Defining System Requirements to meet Business Needs: a Case Study Example

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A correct definition of system requirements is one of the most effective ways of meeting user needs and reducing the costs of post-implementation adjustments. A method for doing this is described, derived from the Author's ETHICS Methodology. ETHICS is a structured design approach that covers organisational, administrative and quality-of-working-life factors.

1. DEFINING SYSTEM REQUIREMENTS

1.1 Why this definition is important

It can be argued that the most important stage in systems design is the definition of system requirements. It is important for the following reasons. First, it is essential for both the technical designers and the users of the new system to be absolutely clear on what they want the system to do. Only if system requirements are clearly defined will the technical specialists have a set of required outputs against which they can match existing hardware and software. Similarly, only if system requirements are clearly defined will users have a set of precise expectations of what they want the new system to help them achieve. These expectations should be specified as a set of objectives directed at improving personal and group efficiency, effectiveness, job satisfaction and the quality of working life. They will be attained through associating new technology with new organisational structures and using both of these as a means for achieving the objectives. The experience of major manufacturers such as ITT and IBM has demonstrated that considerable expense is incurred if systems requirements are inadequately or incorrectly defined. Costly adjustments have then to be made once the system is in operation.

1.2 How to define system requirements

Poor definition of system requirements occurs when users are inadequately consulted about their needs or are not motivated to think seriously about these. Such problems can be avoided if a design group consisting of user representatives and technical specialists is created to undertake the definition of system requirements and subsequent design of the technical and organisational system. When it is not possible to form a design group, either because a company has no tradition of working in this participative way or because users are so scattered or busy that it is difficult for them to meet regularly, then information will have to be collected through personal interviews carried out either by the project systems analyst or an independent consultant.

Whichever approach is used it is essential that attention is focused on business problems and opportunities and job satisfaction needs. Ideally, technical options should not be considered until the definition of system requirements has been completed and clear efficiency, effectiveness and job satisfaction objectives have been formulated. Once these exist attention can then be paid to creating appropriate technical and organisational solutions and to identifying which of the available range of equipment will best contribute to the achievement of the objectives. If, however, a technical solution already exists and has to be accepted then the definition of system requirements will show up clearly how well or badly it is going to fit.

Any definition of system requirements should concentrate first on business problems and needs and then examine how job satisfaction can be maintained or increased. Although it is important to understand exactly how the existing system operates, the aim should not be merely to improve its operation through the introduction of new technology. Instead, the question should be asked 'What is the mission and key role of this department and to what extent does this differ from existing practices and procedures?' If it is found, after discussion, that the agreed mission of the department is in some way removed from what the department is actually doing, then the definition of system requirements should be related to achieving this mission and not to maintaining present practice.

The ETHICS (Effective Technical and Human Implementation of Computer-based Systems) method, developed by the author, provides a simple step-by-step approach for defining system requirements. These steps are shown in Diagram A. ETHICS is best used as a participative problem solving methodology with representative, or all, members of a user group meeting regularly to systematically think through their problems and needs, but it can also be used as a questionnaire to elicit individual responses.

1.3 Setting out system requirements diagrammatically

Information collected using ETHICS has to be set out in a logical, meaningful and easy-to-assimilate form. Diagram B shows one way of doing this.

Data derived normally from group discussions and interviews are set out using a circle and a four-segment outer band to represent different aspects of the design area and the people working there.

