Advanced Networked Systems Architecture

ANSA

24 Hills Road
CAMBRIDGE
United Kingdom CB2 1JP

TELEPHONE: Cambridge (0223) 323010
INTERNATIONAL: +44 223 323010
TELEX: 817343 BLUCAM G

ARCHITECTURE DESIGN MANUAL
Section 1 - Overview

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Contents

0 Changes since last edition

This edition (AO.1.1) is the first major revision of the Architecture Design Manual since the original distribution as FS.2.0 (and unofficial circulation of FS2.1). It is the basis for the Architectural Overview phase (hence the AO classification), and contains revisions and extensions derived from the use of the method during the Functional Specification phase. The major changes are to the Requirements Analysis Phase which now includes a Balance Analysis and to the Object Extraction Phase which now allows separate models for each perspective and their subsequent reconcilliation into a single model. Major additions are the methods for handling models, and the Animation Phase. The major deletions are the Components of an Architecture, and the glossary which is now superceded by the project glossary.

The Architecture Design Manual now consists of a set of documents. This has been done so that an overview of the whole process can be given at the beginning (this document), and the major aspects treated separately in more detail. It will also ease the change control and reissue of the various sections as the design process develops.

1 Purpose of this document set

The purpose of this document set is to provide a description of the methods used during the design of the architecture. It is structured with an overall introduction to introduce the design process to those unfamiliar with it, followed by a number of sections that provide tutorial introductions to parts of the design process. Final sections provide information on the theoretic basis for the work (as far as this is known), and on the tools set that supports the process.

The target audience for this manual is primarily the ANSA design team, but also includes, as a secondary concern, the designers within the collaborating companies who will be tasked with the application or specialisation of the ANSA architecture.

2 Introduction

ANSA must be suitable for use by a wide range of system designers and be applicable to many product areas. It is therefore very important to ensure that all of the work that goes into the architecture is recorded and justified, that the decisions are documented, and that parts of the architecture can be reworked later in response to changed circumstances. Thus a significant part of the design process is concerned with documenting the developing architecture and the decisions that were important to its formation, in addition to providing the intellectual framework within which the decisions can be taken.

This completeness of documentation is important not only to the recording of the project, but also to the rapid introduction of new members of the team to the current state of the work, and the important decisions taken.

3 Principles

This section describes some of the underlying principles upon which the design of the architecture is based. It is a place-holder for a more complete exposition of the fundamental principles behind ANSA which will be produced as a stand-alone document.

3.1 Requirements

ANSA is based upon a set of outline requirements for the architecture itself, and for ANSA-conforming systems. The design process therefore starts with these requirements and seeks to extract from them the salient features of the architecture. The initial requirements for the Architectural Overview are contained in the **Functional Specification Manual FS.36**.

3.2 Object based design

The design process assumes an object oriented style for describing the entities within the ANSA architecture as well as within the designs of ANSA-conforming systems. The use of objects in an architectural context is the subject of ongoing research in the design methods community as well as increasing use by the ANSA Team (see [1] for a summary of the state of current research thinking in this area). The architecture design process will be modified in the light of relevant results and experience where these identify inadequacies or reveal acceptable improvements. The design manual is therefore subject to evolution and frequent update.

3.3 Entities and Objects

The design process employs two rather similar concepts, **Entities** and **Objects**. It is important to be clear about the difference between them. An **entity** is an outline description of a *possible* object, as expressed within the requirements. An **object** is a result of the analysis of these requirements by the designer. Although there will often be considerable correspondence between the two concepts, they are not identical since analysis may show that some entities can be combined or are equivalent to each other; and also that some objects are necessary to the design but are not identified as entities in the requirements.

3.4 What is a perspective ?

The analysis of the requirements depends on an understanding of **perspectives**, and the corresponding **views** from these perspectives of the system being designed. The first step in developing an understanding of perspectives is to place a conceptual boundary around all of the system. This boundary separates **the system** (normally inside the boundary) from the **rest of the world** (normally outside the boundary - see Figure 3.4). This boundary totally separates the two, and prevents any form of interaction between them. We must therefore open a number of **windows** in the boundary that allow interactions to occur. The use of

