actually be *used* by a wide spectrum of practising analysts, designers or—as I would prefer to call them—information engineers? We need, as has already been said, to get these ideas built into standard procedures, training courses and so on. A first step would be to produce a suitable book or pamphlet: could not the British Computer Society sponsor the production of such a book by a suitable working party?

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The impact of social movements

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1. Introduction

I am very honoured to have been asked to speak at a conference which is being held in memory of Eric Mutch. As has been said a number of times, Eric was very concerned about the problems of the user. In the papers which accompany this one the needs of the user is a factor which occurs again and again. So 'user needs' has become a crucial term and concept in the development of data processing systems.

2. The user

It is my opinion that the term 'user' is not sufficiently precise for a discussion of systems design strategies. It can be used as a common term but if we wish to undertake a detailed examination of different strategies then we need a much more carefully thought out definition.

There are two main ways of considering users, both of which are crucial in their own way. The first is to consider 'functional roles'. In sociology the notion of a role is interpreted in different ways and used in different contexts, but when I use the term role I am thinking about functional roles. This is because, when we are developing systems, we have to consider carefully the different functional roles which are involved. Some examples of functional roles are the following:

(*a*) the operator role—the operator of a system is a person who, in everyday work, is engaged in interaction with the system and the system is dependent on his actions in order to function.

(*b*) the customer role—a customer is a person who interacts with the system in order to obtain some service.

(*c*) the ruler role—a ruler is a person who is in control of resources and in a position to be able to define objectives for a system.

The role of the designer, whom I shall call systems specialist, has to encompass all of these, hence one role can be subdivided into other roles. One person may have a number of different functional roles all at one time. Similarly a role may be enacted by a group of people rather than an individual. Functional roles are most important in systems development since most of the material which has to be prepared is frequently related to these functional roles.

The second way of considering users is to look at them as 'interest groups'. It isn't possible to give a deep philosophical or clear definition of an interest group, rather it is better to look around and see the ways in which people join together in different kinds of association through which they work on behalf of their common interest. The most common forms of interest groups in the industrial scene are employers and trade unions. Interest groups are defined in a different way from functional roles. The assumption is that interest groups spread across functional roles; although people might have different jobs they could still have common interests.

The particular user classification and user concept which I am going to discuss in this paper is that which is related to the problems of organised workers, that is workers organised in trade unions. In particular I shall describe how unions react towards systems development and how they participate in it. During the discussion it may be that a number of points will arise which will have relevance to other interest groups.

3. The system

As part of this discussion of systems design strategies it is also necessary to say something about the concept 'system'. I am doing this not only in order to give my pet definition of a system but also to emphasise something which is important to keep in mind when one is considering the situation where a number of different interest groups are involved in problems of systems development.

Following Langefors it is possible to give a number of definitions of a system. One of these is to define a system as a collection of components which have some relation to each other. But a consequence of this definition is that it is not possible to ascertain whether any part of reality is, or is not, a system because everything is a system and has always been a system. There has always been a system and there always will be a system. Hence this definition is not very useful.

The kind of definition of a system which we use in data processing is something like the following. A system is a part of the world which we regard as the whole for some period of time under consideration and which we separate from the rest of the world. We then define an 'entity', which we define as consisting of a set of components, each being characterised by a set of

*This paper is an edited transcript of the actual talk given by Kristen Nygaard at the conference. The Journal is confident that no loss of salient points has occurred through this method of presentation.

data items, and we see this as an action which may involve other components. In this definition we emphasise the involvement of 'choice'. A thing is not a system by itself, it only becomes a system, or a component in a system, if we choose to include it in our consideration.

If the concept of choice is included as part of the definition of a system then it follows that the person defining the system will impose upon the environment under consideration a certain way of understanding the world and understanding any human relationships involved in that environment. We, as systems people, impose a certain style of thinking about the way we analyse things.

Other people working on systems may also regard the world in certain situations as systems and, in particular, if trade unionists are going to participate in systems design they will contribute their style of thinking about the system. But their view of the whole system may be completely different. Their concept of the world, their opinion as to what are relevant data characteristics and what are the relevant data components, may be very different from that of other individuals or other interest groups within the system.

