An approach for pattern oriented software development based on a design handbook


Distributed and Object Systems Lab, Department of Computer Science and Engineering, Indian Institute of Technology Madras, Chennai, India
E-mail: {janaki,kanthms,raju,anand}@lotus.iitm.ernet.in

In many mature engineering disciplines, reuse of available design knowledge is helped by the presence of handbooks. These handbooks record the details of existing system components and help in the process of evaluating design alternatives while building new systems. In recent times, design patterns have been identified as fundamental components of an object oriented design. However, they are presented in a format that may not be best suited for systematic selection and use while evaluating design alternatives. This paper provides a procedure to construct a handbook based on design patterns. This handbook helps designers in methodical selection of design patterns. The construction of the handbook is based on the identification of a set of key attributes of a design pattern and quantification of these attributes using the principles of measurement theory. A new methodology for object oriented design which consults the handbook during the design process is also introduced. The proposed methodology along with the handbook helps in evaluating different design alternatives.

1. Introduction

Most engineering disciplines provide mechanisms to capture and organize existing design knowledge which can be used while building new systems. Handbooks and manuals are often the desired form of organization of this knowledge [Marciniak 1994]. These handbooks and manuals help the designers in making good design decisions by making them understand the tradeoffs involved in different design alternatives. They act as a medium of communication between the designers of the past and the present, and help in promoting systematic reuse.

Examples of handbooks can be found in chemical engineering [Perry 1997], civil engineering, mechanical engineering, etc. The organization of a handbook depends on the domain of its application. For example, in the case of chemical engineering, the handbook is organized around unit operations. The chemical plant designer consults the handbook to choose appropriate unit operations to realize a chemical process while designing a plant. In mechanical engineering, the properties of components such as gears, nuts and bolts, belts and bearings are quantified. These values help in picking the right components while assembling complete products.

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A similar approach in software engineering, based on handbooks, will aid the designers greatly in crafting effective designs. Though examples of reference materials do exist [Cody and Waite 1980; Knuth 1997; Martin 1971; Sedgewick 1992, 1997] they are more oriented towards algorithms used in a system than the design of the system. This paper provides a procedure to construct a handbook based on design patterns [Gamma et al. 1995; Schmidt 1996] and a methodology for using it.

Presently, design patterns are available in the form of a catalog in which they are classified based on purpose as creational, structural or behavioural [Gamma et al. 1995]. Faced with a design problem, a developer may consult the pattern catalog to choose a pattern for solving the problem. Although the catalog in its present form is useful, an effective usage of design patterns as presented in the catalog depends much on the experience and intuition of the designer. For example, it is very difficult for an inexperienced designer to compare two equivalent patterns when he has to choose between them. This problem can be lightened by presenting the patterns along with the quantified values of its key attributes. These values help a designer in choosing the most appropriate pattern from a set of equivalent patterns. The problem of choosing an appropriate pattern becomes more and more significant with the arrival of new patterns.

For the construction of the handbook, a set of key attributes of patterns is identified. This is followed by quantification of these attributes making use of the principles of measurement theory. During the design process, selection of a pattern for a design problem is based on these quantified values. The design methodology guides the designer in putting the patterns together to realize a complete design.

2. Design handbook construction

Construction of a design handbook requires identification of components which compose a design and quantification of key attributes of these components. Also, a methodology for realizing a complete design by assembling the components is required.

Design patterns can be considered as components of an object oriented design [Gamma et al. 1995]. A design pattern describes a group of collaborating objects or classes which represent a solution for a generic design problem.

From the viewpoint of cost, reusability and maintenance, we identify four key attributes of a pattern viz. size, static adaptability (SA), dynamic adaptability (DA), and extendibility (EX) which can be quantified. Each of these attributes is treated as an indirect measure which can be derived from a set of direct measures. This is in accordance with the principles of measurement theory [Fenton 1994].

For any system, the cost of implementing and testing is very important. Cost is generally a function of the size of the system. For cost calculations, lines-of-code can be treated as unit of measurement of size [Boehm 1984]. It would be useful to have a formula for calculating the size of the system in terms of quantities known early in the life cycle. Since design patterns are identified early in the life cycle, calculating their size is helpful in computing the system size. Examples of similar approach in the context of structured design include [Albrecht 1979; Itakura and Takayanagi 1982].