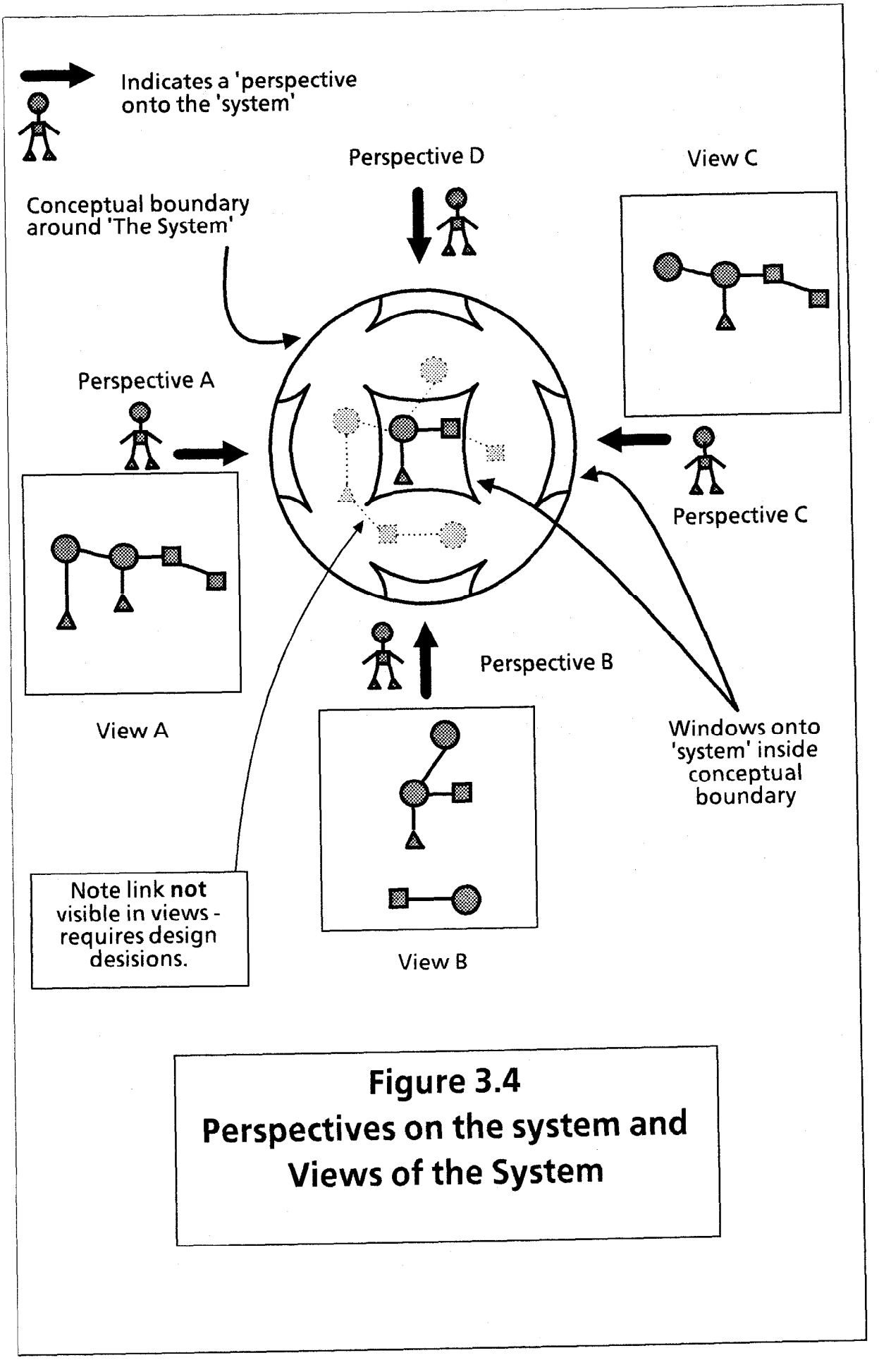

Figure 3.4
Perspectives on the system and Views of the System

windows is only of value if they are constrained to limit the **view** of the system that is obtainable through them. This requires explicit determination of the characteristics of the view obtained through each window. Since the system requirements originate in the world outside the system, and we wish to determine the characteristics of the conforming system designs, we describe the windows in terms of the characteristics of the groups of people in the world that use, or are concerned with, the view of the system presented through each window. The combined characteristics of these groups of people are called **perspectives.**

Clearly it is necessary to determine the factors that should be used to group people into perspectives in such a way as to enable a consistency of view and characteristics to be obtained. In the first instance the groups are extracted from the requirements material, since it is common for the requirements to be expressed in the form of the needs or objectives of particular groups of people. Additional perspectives may be revealed during the requirements analysis, and the designers may recombine the perspective groups in order to obtain more fundamental insights into the system design.

