
DESIGN AND ANALYSIS OF SOFTWARE SYSTEMS

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Foreword

The need for an understanding of System Analysis has been often stated, but such a need has been greatly accelerated due to the high level of growth of technology. Technology can be defined as a systematic way of designing, carrying out, and evaluating in terms of specific objectives and employing a combination of human and non-human resources.

Improved methods of technology offer us tools in the efficient allocation of time, personnel and financial resources. Proper use of System Analysis provides the aids for effective decision making. However, lack of properly trained people and lack of information on how to attack problems have led to inadequate performance and a resistance to technological advances.

The material presented in this text has been designed and will be of value to those who are entering the field and for those who wish to become better informed in the fundamental concepts of computing and System Analysis. The concepts presented draw upon the work and experience of many active authors. Systems that are widely used and accepted are explained and illustrated in the text.

I appreciate the opportunity of being involved in so important an area.

S. Charp
Vice-President, President-Elect
American Federation
of Information Processing Society

Preface

The concept of this book goes back to the early days of computing applications when the computer had ceased to be regarded merely as a calculating device and entered the world of commercial data processing. It was soon realized that the ability to program a computer was not enough. There was an overall requirement to understand how business worked and the flow of information essential for all aspects of control and decision making. A new job specification emerged, 'the systems analyst'.

The systems analyst is an individual capable of interfacing with management decision makers, office workers and computing personnel at programming and operating levels so as to merge traditional business systems into computer-based systems.

The National Computing Centre was one of the first organizations to recognize the need to introduce specific training programs for the development of systems analysts, and in 1967 introduced the first integrated media systems training package for use in colleges and industry. The fourth edition of this packaged material has recently been produced. Both the material and the standard documentation methods recommended in this book can be obtained from the National Computing Centre.

The editors, while at the National Computing Centre, produced the book *Basic Training in Systems Analysis*. This new book is based on much of the material in that book and the editors are grateful to the National Computing Centre for permission to use this material.

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Introduction

The objective of the material in this book is to act as back-up textbook material to all basic courses on systems analysis, in particular, the National Computing Centre's course on Systems Analysis which leads to the NCC's Certificate in Systems Analysis.

There have been rapid technological developments in computing over the past decade and this book takes into account such aspects as sophisticated methods of data input and output, the advent of the microchip and the many new computer applications now feasible with the introduction of cheaper computing hardware.

Basically the material provides a background for people already working as computer programmers and so enables them to enter the field of business and systems analysis. It is also relevant for experienced business people and managers wishing to understand the use of computers in business practice and the problems of introducing a computer system into company procedures.

From Chapter 1, the book sets out to define the scope of the systems analyst and the problems encountered in introducing a computer or a new computing system into an organization where people are suspicious of, or even antagonistic to, the introduction of new technology.

Chapter 2 deals with systems investigation and analysis, i.e. the work of the analyst in fact-finding, fact-recording and the ability to describe in documentary form the essential operational requirements of a business system.

Chapters 3 and 4 consider the problems of output and input design.

Chapter 5 is concerned with file design, various types of storage device and various methods of file organization.

Chapter 6 deals with the traditional approach to systems design. It examines common problems of design and then discusses the establishment of a standard method of documenting the agreed design. The chapter ends with a brief look at the more recent concept of structural programming and, by implication, structured design.

Chapter 7 deals with aspects of controls and security in the system with special attention given to auditing.

Chapter 8 deals with methods of proving the finished design, testing and timing.

Chapter 9 looks at the problem of systems justification, i.e. the computer justifies itself by achieving the desired results taking into account the system objectives and feedback to ensure that these objectives are achieved.

Chapter 10 emphasizes that throughout the whole process, communication and clear report-writing are essential aspects of systems implementation.

Chapter 11 deals with the implementation itself covering the ground from the acceptance of the design to its satisfactory operation supported by appropriate user and operation manuals.

Chapters 12 and 13 deal with general aspects of hardware and software. The hardware is dealt with in broad outline only since hardware requirements will vary and the manufacturer will supply detailed technical literature on the capabilities of various pieces of equipment.

Generally, software is coded instructions or programs which are designed to fulfil a wide range of commonly encountered requirements and make the best use of the hardware.

Chapter 14 is an attempt to put the 'microprocessor revolution' into context and to remove many of the myths associated with micros with a brief look into the future to see how such systems are likely to evolve.

The book assumes no previous knowledge of systems analysis technique and is suitable for both students and programmers wishing to pursue a course in systems analysis, or for business people wishing to acquaint themselves with the basic problems of introducing the computer into an organization. The material is of a general nature and does not attempt to go into specific detail. Managers should particularly note Chapters 1, 3, 4, 7, 9, 10 and 14.

Alan Daniels
Don Yeates

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1 The Scope of Systems Analysis

Before one can study the techniques a systems analyst must understand and apply, one must appreciate the systems analyst's function in the wider context of the employing organization. Regardless of what purpose the organization serves, a systems analyst must have certain fundamental personal qualities to succeed.

