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Guidance on the selection of aerodynamic methods to use at different stages of civil aircraft design

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The preparation of this Data Item

The work on this particular Data Item was monitored and guided by the Transonic Aerodynamics Committee. This Committee first met in 1960 and now has the following membership:

Chairman

Mr G.R. Richards	—	Independent

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Mr J. Alderman	—	Aircraft Research Association Limited, Bedford
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The technical work in the assessment of the available information and the construction and subsequent development of the Data Item and overall responsibility for the work in this subject area was

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GUIDANCE ON THE SELECTION OF AERODYNAMIC METHODS TO USE AT DIFFERENT STAGES OF CIVIL AIRCRAFT DESIGN

CONTENTS

GUIDANCE ON THE SELECTION OF AERODYNAMIC METHODS TO USE AT DIFFERENT STAGES OF CIVIL AIRCRAFT DESIGN

1. INTRODUCTION

Throughout the stages of aircraft design, whether civil, military or rotorcraft various methods are available to support the process from initial definition of the configuration to refining the configuration and finally supporting developments during the lifetime of the design. These methods can be in the form of data sheets, empirical/semi-empirical relationships and CFD methods with different levels of complexity. These methods may have been developed in house, by national research establishments or be commercially available. It is important that the right method or methods are used at each stage of the design to give the data at the required level of accuracy so that an informed judgement can be made.

Although this Data Item will be applicable to aerodynamic design, it is important to understand how this interacts with the other technical areas such as structures, propulsion, materials and systems, for example. Also, acquiring past information, in the form of reports and other sources (including word of mouth), on previous and existing designs may highlight past problems and their solution and also helps to maintain past knowledge and avoid repetition of errors.

The Data Item is intended to be used as a guide and therefore the reader will only need to cover the sections that are applicable to the aircraft type and design stage of interest. However, for someone just starting and who is not familiar with the design process it is suggested that this Data Item is covered as part of their introduction to aircraft design. Section 2 covers the stages of the design process and particularly covers the concept and preliminary stages along with the various regulations that need to be considered. Section 3 gives a breakdown of the stages for civil design. This is followed by Section 4, which gives a summary of the various methods along with their strengths and weaknesses. Section 5 gives a list of the methods that are textbooks or methods free to download or available through ESDU. Finally, Section 6 gives a flow chart which highlights the various decisions that are needed for each design process.

2. STAGES OF THE DESIGN

The following gives the stages for a typical design process from conceptual to support of the aircraft once in service and the design of variants of the basic aircraft. Figure 2.1 gives a schematic of the typical design process from the conceptual design through to in-service support. The schematic shows all the stages for a project resulting in an in-service aircraft. However, there can be many separate conceptual designs (and sometimes later design stage) studies that do not develop into a full design for various reasons. These other studies should be preserved as they can be of value for future projects as they will frequently contain useful data and knowledge. Clearly, it is expensive to embark on a design that is subsequently abandoned. It is important, therefore, that each design stage produces data of the highest possible quality within the allocated budget, so that, if necessary, an informed decision to discontinue a project can be made at the earliest possible stage.

Prior to, and to some extent during, the concept stage there is a continued research and development and marketing activity. Research is conducted into new technologies that could be incorporated into future designs and into the improvement TRL (Technology Readiness Level) of existing technologies that may be incorporated into the designs. For marketing there is continual assessment of future needs and opportunities and these must be tracked throughout the project development. All these activities are linked. Marketing and TRL both influence the project risk analysis and the technologies employed influence price and attractiveness of the product.

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Figure 2.2 shows a typical cost profile for each stage of the design activity. The important aspect to note is that the conceptual and preliminary design process locks in a large percentage of the life cycle cost for a small percentage of the money spent during these stages.

