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Mobile Project Management: introducing personal digital assistants to support project steering and controlling in trade

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Abstract

This paper describes the introduction of a novel system to steer and control projects in small and medium sized enterprises in the German trade sector. These businesses are facing increasing competition and need to find innovative ways to organise processes more professionally. Trade businesses usually plan projects accurately, but once a project has started, the plan does not necessarily reflect the changes that occur in real life. Reporting is usually done on paper with insufficient processing time and therefore problems can not be taken care of in an adequate fashion. The introduction of PDAs to those businesses as mobile devices for steering and controlling proves to make these processes more efficient. Therefore we explore relevant business processes in the building trade, the singular properties of PDAs and related software developing issues as well as introducing our project steering and controlling system.

Keywords

Project Management, Project Controlling, Software Development, Small Business Research, Personal Digital Assistants (PDA), Business Processes, Enterprise Modelling

INTRODUCTION

With the evolving computer industry during the 70's, we have seen a significant move in the use of project management – away from its sole deployment in large and unpredictable projects, towards a more general application across all parts of industry (Barkley and Saylor, 1994). This development was further assisted by the introduction of Microsoft Project, especially with the Project 97 version – we have seen a significant increase in the use of project management software in Small and Medium sized Enterprises (SMEs) (Microsoft 2000).

There can be no doubt about the significance and benefit of project management for project-driven businesses, therefore an increasing interest in affordable and at the same time powerful tools to manage projects in SMEs can hardly be surprising (Fraunholz, 2001). In addition to the general benefits of project management tools, there are further demands to integrate project management and especially accrued data from other parts of the business. At the same time SMEs face the problem of engaging in "proper" project management which can easily cause additional overheads that might eat up or even exceed the benefits (Fraunholz, 2001). Furthermore, there are issues such as training, installation, rejection, etc. that need to be taken into account.

Against this background, we initiated the project ProHIT (Projektmanagement im Handwerk mit informationstechnischer Unterstützung), an action research project concerned with the introduction of project management in the German trade sector. The German trade sector is very traditional and particular in its structure with a governing body, the German Chamber of Trade. More significantly for our research however, trade mainly consists of small with a few medium sized businesses (Fraunholz, 2001). As part of the larger project we are looking at ways to improve the administrative load and make business processes more efficient by introducing computer-assisted project management in selected businesses. Even though not all trade businesses embark on projects, there is a substantial section working on nothing but projects. Focusing on these, we decided to take a closer look at the building trade. We soon found that the mere introduction of project management software is not sufficient;

therefore we saw the need to find additional concepts by making use of available technology.

After some initial research into participating businesses, we found that one of the main problems was the decentralised accrual of data during business processes. This habitually led to a lot of paperwork that needed to be dealt with back at the office. The expected consequence is delay in problem detection, controlling, ordering of supplies and added inflexibility. This certainly is uneconomical and at the same time can be very costly; therefore we looked into possibilities of utilising mobile devices to tackle this problem.

WHY HANDHELD PCS?

Handheld PCs or Personal Digital Assistants (PDA) are comparable in size to larger cell phones, nevertheless, PDAs are capable of assuming similar tasks similar to regular PCs. Size however makes them highly flexible and mobile, thus allowing them to follow the work, providing important information or accepting data. There are special dirt, water and shock resistant versions which can easily be taken to a building site. As we will see later, the restricted functionality with limited user interface focuses the user on the relevant tasks and therefore enables someone with limited computer experience to use the device without extensive training. Once the Handheld is back at the office, synchronisation allows for data to be transferred to the main system.

ORGANISATION OF TRADE BUSINESSES

As part of the development process, it is essential to understand the way trade businesses work. The starting point is the organisation of SMEs. Trade businesses tend to be organised very similarly. Figure 1 shows the typical organisational structure of those businesses examined.