4 Overview of the design process

The Design process is divided into five phases:

1 The analysis of the input requirements (derived from the original requirements directly or via previous cycles of design);

2 The extraction from these requirements of the referenced objects;

3 The design of the models representing the proposed solution to the requirements;

4 The animation of these models acording to the scenarios derived from the requirements;

5 The specialisation of the general architecture to specific application domains.

In addition to these phases, throughout the design process there will be uncertainties, questions, and matters of policy that must be recorded and resolved. These are documented in the Guidelines.

4.1 Requirements analysis

The requirements analysis proceeds in four stages. (see Figure 4.1) First, the input requirements are analysed in order to extract the main **perspectives** (see section 3.3 above). Following this the main **entity** classes and instances are identified and cross-referenced. These are followed by a **balance analysis** which checks the relative amounts of requirements material referring to each perspective and entity. This simplifies the requirements collection by highlighting those areas inadequately covered in currently available material. The final stage of the requirements analysis is the writing of **scenarios** representing typical usage patterns. These are used later in the architecture design process as a basis for animation.

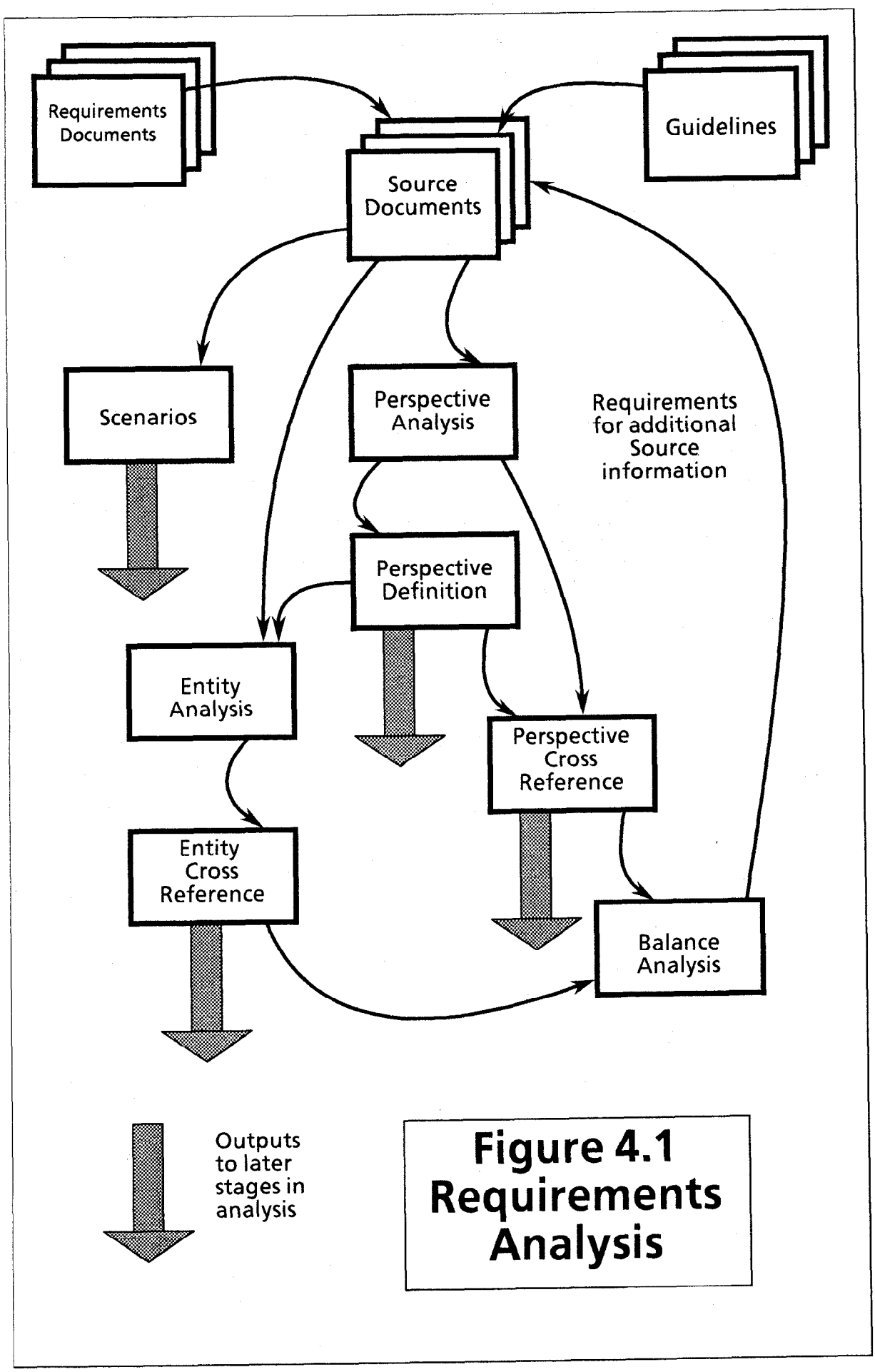

Figure 4.1 Requirements Analysis

4.2 Object extraction

The information extracted during the requirements analysis is used to construct an **identity matrix** which relates the different views of the entities to each other and to the entities themselves (see Figure 4.2). This matrix is analysed and manipulated to identify **objects**, and to consolidate apparently different views and entities into single more manageable ones. From the identity matrix, **analysed requirements** are written to provide sound and consistent information about the different perceptions of the objects and what they are required to do.

