Causal maps of Information Technology and Information Systems managers

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Abstract

It is becoming increasingly recognised that a cognitive view of the individual user executing various tasks at the interface is an inadequate conceptual framework for developing information systems. The conventional cognitive setting has disregarded the importance of how these users execute work tasks in the real world when using information systems. Furthermore, the design process is heavily biased towards scientific problem solving methodologies that omit the psychological cognitive styles of the users. In this paper, IT and IS managers are considered as the 'influencers' in the development of information systems; a role that forms the shape of the system. A methodology for deriving the causal maps is described and then applied to twenty IT and IS managers. The maps are analysed from three perspectives; information analysis, end-users involvement in the development stages and characteristics of the users. The resulting causal maps are used to develop a conceptual framework for development of IS.

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Gurmak Singh is a Principal Lecturer in the Finance, Information and Operations Management Division of Wolverhampton Business School. His major research interests is in the development of an information systems model to incorporate psychological profiles of the end users. The focus of the study is to examine the cognitive styles that have a major impact on the design of management and executive information systems. The model will be of particular value to analysts who adopt prototyping methodologies. The research project involves working with IT managers and developers from local authorities in England. Part of the project is carried out with Nottingham Trent University. Findings from the research have been presented at the Operational Research Society Conference, United Kingdom Academy of information Systems Conference and United Kingdom Systems Society Conference.

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Introduction

Current research shows a growing concern that if computer systems are to be designed to match users' needs then it is necessary to consider the context in which they are used. As aptly stated by Landauer (1987); "There is no sense in which we can study cognition meaningfully divorced from the tasks and contexts in which it finds itself in the world". Study has also shown it is not adequate to carry out cognitive style profiles in isolated laboratory conditions, as management problem-solving and decision-making is not conducted in frictionless planes and vacuums. Hence, a central focus of research in Human-Computer Interaction (HCI) must be the work setting where users carry out their tasks. Users' needs, capabilities and preferences for performing various activities should inform the ways in which systems are designed and implemented. Users should not have to change radically to 'fit in with the system' - the systems should be designed to match their requirements.

During the 1960s and 1970s the main paradigm in cognitive psychology was to characterise humans as information processors. Everything that is sensed was considered to be information which the mind processes. The basic idea was that information enters and exits the human mind through a series of ordered processing stages (Lindsay and Norman, 1977). The information processing model has been highly influential in shaping the development of cognitive models of the user in HCI.

Since the 1980s there has been a move away from the information processing framework within cognitive psychology (Preece, 1994). This has occurred in parallel with a reduction in the importance of the model of the human processor within the study of HCI, and a concomitant development of other theoretical approaches. More recently other alternative approaches such as distributed cognition have been developed that set cognitive activities in the context in which they occur. New frameworks in current development thus attempt to conceptualise cognition within the work context (Hutchins, 1990; Hutchins and Klausen, 1992). The co-existence of users, developer, computer systems or technology and their relations to each other in the environmental setting in which they are situated are referred to as 'functional systems'.

Cognitive psychology has gained a strong influence in the design of information systems and research has shown cognitive styles to have an important place in the development of Information Systems (IS). Thus, to develop Information Systems, cognitive styles need to be an explicit but essential part of the design process. The systems need to be customised around the end-users' cognitive styles, allowing them to maximise their own personal potential in using and benefiting from the technology. In recent years, research to identify the range of cognitive styles has produced over twenty-two dimensions on which styles differ (Haynes and Allinson, 1994). Benbasat (1978) identified three dimensions of cognitive styles having a major impact on the design of information systems. These are a) field independence and field dependence, b) cognitive complexity and simplicity and c) analytic-holistic. Field dependence/independence is regarded as the most important of these styles in the design of information systems. This research project identifies the main attributes of this style that has a major influence in the development of IS as perceived by IS and IT managers.

Research Method

Because the study concerns itself with middle managers, they must be identified and their role in the business environment specified. There is no universal method of classifying middle managers but they occupy the structural area between top managers and first-line supervisors. The classification 'middle managers' includes functional line managers)e.g. sales, marketing, production), and also staff specialists (e.g. planners, analysts). Middle managers may or may not be in charge of subordinates.

