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A Qualitative Approach to Investigating the Behavioural Definitions of the Four-Paradigm Theory of Information Systems Development

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Abstract
Hirschheim, Klein and Lyytinen introduced the four-paradigm theory of information systems development (ISD) as a significant attempt to systematise developer assumptions. The theory perspective is that developers hold key assumptions that may be grouped together and classified into paradigms, and that these paradigms influence their ISD behaviour. The aims of the research described here are theory exploration and explanation in case studies concerning the ISD process in three public National Health Service (NHS) institutions in the north of England. We focus on the behavioral rather than the cognitive (assumptions) aspect of the theory. Our conclusions are, firstly, that qualitative theory explanation is desirable because we need to test theory in practice to show its applicability to wider settings. A rigorous qualitative, interpretive method, paying attention to openness and validity, can satisfactorily undertake such theory explanation; such research can help our IS community to gain wider credibility, authority and acceptance. Secondly, with regard to the four-paradigm theory, its predictions were largely met, as the paradigms were capable of classifying developer behaviour and developers had a dominant paradigm, namely functionalism. We found the theory to be very relevant to the investigation of current IS issues, and we introduce the concept of developer paradigmatic inconsistency.

Keywords

Four-paradigm theory, qualitative research, theory explanation

1. Introduction

It is widely held that the assumptions of systems developers have an important shaping effect on their ISD behaviour (Gasson and Holland 1996; Markus and Bjorn-Andersen 1987). In the light of the traditional, technical perspective on ISD, with recent increasing emphasis on social and organizational perspectives for improving system quality (Westrup 1996) it is

important to understand the extent to which such perspectives are present in developers' assumptions and behaviour.

Hirschheim and Klein (1989), and Hirschheim, Klein and Lyytinen (1995) (subsequently referred to as HK and HKL), introduced the four-paradigm theory of ISD as a significant attempt to systematise developer assumptions. The theory's perspective is that developers hold key assumptions that may be grouped together and classified into paradigms, and that these paradigms influence the ISD process.

The aim of the research described here is to investigate the theory with a qualitative, interpretive strategy, using theory explanation and exploration approaches, focusing on the ISD process within three public NHS institutions in the north of England from 1997-2001. Paper structure is introduction, four-paradigm theory and research objectives, method, data generation and analysis, results, discussion and conclusions.

2. Four-paradigm theory and research objectives

2.1 The theory

HKL/HK do not present their theory systemically; we present it in the form of two propositions inferred from relevant publications, focusing on the behavioural rather than the cognitive (assumptions) aspect of the theory.

Proposition 1: Systems developers hold a wide range of assumptions relevant to the ISD process, that may be grouped together and classified into paradigms, and that may be inferred from their behaviour during the process

All systems developers approach the development task with a number of explicit and implicit assumptions about, for example, the nature of human organizations, the nature of the design task, the value of technology, and what is expected of them. HKL (1995: 46)

The most fundamental set of assumptions adopted by a professional community that allows its members to share similar perceptions and engage in commonly shared practices is called a 'paradigm'. Typically, a paradigm consists of assumptions about knowledge and how to acquire it, and about the physical and social world. HK (1989: 1201)

HKL classify similar types of assumptions together into four paradigms (based closely on those of Burrell and Morgan 1979) of ISD: functionalism, social relativism, radical structuralism and neohumanism HKL (1995: 48).

The assumptions can either be held by the systems developers or embedded in their preferred development approach. HKL (1995: 46)

.. these assumptions play a central role in guiding the information systems development process. (HKL 1995: 46)

HKL describe 21 *dimensions* of ISD, concerning activities, decisions and viewpoints, characterised by *paradigmatic behavioural definitions* (our term) for each of the four paradigms (1995: 49-56), which, together with more detailed discussions (1995: Chapter 4):

.. give archetypical characterizations of how systems analysts might behave if they try to put the tenets of each paradigm into practice. (1995: 49)

Proposition 2: The influence of one paradigm on a person is typically dominant despite their acceptance of other paradigms

.. the influence from one paradigm is typically dominant.   HK (1989: 1212)

HKL (1995), Goles and Hirschheim (2000) describe the dominance of the functionalist paradigm in current ISD approaches.