4.3 Model design

The analysed requirements are the starting point for the design of the model(s) that form the output of the cycle of analysis (see Figure 4.3). Each model is composed of a number of objects, the **interfaces** between these objects, and the **relations** between the different parts of these various models (see [2] for more on relations). Some perspectives may contain sufficient information to allow the construction of a model of their view of the system. These models are later combined into a single definitive system model.

It is expected that all of these models will be multi-dimensional, and that the determination of how many dimensions are required, and which are the most appropriate, will come from an examination of the analysed requirements and perspectives, leading to the determination of the major **cleavage planes**.

During the design of these models, there will be a number of **design decisions** that must be taken, for which no guidance can be obtained from the available input material. These decisions are ultimately the responsibility of the Chief Architect, and will be recorded, checked, and fed back to form part of the input requirements. This naturally changes some of the detail of the analysis, and so the entire analysis must be reviewed.

4.4 Animation.

Once the models have been constructed, they are animated by using the scenarios extracted in the first step (see Figure 4.4). This ensures that the resulting architecture is capable of supporting the range and type of usage required, and also highlights any difficulties or omissions.

4.5 Specialisation

ANSA will produce generic parameterised architectural models, which will be specialised into implementation architectures appropriate to different fields of application and manufacturers product ranges. (see Figure 4.5). This specialisation process will be performed mainly by the users of ANSA (ie the system designers). The ANSA team are likely to perform some partial specialisations of the architecture in order to test the procedures.

