Examining Methodology Adoption and Use: Building Understanding from Process Research

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Abstract

Research has consistently shown that formalised and documented methodologies have failed to become an integral part of professional systems development. This paper presents an intensive field study of the process of methodology adoption and use. The findings emphasise the influence of contingency factors on methodology use, and the resulting adaptations that occur, throughout the development process. Some of the implications of these findings for project quality and systems development in rapidly changing environments are discussed and the value of high-level methodology frameworks is suggested.

Keywords

IS development methodologies, Organisational change, Field study

INTRODUCTION

Developing timely, useful and robust information systems has long been a problem for information systems (IS) practitioners. Efforts to develop quality IS have focused on improving the development process through technical innovation and process prescription. Technical innovation in languages, tools and techniques has not eradicated quality problems (Humphrey 1989:2). Prescriptions for managing the development process include formal, documented methodologies, quality management methods (such as standards and Total Quality Management) and process improvement models (such as the Capability Maturity Model and SPICE). The focus of this paper is formal, documented IS development (ISD) methodologies.

Examining ISD methodologies is particularly important given the complex and changing environment in which today's systems are developed. Systems developers are currently immersed in an environment characterised by Web-based global systems, numerous new tools, techniques and languages and expectations of ongoing and escalating change (Truex, Baskerville and Klein 1999). Such a development environment suggests the need for adaptability to change, for flexibility to accommodate unexpected contingencies, and for improvisation to capitalise on the many opportunities that will emerge from technological innovation. It also implies the need for speed, to enable systems to be placed in the marketplace ahead of competitors, and quality, so that systems are sufficiently robust to provide the foundations for evolutionary development. Most ISD methodologies were devised in a different type of competitive environment for very different classes of systems. Consequently, investigation of the adoption and use of ISD methodologies in commercial practice and assessment of their value in a changing world is needed.

Although powerful and persuasive arguments have been provided to support the adoption and use of ISD methodologies (De Marco 1978; Yourdon 1987), research has indicated low use of methodologies in practice (Dekleva 1992; Fitzgerald 1997; Necco, Gordon and Tsai 1987; Russo, Wynekoop and Walz 1995). This paper reviews research into the adoption and use of methodologies and identifies shortcomings in the research approaches used. An alternative research approach focussing on the *process* of adoption and implementation rather than *factors* that influence success is proposed. A processural approach is applied in a single, intensive study of methodology selection and use and the benefits of this approach are described. The findings provide tentative explanations for the low use of ISD methodologies. Further, use of methodological frameworks is suggested as a usable and useful alternative in a dynamic development environment.

RATIONALE FOR METHODOLOGY USE

A methodology is "*a collection of procedures, techniques, tools, and documentation aids which will help the systems developers in their efforts to implement a new information system.*" (Avison and Fitzgerald 1995:10). Avison and Fitzgerald argue that the distinction between a methodology and an eclectic collection of tools and techniques is a philosophy; a methodology incorporates a set of assumptions or theories that reflects the belief that attention to certain aspects of systems development is a prerequisite for project success. ISD methodologies were introduced in the 1970s (Necco, Gordon and Tsai 1987) to deal with the problems of size and complexity (Avison and Fitzgerald 1999). Ad hoc and uncoordinated methods were seen as contributing to the software crisis where systems were delivered late, over budget and not meeting customers' needs. In addition, the success of early systems development efforts relied on the talent and mastery of a few gifted practitioners. It was hoped that introducing a more systematic, engineering approach to systems development would provide less talented and experienced developers with the means to perform competently (Shaw 1990).

Benefits claimed from the use of ISD methodologies include superior management of projects (Russo, Wynekoop and Walz 1995) and a standardised process involving a common approach within an organisation (Avison and Fitzgerald 1995). Decomposing the development process into a sequence of stages that provides clear deliverables enables more effective project estimation, resourcing, monitoring and control. Storing data about projects and comparing and contrasting estimates, resources, internal and external risks and final outcomes enables developers to learn from successes and failures. The idea of standardising the development process, to facilitate an exchange of staff, expertise and techniques between projects, relies on the idea of applying a methodology in a constant way: both between developers and between projects.

ISD methodologies, in common with the quality management theories prevalent in the later stages of the twentieth century, focus primarily on the process rather than on the end product. The assertion that an improved, reliable manufacturing process leads to an improved, reliable product (Deming 1986) has been applied to systems development; the underlying assumption is that an improved systems development process will lead to improved systems. However, the manufacturing analogy has a number of weaknesses for systems development including lack of process repeatability except at a high level of abstraction (Carroll 1996), significant impacts of human and organisational factors, lack of agreement as to what constitutes a quality information system and an inability to measure such quality.