2.2 Research objectives

Based on the propositions, we expressed our research objectives with these research questions:

RQ1 - Do the paradigmatic behavioural definitions adequately categorise the relevant dimensions for a given individual?

We wanted to establish whether we were able to use the behavioural definitions to categorise a developer's behaviour.

RQ2 - Is the influence of one paradigm on a developer's behaviour dominant despite the presence of other paradigms?

By seeking to categorise a developer's behaviour using the behavioural definitions, and thence the paradigm(s) to which the behaviour belonged, we wanted to investigate whether the influence of one paradigm on a developer is dominant.

RQ3 - Are the paradigmatic assumptions and behavioural definitions useful as a sensitising device for explaining ISD behaviour?

We wanted to investigate whether the theory was useful for sense-making of ISD behaviour and whether it could be used to generate concepts or further theory.

2.3 Related literature

In other research similar to theory explanation, Markus and Bjorn-Andersen (1987) have explored a model of power exercised by systems professionals over users by investigating literature case studies. Concerning assumptions and ISD behaviour, Boland and Greenberg (1992), in an experimental research design, asked groups of systems analysts to use a metaphorical assumption in which they were trained (organization as machine or organism) to analyze a common problem situation description, and they concluded that the groups employed different language practices to produce different (natural language text) problem analyses, characterized by the metaphors, constituting different organizational interpretations and enactments. Orlikowski and Gash (1994) and Gallivan (1996) provide evidence that technological frames - sets of technological assumptions - shape individual ISD behaviour.

3. Method - research situations, strategy and design

The organizational context was characterised by government-driven rapid change, with adoption of technology in the health sector a priority, under media scrutiny, making individuals in the organizations cautious and aware of political implications of their behaviour. Organization 1 was a hospital where we studied a project to integrate seven distributed day clinics into one clinic in a single location, involving 130 staff, supported by a new administrative information system. We made 36 visits from 10/9/97-2/9/98, involving six developers. In organization 2, the pharmacy department (36 staff) of a general hospital, the project concerned the replacement of an existing pharmacy system with a Y2K-compliant system. We made 22 visits from 15/7/98-15/10/01, involving nine developers. Organization 3 was a community healthcare organization operating from 99 locations. The project, based in the IT department, concerned an Intranet to link geographically distributed sites. We made 35 visits between 30/6/98 and 3/12/01, involving twenty one developers. Typically, more than one meeting or interview took place in one visit. Developers constituting project teams set requirements for software suppliers. This phase of the project took about a year. After software system delivery, developers were involved in implementation and integration.

We chose a qualitative, interpretive research strategy, using a longitudinal case study design, to generate rich data in the organizations. Our aims were theory explanation and theory exploration (Yin 1994). Theory *exploration* is a mainly inductive approach, typical of

qualitative studies. However, theory *explanation* is a mainly deductive approach, where we seek to confirm or disconfirm, or refine, hypotheses based on the four-paradigm theory. Following Silverman (1993), we believe that qualitative research should spend more time building cumulative knowledge, and demonstrate that it can transcend the positivist overtones historically associated with a deductive process. Concepts such as generalisability (Hammersley 1990) explain, in principle, how we may transfer theory to settings other than those from which it has emerged, with the aim of theory refinement, involving theory reformulation as well as establishing whether there are wider settings in which the theory is (theory strengthening) or is not (theory weakening) applicable. Such less 'realist' terms than Yin's are more appropriate to our research aims.

Hammersley's (1990) validity and relevance criteria were used for our research design. Access was gained by personal contact and maintained by establishing trust, promising confidentiality of data and respondent validation. In organization 1 management kept researchers away from lower-level workers but other organizations allowed access to all developers. Ethically, we obtained informed consent from all participants. Methods and sources triangulation were used for study breadth and validity. Longitudinal studies allowed us to study and (dis)confirm behaviour by repeated observation over a long period, rather than a snapshot view. One researcher (ZIH) carried out data generation, assuming the role of participant/observer; data analysis was undertaken by both authors.

