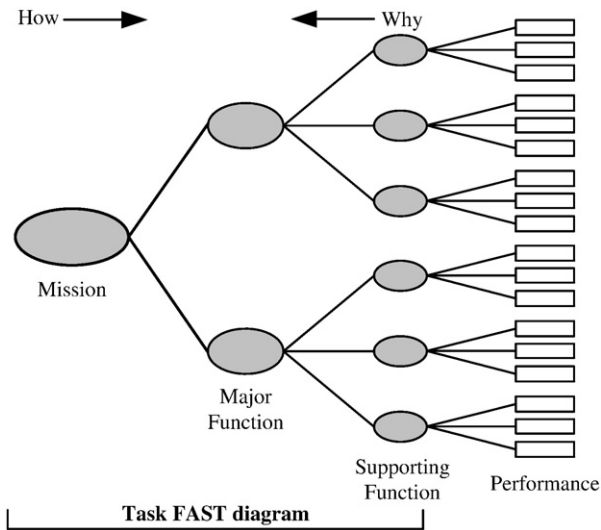


Fig. 1. Structure of FPS (adapted from [34]).

System Technique), which utilizes ‘why-how’ logic to address the difficulty of getting agreement on the basic function of an assembly or component [24]. Bytheway succinctly summarizes the ‘why-how’ logic and features of the FAST in the following statement: ‘the result of writing down the functions as they relate to each other generated a visual diagram which showed how each function is performed by merely observing the functions posted immediately to the right of any given function. By the same token, if one desired to know why a given function is required, the function posted at its immediate left provided the answer [25]’.

Job plan is another key component of VM methodology [23]. It is a structured process which has a definite beginning and a definite end. A good job plan lays down the procedure of a VM workshop explicitly. A successful attempt in the functional representation of client requirements is the Charette job plan, which rationalizes client briefs primarily through the function analysis of space requirements. Shen et al. [20] contended that it should be broadened to include other issues of client requirements and to communicate them clearly to the designers.

2.2. Functional Performance Specification (FPS)

As one of VM techniques, FPS was originally developed in French manufacturing, and was used in Europe as a system for the explicit

statement of optimum product definition for a given market within a tool for conception and design management [26]. Currently, the application of FPS is primarily in the two realms of software engineering [27–30] and manufacturing industry [26,31,32]. FPS represents requirements in terms of functions in the form of ‘verb + noun’, functional performance criteria, and flexibilities of these criteria indicating which of them are imperative (with a certain tolerance) and which are desired but open to negotiation. The structure of briefs achieved by conducting FPS is shown in Fig. 1.

Shen et al. introduce FPS to the construction industry and developed a structured framework for identifying and representing client requirements in briefing [19]. In the context of a briefing team of multidisciplinary stakeholders, where the focus, perspective, orientation, knowledge, and expertise of the stakeholders are often quite diverse, there is a strong need to have a common language to present client requirements. As a performance-based approach thinking and working in terms of ends rather than means [33], FPS constructs a design-neutral way allowing all team members to communicate more effectively.

To further prompt and validate the framework by Shen et al., a computer-aided tool *FPS Genius* was developed by Luo and Shen [34]. However, during the course of applying the computer-aided tool in practice, it has become apparent that to efficiently and accurately define functions and their performance in the function analysis phase with a fixed and short duration is a big challenge.

3. CBR for FPS

CBR is useful in interpreting open-ended and ill-defined concepts; in other words, CBR allows a reasoner to propose solutions in domains that are not completely understood by the reasoner [35]. With respect to the uniqueness and complexity of building projects, it is feasible and practical to introduce CBR to address the problems encountered in using FPS in briefing. Unique cases defined in the briefs of previous analogous building projects could and should be reused. With the recommendations by CBR, those normal inexperienced clients are expected to understand their projects and clarify their requirements more easily. To combine CBR with the FPS practice, we adapt the job plan in [19] and propose a new one with five phases (see Fig. 2):

- 1) preparation phase to organize the briefing team and define the briefing workshop,
- 2) information phase to establish a shared understanding of the project among all participants,

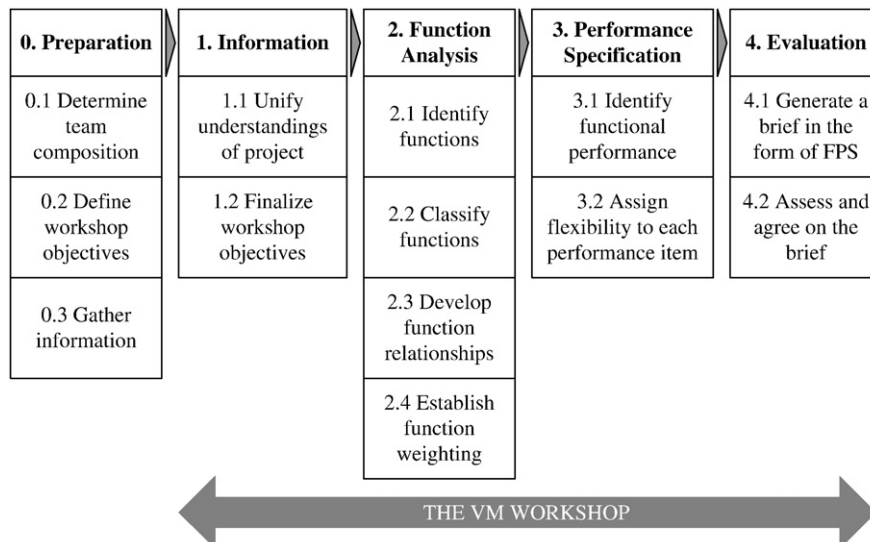


Fig. 2. Job plan for using FPS in briefing.

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