RESEARCH INTO METHODOLOGY USE

Research into ISD methodologies has investigated their adoption and use. Adoption refers to methodology selection and examines factors that influence the choice of a methodology; these contingency factors include uncertainty, project size and risk (Davis 1982). This selection occurs at the start of the project and relates to the *perceived* project situation. Use refers to implementation of the methodology, most commonly in terms of the number of analysts, projects or organisations using them. Surveys investigating ISD methodology adoption and use include Chatzoglou and Macaulay (1996), Fitzgerald (1997), Necco, Gordon and Tsai (1987) and Russo, Wynekoop and Walz (1995). Despite the benefits claimed for both the systems development product and process (Fitzgerald 1998:103), these surveys indicate that ISD methodologies have failed to become an integral part of professional systems development practice.

There are several criticisms of investigating methodology use with surveys. Firstly, survey research has typically taken a binary approach, examining use or not of methodologies (Fitzgerald, 1998). This oversimplifies methodology use and raises the issue of what it is to use a methodology (Bansler and Bodker 1993): use of formal or informal, commercial or in-house methodologies and the extent and manner in which methodologies are followed. Surveys have been supplemented with interviews (Fitzgerald 1997; Russo, Wynekoop and Walz 1995) to provide deeper understanding of methodology use. As a result of interviewing a limited number of survey respondents, Fitzgerald (1997) found that his earlier survey overestimated actual methodology use and that some of the organisations classified as using a formal methodology on the basis of the survey were not using one. However, interviews only provide post hoc interpretations about methodology use, often long after completion of a project. The researcher is only gaining access to the respondents' 'espoused theories' (Argyris and Schon 1996) rather than examining actual methodology use in practice.

Criticisms of survey research into the adoption and use of ISD methodologies indicate a more fundamental problem. Most of the existing research examines the factors or variables that influence methodology adoption and use. The research reported in this paper takes a different approach. Instead of using static research methods that supply a snapshot of methodology practices, a dynamic approach of studying the process of methodology adoption and use is taken. There has been extensive discussion in the organisational (Slappendel 1996; Wolfe 1994) and information systems (Galliers and Swan 1999; Kwon and Zmud 1987; Markus and Robey 1988) literature about the comparative advantages of static factor research and dynamic process research. The predominance of factor research in IS has long been criticised (Franz and Robey 1987; Kwon and Zmud 1987). Ambiguous research results in IS implementation research led Franz and Robey (1987) to suggest a focus on process and examination of the interaction of factors, and changes in factors, over time. Subsequent research suggests that processes be examined as episodes of change (Newman and Robey 1992) or dynamic, continuous change (Markus and Robey 1988; Slappendel 1996). Process research usually involves qualitative data (Wolfe 1994). Greater acceptance of qualitative data in IS (Markus 1997) and acknowledgement of the dynamic nature of organisational contexts (Truex, Baskerville and Klein 1999) suggest that increased use of process research in IS may be expected.

There has been little longitudinal, engaged field research examining the process of ISD methodology adoption and use; Fitzgerald (1997) and Russo, Wynekoop and Walz (1995) use on-site interviews and Dekleva's (1992) 'exploratory field study' involved a mail survey. In

response to criticisms of static, snapshot research approaches, a process oriented approach was used to study the dynamic interplay between people, context and technology (Markus and Robey 1988) that shapes methodology adoption and use. Such an approach provides greater insights into ISD methodology adoption and use. This paper presents a field study involving a commercial systems development effort. It examines the earliest stage of the development process, where understanding is built of the problem, the problem context and stakeholders' needs within that context, in order to determine the feasibility of developing a system. These activities are critical in systems development because understanding the underlying problem and determining the requirements act as the foundation for the rest of a project.

THE CARE CASE

The case concerns a feasibility study performed by a consulting team. The client organisation, a government agency called CARE (a pseudonym to protect its identity), is responsible for the provision of services to people with disabilities (both physical and intellectual). CARE oversees service provision but does not provide the services: its head office controls policy and funding while a network of regional offices allocates customers to independent service provider agencies. CARE called for tenders to investigate the feasibility of developing a payment system based on business transactions. A primary goal in developing a new system was to increase accountability for the funding provided by CARE. The tender document specified that electronic commerce technologies and, in particular, smart cards were to be investigated. Surrounding these aims were a number of social issues relating to the needs of customers with disabilities, as well as privacy and data security. CARE emphasised the need to investigate both the social and the technical issues surrounding any proposed changes.