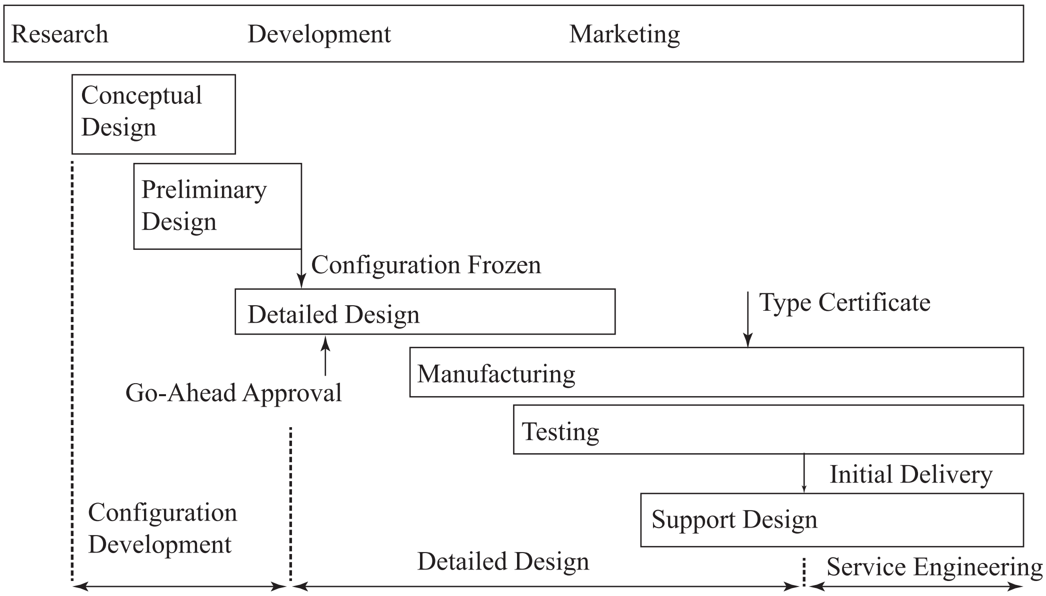

FIGURE 2.1 Airplane Design and Development

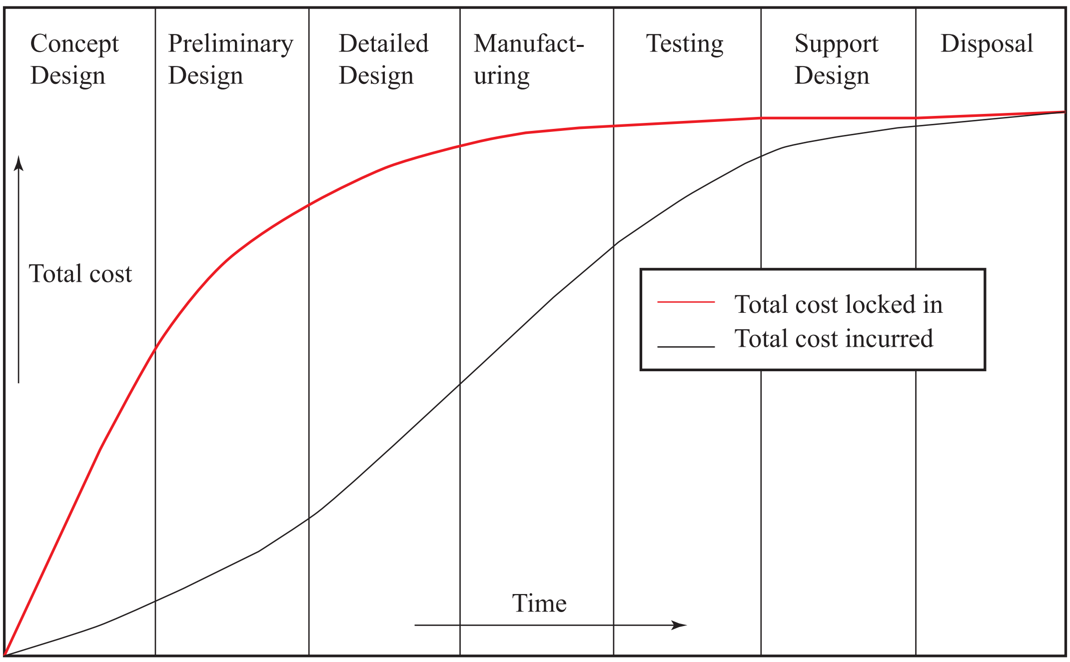

FIGURE 2.2 Example of Design Cycle Cost

The objective of the conceptual design stage is to investigate the viability of the project and to obtain a first impression of the most important features. At this stage sketches are created of the aircraft's configuration in terms of fuselage, wing position and shape, engine location and size, and fin and tail. Checks are made