Let us assume, for the purpose of illustration, that the design area is a single department. The circle in Diagram B represents the stable core of the department. Departmental features which are relatively stable and enduring will be placed in this circle. These will include the *departmental mission* and the *key tasks* associated
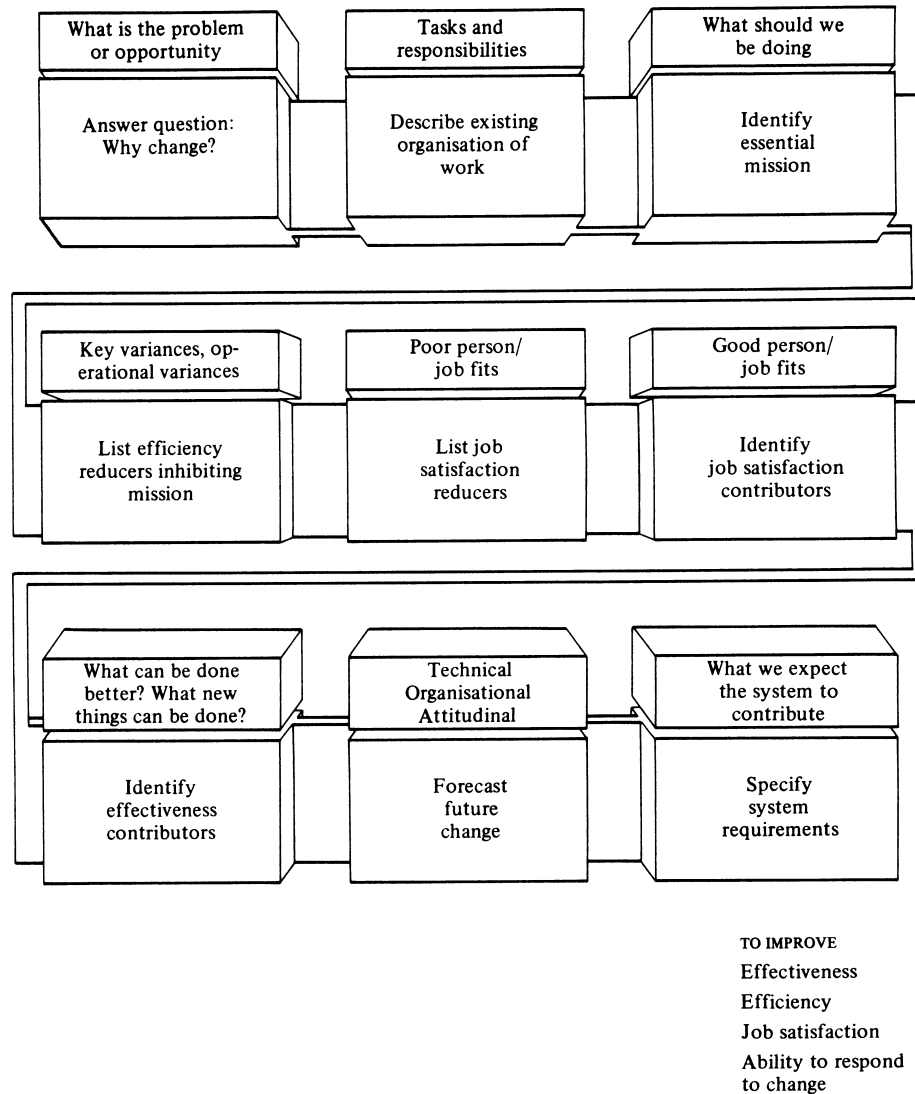
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CPJ 28

What is the problem or opportunity	Tasks and responsibilities	What should we be doing
Answer question: Why change?	Describe existing organisation of work	Identify essential mission

Key variances, operational variances	Poor person/ job fits	Good person/ job fits
List efficiency reducers inhibiting mission	List job satisfaction reducers	Identify job satisfaction contributors

What can be done better? What new things can be done?	Technical Organisational Attitudinal	What we expect the system to contribute
Identify effectiveness contributors	Forecast future change	Specify system requirements

TO IMPROVE
Effectiveness
Efficiency
Job satisfaction
Ability to respond to change

Diagram A. ETHICS. Specifying system requirements.

with the attainment of this mission. These represent what the department should be doing, not necessarily what it is doing. Other relatively stable features will be the *mix of tasks* for which staff are currently responsible, and the *key variances* – deep-seated problems which arise from the nature of the departmental mission. *Key information inputs and outputs* related to the departmental mission will also be relatively stable. All of these provide the foundation for departmental values and objectives and are hard to change without major reorganisation and major changes in attitudes.
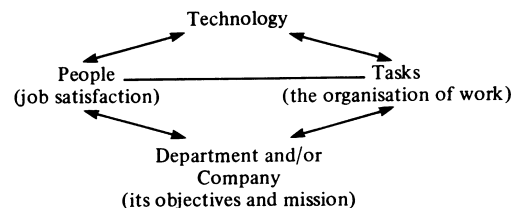
Departmental features which are more adaptive and easily changed are set out in the four segments of the outer band. *Efficiency reducers* are the day-to-day operational problems which reduce the quality of service provided and increase costs. These are often due to poor work organisation or inadequate resources. *Job satisfaction reducers* are those frustrations which cause staff dissatisfaction as well as reducing efficiency. *Job satisfaction contributors* are positive factors which enable staff to get interest, stimulus and a sense of achievement from their work. *Effectiveness contributors* cover those significant tasks which staff believe they are already doing quite well, but could do better, and new tasks, procedures

and relationships which staff believe could increase their personal effectiveness.

1.4 The logic behind Diagram B

Diagram B is derived from the following propositions about good system design.

(1) That it requires the design task to cover the four variables shown below:

Technology

People   Tasks
(job satisfaction)   (the organisation of work)

Department and/or
Company
(its objectives and mission)

(2) That the introduction of new technology provides an opportunity for wider change and improvement. Therefore an analysis of what is impeding efficiency and what could improve effectiveness is essential.