Middle managers have been isolated for study partly because the speculative literature states that IS will have its heaviest impact on them, but the main reason for specific study of middle managers is that they have such a vital role to play in IS development. Their role is critical in the design, conversion and operation of Information Systems. Furthermore, Information Systems have more impact on managers of business/organisational components which process large amounts of quantitative data than those who do not. The impact on organisational structure, decision-making, planning, budgeting and evaluation was found to be significant at the operational levels, unclear at middle management and slight at general management.

Causal maps are used to represent the problems associated with the development of an end user system as identified by the developers. These maps recognise the associations which are perceived to exist amongst the elements in the development stage. Furthermore, the method for developing these maps captures and encapsulates the developers' sense of satisfaction and disappointment in the course of the process, thus leading to reflective thinking which may provide foundations for a solution.

For us to be able to utilise our data as a basis for comparison between numerous causal maps (or equivalents) generated in relation to multiple research subjects, an elementary requirement is that our probing and the data produced pertain to identical topics, issues or domains of action uniform over the subjects. However, at the outset of the research, we do not know what those domains or topics are. Therefore, a two-phased approach is used for data elicitation (cf. Bougon 1983; Bougan et al. 1977, 1990). By conducting and analysing interviews with the subjects, the first phase was instrumental in developing a pool of constructs subsequently used in the second, mapping phase.

Interview session 1

This was targeted towards collecting background information and, specifically, locating key issues and jargon of the domain of the manager. A sample of four IS/IT managers was selected whose profile resembled the main study. Their outlook, attitudes, precepts and experiences were of similar range and variety to the main sample, thus avoiding unanticipated responses later. The interviews lasted between 45 to 90 minutes and were taped and transcribed.

	Qualifications	Age range	Length of service	Number used for initial interviews	Number used for cause maps
IS Managers	MBA	40-55	3-10	2	10
IT Managers	B. Sc. (varied disciplines)	40-55	5-20	2	10

The interviews produced a great deal of data, some partly redundant. However, from the thirty two constructs identified, twenty three key issues were extracted.

Interview session 2

The subjects were requested to select ten key concepts to be used as so-called 'anchor' themes, i.e. as discussion hubs, during the next interview stage.

Findings

Interview stage

The most common areas selected in the second round of interviews are listed below.

> User requirements
> Information requirements (users)
> User understanding of systems
> Types of user
> Data collection methods
> Types of developers
> Development methodologies
> High level Information Systems
> Development process
> Role of the analysts

From a literature search twelve statements were extracted that best described this cognitive style. The respondents were asked to select the attributes of the end users that would have an impact on the development of IS. Five attributes were selected, four of which reflected the management of information by the user. It was also perceived that flexibility in the system was an important attribute of the user that developers need to consider.

Field Dependent	**Field Independent**
1. Leaves information in a global form and does not impose any structure on it.	Tends to analyse information and restructure it.
2. Inability to separate information from its contexts.	Perceives information as discrete from its background.
3. Has difficulty in restructuring information and problems	Able to restructure the information and problems
4. Has difficulty in using information in new and different ways	Able to use information in new and different ways
5. Has few independent ideas and hence prefers systems and routines	Has more independent opinions and hence does not like systems and routines

Mapping: The Merging Process

The individual approach requires very large commitments of time and effort by the researcher and participants. Furthermore, to get a more general view of complexity, individual maps would have to be integrated into a combined map - a further step for which there is no

generally accepted methodology. The purpose is to understand what each respondent includes within the referent anchor phenomenon. Thereafter the discussion moves to the anchor's antecedent and outcome phenomena, firstly asking the subjects what the 'causes and effects are in his/her mind (Laukkanen, 1994).

To compare individual actors' cognitive maps, the natural language expressions (NLUs) underlying them were first standardised and converted to standard terms.

The first pass produce 91 Natural Language Units and 30 Primary level terms. Further successive rounds of regrouping produced smaller meaning categories, until a solution was found which was an acceptable compromise in terms of internal homogeneity and the level of compression necessary. This redundancy removal is only a special case of compressing raw data by successively collapsing the previous level's concepts into larger meaningful categories at higher level or by mapping them 'side-ways' into a meaning system based on a different viewpoint.

Participants	Natural Language Units (NLUs)	Primary Level terms (PLT)
Information Systems Managers	53	17
IT Managers	38	13
	91	30

Information Systems Managers

The IS managers identified a unique self created role, a role that occupied the gap between the IT department and the user department. The need for this role stems from the perceived inability of users to identify their requirement. IS managers viewed users as not having the ability to formulate their informational requirements, not having the level of imagination to distance themselves from day-to-day functional tasks and having a low level of analytical ability.