4. Data generation and analysis

4.1 Dimensions of ISD behaviour

HKL (1995: 52-56) describe twenty one dimensions of ISD behaviour, together with their *paradigmatic behavioural definitions*, in four tables: table 3.2 part I (Implications for ISD), table 3.2 part II (Limitations of the paradigms and their implications for the definition of system goals), table 3.3 (Paradigmatic implications for ISD functions) and table 3.4 (Differences in developed systems produced by the four paradigms). The dimensions are shown in table 1. We report on 11 dimensions in this paper, shown in bold.

Table 3.2/I	**Role of IS designer, Nature of information system application, Objectives for design and use of information systems**
Table 3.2/II	**Implications for legitimation of systems objectives,** Deficiencies
Table 3.3	**Preferred metaphor for defining information, Preferred metaphor for framing ISD, Problem finding and formulation, Analysis, Logical design,** Physical design and technical implementation, **Organizational implementation, Maintenance**
Table 3.4	Technology architecture, Kind of information flows, Control of users, Control of systems development, Access to information, Error handling, Training, Raison d'etre

Table 1. Dimensions of ISD behaviour

4.2 Data generation sources and research methods used

To generate data concerning developers' ISD behaviour, we took an interpretive approach to (a) developers and (b) texts, using four research methods: observation, qualitative interviews, unstructured questioning and document analysis. We distinguish four types of data source which we used to generate data: formal, pre-arranged, project meetings (observation), pre-arranged interviews (qualitative interviews), informal (spontaneous) meetings (observation and unstructured questioning), and documents (document analysis).

All sources were in the developers' workplace. Observation was the main research method, as we considered this the most effective method for generating data related to developer behaviour in these settings. We considered that interviews, asking developers how they might, eg behave in a given situation, would generate unreliable data. We reduced the risks of influencing the study due to our presence (Mason 2002) by a combination of trust maintenance and construction of an identity that presented ourselves as empathetic listeners to problems and interested, non-biased (not necessarily evaluative and certainly not critical) observers of organizational ISD processes. We avoided getting drawn into making detailed recommendations during the study to maintain this 'muted' presence.

We adopted a 'suspicious' perspective in interviews when we asked developers to explain an action (either theirs or another developer), as developers could 're-interpret' actions after the event or interpret another's actions subjectively. Where there was inconsistency that was unresolved we relied on observation. Unstructured questioning was used when we attended informal meetings that occurred during our visits, made up of developers as they discussed their project and took related actions; we attempted to follow the thread of the conversation and ask developers for explanations to understand actions, issues and viewpoints. Such meetings might be viewed as unstructured focus groups. Documentary data was limited in scope. The primary reason for this number of research methods was to add breadth to the data generated; however, this was also useful for triangulation of methods and of sources, where we could compare actions in documents against observed actions, as well as actions explained in interviews with observed actions, or actions from source 1 with actions from source 3.

4.3 Data generation and analysis procedures

Typically, in meetings (sources 1 and 3), a developer would say or do something (for example, make a remark, ask a question, initiate a course of action, express an opinion) that was ISD-related, which we would then note and attempt to categorise using the dimensions and definitions. Our procedure was to use sources 1 and 4 to begin with, and seek to explore this behaviour in sources 2 and 3. Data analysis was concerned with analysing the manual notes made during data generation. The notes concerning meetings were the most complex as they contained details of meetings (developers, date, time, location, behaviour observed) as well as developer quotes, remarks on discussion context and other remarks that helped us in the analysis to categorise behaviour using the dimensions and definitions. We would identify firstly which dimension was relevant for categorising the developer ISD behaviour on which we were focusing, and then secondly identify the relevant definition. To do this, we used the behavioural definitions together with their related discussion in HKL Chapter 4. Our analysis generated a summary section, organized by developer, which recorded the dimensions and definitions that we used to categorise their behaviour as well as quotes. We used interviews and meetings to seek explanations for behaviour which was ambiguous. This hermeneutic approach led us to meet a developer more than once, benefiting from the longitudinal design, and we would seek with respondent validation to check any classifications we had made, usually by steering discussion to relevant topics and asking further questions.

