

# System development overview

## Introduction

1. A system development project encompasses all the activities undertaken from the time at which a potential requirement is identified until the resulting system is fully implemented and accepted by the end user. The process can involve many stages over a long period. The following section highlights some fundamental issues to be considered, outlines the main stages in development and procuring new systems, and indicates when and how the auditor should be involved.

## Information systems strategy : the starting point

2. An information system acquired today must not only satisfy present business needs; it must also be flexible and capable of being enhanced to meet changing circumstances well into the future. Thus a pre-requisite to the introduction of a new system is for management to identify and understand their organisation's mission and its related information needs. Writing this down helps to ensure common understanding and direction, and provides a yardstick against which achievement can be measured.

3. An Information Systems Strategy is typically a high level management document. It serves to identify corporate information needs, the information systems required to satisfy those needs, the skills and resources required to develop and implement them, and the development timetable. The Strategy should also define the general technical direction to be taken during development or procurement by stating the technical and managerial policies to be followed during the system life-cycle (i.e. from strategic planning through to eventual system disposal).

4. Auditors should be familiar with their client's Information Systems Strategy and especially with plans for new systems and technologies which are likely to effect their audit approach. The auditor is then well placed to advise the client on external auditing requirements, *and at a stage in the system life-cycle when they can be taken fully into account.*

## Life-cycle method

5. A life-cycle method supplements an Information Systems Strategy by defining in greater detail the roles and responsibilities of the Information System Department in planning, developing, testing, implementing and operating an organisation's information systems. It also describes the technical policies, standards, methods and procedures that will govern such functions as :-

**programme management** : by defining the way in which large-scale change (often only possible through the exploitation of IT) within the organisation is to be managed;

**project management** : by defining the way in which information on all aspects of a project are collected, recorded, and reported to all levels of management;

**system design and development** : by defining a standard approach to systems analysis and design, and to the building and testing of new information systems. This may include policies regarding the use of CASE (Computer Assisted Software Engineering) tools;

**configuration and change management** : by defining all the components of a new information system, subjecting them to quality control, and then controlling all subsequent changes to them;

**quality assurance** : by ensuring that information systems are planned, developed, changed, and operated in conformity with the organisation's life-cycle method;

**post implementation reviews** : by ensuring that the organisation achieve what they set out to achieve. The life-cycle method should provide advice on when reviews should be carried out, by whom, and with what objectives.

6. With the exception of a post implementation review which is generally undertaken some months after project completion, a project team will need to address each of these issues during the development process, and within them complex problems can arise. If these are not anticipated and resolved effectively, the overall risk of the project failing to meet its targets will increase.

**Typical IT project risks are that a new system will:-**

- be delivered late, or never;
- make excessive demands on user resources, and exceed budget;
- lack essential functionality and/or contain significant errors;
- be unreliable and/or unresponsive in operation;
- be unfriendly and fail to be accepted by its users;
- be costly and difficult to maintain and enhance.

7. Within the context of this guide, functionality, reliability and the ease by which a new system can be amended are particularly important. These factors will influence the system's ability to meet existing and changing business needs, and also the amount of audit resources that are needed to form an opinion on the account. *They may also determine whether the account is auditable* (discussed in Part 2).

8. Adopting a life-cycle method doesn't remove project and operational risks, but it will help to reduce them to more manageable proportions by providing a clearly defined framework of standards and procedures within which to work. It will also ease the audit task by providing a more authoritative yardstick against which to audit, than is provided by general "good practice".

### Approaches to system development

9. There are now many packaged financial systems on the market and the NAO's clients usually find it quicker, cheaper and less troublesome to buy, rather than build, new systems. But there remain financial requirements that are peculiar to government that cannot be satisfied by off-the-shelf software; for example, the need to process tax returns and social security benefit claims. In these cases, the client has little option but to develop a bespoke system, although the mechanics of this process are increasingly being outsourced to external service providers.

10. Essentially there are two methodical approaches to system development; the traditional step-by-step or "waterfall" (because one stage flows into the next in a logical sequence) approach, and Rapid Application Development ("RAD").

11. The underlying pragmatism in RAD has resulted in this technique gaining widespread and growing acceptance. However, because the technique is less well defined than the waterfall the auditor is more likely to need to consider the efficacy of the procedures being followed. This applies in particular to that end of the RAD spectrum known as "end user computing", where a PC package (e.g. a spreadsheet or database) is used by an end-user to develop an application, the outputs from which can influence important business decisions.

### The "waterfall" approach

12. The waterfall approach comprises a number of discrete steps. In theory a step does not start until the previous step has been completed, although in practice there is often considerable overlap.

13. Following a feasibility study (understand the problem; can we solve it?; should we solve it? most cost-effective solution), the steps that comprise the waterfall approach are as follows :-

- the users' requirements are specified in detail, together with related acceptance criteria;
- the users' requirements are then translated into designs for an operational system;
- designs are then translated into an operational system (software is developed, hardware procured, networks installed, etc.);
- the developed system is tested, first by the developers in their own environment and then by the end-users in the operational environment; and if it is found to be satisfactory.....
- the new system is brought into operational use; and finally....