The role of the IS managers was seen as a non-technical and non programming role They were viewed as acting in a liaising capacity in determining business requirements and translating these into IT objectives. The role entailed ensuring that projects undertaken fitted in with corporate strategies and were prioritised accordingly. IS managers helped to budget projects, develop business plans, aid in project management and prepare committee reports to obtain approval for projects.

We can predict structural changes in organisations and speculate on the impacts they will have on the activities of managers. There will be a necessary upgrading of skills at all levels and particularly in managers' analytical and computer-related skills. A greater number of programmed decisions will mean fewer actual decision-making managers but not fewer managers in total. All IS managers wanted more high level corporate information, trained managers with analytical ability.
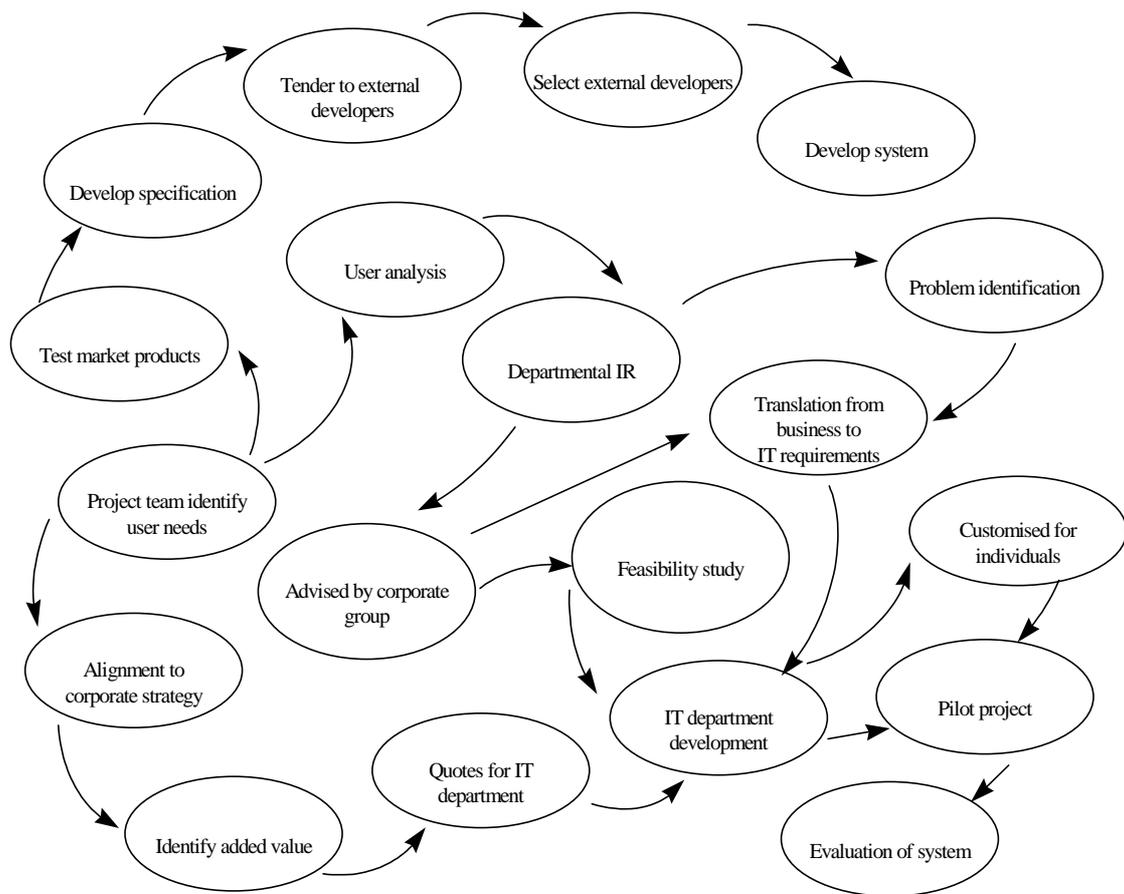
Figure 1: Merged map for IS managers

IT Managers

It was found that no specific IS methodologies were employed. A broad brush approach was used to develop systems and techniques such as DFS, and generation sheet diagrams were alluded to, but not rigorously applied. Also a form of prototyping approach is adopted by breaking into small iterations and refining over many years. IT managers viewed the focus of the analyst's job as collecting information from the users by way of interviews. The analyst's job is not only to ascertain what the users want but also why they want it, clearly indicating a lack of confidence in the users' ability to come to sound decisions about specifications. Interviewing was considered a prototyping method. Users were seen as individual entities having different skills and working practices.