5. Results

Our study had limited resources, which would not support theory explanation of the 21 dimensions and their associated 84 behavioural definitions with all 36 developers in the three organizations. Also, we judged that the extensive nature of the evidence (for example, contextual descriptions of behaviour, quotations, participant descriptions) that would be

required to support assertions associating all of the behavioural definitions with developer behaviour would make it difficult to present a plausible account to the reader. HKL also state that the dimensions are not an exhaustive list; hence such a study would have been partial. We therefore decided to limit our investigation for *theory explanation* to focus on eleven of the 21 dimensions, involving the ISD phases in which developers were concerned, and we present our results below for organization 2 (nine developers). For our *theory exploration* investigation we used the four paradigm theory as a sensitising framework to generate middle range theory from the research situations for further research, and we present one example.

5.1 Theory exploration results

Space permits us to present the results of only one of the dimensions, for three developers, one from each organization. We firstly show in table 3 the behavioural definitions for each of the four paradigms. HKL explain that the *Role of IS Designer* dimension is 'what the IS developer's function should be' (1995: 51). Secondly, we defined the concept of *Dimensional Behaviour Types* to be the main types of behaviour exhibited by developers, for a dimension, that we found most common and useful in assisting us to categorise that behaviour in terms of the definitions; for this dimension these were: methods, change and user involvement. Thirdly, for each of the Types, we used quotations from the supporting discussion in HKL Chapter 4 to assist us in behaviour categorisation. In addition, the principal concepts and ideas associated with each paradigm, obtained from those in HKL (1995: 50, table 3.1, and 1995: 91: figure 4.1) were referred to. Together, these constituted our *systematic categorisation approach*. We give examples below of contextual descriptions and quotes from developers, showing how we categorised their behaviour. The dimension descriptions, behavioural definitions, behaviour types and collected data all underwent researcher checking for researcher bias and assumptions, involving repeated discussion and modification between the researchers. We track three developers who were project leaders: Project Manager (from organization 1), Chief Pharmacist (organization 2), IT Manager (organization 3).

	Functionalism	Social Relativism	Radical Structuralism	Neohumanism
Role of IS Designer	The EXPERT; similar to an engineer who masters the means for achieving given ends	A CATALYST who smooths the transition between evolutionary stages for the social system for which he is a part	A WARRIOR on the side of the forces of social progress	An EMANCIPATOR from social and psychological barriers

*Table 2. Behavioural definitions for the **Role of IS Designer** dimension*
[Source: 1995: 52, Table 3.2 (Part I)]

In organization 1, the functionalist paradigm was dominant for the Project Manager, as she worked systematically, emphasising project management techniques to manage different phases. She said: ***"My role involves a lot of responsibility and is open to checks, so one has to make sure that different components of the system fit well with each other"***. Being based in the IT Department and working along with software engineers we noted that her discourse gradually became more influenced by engineering terms such as specification, procurements and logic, behaving like an expert engineer. She diligently followed the NHS IS procurement methodology (POISE) in a logical sequence to document IS requirements. She commented that: ***"My role involved taking a systematic approach in developing the system, where each step served as a pre-requisite to the next. So firstly I had to collect the requirements, then interpret them and then document them etc…"***. Strategic management asked her to work

closely with line management to specify the most efficient system for Day Clinic management. She felt under obligation to draw up requirements for a system that would meet efficiency targets. The emphasis was on saving money, as the Project Manager said: ***"The main purpose of this project is to save pounds".***

However, at initial project stages, she displayed a 'listening ear' by smoothing eventual system acceptance by gathering requirements from the users and promising to incorporate them into the system specification. She thus appeared also to be a social relativist, as she acted as a catalyst for organizational change, engaging in dialogue and working closely with different users. She commented: ***"I think people are very important and need to be paid a lot of attention".*** However, as she was initially overwhelmingly a functionalist in the majority of our observations, this strong developer *paradigmatic inconsistency* raised doubts in our minds, confirmed by the fact that at later stages she excluded many lower-level workers from requirements discussions as well as denying us access to them.