(3) That when improvements are being made, some things are easily changed and others are very difficult or
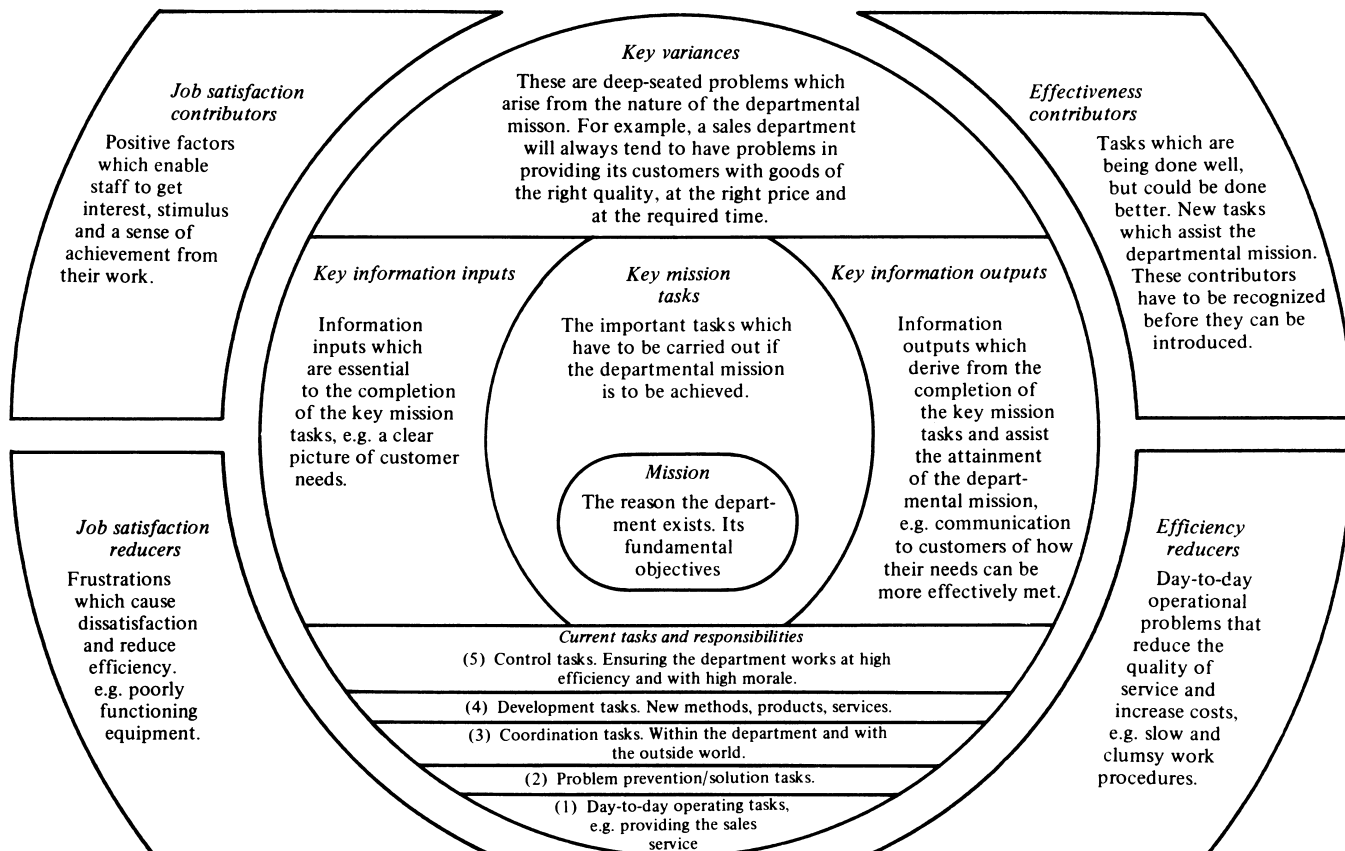
Diagram B. Setting out system requirements diagrammatically (using a sales department as an example).

impossible to change, and that it is important to be able to distinguish the first from the second.

(4) That changes in people's tasks and job responsibilities will usually be a consequence of the introduction of new technology, therefore job redesign needs to be a part of the design task. This requires a method for describing jobs which enables high-level skills such as problem solving, coordinating, developing and controlling to be built into them. The hierarchical model used to describe current tasks and responsibilities in Diagram B has been derived from the work of Stafford Beer.

The aim of good systems design is to introduce a mix of technical and organisational change that will assist the department, and the individuals working there, to achieve group and personal missions. It should provide the information needed to carry out key tasks and assist better control of key variances. These are the stable elements in most situations. They will not be subject to major or frequent change. It is very important for a group intoducing new technology, and wishing to produce an accurate definition of system requirements, to think clearly about its mission, key tasks, key information needs and key variances, at the start of the analysis process.