This book is primarily directed toward new entrants to the field of systems analysis. The following brief discussion of the analyst's purpose is intended to establish a basis of agreement about what analysts seek to be and do. This definition of purpose will help the new analyst to see the total activity in perspective before becoming immersed in the finer details of the procedures which are described in subsequent chapters.

1.1 Personal qualities and training

The disadvantage of setting down a list of qualities required for any job is that no one person possesses them all. However, it is worthwhile to recognize the attributes that the job demands, since the trainee will probably acquire those he lacks as his experience grows.

An analyst must be able to discover the fundamental logic of a system, produce sound plans and appreciate the effects of new facts in planning. The analyst must be perceptive, but must not jump to quick conclusions, be persistent to overcome difficulties and obstacles, and maintain a planned course of action in spite of setbacks.

There is also a need for stamina, strength of character and a sense of purpose; a broad, flexible outlook, an orderly mind, a disciplined approach and logical neatness are essential. The job will frequently require working without direct supervision and the ability to express thoughts, ideas and proposals clearly, both orally and in writing. To maintain control through numerous interviews requires an accurate

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and precise conversationalist who must have more than average social skill to communicate and work with others.

Suitable candidates for systems analysis trainee positions often come from a background of analytical work in the commercial area or computer-oriented work involving programming. Since the systems analyst will need both types of experience, the first step in training must be to develop the area of experience that the trainee lacks. Some trainees must develop communication skills, both oral and written; others must be trained in application areas. The level of experience to be developed may vary from a restricted and detailed knowledge of a specific area such as steel production to an overall understanding of a broad area such as management information systems.

This area of training is similar to an apprenticeship and cannot be satisfied, as has sometimes been tried in the past, by a two week course in business organization. The more successful analysts have served lengthy apprenticeships in an application area in addition to their professional qualifications.

The analyst must also be trained in the use of such relevant hardware as computers and peripheral equipment and must know the types of equipment best suited to the solution parameters, overall methods of computer application strategy, and detailed computer systems techniques. Training in this area must be continuous, because new equipment and techniques arise constantly.

Finally, the analyst must be trained in an appreciation of software and know which packages are currently available, so as to decide which are suitable for the system's needs. There is also a need to understand the principles of programming. It is pointless to specify a system that cannot be programmed with currently available software.

1.2 Organizational background

Systems within an organization do not exist in a vacuum. They reflect the organization's structure and purpose, and to a lesser degree are influenced by the personalities of both management and staff concerned. When the systems analyst is to start work on a particular project, an informed awareness of the employer's organization is necessary. This will help during employee interviews and will also assist in placing details of the current system in perspective. Often insufficient time is devoted to this area of training. As a result, the analyst does not comprehend fully the significance of some matters

discovered during the fact-finding phase of the work, and may design the new system with the limitations of the old.

There must also be an understanding of the constitution of the organization. This covers the overall arrangement of its constituent parts, and the strength of its affiliations with other organizations. When the organization involved is diversified across more than one location, the analyst should discover the function of each.

The analyst will benefit from a knowledge of the organization's history. By tracing the major milestones in the evolution of the firm, the type of management decisions that were made in the past can be identified. The management's overall policies should be kept in mind. The company's annual reports, employee handbooks, the trade literature, investment reviews and press clippings should be examined. This background will help the analyst to appreciate the precise divisional structures currently existing at each location. From this it can be discovered how much of the structure is carefully planned and how much is dependent on former structures. At the same time an attempt should be made to discover how closely the present objectives of each main function are in accord with the policies now being followed.

As part of the fact-finding operations, the analyst will need to detail the departmental structure of the area in which the study is being carried out. If there is a company organization chart, the analyst should ascertain that it reflects current conditions and become acquainted with it. If no chart exists, then one should be prepared. In any case, some clear distinction should be drawn between those operations that involve line management and those that are staff functions. The former are responsible for executing policies and translating them into attainable objectives, while the latter usually act as advisors.

Conventional organization charts, which show a number of branches from a chief executive or board of directors at the top, represent the pyramid of control found in most organizations. The analyst should superimpose on this structure another one that describes the true lines of communication. This structure may not follow the strict divisional and departmental boundaries implied by the original chart, but it will show the analyst how the proposals introduced in one area may affect the work in others. Probably much of the material mentioned above is recorded in one form or another, and will have to be edited and distilled to obtain a coherent picture of the organization. However, there will probably not be any recorded information about the environment in which the organization operates. This

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information is needed because the firm itself has little direct influence on its environment, which is constantly changing.

Some examples of facts the systems analyst should try to discover are the organization's position within its industry, the labour relationships in the industry, and the effect of government policies on the industry. A new system may operate no better than a previous system, although it may appear much better on paper, simply because some environmental condition frustrates its operation. The systems analyst may find it necessary to estimate and predict environmental conditions to anticipate flexibility of the system designed.