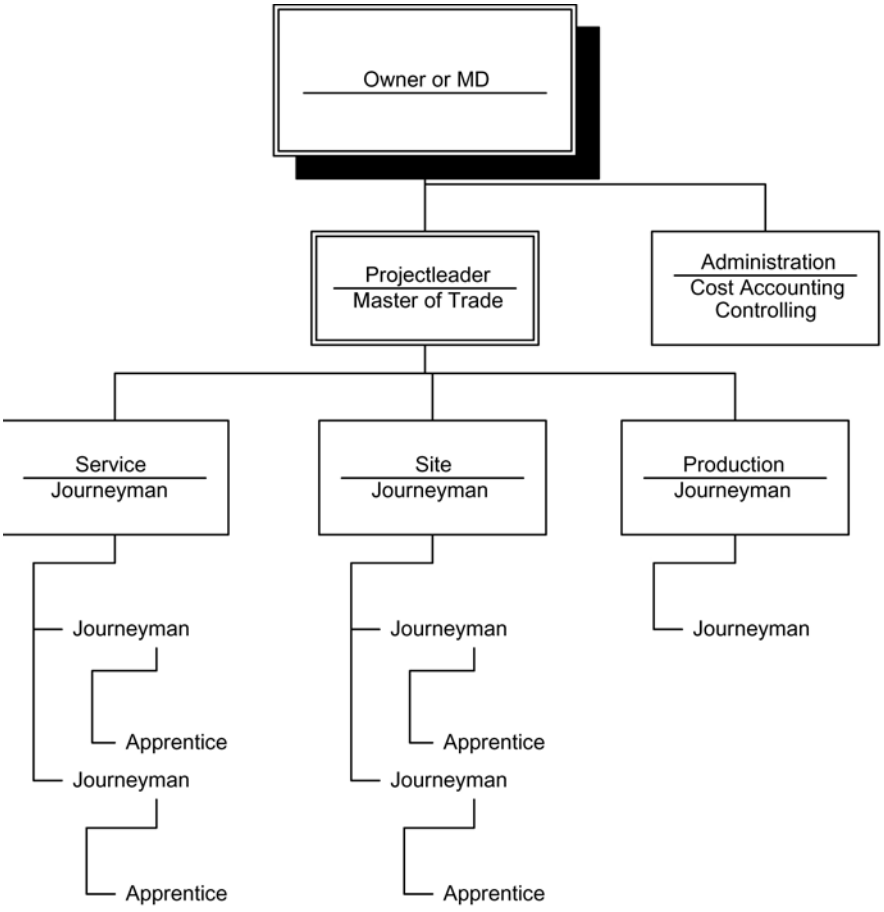

Figure 1: Organisation of small trade businesses

The owner or managing director always stands at the top. S/he is head of administration looking after financial and cost accounting as well as stock. The owner will also be superior to the master of trade. In some businesses, the master and owner may be the same person. The master heads the journeymen (Germany has retained the tradition of the medieval trade guilds, for more information see Fraunholz 2001) in various departments such as service, site, production; which in turn are in charge of other journeymen and apprentices.

Looking at the description above, it becomes apparent that many instances are involved at different stages and in various functions during projects. We will not describe project stages in general because those are widely recognized (for more information on project management, see Lock, 1996) and even though they compose the foundation for our project, they do not have a direct impact on this research. However we want to depict those areas significant for the introduction of mobile devices. Consequently we have focussed on phases concerned with project implementation.

ADDAPTING PROJECT MANAGEMENT PROCESSES

The implementation of projects must be looked at in two ways. First there is the implementation of a project and secondly there is project controlling. The ground work of those projects is usually carried out by journeymen with the assistance of apprentices. Looking at the processes involved, those activities can be described as iterative. An exemplary simplified version of the processes involved is described using MEMO (Multiperspective Enterprise Modelling Language Process – here the Modelling Language; Frank, 2002) see Figure 2.