An improvement in efficiency, job satisfaction and effectiveness will also require the elimination or reinforcement of factors that can be more easily changed. Day-to-day operational problems (variances) which are a product of poor procedures and organisation can often be removed altogether, as can factors which are causing frustration and reducing job satisfaction. Similarly, factors which are already contributing to job satisfaction and effectiveness can be strengthened.

This design strategy can only be used if systems designers have a clear and comprehensive knowledge of the needs and behaviour of the user department. The involvement of users in the design process is seen by the author as the most effective way of achieving this knowledge. ETHICS facilitates such participation by providing a simple step-by-step method that can be used by non-technical staff to identify their efficiency, effectiveness and job satisfaction needs and problems.

2. DEFINING SYSTEM REQUIREMENTS IN THE MANAGEMENT SERVICES DEPARTMENT OF TECH LTD.

In Tech Ltd a pilot group was selected in Management Services to test out a number of office management systems and establish which would fit best with the short- and long-term needs of the department. The pilot group members were section managers and their secretaries from the Management Services functions, plus an internal consultant and the head of the department. The author was external consultant to this group.

As all of these individuals were extremely busy it was decided that regular meetings would prove difficult to organise and that the external consultant should collect information by interviewing each pilot group member individually, using a questionnaire based on the ETHICS method. There would be two feedback sessions to the group as a whole. The first of these would be after all the interviews had been completed, the second would be after the final report had been written by the external consultant and read by all the members of the pilot group.

This approach enabled a substantial amount of

information to be collected, although the absence of regular and frequent group discussion meant that there was little opportunity for shared problem solving and a comparison of needs and experience. In the author's view this was a disadvantage.

The interviews and first feedback session enabled the following analysis of needs to be prepared and accepted as accurate by the pilot group. Following the format of Diagram B it was divided into long-term, enduring needs and problems – described as the *stable centre* – and more volatile and easily changed needs and problems – described as the *adaptive periphery*.

Diagram B is not used below as there is insufficient space on the page of this journal to enable it to be read easily.

2.1 The stable centre

2.1.1 Departmental mission and key tasks

The *mission* of the Management Services Department was seen by the members of the pilot group as having two aspects.

(1) To assist Tech Ltd to achieve its objectives by identifying and developing appropriate systems and enabling the company to make the best possible use of these.

(2) To provide user departments with efficient, flexible and user-friendly systems.

The *key tasks* stemming from the mission were seen as:

(1) Promoting computer committee terms of reference through guidelines and standards.

(2) Providing a company-wide communications structure.

(3) Advising on, and developing, new systems for user areas.

(4) Running pilot projects.

(5) Supporting existing systems.

(6) Finding staff of the right calibre to undertake these tasks – highly skilled, creative, dependable, flexible.
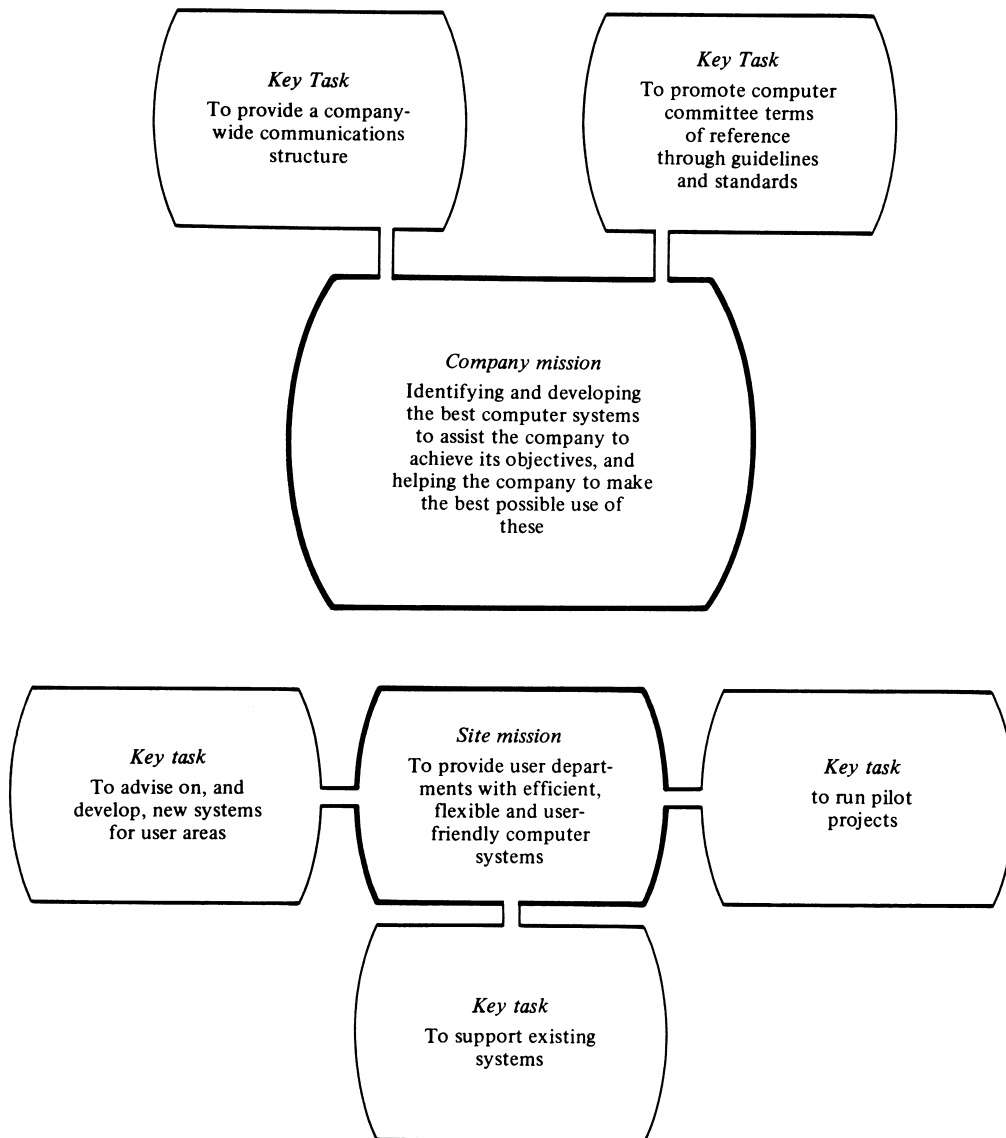
These are shown in the diagram below.

