CHAPTER 5
A REUSABLE DESIGN APPROACH FOR DEVELOPING KNOWLEDGE BASED SYSTEMS

In this Chapter

5.1 INTRODUCTION
5.2 THE METHODOLOGY
5.3 DEVELOPING KBS THROUGH RDA
5.4 CASE STUDY
5.5 CONCLUSION
5.6 FUTURE SCOPE
5.1 INTRODUCTION

This chapter elaborates a Reusable Design Approach (RDA) to develop a KBS using the Object Oriented Approach (OOA). Instead of focusing on the reusability of the code/modules of the system, the approach focuses on the reusability of the design. Requirements of the system (may be dummy or virtually simulated) are collected and the flexible design is developed. Moreover, development of a Knowledge Based System with an additional workspace is discussed at the end.

Design is a complex task involving different types of information and/or knowledge and problem solving strategies. All organization from smallest one-man business to the largest multi-national enterprise, have information or knowledge system; which may be manual or computerized. To facilitate organizational activities and to keep track of knowledgeable assets of employees in the organization, knowledge management systems are used. Such knowledge management systems capture, search, retrieve, analyze and store knowledge for future use[4]. These systems may vary according to internal/external factors like environmental, economical, legal, communicative, adaptive, expectation-wise and opinion-wise. Information Technology (IT) makes use of information/knowledge in a domain in active (with understanding of information used by it) or in passive way[6] to develop a quality design for the system. Thus an information system may consist of formal and/or informal human and computerized system.

The design and implementation of an information system has been based on different models. Many of these follows a life cycle model, which has limitations like:

- Freezing of the requirements,
- Uncertain, untested nature of real life model,
- Communication gap between users and developer group.

Several other approaches are introduced viz.

- Prototype or participative of users approach
- Continuous system development approach

Because of varying nature of the requirements and information, design of the system under consideration needs to be changed drastically. This may leads to the re-development of the same system. In such
circumstances, the Reusable Design Approach (RDA) may be one of the effective alternatives.

The RDA focuses on the reusability of design rather than the reusability of the code. Whenever there is a rapid change in the requirements, the same design can be reusable to develop different type of code. Aid like program generator does the task efficiently, easily and quickly. This might save the extra effort, cost and time to develop a new design for the old project. On other hand, the RDA gives more flexibility of the system development process. Units of design models can be created and used in various combinations to form a design of an application. In addition, code may be written in many different ways without changing the design specification by just transferring/considering the system into its transition state instead of starting from scratch. Especially, the people oriented projects are facing difficulties of frequent rapid changes in level, area and work of person involved, which is directly related to design specifications of the system. Thus, corporate information/knowledge systems are the basic candidates for the above approach.

Many applications like finding suitable beneficiaries of a given scheme, planning for sustainable development of an area, awareness programmes, technical skill development workshops/tutorials etc. can be effectively designed using the RDA to meet multi-objective decisions by applying an appropriate knowledge base. Repository of information/knowledge about the lowest administrative block level can be stored electronically as a knowledge base of one of more KBS for various applications. For example, information about land and associated families and their business can be utilized as knowledge base for planning administrative KBS for development. This example is discussed later in the topic 5.4 of this chapter.

5.2 THE METHODOLOGY

As mentioned earlier, some of the methodologies need all requirements of the system to be frozen in very early stage and force the activities of the development to be carried out in a strict predefined manner. Most of them are neither involving users nor accepting any other change of requirement coming to them every time. The advisable methodology is to use the prototype or simulated version of the system. This prototype need not be an exact working model even but an image of the system design. Also, this may help to collect & compile the additional, hidden or complex requirements. Using this Virtual Prototype as a base of design,
a new object oriented design can be developed. The Object Oriented Approach (OOA) helps in developing such reusable design through different types of prototyping approaches. The example may be the iterative (simple) prototype or virtual prototype using object methodology. For the real life system, the OOA is more likely to fit, as the objects are having direct correspondences with the real life components and the methodologies/interfaces to use the data together at a common place. This type of encapsulation gives the system better security because without using the standard interfaces nobody can access the data within the object.

Polymorphism in the OOA supports the ability to work for an object in many different ways according to the needs. This helps in rewriting the code using same class and/or object definitions. When needed, new classes can be generated or inherited accordingly.

Beside these advantages of OOA, there are few limitations also. Conversion of existing systems in traditional approaches like functional oriented approach, or developing system with object oriented approach is difficult comparatively. The second difficulty lies in the development methodology.

5.3 DEVELOPING KBS THROUGH RDA

Different alternatives can be provided to design Knowledge Based Systems like

- Function oriented approach for a specific KBS
- Partitioning knowledge base in single layer
- Multi layer approach[1]
- Database conjunction with knowledge base
- RDA

RDA can be applied at (i) knowledge base design and (ii) KBS design as shown in Figure 5.1 A for administrative and local level benefits. Design techniques can play a vital role in this process. The affecting parameters for design are environmental parameters, system parameters and individual parameters. In a given field, many KBS applications exist using a common knowledge base with different objectives. This knowledge base may lie in a centralized library of area/organization. If this knowledge base is designed using the RDA, many applications can be developed without changing the design of the basic information in it. The
meta knowledge of the knowledge base can be enriched with the heuristic functions like measuring the degree of change between different applications of given designs according to their objectives as in Figure 5.1 B. The Figure 5.1 A shows the design parameters and outcomes.