This is a conceptual difficulty which we, as systems people, have to overcome. A system, even when regarded as a system, may be conceived by different interest groups in very different ways. This is something which, I feel, systems people are not sufficiently trained to realise. A recent paper which looks at the likely interests of information systems specialists in the 1980s comes to the following conclusions:

1. The decade 1980 to 1990 will bring very significant changes in the task and the work environment of the systems specialist.
2. A large proportion of the current population of systems specialists today is not qualified for the new task and the goals associated with the changes in the task.

The consequences of this may be serious both for the individual systems specialist, for the organisation and for society.

4. The involvement of trade unions in systems development in Norway

In Norway trade unions began to become interested in the development of information technology in 1967. At first it was thought that the unions would have to look ahead into the future, like some author of science fiction, to see what was going to happen. But it was realised very quickly that this was not something of the future, it was something in immediate past history, it was there and it was coming in rapidly. Hence the trade unions had to consider how to react to it.

It was realised that the first step was to build up knowledge. But it was realised also that that knowledge could not be built up by reading the existing books, because all information is generated for some purpose and the books available at that time were designed to be useful to systems specialists, engineers, managers and manufacturers. If trade unionists were just to read these then they too would brainwash themselves into looking at the world in the same way as the systems specialists. Therefore the knowledge had to be built up from the basis of a different way of viewing the system. Money was obtained in order to initiate research into the needs for knowledge of unionists involved in systems developments, the results of which have been fed to a number of unions through a formal educational programme.

Another outcome of trade union involvement has been the creation, originally dating from 1975 but revised in 1978, of a data agreement. This is an agreement negotiated between the Norwegian TUC and the Norwegian Confederation of Employers which regulates a number of aspects relating to computer based systems. It has been widely accepted across a very broad section of industry. In addition there have been corresponding agreements between the government and all the unions involved with workers in government service and municipal services. I think that more than 90% of all organisations employing workers who are members of unions are in the situation that systems development is regulated in the manner of this data agreement. The data agreement covers two aspects: what properties a system should have and what properties the systems development process itself should have.

In addition, dating from 1977, there is a Working Environment Act which has replaced the old Place of Work—Safety Act. This act is important in a number of respects but mainly because it defines by implication a number of system properties. It states which environmental factors are negative and should be prohibited, but it also gives guidelines about which environmental factors are positive and should be included in any design. What is much more important, and particularly relevant to systems specialists, it states categorically that systems which relate to the control, direction and planning of work must be developed in a way which allows people or workers affected to participate.

Dating possibly from 1970 there has been a Norwegian law on co-determination. This relates to some extent to systems development and reinforces some of the concepts mentioned before.

5. Conclusions from the Norwegian experience

The lessons learned from the Norwegian experience can be summarised in five points:

1. Trade union participation is a not a state which suddenly exists as a result of some event. It has to be won by a slow, difficult and unending process. A union should not be concerned to be all of a sudden in a state to define a development process, but should be concerned about the creation and definable characteristics of such a self-reinforcing process.
2. Trade union participation implies a major extension or change in union policy. When the process starts it must not be confined to what managers and/or systems specialists regard as useful and justified. Unionists will need to become involved.
3. Trade union participation cannot safely be built upon centralised activities within the union or by relying upon hired specialists. It must be built upon a broad understanding and activity among its members and shop stewards on the shop floor. Co-ordinated centralisation of understanding, however, could support central authority.
4. Trade unions should not start their education in this area by acquiring current knowledge and understanding of the data processing of systems specialists and managers. Instead they must start by building up their own basic understanding in terms related to their own job situation and the trade union's picture of the work. Later on existing knowledge may be integrated into the new framework which has been established. For example, the social value sets of the unions are different from those value sets underlying a textbook in business economics. Solidarity is not a natural subject in business economics but it is a very manifest thing in a union.
5. Trade unions have experienced a number of defeats in the participation process, even when their formal rights may have been granted. This is because, although formal rights are useful, they actually produce nothing unless they are coupled with a considerable amount of understanding and competence. Therefore an education programme is an essential part of any union involvement.

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6. The systems specialist/trade union relationship

If systems specialists are to become involved increasingly with trade unionists it is important that they are aware of some of the situations that are likely to arise.