Diagram C. The achievement of mission and key tasks depends on the company's ability to find staff of the right calibre – highly skilled, creative, dependable, flexible.

2.1.2 Current tasks and responsibilities

The pilot group members were asked to describe their jobs in terms of a five-level hierarchy of tasks and responsibilities ranging from simple to complex. Level one is the regular day-to-day operating tasks associated with the kind of service which the job holder provides. Level two is more complex and covers problem solving or problem prevention tasks directed at ensuring that the job can be done without major crises occurring (these are called key variances in Diagrams A and B and in the next section). Level three is concerned with coordination. Either the coordination of different parts of the job or the coordination of the whole job with the work of others. Level four is development activities – thinking about or creating new methods or services – and level five is control. This highest level is concerned with the responsibility of the job holder for monitoring and controlling the total activities of his or her job and section.

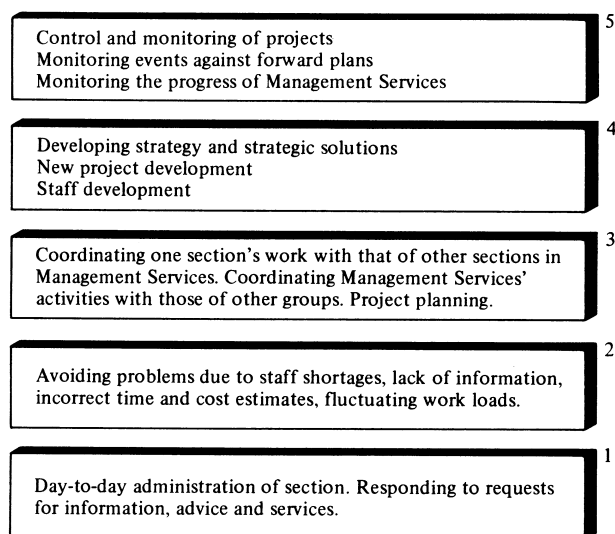Diagram D shows the different tasks carried out by those managers who were in development roles.

Control and monitoring of projects Monitoring events against forward plans Monitoring the progress of Management Services	5
Developing strategy and strategic solutions New project development Staff development	4
Coordinating one section's work with that of other sections in Management Services. Coordinating Management Services' activities with those of other groups. Project planning.	3
Avoiding problems due to staff shortages, lack of information, incorrect time and cost estimates, fluctuating work loads.	2
Day-to-day administration of section. Responding to requests for information, advice and services.	1

Diagram D. Tasks associated with development roles.

2.1.3 Key variances

Key variances are those deep-seated problems with which the Management Services Group has to cope because of the nature of its mission and key tasks. A variance is defined as the tendency for a system, or a part of a system, to deviate from some desired or expected norm or standard. A key variance, because of its association with the intrinsic and enduring elements of the system, will be extremely difficult, or even impossible to remove. The aim of new technology or a new form of organisation is to get key variances under more effective control by issuing a warning when the problem is starting to appear and advising on the quickest, easiest and cheapest methods for reducing its impact.

