

## Overview of Domain Engineering

- The **prerequisite** for studying this chapter is that you are ready now to embark on the long journey of getting to understand the first of the three core phases of software development. You have understood the material of previous chapters, and, preferably also the (formal) abstraction and modelling principles and techniques of Vols. 1 and 2 of this series of textbooks on software engineering
- The **aims** are to present a capsule view of stages and steps of domain engineering, and to present a capsule view of the documents that result from domain engineering.
- The **objective** is to make you feel at ease with the very many stages and steps of domain development, and the very many parts of resulting documents.
- The **treatment** is informal and systematic.

### 8.1 Introduction

In this part, starting with the present chapter and going on for eight more chapters, we shall cover one of the three main software development activities: domain engineering. The other main activities are those of requirements engineering (Part V) and computing systems design (Part VI). They are considered main phases of software development in that everything else, i.e., all tools and management activities, group themselves around these three main sets of activities.

In this introductory chapter we shall briefly identify and briefly explain a number of issues that enter into domain engineering. Each of these issues will be dealt with in more detail in following chapters.

As has been argued before:

- Before we can design the software, we must understand its requirements.

- And before we can develop requirements, we must understand the application domain.

In Chap. 1 we reviewed domain engineering. Now we give a more systematic and comprehensive treatment. We shall emphasize principles, techniques and tools of domain engineering.

## 8.2 A Review of *Why Domain Engineering?*

**Characterisation.** By a *domain model* we understand the meaning of a domain description. ■

**Characterisation.** By a *domain description* we mean a document (or a set of documents) which describes what the domain is, its entities, functions, events and behaviours. ■

**Characterisation.** By a *domain theory* we mean a set of theorems that are claimed to hold of the domain model. ■

**Characterisation.** By *domain engineering* we mean the processes overviewed in this chapter and otherwise detailed in this part (Part IV). ■

Just as physicists have researched and developed models of Mother Nature for at least 500 years, and just as classical engineers have designed artifacts based on the theories of the natural sciences, so we shall advocate research into and the development of theories of the man-made domains in which human activities, rather than nature, play the major role. Then we can develop the requirements for and the designs of software in a more trustworthy and in a scientifically more believable manner.

To research and develop domain theories is a new activity. But many present software engineering processes already touch upon domain engineering. In these volumes we bring domain engineering *more out into the open*, thus simplifying many past concerns of software engineering, especially those of requirements engineering. That is, we strongly think that many previously — by other authors — advocated issues of requirements engineering become far easier to handle (or they outright “disappear”) once we have done our domain engineering job! So we claim, at least!

## 8.3 Overview of Part and Chapter

Proper domain engineering, i.e., the proper development of a domain model, proceeds in stages:

- identification of domain stakeholders, Sect. 8.4 and Chap. 9

- domain acquisition, Sect. 8.5 and Chap. 12
- domain analysis and concept formation, Sect. 8.6 and Chap. 13
- domain modelling, Sect. 8.7 and Chaps. 10–11
- domain validation and verification, Sect. 8.5 and Chap. 14
- domain theory formation, Chap. 15

The reader may observe that we are presenting principles and techniques for each of these stages in not quite the order in which they are listed above. The reason is given now and is further elaborated upon later.

#### Domain Model and Domain Theory

The most important outcome of domain engineering is a domain model and its associated domain theory.

Without knowing what domain models contain one cannot know how to go about constructing them. Chapter 11 presents principles and techniques for what domain models contain. Chapters 12–13 outline how to gather material for domain model construction (domain acquisition) and how to analyse and understand such material (analysis and concept formation). But the issue, the role of stakeholders, is so important and often forgotten (or, at least, “minimised”) that we have decided to present principles and techniques for identification of and liaison with stakeholders first, in Chap. 9. Chap. 10 is a preamble for Chap. 11.

## 8.4 Domain Stakeholders and Their Perspectives

**Characterisation.** By a *domain stakeholder* we shall understand a person, or a group of persons, united somehow in their common interest in, or dependency on the domain; or an institution, an enterprise or a group of such, (again) characterised (and, again, loosely) by their common interest in or dependency on the domain. ■

Identification of domain stakeholders embodies development principles, techniques and tools. These will be surveyed in Chap. 9.

**Characterisation.** By a *domain stakeholder perspective* we understand the, or an, understanding of the domain shared by the specifically identified stakeholder group — a view that may differ from one stakeholder group to another stakeholder group of the same domain. ■

Identification of stakeholder perspectives (i.e., views) embodies development principles, techniques and tools. These will be surveyed in Sect. 9.3.