The case involved multiple stakeholders with diverse views: CARE head office, being responsible for financial, legislative and policy issues and managing outsourced service provision; regional officers from CARE, providing client placements and managing many service provision agencies; service provision agencies, managing service provision and reporting to CARE; service providers, providing care to customers and reporting to agencies; customers, who receive care; and service providers' and customers' associations.

On winning the tender, the team leaders organised a team with expertise in three main areas: electronic commerce, requirements and social issues. The team leaders were a systems analyst and a sociologist, who acted as project manager for the process. There were five other members of the team, including the author. Information about the current system and stakeholders' needs was gathered by the team through an intensive program of interviews and meetings with CARE staff, managers of service provision agencies, service providers and customers and their representatives. A report was then written (chiefly by the project manager) and submitted to CARE. After several months, the team was asked to make minor additions to the report which was finally submitted and accepted almost 12 months after the first team meeting.

Research Method

Data were collected by participant observation. The author joined the process when the team was constructed. Access was provided to the requirements process in return for acting as a secretary and recording the conversations and interaction in the information gathering sessions; not all interactions could not be observed due to parallel sessions and informal contacts. CARE was willing to allow a researcher access to the interactions as long as

confidentiality was maintained; this meant that interactions with the client organisation and their stakeholders were not tape-recorded. Data were collected from review of documents (from CARE, the service provision agencies and the team itself), observation and participation in team meetings and information gathering sessions and multiple interviews with the team leaders. Follow up interviews were held after initial submission of the report (with the analyst) and final submission of the report (with the project manager). Therefore, data were collected on the process, the author's interpretations of the process and the team leaders' interpretations of the process (these can be related to the positivist, interpretive and subjective understanding described by Lee 1991). The author's understanding and interpretations of the process were checked through discussions with the team leaders both during the process and after its completion. A summary of the interactions and the number of participants, excluding the author, is presented in Table 1.

Interaction type	Number of meetings	Number of individuals
Team meeting	3	6
Meeting with S1	6	1
Meeting with A1	6	1
Meeting with CARE staff	1	8
Meeting with service providers	5	19
Meeting with customers	2	12
Total	23	45

Table 1: A summary of interactions

Multiple strategies were used for the data analysis (Langley 1999). Although dealing with the large amount of data was daunting, the limited unit and level of analysis (examining methodology use by one analyst in one project) reduced the complexity of the data analysis. It started in the field where interpretations of the process were made in field notes. All notes were transcribed as soon as possible after they were recorded (usually within 24 hours) and a summary of each interaction was recorded. Coding of the data, while useful for studying factors of influence, was found to be ineffective for tracking changes over time. Therefore, a narrative of the 'story' of the case was then constructed using the documents and transcribed notes. Graphical representation or visual mapping is valuable for showing changes over time (Langley 1999). Use of tree diagrams and a time line enabled analysis of the narrative. The process of ISD methodology adoption and use appeared to fall into three stages which are described in the following section.

DISCUSSION

Planned Methodology Use

The analyst selected two methodologies during the initial planning of the project. He outlined his approach during the first interview (Carroll and Swatman 1999). Use of Soft Systems Methodology (Checkland and Scholes 1990) was planned for the early stages of the project to identify the technical and user requirements. This is appropriate as there were multiple, diverse stakeholders in the case and Soft Systems Methodology (SSM) would increase

sensitivity to a range of viewpoints. The analyst believed that this was "*the obvious way to go*" as there is a limited range of tools with which he is familiar, and SSM is suited for this situation where there are "*multiple perceptions and no absolute truths*".

A socio-technical approach was also chosen. Social issues were of great importance in the project. The client, being responsible for services to people with disabilities, specified that consideration of social issues was an integral part of the study. Such issues included the unintended consequences of any new system, such as effects on the quality of care, the viability of service provider agencies and relationships between carers and clients and its potential use as an instrument for future cost-cutting. Therefore, the analyst planned to use a socio-technical methodology to ensure that any technical solution was compatible with the social and organisational aspects of the CARE system. Socio-technical methodologies include ETHICS (Mumford and Weir 1979) and Multiview (Avison and Wood-Harper 1990).
Given the possible changes to the quality of carers' working life and job satisfaction, a participative methodology such as ETHICS could be valuable. The analyst planned to use a socio-technical methodology so that the team could "*work on the technical solutions and the social solutions, then tie them together a la Enid Mumford*". In ETHICS, work on technical and social aspects occurs in parallel. Technical needs and physical factors are specified, resources and technical constraints are identified and then technical objectives are specified. Human needs are specified, resources and social constraints are identified and then social objectives are specified. Next, the compatibility of the social and technical solutions is checked, followed by the delivery of separate alternative technical solutions and social solutions. Finally, the developers work to evaluate the socio-technical solutions.