In organization 2, the behaviour of the Chief Pharmacist conformed to the functionalist paradigm, as he behaved like an expert engineer who possessed a high degree of knowledge about the Pharmacy, IS and organisational rules through which he succeeded in keeping overall control over the ISD process. The Chief Pharmacist stated: ***"I was systematic in planning the use of the new system. It was basically through evaluating what the existing system does and what the new system could do".*** The Chief Pharmacist, with help of his colleagues, initially specified requirements in a narrative form, which were then re-written in the organisational format. He was involved in undertaking a step-by-step analysis of how the system would work in the Pharmacy.

In organization 3, the IT Manager's behaviour conformed to social relativism, as he acted as a change catalyst, smoothing transition from one state to another. This was applicable because at the end of the project a new evolution had started in terms of the value given to IT in this organisation. As he commented during a meeting: "***I think workers will eventually realise how much benefit this technology*** [Intranet] ***has provided them. They will find it much easier to do things that currently they either can't do or takes them long time to do***". Before the Intranet all communication was via memos and letter and patient records were not available electronically to all departments. He also behaved as an emancipator (neohumanist), trying to change the attitudes of workers and giving them better access to information. He aimed to use his expertise to change organisational culture so that it was more positive towards technology. He commented: ***"My personal aim is to change the organisational culture and increase the IT awareness of workers".***

The IT Manager perceived the organisational culture as too traditional, with outdated bureaucratic procedures, hindering creativity and innovative ways of working and thinking. His view was that it was necessary for the workforce to respond positively to rapidly changing approaches, treatments and attitudes to community health medicine. Knowledge of these changes would not only benefit patients but would also assist in workforce career development. Hired on the basis of his commercial IT experience, he sought to create a more dynamic and forward-looking organisation. He believed that there was a need to bring workers up-to-date professionally, and one way to do this was to bring them to a similar level of IT awareness as their counterparts in the commercial sector. He said in an interview: "***Our workers definitely need to change".***

He managed to influence the traditional beliefs held against the use of technology in his organisation. For example, a line manager demonstrated her new awareness of technology by saying: ***"We need to keep up to date with everybody else. People doing research*** [nursing and illness related courses] ***wanted the Internet*** [Intranet] ***here*** [this site] ***to help them. It will***

also save time and money". Another line manager told the researcher that purpose of the Intranet was ***"to help us to become more aware of things and to communicate with one another"***.   These remarks were in contrast to their suspicion about the project at its start.

5.2 Theory explanation results

Behaviour was sufficiently similar to allow us to summarise results for the developers, shown in table 3. Each row of the table shows an ISD dimension together with the paradigm that classifies that behaviour.

RQ1 - Do the paradigmatic behavioural definitions adequately categorise the relevant dimensions for a given individual?
RQ2 - Is the influence of one paradigm on a developer's behaviour dominant despite the presence of other paradigms?

Using the categorisation approach described in the previous section, we were able satisfactorily to identify behavioural definitions that characterised developer behaviour for the different dimensions. The functionalist paradigm was dominant over the majority of the dimensions, with the exception of *Role of IS Designer* and *Analysis.*

Dimension	*Paradigm*
Role of IS designer	Neohumanist/Functionalist (at the start) and Functionalist /Neohumanist (at the end)
Nature of IS application	Functionalist
Objectives for design and use of IS	Functionalist
Implications for legitimation of systems objectives	Functionalist
Preferred metaphor for defining information	Functionalist
Preferred metaphor for framing ISD	Functionalist
Problem finding and formulation	Functionalist
Analysis	Functionalist (at the start) and Neohumanist/Functionalist (at the end)
Logical design	Functionalist
Organizational implementation	Functionalist
Maintenance	Functionalist