Many key variances are found at the boundaries between one group and another. The key variances of the members of the Management Services pilot group were of four kinds.

(1) Variances associated with *external relationships*. For example, problems that arise when new systems are being introduced or existing systems function badly. Problems when users have conflicting sets of needs.

(2) Variances associated with *internal relationships*. These are principally internal communication problems, particularly a lack of shared information on current planning activities and future plans.

(3) *Project management variances*. These are difficulties in estimating accurately project time requirements and costs. They also include shortages of resources, conflicts of priorities and 'objective drift'.

(4) *Information management variances*. These are difficulties in finding, obtaining, manipulating and transmitting information.

2.1.4 Key information inputs

These are the information inputs that members of Management Services believed were, or would be, of most value to them in carrying out their key tasks. They can be separated into three categories: information for internal management, external relationships and personal development.

Information for internal management

This covers:
  Plans made within Management Services
  Staff work loads, projects etc.
  Stocks held, suppliers etc.
  Staff whereabouts
  Authors' requirements
  New products and their costs

Information for external relationships

This covers:
  User plans and future requirements
  Change in user needs
  Project feasibility and progress reports
  Company policy and top management thinking
  Government and EEC policy and thinking

Information for personal development

This covers:
  State of the art and professional knowledge.

2.2 The adaptive periphery

All systems have parts which are very stable, enduring and difficult to change and parts which are more volatile and open to change. Systems designers need to understand which factors in a situation are in each category and to recognise that those in the second category can be manipulated to secure system improvements.

Factors that can be relatively easily changed are divided into two groups – positive factors that contribute to increased job satisfaction and effectiveness, and negative factors that reduce job satisfaction and/or efficiency. The aim of good systems design will be to maintain or increase the positive factors and eliminate or reduce the negative factors.

In Tech Ltd Management Services the most important contributors and reducers were as follows.

2.2.1 Job satisfaction contributors

The opportunity to increase personal knowledge provided by the work in Management Services is the major contributor to job satisfaction.

2.2.2 Effectiveness contributors

The most useful contributor to increased effectiveness is seen as more information.

2.2.3 Efficiency reducers (operating variances)

These are problems which are not deep seated and can be eliminated or greatly reduced once they are recognised.

These are primarily *communication problems*, due to communication being inadequate, slow to arrive and arriving too late; or *resource shortages*, particularly time and manpower.

2.2.4 Job satisfaction reducers

These are the same as efficiency reducers, i.e. *communication problems*, both internal and external; or *resource shortages*, time, materials and machines. There is no space here to provide details of all the job satisfaction and effectiveness contributors or of the job satisfaction and efficiency reducers in the Management Services of Tech Ltd but a few points can be made.

The major source of job satisfaction was the opportunity provided by the work of the department for staff to increase their personal knowledge. The greatest contributor to effectiveness was seen as more information to assist both internal management and policy development.

The two factors that were seen as reducing efficiency were communication deficiencies and a shortage of resources, particularly time and manpower.

Job satisfaction was reduced by communication problems, difficulty in obtaining information and a shortage of resources.

The pilot group's views on likely future changes in technology, attitudes, environmental and organisational factors were also recorded, as these would provide guidance on how flexible any new system needed to be.

3. SYSTEM OBJECTIVES FOR TECH LTD MANAGEMENT SERVICES

The data described so far provided a basis for setting some *business* objectives for the new system. These business objectives were identified and documented for a number of reasons.

(1) To ensure that users and systems designers had a clear vision of what they were trying to achieve in their jobs. This would help them to assess what a new technical system had to offer.

(2) To provide a mechanism for evaluating the success of the new system once it was implemented. This is done by checking the extent to which objectives are being achieved and how the technical system is contributing to this achievement.

(3) To provide an awareness of when the system needs changing. As departmental objectives alter to meet new needs so the technical and organisational systems will also have to be altered.

Business objectives focused on the following.

(1) How users of the system could more readily achieve their mission and carry out their key tasks.

(2) How users could control their key variances more easily, quickly, cheaply and effectively.

(3) How users could obtain easily and quickly the information which they require to achieve 1 and 2.

(4) How users could eliminate many of their efficiency reducers.

(5) How users could eliminate many of their job satisfaction reducers.

(6) How users could increase their job satisfaction.

(7) How users could increase their effectiveness. Effectiveness is defined as doing better things that are already done well and doing new things that have a positive effect on the working of the system.

3.1 The selected business objectives

The business objectives identified as most important are set out below, together with a brief description of those factors which influenced the choice of these objectives. Any new office system would be evaluated in terms of its ability to help their achievement.

(1) Departmental mission

Management Services is dedicated to assisting the company to achieve its objectives by identifying and developing appropriate systems and enabling the company to make the best possible use of these. It also has a local site role of providing user departments with efficient, flexible and user-friendly systems.