IT managers were found to be under pressure from strategic managers who wanted management and control systems thus making the systems too complex. Tension was also created by the ever-present pressures to move on and start on the next project, thus meaning that adequate training and documentation was left out of the process.
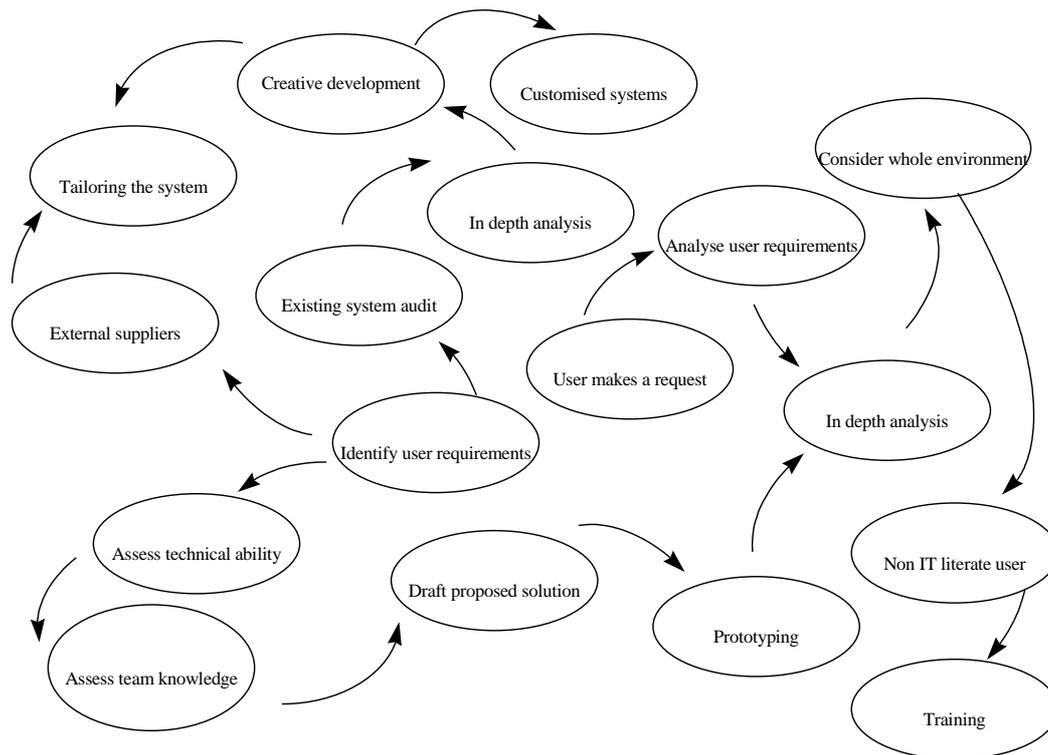
Figure 2: IS managers

IT and IS managers agreed that systems that have been customised according to the users' cognitive styles potentially offer many benefits. The users are able to learn the system more quickly, are able to navigate the system more efficiently and are more likely to use the system. The system is more efficient as unnecessary elements are not included.

Summary

The gulf between developers and users of information systems was recognised over twenty years ago. System developers are recognising the need to 'humanise' systems in they way they interact with the users, but the progress has been slow. Those more progressive IS methodologies that involve users in the development have won accolades from many quarters, but are not being widely used. The major arguments of information systems designers against customised Information Systems stem from the need to have flexibility. There are likely to be many users of the same system and the problem task is revised continuously. This will cause major problems for customised systems which do not build in flexibility. The task analysis stage of system development needs to be oriented towards the user's needs and may thus use a range of "subjective" or participative techniques such as interviewing, meetings and seminars. These can be complemented by prototyping-iterative methodologies offering a way forward in establishing how the users will use the system, how tasks will be performed and help in carrying out information requirements and information structuring.

Middle managers have identified a 'hybrid' position in the development of information systems, and thus are becoming the main drivers in the way these systems are developed. Even though they recognise they need incorporate cognitive attributes of the users in the development information systems, they remain sceptical about customising these systems to users.

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