

Evaluation of A Manufacturing Task Support System Using The Task-Technology Fit Model

Technology and Information Management

Abstract

This paper presents an exploratory study of a Task Support System (TSS) supporting manufacturing task operations. The study investigated the degree to which a TSS, in use in a company, actually supports the task of the shop floor personnel. The approach has been to adopt the Task-Technology Fit (TTF) instrument to measure the degree of fitness between the TSS and the associated task. The analysis gives an indication of the state of the TSS and the potential improvements that can be made. The study also shows that the instrument can be used as a foundation for the development of a hypermedia TSS and a benchmarking tool for a TSS.

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Introduction

A computer-based Task Support System (TSS) provides shop floor personnel with task-oriented information and a tool to improve their performance. Emerging Internet and web technology now permits hypermedia TSS to be developed. However, developing such a hypermedia TSS for shop floor worker requires more care than usual (Fakun *et al*, 1999), because the users can navigate a hypermedia application in non-linear fashion. Thus, even though a hypermedia system offers the advantage of emulating how human memory accesses information, a complex hypermedia application could be difficult to use and confusing if it is not well structured.

The challenge, therefore, is to ascertain whether the hypermedia TSS is actually supporting the operator task and improving their performance. In theory, meeting the demand of the worker should lead to the system usage (Davis, 1989). While previous research in manufacturing systems has proposed the concept of a task-centred information system, i.e. any information related to a particular task is provided in a structured manner to assist the user carry out the associated task (Wu *et al*, 1999), the key concern in TSS research is to better understand the link between the information system and the task. To determine the extent to which a TSS actually supports the operator, an instrument based on a model known as Task-Technology Fit (TTF) (Goodhue, 1998) was adopted.

This paper discusses some insights from an exploratory study of a TSS for a manufacturing task. The TSS chosen was a hypertext application that has been used for three years. The paper first presents and defines TSS and its application in manufacturing. It then describes the TTF instrument and the dimensions applicable to a TSS. The pilot study using the TTF instrument is described together with the empirical results. The paper concludes with the recommendation on how the TTF instrument may assist researchers and the company in developing a benchmarking tool for the TSS.

Task Support System

As early as 1991, Gery pointed out the need to improve the individual's performance with an Electronic Performance Support System (EPSS). The latter, a computer application, is aimed at improving employee job performance by providing the information that an employee needs to perform a task with minimum support from other people (Gery, 1991). EPSS integrates knowledge and training experience to increase employee performance as quickly and effectively as possible when required since much of this knowledge has a limited life span.

Kasvi *et al* (1996) brought the EPSS concept into the industrial field with the Interactive Task Support System (ITSS). It is defined as a source of information to support the completion of good quality of work, which is available on-demand and is associated with the task supported (Kasvi *et al*, 1996). 'Interactive' implies the end users are accessing the information in the order decided by them. ITSS not only provides on-demand information, but also enhances individual learning. Although ITSS was introduced as a critique of EPSS, both aim at improving performance of the worker.

Task Support Systems (TSS) have evolved from a simple and stand-alone applications to more sophisticated distributed systems with the growth of the web and Internet technologies. Hypermedia technology is now utilised to develop shop floor applications providing information support to shop floor operators. One example is a prototype hypermedia application that supports maintenance of a complex automated process within an automotive engine assembly plant (Greenough *et al*, 2000). The application serves two purposes. One, to provide teams of multi-skilled workers with maintenance information, and two, to familiarise new operators with the work centre through animated sequences. Another example is a hypermedia TSS supporting the manual assembly of cellular phones (Greenough *et al*, 2000). The TSS uses animations and digital video to replace much of the text of a paper based assembly instruction manual. In addition, the assembly instructions were linked to other documents such as part drawings and specifications.

An ongoing research project, sponsored by a major cellular telecommunication company, focuses on the development of a distributed hypermedia TSS to support testing of base transceiver stations for the cellular network (Tjahjono & Wu, 2001). The test department is obliged to provide an accurate test specification at the test stations thereby ensuring the product quality. The system may be used to provide interactive procedures and test information retrieval, and also to provide on-demand training environment to all in-house operators and joint venture partners around the world.

While these examples show that hypermedia technology can be used to develop TSS, it does not indicate whether the TSS application is actually supporting the task or how this affects TSS usage.