When trade unionists are first involved in a systems development they are easy to fool and manipulate. It is important not to try to take advantage of this as this will affect relations later; really the specialist should try to follow the spirit of the data agreement.

Systems specialists, and managers as well, may often feel that unions are being irritatingly unreasonable. If this is the case then it is because the unions have little initial information on which to work. There is an imbalance between the information available to the specialists and management and that available to the union representatives.

The systems specialist must accept also that when unions first begin an involvement in the systems development process they will have problems in their own right since, as I said before, it is a major change of role for them. In Norway the attitude of the unions has been that if we don't involve ourselves, if we don't actively influence the systems development process, things will still happen. We cannot avoid them simply by saying 'No!'. So unions have seen that to influence the outcome they have had to become active. This has generated a degree of satisfaction, but it is a new type of strategy for a union. To become a part of the change process and to adapt the local organisation to accept this is something which is difficult and may take time and create internal conflicts.

Again, the systems specialist must realise, and this is particularly true today, that the extent and nature of trade union involvement will depend very much on the general trend in the economy and development of society. In times of economic crisis or high unemployment workers' involvement will be different and they will adopt different objectives. I am somewhat unhappy and concerned about the trend of the discussion going on in Western Europe today about the social implications of computer systems. It is as if the social implications of computer systems suddenly came into existence at the moment of birth of the microprocessor. Of course this is nonsense. The social implications have been with us all the time.

One of the unfortunate things at the current time is that there is a pressure to consider the question of unemployment. This then creates a situation where the unemployment situation totally dominates any discussion. But if unions are going to get to grips with this problem at all they must consider not only job numbers but also job contents; they must think about what kinds of jobs are going to be created. Otherwise we shall always just be running after new jobs, without monitoring the total development.

7. Impact on the systems development process

In Langefors' methods for systems design, he starts by considering the information sets and how these are transformed. He specifies all kinds of formal tools which can be used to analyse the relation between the different information sets, and from which one can derive the mapping from one information set on to another. He then begins the design of the transactions and specifying how these transactions are to be carried out. From the trade union point of view this approach cannot be accepted because when the transactions are combined, this constitutes the design of a job. But for people in the union it is necessary from the outset that the composition into jobs is done in a participative way.

In the data base strategy, the initial stage is the data analysis and definition of the central data structure. But if a central data facility is accepted then it is very difficult to crush it to extract the components of distinct jobs. What unions want is methods which from the outset emphasise what kind of parts will be needed and what composition of those parts will be used to generate jobs.

One may consider also the linear strategy. From the union point of view, based on union experience, this practice is very dangerous. It is one of the chief ways in which manipulation, perhaps not deliberate manipulation but at least effective manipulation, can be achieved; particularly in the situation where the unions are relative newcomers. As a system develops, there comes a moment at which the union is able to see all the implications. At that point it must be possible to go back and correct any mistakes. The unions would prefer, not in the initial stage but in the specification stage which follows the initial stage, to have methods which look at aspects of the systems development and not to have methods which imply that development is a series of sequential states.

In the data agreement it is stated that unions are entitled to have information sufficiently early that they can contribute to the decision making. The conclusion to be drawn from this is that the unions should be involved in any project from the start. But where the unions have had the competence and the data shop stewards to enable them to participate, management has introduced a pre-project stage. The consequence of this has been silly; the unions have been forced into a situation where they are encouraging the closure of a project. But systems development is an ongoing process, it isn't something which has a start and a stop. Although it is an ongoing process it does have certain stages which are more active and which require greater involvement if there is to be an impact on the ongoing project.