#### Domain Stakeholders

Without clearly identifying and liaising with all relevant domain stakeholders one cannot hope to construct a believable domain model.

We shall return to the concept of stakeholders in Chap. 9.

## 8.5 Domain Acquisition and Validation

**Characterisation.** By *domain acquisition* we understand the gathering, from domain stakeholders, from literature and from our observations, of knowledge about the domain. This knowledge includes phenomenological *entities, functions, events* and *behaviours*, with this “gathering” being manifested in terms of rough statements (i.e., fragments of sketches). ■

Domain acquisition embodies many development principles, techniques and tools. These will be surveyed in Chap. 12.

**Characterisation.** By *domain validation* we understand the assurance, with stakeholders, notably clients, that the domain descriptions produced as a result of domain acquisition, domain analysis, concept formation and domain modelling (the latter including the description) is commensurate with how the stakeholders view the domain. ■

Domain validation embodies many development principles, techniques and tools. These will be surveyed in Sect. 14.3.

## 8.6 Domain Analysis and Concept Formation

**Characterisation.** By *domain analysis* we understand a study of domain acquisition (rough) statements, with the aim of discovering inconsistencies, conflicts and incompletenesses within, as well as with the aim of forming concepts from, these domain acquisition statements. ■

Domain analysis embodies many development principles, techniques and tools. These will be surveyed in sections of Chap. 13.

**Characterisation.** By *domain concept formation* we understand the abstraction of domain phenomena, as hinted at by domain acquisition (rough) statements, into concepts. ■

Domain concept formation embodies development principles, techniques and tools. These will be surveyed in sections of Chap. 13.

## 8.7 Domain Facets

**Characterisation.** By a *domain facet* we understand one amongst a finite set of generic ways of analysing a domain, that is, a view of the domain such that the different facets cover conceptually different views, and such that these views together cover the domain. ■

We list the main categories of domain facets:

- *business procedure* facets
- *intrinsic* facets
- *support technology* facets
- *management and organisation* facets
- *rules and regulations* facets
- *script* facets
- *human behaviour*

These facets will be covered in Chap. 11.

Domain Model  $\equiv$  Model of Domain Facets

So by a domain model we mean a set of one or more commensurate models of domain facets — these may possibly be rewritten (and reformalised) into one consolidated model.

## 8.8 Auxiliary Stages of Domain Development

Earlier we used the prefix design when enumerating some stages of development. Now we use the term auxiliary. Why we do this will transpire from the immediately following text.

The *auxiliary stages of development* include the following:

- domain (knowledge) acquisition
- domain (knowledge) analysis and concept formation
- domain (knowledge) verification
- domain (knowledge) validation
- domain theory formation.

We shall cover these in later sections. Suffice it for now to say that they “adorn” the major stages of domain facet modelling: to model a domain facet we must first acquire it; then we must analyse what has been acquired, and form concepts from what has been analysed; then we can describe it: (a) roughly, (b) terminologise it, (c) narrate and (d) possibly formalise the facet. Stages (a–d) form the major stages. In between these latter descriptive activities, we verify properties of the domain model, validate the domain facet description (i.e., the model), and possibly we build up elements of a theory of the domain.

## 8.9 The Domain Model Document

### 8.9.1 A Preview of Things to Come

The aim of domain engineering is to create informative, descriptive and analytic documents about and constituting the domain model. Therefore it is important to always keep in mind what a possible contents listing could be of such a complete set of documents. We shall therefore outline, in “capsule” form, what a possible, and, to us, desirable *table of contents* structure could be of such a set of domain documents. The aim of Part IV is, therefore, to present the principles, techniques and tools for creating, i.e., developing, such sets of domain documents.

### 8.9.2 Contents of a Domain Model Document

We list a comprehensive, desirable *table of contents* structure for a typical set of domain documents. We refer to Chap. 2 for an overview of these kinds of documents, and especially for the first category of informative documents.