Task-Technology Fit Instrument

To measure whether a hypermedia TSS fits the user needs, an instrument based on the Information System (IS) model known as Task-Technology Fit (TTF) was adopted. TTF is defined as the degree of fit to which technology assists an individual in performing their portfolio of tasks (Goodhue, 1998). Goodhue argued that an IT system will be used if (and only if) the functions available to the user support the activities of the user. By extension, a system that does not offer sufficient support will not be used. The TTF instrument is part of

the TTF model in which it is postulated that the fitness is determined by the task and technology characteristics and that the degree of fitness influences the level of utilisation.

Dishaw and Strong (1998) investigated the TTF model using software maintenance tools. The subjects in their study were professional computer programmers, working in aerospace, insurance and financial services companies, supporting maintenance of both software and data. They found that the tool functionality had a positive significant relationship with TTF while task requirements had a significant negative relationship with TTF and actual use of the tool. They concluded that task requirements together with the fit between the task requirements and the technology functionality drive the usage of information technology.

Mathieson and Keil (1998) investigated the relationship between task/technology fit and perceived ease of use (the degree to which an individual perceives a system easy to understand and use). Subjects - undergraduate business students enrolled in an IT course - took part in a laboratory experiment and had to create database queries to answer question to a given problem domain using two different systems. They found that perceived ease of use was a function of task/technology fit. Lastly, a study undertaken by Zigurs *et al.* (1999) showed how a poor fit between a Group Support System (GSS) and the group's task affected the group's performance. These studies indicated that the TTF instrument is a good measure of the extent to which a particular task can be performed effectively and efficiently with a particular technology.

The TTF instrument devised by Goodhue (1998) has 12 distinct dimensions (see Table 1). He tested the reliability, discriminant validity and predictive validity of the instrument on an organisation's information systems and services that support decision making by its managers. The 12 dimensions proved to be reliable and exhibited discriminant and predictive validity. Reliability implies that the dimensions are dependable and consistent. Discriminant validity means that responses to one construct are not associated with another different construct, implying that each dimension can be used on its own. Predictive validity is when an indicator predicts future events that are logically related, i.e. the degree of TTF predicts level of utilisation.

See Table 1

Based on his study, Goodhue (1998) argued that the dimension of fit applies to any IT system, including hardware, software and data. However, the TTF instrument would seem too specific to the information systems and services used to test it. As such, not all dimensions are appropriate for the evaluation of a TSS.

The four dimensions of TTF, depicted in Table 2, theoretically should not be an issue in a hypermedia TSS on the grounds that the data are already hyperlinked in the system. The remaining 8 dimensions are deemed relevant to measure the task/technology fit of a TSS.

See Table 2

The next section presents an experimental survey to identify to what extent a TSS exhibits task/technology fit.

Pilot Study

The study was part of the ongoing research project on TSS. The sponsoring company has a TSS in use and the objectives of the study were twofold. First, to test the appropriateness of the TTF instrument to measure a TSS. Second, if the first objective is met, to obtain a measure of the task/technology fit of the current TSS to act as a benchmark which the TSS under development should exceed.

The Task Support System (TSS)

The TSS under study is a hypertext system that assists the operator in performing the task of testing a base transceiver before despatch. In order to meet the necessary quality requirements, the product has to pass a number of system tests. The TSS provides online access to information associated with the product to be tested and the task to be performed. The successful completion of the task depends on how the operator sets up the connections for the test. As each transceiver is built to customer specifications the configuration of the components varies resulting in complex testing procedure. To meet production deadlines, the changeover process from one configuration to another should be fast. Hence, a TSS was developed and provided on every test station to facilitate the changeover.

The operator uses the TSS to find the configuration number, a unique number for each product variant, which is linked to the configuration diagram showing the connection among the product components. Using navigation bars, the user moves forward and backward between pages illustrating the step-by-step task procedures, and uses hyperlinks to navigate among documents such as the associated product specifications. The TSS, a hypertext application, was developed in Adobe PDF format to maintain the compatibility with the original documents authored using Adobe Framemaker. The TSS also offers full text searching and indexing to facilitate the retrieval of information.

Subjects

The subjects were shop floor operators and technicians working on the testing area of the assembly line where cellular communication infrastructure systems are manufactured.