- following a period of live operation the system is reviewed to assess the extent to which the original goal has been achieved and to identify any changes that need to be made.
14. From the auditor's perspective, a key output in a waterfall project is the User Requirements Specification. This is a detailed non-technical document that forms the basis for the new system and covers its functionality as a whole, including requirements for audit trail, data extraction and security.
15. In a waterfall project it becomes increasingly expensive to correct errors and omissions as development progresses because of the increase in the amount of re-working that is necessary as the project progresses. It is therefore important to get the business analysis and requirement specification exactly right before any software is developed. Consequently, much time can elapse before the end-users see a working system, even at the testing stage. If what they then see fails to meet their requirements, the waterfall has to be rolled back, revised requirements re-specified; new or amended designs produced; further development undertaken followed by re-testing.
16. The waterfall is therefore inherently slow, but due to the need for rigorous system analysis and specification it remains the preferred approach for developing systems where it is very important to get the specification exactly right (for example, in processes which are computationally complex or safety critical).

### Rapid Application Development ("RAD")

17. The RAD philosophy is based on a recognition that businesses now rely on information technology. As a result, they must be capable of developing and deploying new information systems rapidly if they are to maintain competitive advantage or meet their political deadlines as the case may be. However, the time required for a waterfall development represents a severe constraint which RAD attacks by making two fundamental assumptions; that nothing is ever perfect first time, and that 80% of the ideal solution satisfies most business needs and can be produced in 20% of the time required to deliver the ideal solution.
18. In RAD it is important to identify and prioritise the components that will deliver the bulk of the benefits that a new system has to offer, and then to develop these as rapidly as possible. Satisfying key business requirements therefore assumes a higher priority than the quality of the system's operational characteristics; in other words, the RAD approach is to "build the right system before you build it right". Consequently, technical excellence, while not unimportant, becomes a means to an end rather than an end in itself. But this aspect of the RAD philosophy, if taken to extremes, can result in a poorly engineered system; for example, one which is unresponsive and which lacks important non-functional features, such as adequate security.
19. RAD takes a rather different approach to the development life-cycle than the waterfall by :-
- concentrating on identifying and delivering the main business benefits as rapidly as possible;
  - allowing project teams to take important decisions regarding the project without the need to refer back to top management for authorisation ("empowerment");
  - requiring very close co-operation between users, developers and other stake-holders (including the auditor) aimed at getting the right system. It is essential that trained and experienced users form part to the project team;
  - using a life-cycle method that is designed to exploit the strengths of RAD and manage its weaknesses. Sensible conformance with a reputable methodology (e.g. the Dynamic Systems Development Method) will help to reduce the risk of an unsuccessful outcome;
  - investing in Computer Assisted Software Engineering (CASE) technology, together with training to enable developers to use it effectively and within the structure of a RAD life-cycle method;
  - using CASE tools to identify the true user requirements by means of a sequence of rapidly developed prototypes ("prototyping") which iterate towards an acceptable business solution.
20. In practice development projects sometimes use elements from both the waterfall and RAD approaches, particularly where the client is new to RAD and is not yet comfortable with the technique. For example, a feasibility study might be undertaken using prototypes to evaluate different technical

solutions and RAD might be employed to define the user requirements, following which the project is completed as a waterfall development.

## System procurement

21. There is a wide market for accounting systems with over 600 vendors offering their products. Choosing the most suitable is a difficult task, and one in which mistakes can be impossible to remedy later. The buyer must also recognise that *implementing a new financial package will inevitably cause major upheaval in mission critical applications*. A procurement project should therefore be carefully planned, managed and adequately resourced, particularly in respect of training and testing which are often skimmed or overlooked.

22. In order to reduce the risk of selecting an inappropriate system, the client should undertake a thorough needs analysis. An existing system can provide a useful yardstick against which to judge the minimum functionality of a new system, but all potential users should be consulted on their particular needs. This can be a lengthy process.

23. It may be necessary to employ specialists to advise on technical evaluation and on contract negotiation and the related legal issues. Appendix 1 contains a checklist of the main contractual issues to be considered when procuring a packaged system.

24. *The auditor's needs do not differ from those of management* and should not impose an additional burden on project resources. Essentially external auditing needs centre on a financial audit trail and the retention of audit trail information; adequate internal controls; and a flexible data extraction and downloading utility.

### **Suggested steps for system procurement:-**

- plan and resource system procurement project;
- draw up a comprehensive statement of requirements for the new system;
- define evaluation criteria for each requirement;
- summarise essential requirements in a Request For Information (RFI);
- circulate the RFI to 6-10 vendors;
- evaluate responses against the RFI;
- short-list 2-3 products for further research;
- contact existing users of the products;
- arrange detailed demonstrations to evaluate short-list against the RFI;
- identify a preferred product;
- visit reference sites;
- undertake detailed testing (see step 3) using the organisation's data, and if satisfied....
- complete cost and contract negotiations;
- plan and resource system implementation project.