Table 3. Summary of developer paradigms applicable to dimensions in organization 2

6. Discussion and conclusions

6.1 Four-paradigm theory

For *theory explanation*, we found the main propositions of the theory (studied only in organization 2, for eleven dimensions), to hold. RQ1 was met, as we were able to identify behavioural definitions that characterised developer behaviour for the different dimensions. RQ2 was also met, as aggregate developer behaviour exhibited a dominant paradigm, which was functionalist. Thus, based on our settings, these results strengthen the theory.

However, we encountered ambiguity in the definitions of the radical structuralism (RS) paradigm. Tables 3.2 and 3.4 (1995:52/6) define RS solely from a worker viewpoint (eg, *all objectives other than those which further the class interests of the workers are considered*

illegitimate and reactionary), but table 3.3 (1995:53) defines RS from either a management or from a worker viewpoint (eg, *improved productivity of the workers; or improve the position and enhance the craftsmanship and skills of the workers* - our underline). As this management viewpoint appeared close to functionalism we adopted the worker viewpoint for our RS definitions. This aspect of the theory should be clarified for future research.

We noted that the paradigms for some of the behaviour of the developers changed as the project progressed, in the functionalist direction. The possibility of such change is not mentioned in the theory, which has interesting implications and should be investigated further, as it raises the question as to the influences on developer behaviour and the extent to which dominant paradigms are fixed.

For *theory exploration*, the theory was a useful device in facilitating our sense-making of ISD in these organisations. The dimensions and behavioural definitions, together with the dimensional behaviour types and data source activities we defined, gave us a *systematic categorisation approach* with which to approach data generation and analysis, reducing investigator bias. RQ3 was thus met, and this led us to form the concept of developer *paradigmatic inconsistency,* which we see as being characterised by basic contradictions occurring in a developer's emerging paradigm profile, leading us, in the example we gave, to doubt the genuineness of certain of the actions and words of the organization 1 Project Manager. This concept could be widened to assist sense-making in the ISD process, in areas such as obtaining user requirements and building organizational IT strategy, or more generally when conducting a stakeholder analysis, where such inconsistency could be suggested in the early stages and either dealt with or anticipated. It may reveal confusion or doubt, or as we discovered, it may reveal when an individual says or does one thing but really means another.

Although there are many criticisms of the underlying Burrell and Morgan model (Schultze 1999, Westrup 1996), we found its underlying epistemological and social theoretical principles to be clear, enabling us to construct paradigm definitions. Furthermore, we found that the distinctions between the four paradigms were very relevant in encapsulating important assumptions and behaviour of individuals that are directly related to the different viewpoints concerning IS and ISD issues which are widely debated today. For example, the extent to which information systems are a means of control, user perceptions of success, e-government and wide access to information, and whether stakeholders should participate in ISD. However, as the functionalist paradigm was exhibited by the majority of developers, it could usefully be subdivided into different types to reflect different shades of functionalism, perhaps by refining the subjective-objective dimension by adding Hammersley's (1990) concept of 'subtle realism', although this would add to model complexity.

6.2 Qualitative theory explanation

Qualitative theory explanation studies are rare due to perceived methodological and practical difficulties in carrying them out. Our study is the first of this type applied to the four-paradigm theory. However, the successful, in our view, undertaking of the study carries with it an important, if challenging, message for our IS community, namely, that it is both desirable and possible to engage in this type of theory explanation. It is desirable because we need to test theory, in the world of practice, to build on and refine theory (Benbasat and Zmud (1999) and to show its applicability to wider settings. It is possible as we have demonstrated that a rigorous qualitative, interpretive method (that can avoid positivist characteristics and that should be adapted to the research situation), paying attention to openness and validity, can satisfactorily undertake such theory explanation. Such research, founded on a rigorous

method, can help our IS community to gain wider credibility, authority, relevance and acceptance.

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