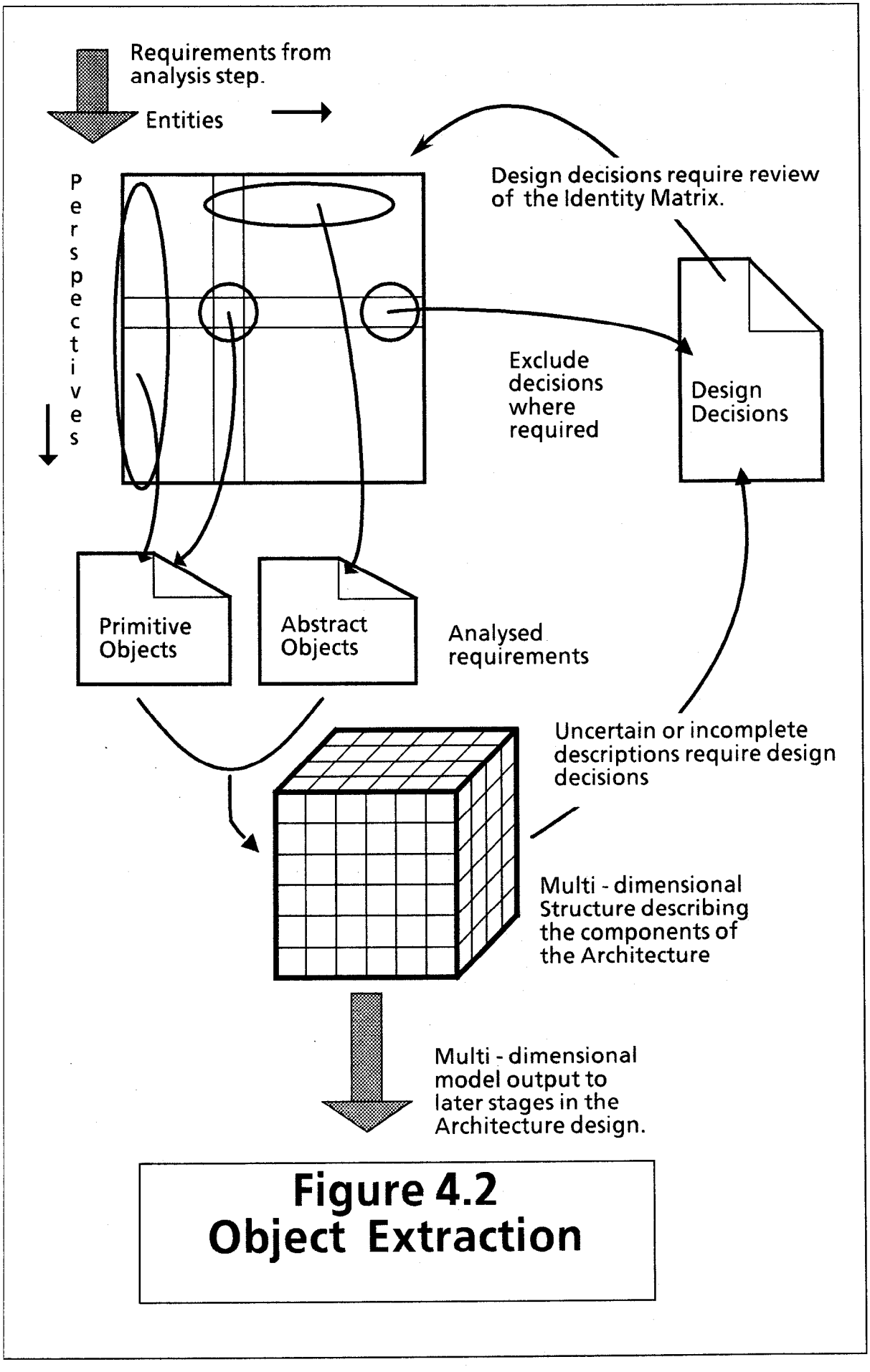

Figure 4.2
Object Extraction

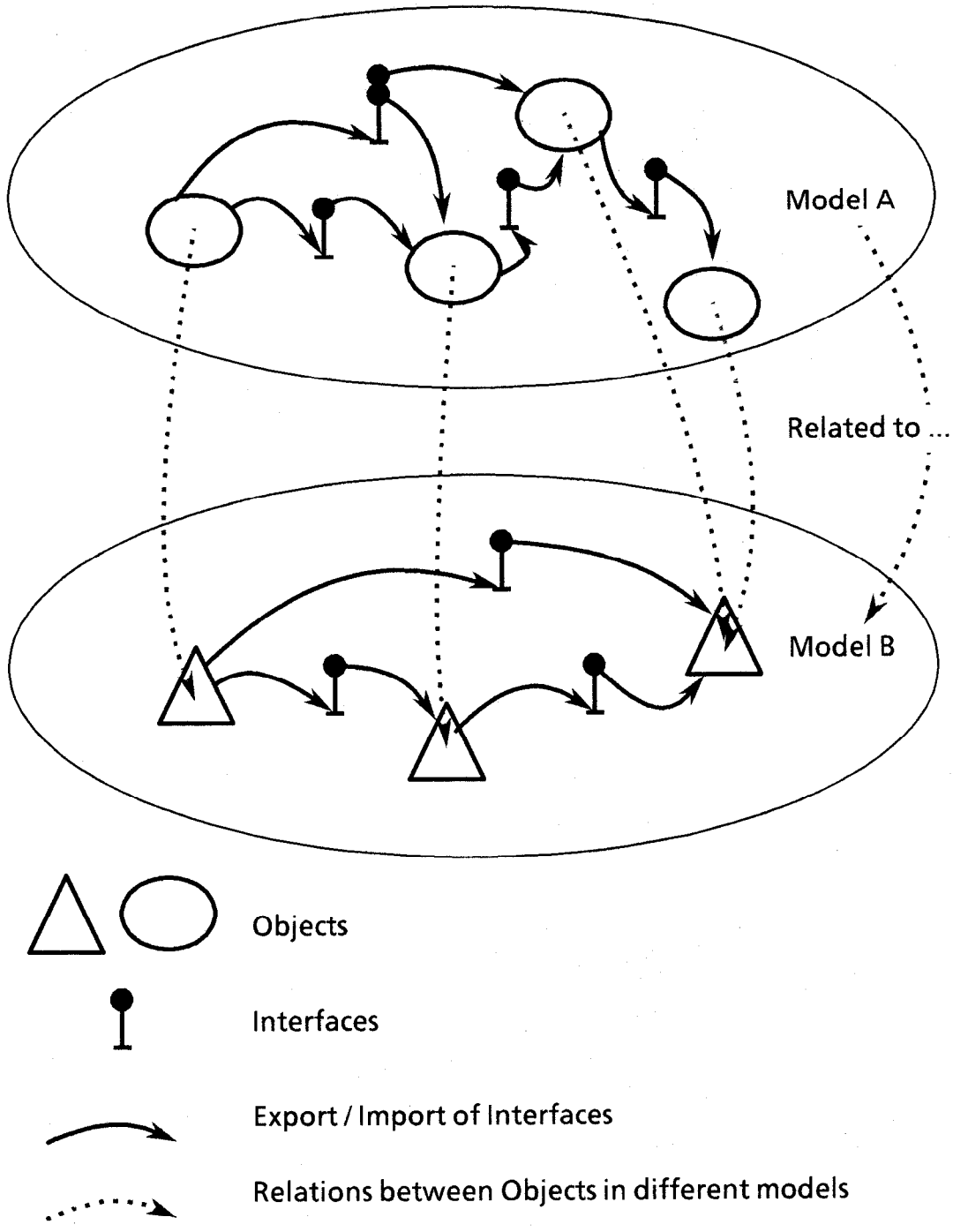

Figure 4.3
Model Design

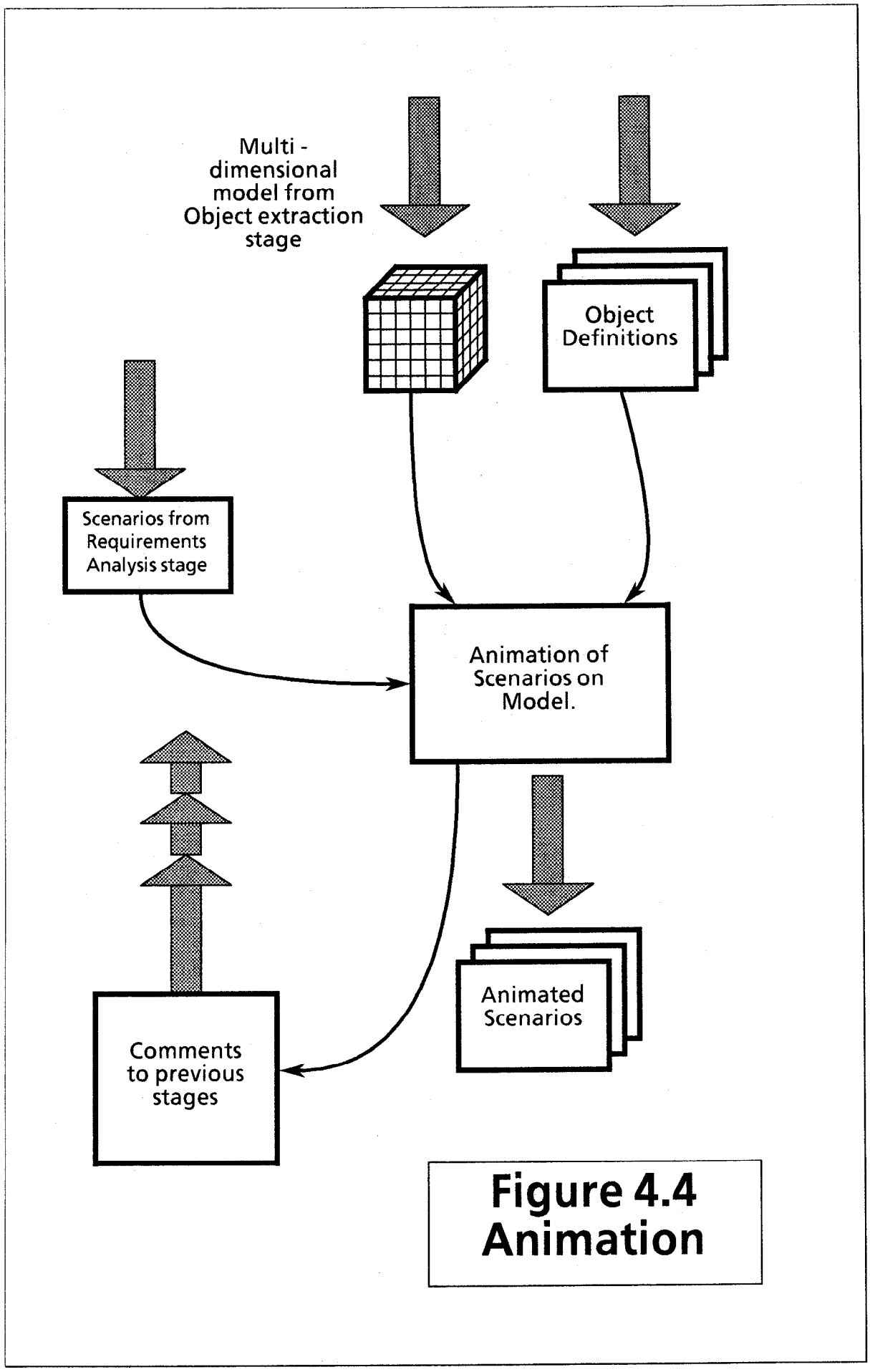

Figure 4.4 Animation

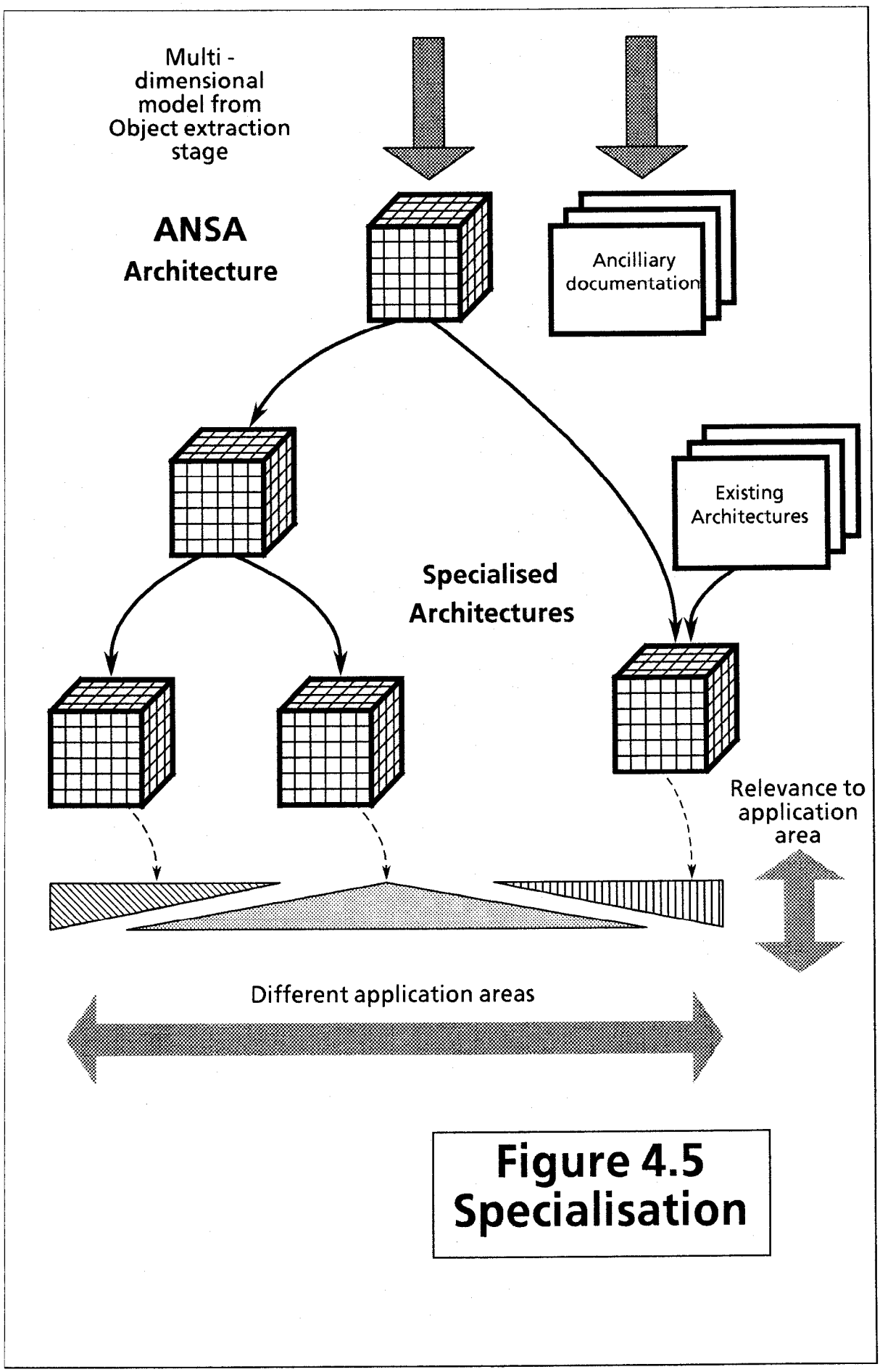

Figure 4.5 Specialisation

4.6 Guidelines

The Guidelines contain all of the material that is applicable to the whole of the design process, rather than a single part of it. In the main the Guidelines contain statements of **policy** (issued with the authority of the Chief Architect), and **pending questions** raised during the analysis together with their resolution.

5 Step by step guide

This section provides a quick reference guide to the steps in the design process.

Step 1, Perspective analysis

The perspective analysis extracts and characterises the points of view of the main groups of people who are concerned with the system.

Step 2, Entity analysis

The entity analysis extracts the classes and instances of entities referred to in the requirements documentation, and collects the references to them.

Step 3, Balance analysis