These can be facilitated by

Objective 1. *An improvement in the ability of Management Services to develop its knowledge resources, and to make this knowledge available to its own staff and to individuals and groups in other parts of the company.*

(2) Key variances

These deep-seated intrinsic problems are associated with external and internal relationships, project management and information management.

External relationship variances occur when new systems are being introduced, when installed systems cause problems and when users have different, and conflicting sets of needs. These can be assisted by

Objective 2. *Achieving fast two-way communication between users and Management Services so that problems of this kind are known as soon as they appear and can be dealt with immediately.*

Internal relationship variances are caused by a lack of information within Management Services. They can be assisted by

Objective 3. *Improving internal communication within Management Services.*

3.2 Translating business objectives into system requirements

The objectives which have been identified can be grouped into two broad categories.

A. *Those concerned with the collection, coordination, storage, management, dissemination and use of information* (*objective 1*)

This information will be used for policy development, project planning and the internal management and administration of the Management Services Department.

B. *Those concerned with external and internal communication* (*objectives 2 and 3*)

External communication covers fast, effective two-way communication with Tech users outside Management Services on systems planning, development and operation, and with computer manufacturers and other agencies outside the company.

Internal communication is concerned with communication within Management Services. There are a number of objectives specific to this.

(1) To improve internal communications, particularly those associated with planning.

(2) To establish what is the information and knowledge base of Management Services (e.g. who has what information, who wants to know what, who wants to communicate what).

(3) To share information on plans and planning that is useful and relevant.

(4) To inform members of Management Services as quickly as possible when plans change.

(5) To ensure that Administration is kept informed.

The objectives in categories A and B provide the means by which objective 4 can be attained. Objective 4 is directly related to the mission of Management Services.

Objective 4 *is an increased ability to recognise the need for change, respond positively to it and introduce it easily and successfully into both Management Services and other parts of the company.*

3.3 System requirements

Technical assistance for category A objectives can be provided by the development of *a comprehensive database containing relevant and up-to-date information on hardware and software developments, the organisational consequences of office automation and communication networks, and strategies for introducing and managing change*. This data base will also contain computer committee guidelines and standards and a record of past and present user projects.

With this facility Management Services can provide a comprehensive advisory service to any part of the company and should be able to control and monitor projects more effectively.

Technical assistance for category B external communication objectives is at present provided by the telephone and the post. More sophisticated means for communicating depend on how quickly Tech develops a *company-wide electronics-based communications network* which links into the systems of other agencies. This is in hand but is some years off completion. These objectives cannot be realised in the short term.

The improvement of internal communication within Management Services is seen by the pilot group as an important and pressing need. The present plans to introduce *an office management system incorporating electronic mail* should assist the realisation of this objective, but it must be emphasised that technology cannot solve ill-defined problems and can only partially

solve well-defined ones. More research into the nature of this problem is required.

3.4 Evaluation

Any new systems that are introduced into Management Services and into those areas of the company with which Management Services staff interact will be evaluated in terms of their ability to contribute to these objectives. By 'system' is meant new organisational and technical arrangements which alter roles, responsibilities and relationships, and the technical aids that assist these. Although objectives set at one time are not necessarily appropriate and relevant at another, it is probable that these broad objectives will be valid for some time ahead.

Additional short- and long-term objectives are likely to occur, however, and these must be recognised and introduced into the system evaluation. They will provide a measure of the systems flexibility and ability to accept new inputs without losing efficiency.

Technical aids such as electronic mail and word processing need to be evaluated in terms of their ease of use and contribution to efficiency. This requires both the user's subjective assessment of the technology and, where possible, objective measures. If objective measures are to be used then it is necessary to have pre-change measures of efficiency with which post-change measures can be compared.

3.5 Conclusions

The approach described here provides a simple but effective way of defining system requirements. This definition is derived from a careful and systematic analysis of a department's mission, key tasks and key problems, and efficiency and job satisfaction contributors and reducers. This analysis is used as the basis for setting a number of important business objectives which will assist the achievement of the mission and increase the department's ability to control key problems, remove efficiency reducers and increase job satisfaction and personal effectiveness. These business objectives are then translated into a set of system requirements. New technical systems will be designed to contribute to the achievement of the business objectives and will be associated with organisational restructuring, which also contributes to these objectives.

If a package solution is being considered then individual packages can be matched against the system requirements to establish how well they fit.

It must be emphasised that the success of this approach depends very much on considerable user involvement. Users have an excellent knowledge of the working of their own departments and therefore are the group most competent to carry out the analysis of mission, problems and needs and best able to define important business objectives. By users is meant a representative group of staff drawn from all levels and functions in the department.