Potential Problems in the Project

Further analysis of the project through review of the documents collected and discussions with team members led to refinement of the selection of ISD methodologies. In the CARE case, the analyst did not select the methodologies in their entirety; rather, he planned that aspects of two methodologies would be used. This was observed to relate to his identification of potential problem areas in the project. In particular, the analyst stated that reaching some kind of agreement between a range of stakeholders having diverse and conflicting views would be a major problem. Aspects of SSM would be used to reach accommodation between the different groups of stakeholders.

In the CARE case, there was a marked division in the expertise of the team. The team members working on the requirements and electronic commerce had a mainly technical and systemic view of the problem, while the sociologist had an interest in human issues and the social implications of the use of technology. The analyst was comfortable with technical issues but not with social or, as he called them, "*soggy*" issues. The sociologist had no experience of IS projects. The analyst expressed concern about the team's inexperience and unease at working in unfamiliar domains (the technologists in working with social factors and the sociologist in working in a technical domain). Therefore, it was planned that different team members would work separately on the technical factors and the social factors as described in ETHICS. These factors would be brought together in the report produced at the end of the project. Such an approach was appropriate for aligning different goals within the team, particularly the problem of assimilating, synchronising and eventually synthesising very different views, understandings and interpretations from team members in a multi-disciplinary team. Given the lack of knowledge and experience in two different and important domains, ETHICS seemed appropriate for the CARE case.

Actual Methodology Use

Neither SSM nor its associated techniques (such as rich pictures, root definitions and conceptual models) were used. It became apparent early in the information gathering sessions that the views of stakeholders fell into one of two distinct groups (Carroll and Swatman 1999):

- the head office of CARE appeared concerned with financial issues, legal questions relating to accountability and a desire to exert control over service provision.
- the remaining stakeholders expressed consistent, and similar, views as to the nature of the problem, that of poor communication and lack of understanding by CARE's head office of the practical issues faced in the field (by both service providers and customers). The analyst suggested that about 80% of understanding was shared by the agencies, service providers, customers and CARE regional staff.

Therefore, it was not necessary to reach an accommodation between multiple, diverse viewpoints. Rather, the team's task was to educate the client as to the nature of service provision practice in the field. While the choice of SSM seemed well-founded, the analyst indicated that SSM was unnecessary given the nature of the stakeholders' views. Educating the client was an effective way of gaining agreement about the nature of the underlying systemic problems. However, it was evident that the philosophy of SSM played a role in increasing the team's sensitivity to the need to interview a wide range of stakeholders and to consider diverse viewpoints.

The team leaders used a socio-technical approach. Their approach did not involve strict adherence to a formal methodology and did not follow the ETHICS model where the social and technical factors are investigated in parallel. In the CARE case, the social and technical aspects were often tightly intertwined. The team members responsible for technical and social factors worked both together and separately in the field. The sociologist focused on social, political and ethical issues while the analyst investigated systemic and technical issues. They held frequent discussions to share understanding and views; these served to co-ordinate and synchronise their efforts. In this way, the separate streams of social and technical understanding were brought together throughout the process, not as a synthesis but as two complementary and mutually-enhancing views of a problem situation. Thus, the socio-technical approach was a rather loose way of tackling the project that the team members developed as part of the project rather than strict adherence to ETHICS (Mumford and Weir 1979) or any other formal socio-technical methodology.

Methodology adaptation

The CARE case illustrates an aspect of methodology adoption and use that has received little attention in the literature, that is, that contingency factors come into play *throughout* systems development. Methodologies need to be selected for the perceived contingencies of any particular project, such as the type of problem, skills of the participants, time available, uncertainty and risk (Avison and Fitzgerald 1995; Avison and Taylor 1997; Davis 1982). Early in the CARE project, the analyst selected two candidate methodologies according to the perceived characteristics of the CARE project. Next, as more detailed planning occurred, potential problem areas were highlighted. The analyst selected *aspects* of the two candidate methodologies to be used, in order to attend to perceived problem areas in the project (multiple, diverse stakeholder views and team members' lack of experience in the social and technical domains). Thus, he planned to use fragments of two methodologies. A similar

strategy was observed by Russo, Wynekoop and Walz (1995:3), who note that "*Selection of the particular pieces of the methodology that fit the particular development project appears to be common*." Finally, during the project, the analyst adapted the chosen methodologies according to the contingencies of the situation as it unfolded, as shown in Figure 1.