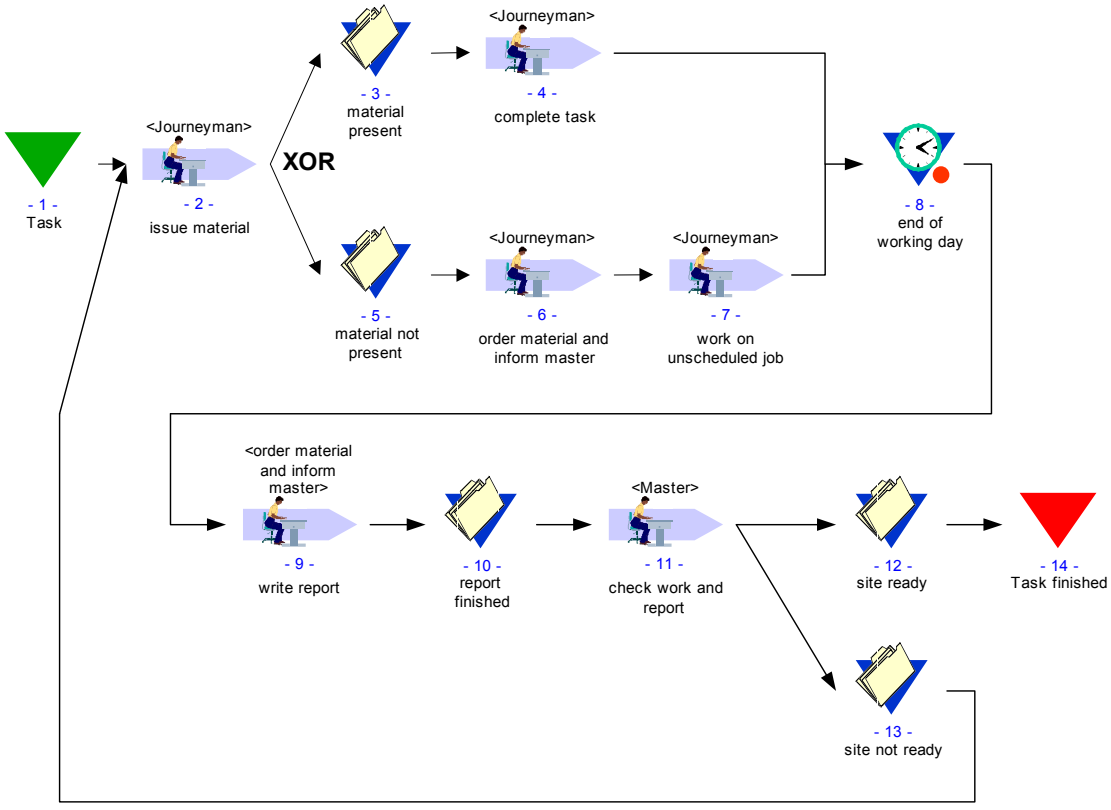

Figure 2: Project Implementation

For our purpose the most significant part of this model is the journeyman receiving his daily workload and the master checking the work and corresponding report.

The journeyman has to receive his timesheet with all tasks for the day and will then find relevant material. Once completed, s/he will write a report and complete the timesheet.

The master's check is done on a daily basis and naturally focuses on technical issues like examining if the journeyman has connected the wiring according to the circuit plan. The second instrument used by the master is timesheets. These are used to note the time and

tasks performed by the journeymen or apprentices. Additionally they are also utilised to register material used. This allows the master to get a representative picture of the site but s/he has no means to match this to the actual project plan and therefore very frequently makes urgent decisions by gut feeling.

There are various constraints that need to be taken into account in order to implement PDA assisted project management in trade businesses. Primarily we are looking at the problem of potentially increasing the workload for the master and the cost involved:

- The **cost factor** can hardly be relevant because we are only looking at an additional acquisition of a few PDAs. The integration with a synchronisation server is hardly probable because we are only dealing with SMEs.
- Primarily, the **additional workload** will definitely increase because at the initial stages of the project, the master will need to put in an extra effort in precise project planing. However, s/he should be persuaded that this is well worth the attempt and that software will assist the planning and controlling process.
- One of the big advantages is that there will not be a **change of media** to instruct our journeymen and later update the plan with the actual workload because the data can be taken to the site and updated dynamically. The device will then be returned and the data copied back into the system. When the master does the controlling, s/he can look at what has been done and will be able to focus on technical control.
- **Usability** is another important factor. Such a system needs to be easy and comfortable to use. The master should be able to use and maintain the system single-handedly. Therefore MS Project 2000 seemed a good choice as the project management base because of the numerous sources of support and information available e.g. on the web or in newsgroups etc.