#### A Generic Domain Documentation Contents Listing

- |                                  |   |
|----------------------------------|---|
| 1. Information                   | (d) Business Processes                    |
| (a) Name, Place and Date         | (e) Facets:                               |
| (b) Partners                     | i. Intrinsic                              |
| (c) Current Situation            | ii. Support Technologies                  |
| (d) Needs and Ideas              | iii. Management and Organisation          |
| (e) Concepts and Facilities      | iv. Rules and Regulations                 |
| (f) Scope and Span               | v. Scripts                                |
| (g) Assumptions and Dependencies | vi. Human Behaviour                       |
| (h) Implicit/Derivative Goals    | (f) Consolidated Description              |
| (i) Synopsis                     | 3. Analyses                               |
| (j) Standards Compliance         | (a) Domain Analysis and Concept Formation |
| (k) Contracts                    | i. Inconsistencies                        |
| (l) The Teams                    | ii. Conflicts                             |
| i. Management                    | iii. Incompletenesses                     |
| ii. Developers                   | iv. Resolutions                           |
| iii. Client Staff                | (b) Domain Validation                     |
| iv. Consultants                  | i. Stakeholder Walkthroughs               |
| 2. Descriptions                  | ii. Resolutions                           |
| (a) Stakeholders                 | (c) Domain Verification                   |
| (b) The Acquisition Process      | i. Model Checkings                        |
| i. Studies                       | ii. Theorems and Proofs                   |
| ii. Interviews                   | iii. Test Cases and Tests                 |
| iii. Questionnaires              | (d) (Towards a) Domain Theory             |
| iv. Indexed Description Units    |   |
| (c) Terminology                  |   |

## 8.10 Further Structure of This Part

We start with a brief analysis of the stakeholder concept (Chap. 9). To know how to properly acquire domain knowledge we believe that it is important to know what the end result of domain engineering should be. We therefore detail two core aspects of a domain model: the attributes of the phenomena and concepts modelled (Chap. 10), and the facets of domain phenomena and concepts (Chap. 11). Thus we present principles and techniques for those aspects of domain models. And we do so before we treat principles and techniques for domain acquisition (Chap. 12). Then we cover domain analysis and concept formation (Chap. 13) — on which the domain models build. Once domain models are believed ready, they can be validated (Section 14.3), and stages and steps of domain modelling work can be verified (Sect. 14.2) — often during domain modelling. Chapters 15 and 16 end this part: They deal with thoughts (very briefly) on domain theories, and summarise the domain engineering process model.

We emphasise, to the reader, that the order of chapters of this part does not follow the order of the work to be done in domain development. We repeat: Before we can do proper domain acquisition (Chap. 12), concept analysis and formation work (Chap. 13), we must understand what the form and contents of proper domain models should desirably be (Chaps. 10 and 11). Hence Chaps. 10 and 11 come before Chaps. 12 and 13. It is to *keep our tongues and fingers straight* that we presented the *table of contents* structure for a typical set of domain documents in Sect. 8.9.2.

## 8.11 Bibliographical Notes

Our approach to domain engineering possesses some rather novel features. That is, we bring new principles and techniques into software engineering — namely the entire concept of domain engineering — that are not covered elsewhere in the currently available literature on software engineering [121, 275, 284, 338, 369].

## 8.12 Exercises

The exercises of this chapter are *closed book* exercises. That means that you are to try write down a few lines of your solution before you check with the appropriate section for our answer to the questions.

**Exercise 8.1** *Why Domain Engineering?* Without consulting chapter texts in this volume, recapitulate, in a few lines of informal text, how this book motivates domain engineering.

**Exercise 8.2** *Stages of Domain Engineering.* Without consulting chapter texts in this volume, recapitulate, in some six or so lines of informal text, the ordered stages of domain engineering.

**Exercise 8.3** *Substages of Domain Modelling.* Without consulting chapter texts in this volume, recapitulate, in some seven or so lines of informal text, the ordered stages of domain facet modelling.

**Exercise 8.4** *Domain Acquisition.* Without consulting chapter texts in this volume, characterise, in a few lines, how this chapter defines domain acquisition.

**Exercise 8.5** *Domain Validation.* Without consulting chapter texts in this volume, characterise, in a few lines, how this chapter defines domain validation.

**Exercise 8.6** *Domain Analysis.* Without consulting chapter texts in this volume, characterise, in a few lines, how this chapter defines domain analysis.

**Exercise 8.7** *Domain Concept Formation.* Without consulting chapter texts in this volume, characterise, in a few lines, how this chapter defines domain concept formation.

**Exercise 8.8** *Stakeholder.* Without consulting chapter texts in this volume, characterise, in a few lines, how this chapter defines the concept of a domain stakeholder.

**Exercise 8.9** *Stakeholder Perspective.* Without consulting chapter texts in this volume, characterise, in a few lines, how this chapter defines the concept of domain stakeholder perspective.

**Exercise 8.10** *Domain Documentation.* Without consulting chapter texts in this volume, list, in as exhaustive and structured a fashion as possible, generic domain documentation table of contents.