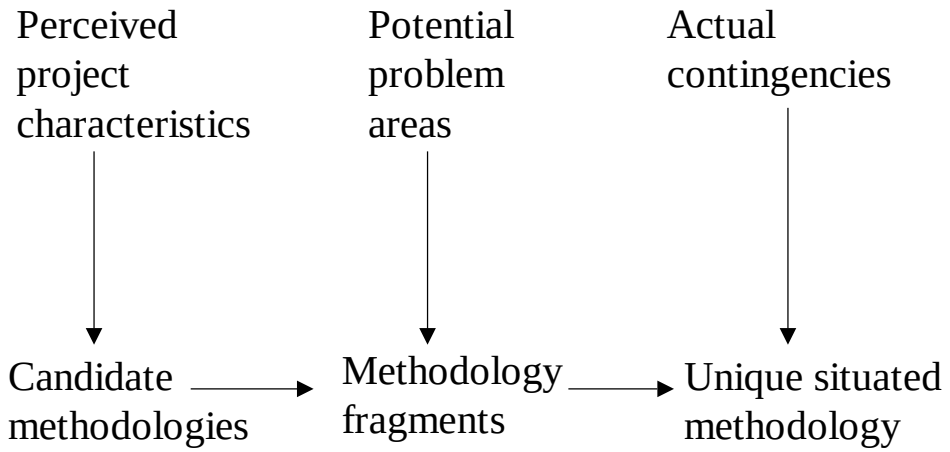

Figure 1: Methodology selection and adaptation

In the CARE case, the teams used fragments of ISD methodologies along with such tools and techniques as semi-structured interviews, scenarios and data modelling to construct an informal methodology. This supports Fitzgerald's view that "*a unique methodology-in-action is enacted for each development project*." (Fitzgerald 1997:202) in that the methodologies were adapted for the contingencies of the CARE case. The methodologies were used as tools to assist the analyst in his professional practice rather than a means of controlling that practice.

IMPLICATIONS

The CARE case provides rich details about one project team's planned and actual use of ISD methodologies. The findings from the case have a number of implications.

Mandatory adaptation

The major finding of the paper is that, in some cases, methodologies *must* be adapted in use in order to fully support the development process. If, as Fitzgerald (1997) argues, a unique methodology is enacted for each development process, then the CARE case has helped to show *why* this occurs. In this case, candidate methodologies were selected and adapted according to perceived characteristics of the project and problems within the project but these perceptions were inaccurate and further adaptation was needed once the project commenced. Systems development is a human activity: humans learn and then adapt their plans and strategies to reflect this learning and increased knowledge. More generally, systems development can be viewed as a situated and emergent activity, the contingencies of which can never be wholly foreseen (if this was not the case, IS project management would not be so difficult).

The CARE case details the adaptation that was necessary to tailor a methodology suited to the project characteristics that unfolded over time. It is likely that developers may need to adapt their development strategies as they learn more about the circumstances of the project (such

as the constraints, the attributes of the stakeholders and the capabilities of development team) and build understanding about the underlying nature of the business opportunities or problems. Further, in some systems development projects, the gap between the developers' perceptions about the project (project characteristics and likely problem areas) and the actual circumstances of the development effort will be so great that a methodology cannot be adapted sufficiently to support the developers. Therefore, the development strategies will involve improvising a methodology that is suited to the needs of the situation.

In a rapidly changing development environment, the gap between initial perceptions of a project and its actual circumstances may be substantial. Extremely rapid and unpredictable change is common, arising from such factors as technological innovation, new procedures and tools and the need to capitalise on emerging opportunities. It is possible that, in such an environment, any plans or methodological prescriptions may have value only as post hoc rationalisations of what was done, rather than as blueprints for future actions (Suchman 1987).

Further, failure to adapt a methodology to the project circumstances may lead to project failure. This is particularly important in those commercial situations where use of a commercial or in-house methodology is considered mandatory for all projects (thus eliminating the first step in Figure 1). Using procedures, tools, techniques and an underlying philosophy that are not appropriate for the project may be disastrous. Developers will not gain maximum support in their work and may even by hindered. One of the promised benefits of an engineering approach, whereby methodologies enable developers of unexceptional skill to perform competently, may not be gained: ordinary developers using unsuitable methods and tools cannot be expected to perform competently and deliver systems that satisfy customers' needs.