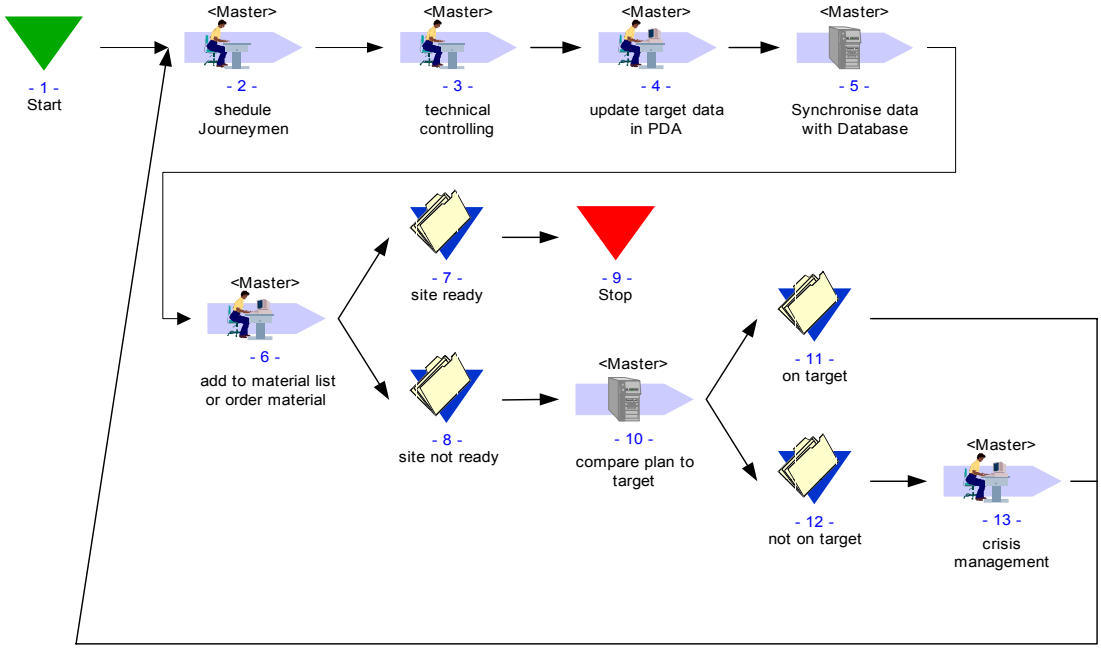

Figure 3: PDA Project Controlling

In order to achieve the project steering and control, we use schedule and resource planning as our foundation. Individual work packages are mapped to due dates and linked with constraints. Once all resources have been planned, the list will then be issued to “supply”, to match with stock and if necessary, place orders. Based on this plan, individual targets for each journeyman can be issued and taken to the site. Also all material used or missing can be documented. Controlling as described by Figure 3 can now take place more efficiently because all the data from the journeymen is transferred back to the project plan in the

project management system and any discrepancy becomes apparent immediately, leaving more flexibility for the master to manage a potential crisis.

PROGRAMMING MOBILE DEVICES

'Mobile device' is a term not sufficiently defined, but there are some informal definitions by Hansmann (2001) and Giguére (2000) – generally mobile devices are introduced by example. Some major examples are:

- Mobile phone
- Personal Digital Assistant (PDA)
- Smart Phone
- Some Embedded Systems

However when looking at mobile devices, we exclude sub-notebooks or laptops because of size and similarity to desktop PCs. Therefore we can conclude with a rather ambiguous definition: mobile devices can be carried comfortably and allow for some form of communication.