The balance analysis checks that the various perspectives and entities have sufficient requirements material that refers to each of them, to ensure adequate confidence in the relevance of the following steps.

Step 4, Scenario generation

Scenarios are derived from the original requirements in this step, and illustrate the expected usage patterns.

Step 5, Identity matrix

The material obtained by the perspective and entity analyses is tabulated in the identity matrix, and is there analysed in order to identify the objects comprising the model(s) of the system at the analysis level, removing duplication, uncertainty, and inadequacy in the requirements.

Step 6, Expanded requirements

From the identity matrix, and the original requirements material as cross-referenced during the preceeding steps, a set of analysed requirements documents are generated. These provide a well structured and complete description of each object or class, and form the basis for the design of the models.

Step 7, Cleavage planes

The results of the analysis so far are examined in order to determine the cleavage planes, and so determine the most appropriate dimensions for the description of the system model.

Step 8, The model

Once the dimensions of the model are determined, the analysed requirements can be split up and the models constructed from the analysed requirements. This will lead to the identification of gaps in the requirements, as well as areas for which design decisions must be taken.

Step 9, Animation

Once the model has been constructed, the scenarios are used in order to exercise and animate the model, so ensuring that it is capable of supporting the range and types of activity origionally forseen.

Step 10, Specialisation

Once the Architecture is defined, specialisations will be mader, either by ANSA itself, of by designers using the ANSA architecure as a basis.

5 Documentation

The documentation of the design process has two forms - one using Star facilities, and the other using Interlisp facilities. The Star versions of the forms included in this documentation set provide a convenient method of recording the information in the office systems world, but are not easily processed when using the tool set (see Section 8) The Interlisp version is targetted at machine processable recording of the data so that the analysis can be integrated with the rest of the design process.

6 Relationship to other documents

The remainder of the document set contains more detailed tutorial material on the major parts of the design process. The titles and identification of these documents are given below.

Architecture Design Manual,

AO.1	Section 1	-	Overview ----- **This document**
AO.2	Section 2	-	Requirements Analysis
AO.3	Section 3	-	Object Extraction
AO.4	Section 4	-	Model Design
AO.5	Section 5	-	Animation
AO.6	Section 6	-	Specialisation
AO.7	Section 7	-	Theoretic Basis
AO.8	Section 8	-	Supporting Tools

7 References

7.1 ANSA Internal References

FS.18 Glossary

FS.36 Functional Specification Manual

7.2 External References

[1] **Object-Oriented Development** by Grady Booch. IEEE Transactions on Software Engineering Vol SE-12, No 2 Feb 1986.

[2] **An Expanded Approach to Objects** by Harold Lorin, IBM Systems Research Institute. Operating Systems Review, Jan 1985.