Frameworks not blueprints

Given the finding that, in some cases, ISD methodologies must be adapted or only partially applied, it is valuable to examine what form of methodology might be useful in commercial practice. Examination of in-house methodologies (Fitzgerald 1997) indicates that they tend to be brief, provide less detail than commercial ones and only cover those parts of the development lifecycle that are important to the organisation. Such methodologies accord with the description of systems development as situated and emergent. High-level frameworks act as guides to developers and may be customised for the situational surprises and the unique interplay of factors that characterise each instantiation of the development process. These frameworks may be contrasted to prescriptive methodologies that lay out 'one best way' to develop systems of a particular class (where a contingency framework has been used to select a methodology) or in all situations. The nature of systems development is such that prescriptions cannot be appropriate for every problem situation, for every development team and for each combination of situational factors.

Fitzgerald suggests that adaptation of ISD methodologies can be explained by the shortcomings in existing methodologies and the immaturity of our discipline. He argues that "*it is perhaps the case that the process was never well enough understood to definitively prescribe a methodology*." (Fitzgerald, 1997: 211). This implies that, if only we can understand systems development more fully, methodologies that will work in most, if not all, situations can be prescribed. The findings from the CARE case suggest otherwise: the need to adapt methodologies lies with the nature of the development process. Systems development is a human activity that is situated in a unique context. As a result, the early stages of systems

development - as were examined in the CARE case - have a common process only at a high level of abstraction; each instantiation of such a process has its own characteristics that emerge from the interaction of people and technology in a particular context. Accordingly, formal prescriptions outlining how to perform the process may have only very limited application in practice. Indeed, this supports Fitzgerald's finding that high-level, in-house methodologies are used but detailed, prescriptive ones are not. Therefore, methodological frameworks that can be interpreted by different developers and applied according to the needs of a project may be the most appropriate and effective way to guide a project to completion.

Implications for project quality

Taking a contingency approach to selecting and using ISD methodologies throughout development and using methodological frameworks rather than formal, documented methodologies have implications for the quality of the systems development process. The success of such flexible approaches relies largely on the skills of developers. Selecting a methodology requires knowledge about a range of methodologies and the experience and skill to select an appropriate methodology for project circumstances (Avison and Fitzgerald 1999). In the CARE case, the analyst was very experienced and able to match methodologies to the perceived project characteristics. Applying a methodological framework requires a breadth of experience and a well-equipped professional 'toolkit' from which appropriate tools and techniques may be selected and applied. Greater reliance on individual experience and skill works against the goal of providing competence to non-gifted practitioners (Shaw 1990). It also increases the pressures on project managers trying to manage, monitor and control systems development projects, especially those involving inexperienced or unexceptional analysts.

There is also the problem of quality control and developing indicators of aberrant behaviour (rather than achieving a minimal level of quality through conformance to the standards of a methodology). The findings from this case suggest that claims that methodologies help to achieve standardised processes may be unrealistic or that, if standardisation is achieved, it will be at the expense of accommodating other important project factors, such as sensitivity to the development circumstances or the changing needs of the environment. Further, they suggest that standardisation ensures that the development process is responsive only to the contingencies perceived during planning rather than the actual contingencies of practice.

CONCLUSION

A major assumption underlying arguments supporting methodology use is that, by applying engineering principles to systems development, the development process is supported in practice. In this paper, ISD methodology adoption and use is examined in a commercial project. In this case, two candidate methodologies were selected as appropriate for the perceived characteristics of the project. Analysis of potential problem areas led the analyst to select fragments of the methodologies. As the project unfolded, a unique methodology was crafted for the particular circumstances of the CARE case. The findings suggest that it cannot be assumed that use of ISD methodologies is appropriate for all systems development projects. While the findings from only one case are reported, they are supported by the low use of ISD methodologies found by factor research. In this paper, process research is used to examine the changes in factors over time (Franz and Robey 1987) that influence the selection and use of ISD methodologies. A processural approach complements existing factor research and provides some understanding of *why* ISD methodologies are little used. Deeper understanding of the process of applying ISD methodologies in professional practice has

resulted in the suggestion that high-level methodology frameworks may enable developers to respond to both perceived and actual project characteristics. Such an approach is especially appropriate in a rapidly changing development environment, where the gap between perceived and actual project characteristics is likely to grow throughout the development process.

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