For the purpose of this research – with the necessity to enter data, tick off tasks and have some type of processing power, with the ability to synchronise or communicate with a server, we focus on mobile devices – taking the form of a PDA.

Limitations of PDAs

Mobile devices are limited compared to desktop computers (Satyanarayanan, 1996). Those limitations come into play when choosing a specific platform.

One of the most significant and apparent limitation is performance. Looking at today's common practice of software development such as component-oriented software development, powerful middleware technologies, and generic frameworks, we have to revert back to more traditional concepts from the days when memory and processing power were scarce. The return of investment on reusable frameworks is higher than for a specialised approach and platform independent code like Java, which is not compiled to machine code but has to be interpreted. Generic software development and reuse of certain artefacts has become increasingly popular and makes the process more productive, but the price for this is a significant overhead in code size. As much as these techniques can be said to be adequate for today's desktop PCs with up to 2.6 GHz CPU speed and commonly 512 MB RAM as well as 80 GB hard drives, they can hardly be acceptable for devices that usually offer (Compaq, 2002):

- Up to 206 MHz CPU speed
- Up to 64 MB built-in volatile memory
- Supplementary non-volatile memory

A second restriction with PDAs is the user interface. As much as 50% (Myers and Rosson, 1992), and in extreme cases up to 80% (Jacobson, 1992) of the expenditure and code is spent on the design and development of the user interface. Therefore one can safely assume that the user interface is a highly relevant element of software, it determines the acceptance and inevitably the success of software by ease of use. The user interface for PDAs is defined by the form factor (Giguère, 2000). The small dimensions of PDAs naturally do not offer scope for huge displays, keyboards or mice. As a result, established user interface concepts have to be substituted by tailor-made solutions for PDAs. There are two elements to the user interface (Collins, 1995; Martin *et al*., 1991; Hofmann, 1998).

Presentation of information:

The presentation language comprises of all user interface components necessary for mere presentation of applications by mapping application data to a comprehensible presentation for the user. Output methods for PDAs are display, indicator lights, and sound output. The sound and light however can hardly be used because they are only suitable for notifications and despite the ability to play music; sound is not an appropriate method to represent data for business applications. This leaves the display as the main means of interaction. In the case of a Compaq iPaq H3660, the resolution is 200x320 pixels. This is very small

compared to desktop computers with a resolution of 1024x768 pixels and therefore the user interface must be designed with even more care, reducing the screen layout to an absolute minimum (Hansmann, 2001).

Figure 4: Virtual Keyboard of a Compaq iPaq H3660

Interaction with the user:

The action language is responsible for user interaction with an application. It offers the mechanism for data creation, editing, deletion, and manipulation. The nature of a PDA with a touch-sensitive display as the main interface make the graphical user interface with components like menus, push buttons, combo boxes and list views an essential element. The main two PDA operating systems available, namely the Palm OS and Windows CE offer two concepts for data input: character recognition in a dedicated area subdivided by numbers and letters or a small virtual keyboard (Figure 4) displayed on the screen (Hansmann, 2001).

The last restriction is also one of the advantages of PDAs. As many of today's applications depend on continuous network connections, this can not always be secured with PDAs when they are out in the field. Therefore, the synchronisation with a mail server or a central corporate server is a bit more complex than that of networked PCs upon which many applications are based e.g. on a client server architecture or a distributed data management system with a certain type of communication infrastructure. Mobile devices are not usually connected to a wired network; therefore they depend on mobile communication or other adequate substitutes. Two main possibilities for the integration of PDAs are as follows.