Figure 5.1 A: Design Parameters and Outcomes

Figure 5.1 B: Heuristic Function for Degree of Change
Various design models and sub-modules can be embedded with corresponding objectives, generated and kept in a design library at common place or in the knowledge base itself as different clusters. The knowledge base can be divided into different partitions/layers according to parameters like the design module and storage scheme. In this case, one of the layers contains the meta rules plus control strategy for selecting other partitions. While decision making, different types of knowledge and information are to be combined in a separate location. For this, a knowledge base should be partially empty. A minimum amount of space can be represented and kept empty always for the purpose. Optionally this area may be kept separate from knowledge base to have advantages like modularity, clarity and ease of use. This additional workspace can be useful as a temporary repository of knowledge. Newly generated knowledge can be kept into this empty workspace and after necessary validation and verification, the updated knowledge can be transferred to the appropriate partition in the original knowledge base[1]. Figure 5.2 shows the proposed structure of the KBS with such additional workspace.

5.4 CASE STUDY

Administrative reform has been undertaken in a number of developing countries by focusing on the Information Technology (IT) considering computer as one of the tools. The technological development of hardware and software may improve the business, administration and other corporate processes effectively by utilizing the scarce resources in the most optimum way. This directly or indirectly helps in solving problems like:

- Population
- Poverty & Unemployment
- Education and Training
- Pollution and Environmental Problems
That is, in rural development strategies, IT can be utilized very effectively. The following are the major points that cause the KBS for rural development to come in a picture.

- Different religion, cast and different types of person. (Social and Environmental Difference)

- Large gap between the economical as well as knowledge level of the population

- Scarcity of the intelligent decision making in the complex situation.

All this factors force presence of an intelligent control to take intelligent and intime decision. Also, the real life information or knowledge is complex and usually in huge amount. For such larger and complex system, object orientation is one of the solutions. Thus, the necessity of the human intelligence and controlling complex & voluminous amount of the knowledge base leads to the development of an Object Oriented KBS.
For sustainable development, information about family (family head information like name, sex, education, business, income etc.; number of persons, number of male, number of female, number of children, living conditions, food habits, number of earning persons, total income, assets etc.) and area (village code, major business information, total population, type of land, irrigation, electricity etc) is recorded and maintained. Such land plus associated family information can be considered as one of the objects in the system as shown in Figure 5.3.

Objects of similar nature and objective can form a class. Cluster of related classes represents information about area under consideration. Such clustering can be based on objective of the application of an object/class, degree of their demand for various applications, their representation schemes and type of knowledge inside in it. This structure can be utilized in various aspects of sustainable development process like:

- Finding suitable beneficiaries of given scheme
An advisory for small business

General awareness programmes like food, nutrition, child development, environmental issues and health care

Tutoring systems for adult education, promoting children education, technical skills development programme for selected group of locality (e.g. sewing machines & its training for poor women), special programmes for drought prone area etc.

All these land plus family object class can be treated as database for various applications at local and administrative levels. Proper KBS can effectively utilize this information in desired manner. Group of such areas can be considered as one of the layers in multi layer structure of knowledge base to achieve advantages like portability, modularity, structuredness and information hiding in addition to advantages of object orientation.

5.5 CONCLUSION

To overcome the disadvantages of a typical life cycle/prototype oriented approach for the system development, the Reusable Design Approach (RDA) using the Object Oriented Approach (OOA) can be used. The encapsulation, polymorphism and inheritance of the OOA increase the degree of reusability of the approach. In addition, the objects simulate the real life entities. Productivity, quality and adoptivity are the other major reason to select the OOA for the reusable design[9].

Most of the KBS have a huge knowledge base and different types of knowledge representation schemes to accommodate variety of knowledge dealing with real life entities. Using the class definition facility of the OOA, different classes of the knowledge can be made according to their type, usage and representation schemes and stored in different levels of the knowledge base. Such leveling of the knowledge base helps in ease of use, reduces complexity and in majority of the cases, increases the quality of the decision. The additional workspace attached with the proposed model of the KBS can be useful as an empty working space to combine different knowledge pieces at the common level when system is active. In rest of the time, the same workspace can be used to contain self-learnt knowledge before applying verification and validation on it. After proper updating of the new knowledge in the workspace, the knowledge can be transferred to the original knowledge base. The case
discussed in this chapter highlights one of the applications in field of sustainable development. Many other cases (listed in topic 5.4) can be considered and developed through RDA approach.

5.6 FUTURE SCOPE
As stated earlier in this chapter, developing object oriented design is different than other traditional designing approaches. This makes development process more complex and difficult, specifically when systems in surrounding environment have been developed with functional oriented approach and designers are familiar with the traditional approaches. Integration of the object oriented systems with existing system can also be given consideration. An intelligent design generator can be developed to provide guidelines in design process. Heuristic functions can be developed which identify the degree of similarity in application objectives and generates design base for the same.

![Figure 5.4 : Generator for an Object Oriented Knowledge Base](image-url)
Main emphasis is given to the effective design of the knowledge base, for that a structure of an object oriented knowledge base generator is given in Figure 5.4, where design modules about knowledge pieces, their inference mechanism along with the suitable objectives of the modules are grouped in various classes and clusters. The inference engine of KBS, with the help of meta knowledge in the knowledge base generated, chooses and frames the appropriate design module according to the application need. Development of such inference engine program can be another related future work for the system.
5.7 REFERENCES


5. JW Han, WJ Fu, "Mining Multiple-Level Association Rules in Large Databases", IEEE Transactions on Knowledge and Data Engineering, 1999, Vol. 11, Iss 5, pp. 798-805