1.3 Human aspects of the job

The analyst must constantly remember that systems involve and affect people and must anticipate a variety of possible reactions to the system and the reasons behind them, even if they seem irrational.

We all have our systems of belief that cause our viewpoints to differ. They are based upon our experience, education, emotional make-up, intelligence, knowledge of specific areas, and our particular interests. Highly intelligent, logically minded people may have radically different yet reasonable views on the same subject. Using the same data, they have reached these views because their basic premises differ. These premises have been developed through the years, and are based on assumptions about the many non-measurable factors in our environment.

Few people are both highly intelligent and coldly logical. Our emotions are close to the surface and have a profound effect on our thinking. We tend to believe what we want to believe. Some of the illogicalities that are normal include generalizing from particular cases, assuming cause and effect from a correlation, attributing a logical reason to an emotional belief, and transferring subconscious dislikes to people or things our conscious minds will accept as scapegoats.

The main motivating forces in mankind have been identified as follows: (1) physiological needs such as those for food, shelter, rest, variety, safety and sex; (2) safety and security against danger and loss of physiological satisfactions; (3) social needs such as the needs of association, acceptance by associates, giving and receiving friendship; (4) ego needs such as recognition, sense of achievement, prestige, independence, realizing one's own potential and being creative. Other motivating factors are curiosity, which often causes people to

look for change or new ideas, and habit persistence, or preferring the familiar to the new. Habit persistence is associated with problems of unlearning. It is difficult to change automatic reactions to external stimuli.

Most people have achieved a reasonable degree of satisfaction in meeting the above motivating needs. Fear of losing them provides powerful resistance to change. Helping people meet these needs has been a basic approach in motivation research and salesmanship for many years. However, most people resist this approach when they realize it is being used.

The analyst must persuade others so as to overcome resistance to change. As much information as possible should be gathered about the system of beliefs of the persons to be persuaded, and about the objections that may be raised. Careful observation, including attention to expressions and casual words, may help detect what a man is trying to conceal. If a group rather than an individual is concerned, the analyst should identify the most influential person in the group, and try to persuade him. The analyst should be established as a person to be trusted and able to persuade others out of sincerity and concern for their interests.

There should be a planned approach to determine intermediate objectives, considering all possible objections and the alternatives that can be offered. Timing should be such that the degree of pressure will get individuals to analyse their present situation or the products they are using and create a desire for change. The following suggestions may be useful during the investigation.

- (1) Do not expect instant conversion.
- (2) Induce participation in decision-making; this causes commitment to the decision.
- (3) Avoid using too many arguments by emphasizing essentials.
- (4) Ask questions that will emphasize areas of agreement.
- (5) Aim at a mutually satisfactory solution, not a total conversion.
- (6) Avoid any criticism of the past; concentrate on positive aspects of the change and a common desire to make progress.
- (7) Listen sympathetically to problems and objections but do not assume that verbal objections are necessarily the real ones; there may be rationalizations of emotional objections that the person knows are irrational and will therefore not admit.
- (8) Present alternatives, such as 'If you buy one would you prefer model x or model y?'
- (9) Be wary of negative suggestions, such as 'It would be fine if we

could do so and so, but it is not really possible in a firm like ours'. This approach may cause an aggressively favourable reaction to the implied challenge, but if it fails it creates a situation from which it is difficult to recover.

Assume that acceptance has been won and stress the advantages and benefits while admitting the difficulties. Suggest that management and supervision will be able to overcome the inevitable transitional problems and make the new system work.

Ask for suggestions as to how the more obvious problems may be overcome. Emphasize continued support and help both during and after the change. Once agreement seems reasonably certain, get the plans, including a program and time-table, accepted as quickly as possible. Give management and supervision the credit for the change. Remember that to be logically right can be psychologically wrong.

Some ground rules for resisting persuasion are worth considering, since they indicate what the persuader must overcome. These may be that the people resisting persuasion behave in one of the following manners:

- (1) they don't listen;
- (2) they attribute ulterior motives to the persuader, preferably behind his back to others who may be affected;
- (3) they concentrate on disliking the analyst;
- (4) they exaggerate objections, especially the danger of repercussions and the unsuitability of timing;
- (5) they raise the temperature of the discussion, and discuss personalities wherever possible;
- (6) they keep their real objections to themselves;
- (7) they stick to their prejudices.

The analyst must consider the possible reasons for which employees resist change. These are as follows: (1) fear of losing one's job, of wage reduction, of inability to learn a new job, of loss of prestige, of loss of interest in one's job; (2) suspicion of management's motives in making the change; (3) resentment against personal attack, or a feeling that any change is a personal criticism of the way a job was being done; (4) social upset caused by breaking up a working group; (5) ignorance, or fear of the unknown.

Among the ways of overcoming these background reasons for resistance are the following:

- (1) Keep people in the picture well in advance, give the full reasons, and sell the benefits.