Data Collection and the TTF Instrument

TTF data was collected using a questionnaire. For this pilot study, three dimensions were omitted from the TTF instrument. These were *level of detail*, *accuracy* and *presentation*. The first two were ignored because they are crucial for the correct completion of the task and the TSS is the only source of information. The length of time the TSS had been in operation is another reason for omitting the three dimensions. There was a risk that respondents would not provide objective measures due to familiarity with the system and more importantly such questions might irritate the subjects. The remaining 5 dimensions of TTF used in the survey are shown in Table 3. Questions were slightly reworded to reflect the TSS. Each dimension was measured with two (one positively and one negatively worded) statements and each item was to be answered using a seven-point Likert scale with 1 being 'strongly disagree' and 7 being 'strongly agree'. The construct items were mixed, i.e. a statement on currency is not followed by the other statement measuring currency, in the questionnaire. Each participant was provided with instructions on how to complete the questionnaire and responses remained anonymous.

See Table 3

Findings And Analysis

The sample consisted of 19 operators and technicians from 2 work-shifts. Cronbach's alpha (a measure of construct internal consistency) of each dimension was estimated. They were above the recommended 0.7 level. Hence item responses for each dimension of TTF was averaged to obtain a dimension index. The mean, standard deviation and Cronbach's alpha for each dimension are shown in Table 4. An overall TTF index for the TSS under study was obtained by averaging the 5 dimensions.

See Table 4

The results show that the TSS does not score equally well on each dimension. In particular, the operators felt that the TSS was not up to date (3.76 out of 7 where 7 is highly current). Moreover the operators' perception of reliability was close to neutral. Only ease of use and meaning had scores that suggested that the operators were slightly happy with the TSS. Overall, the TSS does not exhibit task/technology fit as the index of 4.69 would indicate. The operators surveyed were ambivalent about the TSS. This would suggest that the replacement hypermedia TSS, currently under development, will need to address these issues and be such that it is easily updated with increased reliability. Moreover, improvements on the ease of use, accessibility and meaning should also be implemented.

The survey has shown that the present hypertext TSS is not well received by the operators surveyed and that there is room for improvement. The five dimensions of the TTF instrument are reliable and can be used on their own to detect where modifications to the TSS can be made to improve the overall TTF. It can also be used prior to implementation of a new TSS although the TTF instrument should have the 8 dimensions relevant to a TSS.

Conclusion And Future Work

This paper has shown an approach to measure whether the TSS is actually supporting the task using the Task-Technology Fit model. The instrument used to measure the degree of fitness between the TSS and the associated tasks has shown a good picture about the current TSS and the necessary improvements that can be made.

The limitation of this study has been the small sample size. Nevertheless, the conclusions drawn are valid due to the high internal reliability of the constructs. In the future, the instrument will be fully employed as a basis to evaluate the new TSS being developed to improve the current TSS. In addition, the adoption of other IS model will also to be considered.

This study provides researchers and practitioners with an instrument to measure whether a TSS is meeting the needs of the users. Since the survey was limited to a *hypertext* system, there is a need to see if the TTF instrument is as reliable to measure *hypermedia* TSS. Any TSS that replaces the current TSS should have a higher TTF index if it is to be accepted by users. The pilot study can now serve as a benchmark, which the new system has to exceed.

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<i>Task-Technology Fit</i>		
Lack of confusion	Accessibility	Accuracy
Level of detail	Assistance	Compatibility
Meaning	Ease of use (HW/SW)	Currency
Locatability	System reliability	Presentation

Table 1 – The 12 dimensions of Task-Technology Fit (TTF) (Goodhue, 1998)

<i>Dimension</i>	<i>Definition</i>
Locatability	Ease of determining what data is available and where
Assistance	Ease of getting help on problems with data
Compatibility	Ease with which data from different sources can be compared without inconsistency
Lack of confusion	A result of data stored in many forms and places

Table 2 – Dimensions dropped due to irrelevant context with the TSS to be studied

<i>Dimension</i>	<i>Definition</i>
Accessibility	Easy access to desired information
Currency	The most up to date information
Ease of use	Easy to use the hardware and software
Meaning	Ease of determining what the information or data means
System Reliability	Dependability of access and uptime of systems

Table 3 – Dimension measured and its respective definition

<i>Dimension</i>	<i>Cronbach's Alpha</i>	<i>Mean</i>	<i>Std. Deviation</i>
Accuracy	0.81	4.87	1.28
Currency	0.85	3.76	1.54
Ease of use	0.83	5.11	1.10
Meaning	0.75	5.24	0.98
System Reliability	0.87	4.47	1.29
TTF	0.91	4.69	1.00

Table 4 – Descriptive statistics