Online Communication:

Online communication requires a communication connection to a business information system. This can be either by a cellular network like the most favoured service for telematic services in Germany (Vieweg, 1999), the GSM (Global System for Mobile communication) or its imminent successor (Diebold, 2000) the Universal Mobile Telecommunication System (UMTS). The most appealing feature of mobile telecommunication is the possibility to receive information virtually everywhere. However compared to conventional Local Area Networks (LAN) with a bandwidth of up to 1000 MBit/s, the possible transmission rate of 9.6 Kbit/s achievable by using High-Speed Circuit Switched Data (HDSC) or General Packet Radio Services (GPRS) is very limited (Hansmann, 2001). This problem currently looks as if it is going to remain because the 2 Mbit/s transmission rate possible with UMTS has to be shared between all users in the same cell, and moving customers will only be able to get a

lower bandwidth so that UMTS might in some instances be slower than GPRS or HDSC (Durlacher, 2001). The most significant disadvantage of mobile telecommunication networks however is transmission cost. Airtime as well as packet transmission involves huge expenses with a 1 MB document setting the business back by about €5. With the fees telecommunication providers in Germany paid for UMTS frequency band licenses, this is hardly going to drop dramatically in the near future.

Offline Communication:

The second approach we call offline communication avoids communication over mobile telecommunication networks. As a result there can be no communication between the client and the database while the PDA is on the go. This is made possible by replication of necessary data to the client, and synchronising changes with the business database on return to the office. Synchronisation can either be made by means of a serial interface (RS232 or USB) or the PDA may be connected to the network by means of e.g. wireless network (IEEE 802.11b) with its own network address. Replication must be done before the PDA leaves the business. The frequency can be any adequate period of time for the application. However it is important to secure that after replication all relevant data has been made available on the PDA, because once the PDA leaves the business there is no chance to retrieve additional data. Also the restricted memory of the PDA comes into play because of its very limited space for replication data. The design has to be very specific and actual data must be carefully selected. Synchronisation and replication are not trivial but a lot of work has already been done in this field (Ratner, 1998). The main task here is domain specific design of the replication scheme with relevant data under the constraint of limited memory.

Both concepts above suffer from limitations; therefore we are looking at an additional approach, the **Hybrid Approach**. With this approach, it is possible to use replication to get the main body of data onto the PDA, but if the need for additional data arises and if it is important enough to justify the cost involved, it is possible to establish an ad-hoc connection with a server. This approach makes it possible to deal with some of the problems, but it induces laziness with the replication design and can also incur significant online expenditure. Also the problem of bandwidth and other general restrictions of PDAs still remain.

PDA ENHANCED PROJECT MANAGEMENT

As seen above, we have developed an idea to assist project management by introducing PDAs for steering and controlling projects. During this research we had to focus on areas where project management could be enhanced by introducing PDAs.

Before we started our research we had to take various strategic decisions such as:

- Cost
- Usability of the device
- Interfaces

Platform and Software

For the purpose of this project, we decided to base our research on MS Project 2000/2002 because it is a very powerful package with significant support on the web and in literature. Also, because we are dealing with SMEs, the price for the individual software licenses plays a significant role for accepting the package. With the help of ODBC, it is possible to write data from MS Project into a SQL database. This in return provides for easy access by other software tools. For the purpose of this project we used Oracle 8i but any other SQL database would have been equally sufficient.

We decided to use the Palm platform during the initial phase of the project. Palm had two significant advantages over the Pocket PC. The community of Palm users is widespread, so we assumed it would be easier to develop software for this platform; secondly, the Palm is cheaper and therefore more appealing to participating businesses. However after the initial decision was taken, we realised that the only available language that has evolved beyond beta status on the Palm side was C while on the desktop PC we would have had the choice

between C++ or Java. We decided to continue with C and because of the good database connectivity with the Java Database Connectivity (JDBC), opted for Java (Ullenboom, 2001).

After some initial problems, we also started development on the Pocket PC because of its integration with the Windows operating system and a powerful virtual machine, choosing Java as the sole language on both sides.

The System MoPro (Mobile Project management)

As far as the original project planning is concerned, nothing has changed. The project manager finishes the project plan, allocating resources and time on his desktop PC. During his planning, the systems stores data in a SQL database instead of writing it into MS Project 2000. This database can either be a central server or locally installed on the project PC.