The factors just described influence the approach to the systems development process but there are also aspects of trade union participation which can affect the way in which systems specialists go about their jobs. In the data agreement there is a very important, and novel, requirement, namely that information should be given in language which is understandable to the non-specialist. How many systems analysts/designers have been trained for this? In Norway there have been a number of cases where people have come with their systems descriptions and the local data shop stewards have said 'I don't understand it. Take it back and rewrite it'. In one case it took two months to rewrite it. If someone were to say 'It is impossible, this language is all right' then the shop stewards have had a textbook showing how to write specifications in a language that they could understand, which they could produce and ensure that the specifications could be written in a way to make them understandable. There is also provision that, during the systems development process, information should be produced on how the system should affect the working conditions of any workers affected. Systems specialists will tend to describe their systems in terms of 'something is generated' or 'something should be done' at a particular workstation. This description will then move on to consider another workstation. This method is usually called a task oriented description. But there is another way of looking at a system. One can identify a certain position where people are working and one can describe all the things which the people are doing. This is called a job oriented description. Systems specialists tend to make their descriptions task oriented whereas the workers tend, at least initially, to understand systems in terms of job oriented descriptions. Hence the unions must insist that descriptions of systems proposals should be made in a job oriented version. Even this is not enough because if workers are going to understand the totality they must also have a task oriented description. To date no one has created a single method or technique of systems description which is sufficient. There are many different ways of looking at systems and systems development which must be conveyed and there is no simple technique for it. It is very important to consider all the possible tools for conveying information about a system and to be aware of what kind of

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aspects of the systems and what kinds of ways of looking at the system can best be conveyed by any one tool.

8. An example

I shall conclude by describing one example of the way in which union participation has affected the system properties in one particular development.

It is the story of one new system which is being proposed in Norway but it is still not ready. It is a public data base for poisonous chemicals which will be available for access by people using these chemicals in their work place. The Chemical Workers' Union has sent a letter to the authority dealing with this data base making three points:

1. In this data base the union insists that at least one version of the description of the properties of the chemicals should be in a language understandable to the data shop stewards (as well as doctors and chemical engineers)—it follows that data could be held in a number of different language descriptions.
2. The union wants it to be possible to insert into the data base the subjective experience of using the chemicals in work place situations—for example the unions would wish to be able to record the medical impact on workers using those chemicals.
3. The union has asked to be included with each chemical a list of union representatives in organisations where there is experience in using that chemical so that if a firm begins to use a new chemical then workers within the firm know where they can go for information about how to handle the new chemical (such a system as the one above provides cross-contact, which is something which is most important to trade unionists).

The term cross-contact is not a dictionary term. It is one which has been developed by the Norwegian trade unions as a consequence of their first project. This leads to the final question: 'Is it right that trade unionists should need to be defining new terms as part of their involvement in the design process?'

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A natural language data base interface to the user

P. H. Prowse* and R. G. Johnson†

One of the functions of the systems analyst is to obtain a requirement from a user and produce an outline design for the system. This design is described in a document often called a user specification. The user is then asked to approve this document. This approval often represents the last moment that the user can change his requirements without the risk of an expensive redesign. Consequently it is imperative that any omissions or misunderstandings in it are identified and corrected. The user specification must, therefore, be expressed as clearly as possible in terms the user can easily understand.

With a small set of batch programs the user is dealing with a relatively straightforward document describing a small range of functions. However, in a complex data base system in the very large data base (VLDB) class with several thousand data elements and many hundred relations with significant inter-relation dependencies it is improbable that user management will be able to fully understand the details of the proposed design. The details of the design are obtained from the user and, although the designer can ensure that the information is self consistent, only the user can ultimately check the design.

The existing approach to the documentation of the design maintains very detailed definitions of each data element in the data base and sometimes a brief description of the relations. These definitions generally ignore the fact that there is an underlying domain to the data element and the various roles which the domain plays in different relations may be difficult to determine. Consequently new methods are required to improve the clarity of the description of the proposed design. In particular the constraints imposed by the design on the user, in terms of possible real world relationships which cannot be handled, need to be made very clear.

This paper suggests an approach in two stages to making the relationships clear. Firstly it stresses the importance of third normal form relations as a model of the business system required. From these are derived a set of formal statements about the inter-relation dependencies, or 'business rules'. The second stage uses the business rules and the relations to generate English language sentences describing the system.

Modelling the system

Since Codd wrote his seminal paper (Codd, 1970), much research work has been carried out on all aspects of the use of relations. In the design area, most authors are now agreed that an essential component of the design process is the creation of a third normal form model.

The properties of third normal form models are well described in Wiederhold (1977). For design, one of the main advantages is that a list of data items is generated together with an explicit statement of the functional relationship of elements to each other. From this model data base implementations such as Codasyl networks can be simply created.

The relational model created by the designer contains a great deal of information that the user should agree in the user specification. The designer has identified a large number of distinct data items, each with a unique name, for which he can supply a definition. In addition, for each data item, he has

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