## Project management

25. The aim of project management is to deliver a product of acceptable quality, on time and within budget, and with optimum use of resources. It involves both technical activities - such as planning, and

the regular monitoring of cost and progress - together with management and leadership related skills that are perhaps an inherent quality in a successful project manager.

26. An IT project may be set up to develop a bespoke system or, increasingly, to procure and install an off-the-shelf package. But unless it is entirely concerned with technical infrastructure (e.g. installing a new local area network), project management should not be left to the IT department. The end-users should be fully involved in order to obtain their expertise; indeed, close co-operation between developers and users is an essential requirement of RAD. If possible, the user department should also provide a senior executive to take overall control at the project board level; *this is essentially a management role and does not require extensive technical knowledge.*

27. The complexity of most IT development projects is such that the client's life-cycle method should define how they are to be planned and controlled. The correct application of an IT project management methodology will help in this respect, *although it will not provide a substitute for skill and experience, or the top management commitment that is an essential ingredient of a successful outcome.*

28. "PRINCE" (Projects in Controlled Environments) is an IT project management methodology that was originally developed by the CCTA to assist with the management of IT projects in central government, although it is now used quite extensively in the private sector. The methodology comprises a structured set of procedures designed to ensure that an IT project is correctly specified, designed and implemented, and is kept under strict control at all stages.

29. PRINCE requires a project to be organised into a number of discrete stages, each of which is expected to deliver end products which meet defined quality requirements. Progress to the next stage of the project depends on successfully meeting the delivery targets for the current stage. The methodology fits particularly well with the "waterfall" approach, where project stages might be defined thus :-

- **initiation** : the stage at which the project is formally commissioned and at which a firm base for the management and control of the rest of the project is established;
- **specification** : key end products from this stage are the specification of user requirements, acceptance testing criteria, installation proposals, and education and training requirements;
- **design** : all design tasks, both logical and physical, are completed;
- **development** : the end product, together with its supporting documentation and business continuity plans, is produced/acquired and tested by the developers in the development environment;
- **acceptance testing** : the system is installed in its user and operational environments, and subjected to rigorous user acceptance testing;
- **operation** : the operational system is closely monitored in live use, and any minor corrections and system tuning carried out. The product is then fully handed over and the development project is wound up.

30. RAD does not alter the broad essentials of project management but there are some detailed differences, when compared with a traditional project, which derive from the flexibility that is inherent in the RAD technique.

<b>Waterfall approach</b>	<b>RAD</b>
Detailed contract agreed with customer before the start of project, specifying deliverables, costs and time-scales.	Emphasis is on agreeing with the customer the process by which the business requirements will be met.
Aim is to define and deliver a solution that meets the customer's complete requirement. Time and cost is estimated on this basis.	Project deliverables are ranked in order of business need in the expectation that not all may be delivered within the unalterable project deadline.
User participation highly desirable in the non-technical stages	User participation essential and fully integrated with project team.
Progress is monitored by the deliverables produced against those identified in a detailed project plan.	Progress is monitored against achievement of business requirements within defined "time-boxes".
Project plan and specification created in detail, and following agreement changes are resisted because of their impact on cost, time and project risk.	Outline plan created to establish main parameters of the project and these are expected to change as the project progresses.
Slippage is generally addressed by extending deadlines while retaining the agreed deliverables.	Deliverables are produced within agreed unalterable time-boxes. Slippage is generally dealt with by renegotiating the deliverables within a time-box.

## Testing

31. The auditor will need to know the extent to which the system of internal controls can be relied on to prevent errors occurring in the audited account. It is therefore desirable that both technical and non-technical controls are thoroughly exercised by the client during acceptance testing, and that both test programmes and test results are retained for audit inspection.
32. Testing scripts should be retained and updated throughout the entire life of the system because testing will need to be repeated periodically to confirm that the system continues to operate reliably following the installation of updated versions. *This should not be treated as a foregone conclusion!*

## Post Implementation Review

33. This is the final stage of the system-development life cycle and should take place some months after live implementation when the end-users and technical support staff have become familiar with the new system, and any latent defects have had an opportunity to emerge.
34. The object of the Post Implementation Review is to assess the extent to which the new system actually satisfies the needs of the business, and to identify any lessons that might be avoided in future projects. Post Implementation Reviews can uncover some uncomfortable lessons and for this reason should be undertaken independently of the developers, perhaps by Internal Audit.
35. A post implementation review is likely to conclude that some further development will be necessary to optimise the benefits offered by the new system. This may take the form of hardware changes to improve performance or minor functional enhancements to correct shortcomings in the original user specification. It might also involve additional user training, or recommend that the operation and maintenance of the new system should be outsourced to an external service provider. In an extreme case the post implementation review might conclude that the anticipated business benefits are unlikely to be achieved, and the most cost-effective course of action is to abandon the new system and start again.