Because of the financial constraints of SMEs and the ability to use replication for project data without major restrictions to usability, the DB Connector communicates with the replication routine as soon as the project plan is updated. This routine just passes data on to the PDA where it is stored. This PDA will than be handed to the journeyman to instruct him with his job for the day and a list of all necessary resources. As the journeyman gets to the building site or workshop, s/he will continuously work the task list (Figure 5) and tick it off or note his progress accordingly.

Figure 5: The MoPro User Interface

Once the work for the day has finished there are two alternatives. The first is, the journeyman returns to the head office and places the PDA in the synchronisation device so that data can be written back into the SQL database, thus updating the project plan. Secondly, if the journeyman is not returning to the office s/he could use a GSM phone to dial into the database and synchronise via GPRS. At present, this would be done either by a phone connecter cable or infrared connection but it could also be via Bluetooth or by an internal GSM card. The cost for this is quite moderate because there is not a lot a data that needs to be transferred. However the synchronisation framework has to be very carefully drafted because it is necessary to secure data integrity; also the organisation of the project must reflect the need for synchronisation by making sure that there is only one person in charge of each work package so that any report on this will be explicit.

Once the data from the site has been received, the master gets notification and can check on the daily progress in the project plan. At this stage there is a choice to confirm data coming in from the site or to replicate the data to a PDA and take it to a site to start the project controlling process. As the master goes to the site there is an option to compare the last confirmed progress with that reported by a journeyman. If this is identical nothing needs to be done – variation can be noted and a report is automatically generated. Also this feature can be used for technical controlling by the master so that any necessary acceptance test by the master or even a client can be processed on the PDA.

Once the master has finished controlling the project similar synchronisation options are available as for the journeyman.

CONCLUSION AND FUTURE WORK

So far we have learned a lot about PDA programming. Getting involved in an area of software development at an early stage always bears a certain amount of risk and we have had to deal with a lot of obstacles on the way. Many of the developers' tools had not evolved beyond the beta stage and some were abandoned during our project.

This is especially true for the Palm because the developer kit proved to be faulty; therefore our efforts were significantly undermined. One of the most enjoyable experiences was dealing with restrictions of PDAs and finding adequate solutions. Communication with our businesses had to be very frequent during the development of the user interface to make it as easy as possible to use and achieve functionality and acceptance.

Implications to Date

The introduction of this prototype has caused interesting reactions with our businesses. Owners and project managers have adopted the system with alacrity, having appreciated the benefits straight away. The journeymen however, had initial problems getting used to the device. Even though the initial weakness of a limited user interface has proved an advantage for this application because there is hardly any incorrect choice to be made, there has been considerable concern that this kind of project steering and controlling would amount to something like 24-hour supervision. However after some weeks, we have found that this attitude has changed because the masters have adopted a management strategy to reassure the journeymen and also it has become apparent that with the introduction of the PDAs, there is less paperwork to deal with.

One of the greatest achievements has been that those SMEs have actually started to think about project control and can see the benefit in it. Before we started our project the controlling processes usually consisted of gut feeling and a look here and there, but hardly ever were findings updated in the project plan. Now there is an almost up to the minute picture available and long term planning as well as customer support have benefited tremendously.

Future Work

Clearly we have only installed a prototype and the system is still provisional, therefore we need to continue the refinement process and investigate how the system would need to be adapted to be useful in other trades.

Up to the minute project data in combination with a thorough project plan and detailed CAD design of the final object has the potential to provide customers with a web interface to make it possible to investigate site progress on a daily basis. Such an interface could be utilised for marketing at a later stage.

Additionally it is now possible to involve all trades engaged in the building process in one virtual project so that a joint project base could be instated where all project data and communication is centralised. This would allow all trades involved to do project planning online e.g. by web interface. This in combination with the continuous update by PDA would allow problem identification at an early stage and therefore make it possible to react accordingly.

In parallel we are exploring other uses for PDAs to make the acquisition even more economical. Therefore we are exploring ways to integrate a navigation component with the project component so that the PDA will navigate the user to the site in question. We are also interested in enabling communication from the office to the PDA so that urgent messages, last minute changes or updates can be transferred online via GSM.

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