This involvement not only produces good data, it also ensures the interest and commitment of the user group to the new system. It is they who specify what is required.

When the design or choice of a system is related to business objectives in this way, later evaluation of its

success becomes much easier. This can be measured in terms of the system's ability to contribute to the achievement of these objectives.

FURTHER READING

S. Beer, *The Brain of the Firm*. Allen Lane, The Penguin Press, Harmondsworth (1972).

E. Mumford, *Designing Human Systems*. Manchester Business School (1983).

E. Mumford, *Designing Participatively*. Manchester Business School (1983).

Announcements

21–22 JUNE 1985

Computers and Society, Second Rochester Conference, University of Rochester, Rochester, New York 14627. Subjects of the conference: the relation between computer technology and social phenomena; the psychological effects of computers on individuals; the effects of computers on social relations and on the culture of industrial society; the influence of society on the development and use of computer technology. [Preference will be given to papers that report empirical research; however, essays will also be considered.]
Note: The conference will be held on the campus of the University of Rochester. The conference will be organised to minimise costs to those attending. A nominal registration fee will be charged; housing and meals will be available on the campus for modest cost.

10–12 JULY 1985

BNCOD-4, Fourth British National Conference on Databases. Keele, Staffordshire, England. The primary objective of this series of conferences is to provide a forum for British research workers and practitioners to present the results of their research. At this conference – the fourth in the series – papers will be presented on modelling techniques and methods of knowledge representation and on concurrency and access control. There will be papers on the integration of database software and theory with other well-known software tools

both for the production of new software tools and for more specific end-user applications. In addition to these and other selected papers there will be two invited papers from European experts; Joachim W. Schmidt of the Johann Wolfgang Goethe-Universität in Frankfurt and Giuseppe Pelagatti of the Politecnico di Milano.

Further information may be obtained from:
Frances Grundy, BNCOD-4, Department of Computer Science, University of Keele, Keele, Staffordshire, England ST5 5BG. Tel. 0782 621111.

29 JULY–2 AUGUST 1985

World Conference on Computers in Education
The fourth annual World Conference on Computers in Education (WCCE), to be held at the Convention Center in Norfolk, Virginia will focus on the current use of computers in education and projections for the future. The international conference is expecting educators from over 60 different countries.

The programme will be for experienced and new computer users and will examine instructional programs that address all educational levels. Sessions will include speakers and presenters who will participate in survey and tutorial sessions and special panel discussions. A copy of the conference proceedings is included in the registration fee.

Pre-conference workshops are offered on 26–28 July and will be given by well-known educators. These workshops are limited to 30 enrollees and will require an additional registration fee.

For further information on the Conference Program call (800) 622-1985 in the USA.

21–23 AUGUST 1985

The 11th International Conference on Very Large Data Bases will be held in Stockholm.

VLDB Conferences are intended to identify and encourage research, development and applications of database systems. Their objectives are the promotion of an understanding of current research, the furthering of exchanges of information and experience gained in the design, construction and use of databases, and the provision of a forum for the discussion of future research and development.

The eleventh VLDB Conference will emphasize the contribution of database technology to evolving areas like artificial intelligence, software engineering, CAD/CAM, graphics, office information systems and the new challenges that the interaction with those areas presents to the field of database management.

For further information contact:
Lars Söderlund, Department of Computer Science, University of Stockholm, S-106 91 Stockholm, Sweden.

Conference

16–18 DECEMBER 1985

Fifth Conference on Foundations of Software Technology and Theoretical Computer Science (FST & TCS 5), New Delhi, India, Areas of interest include: programming and proof methodologies, functional and logic programming, formal semantics and specifications, theory of computation, formal languages and automata, VLSI, algorithms and complexity, databases, distributed computing and computing practice. Four copies of each full paper to be submitted by 31 May 1985 to S. N. Maheshwari, Department of Computer Science and Engineering, Indian Institute of Technology, New Delhi 110 016, India.

Call for Papers

20–23 MAY 1986

SOCOCO 86, IFAC/IFIP Symposium on Software for Computer Control, to be held in Graz, Austria.

Submit five copies of a 300- to 500-word abstract on one of the following topics. Real-time languages, Man–machine communication software, Software for distributed control systems, Control software engineering, Reliability, Artificial intelligence methods.

For further information contact:
Mrs R. Hammer, SOCOCO 86, IIG, Schießstattgasse 4a, A-8010 Graz, Austria.

Would **Dr Chingmin Jim Lo**, whose address at the time he submitted his recent paper 'Unifying multiple semantic intentions for a syntactic construct' was:

> 660 Eigenmann Hall
> Indiana University
> Bloomington
> Indiana 47406
> USA,

and who has since moved, please contact the Editor of *The Computer Journal*.