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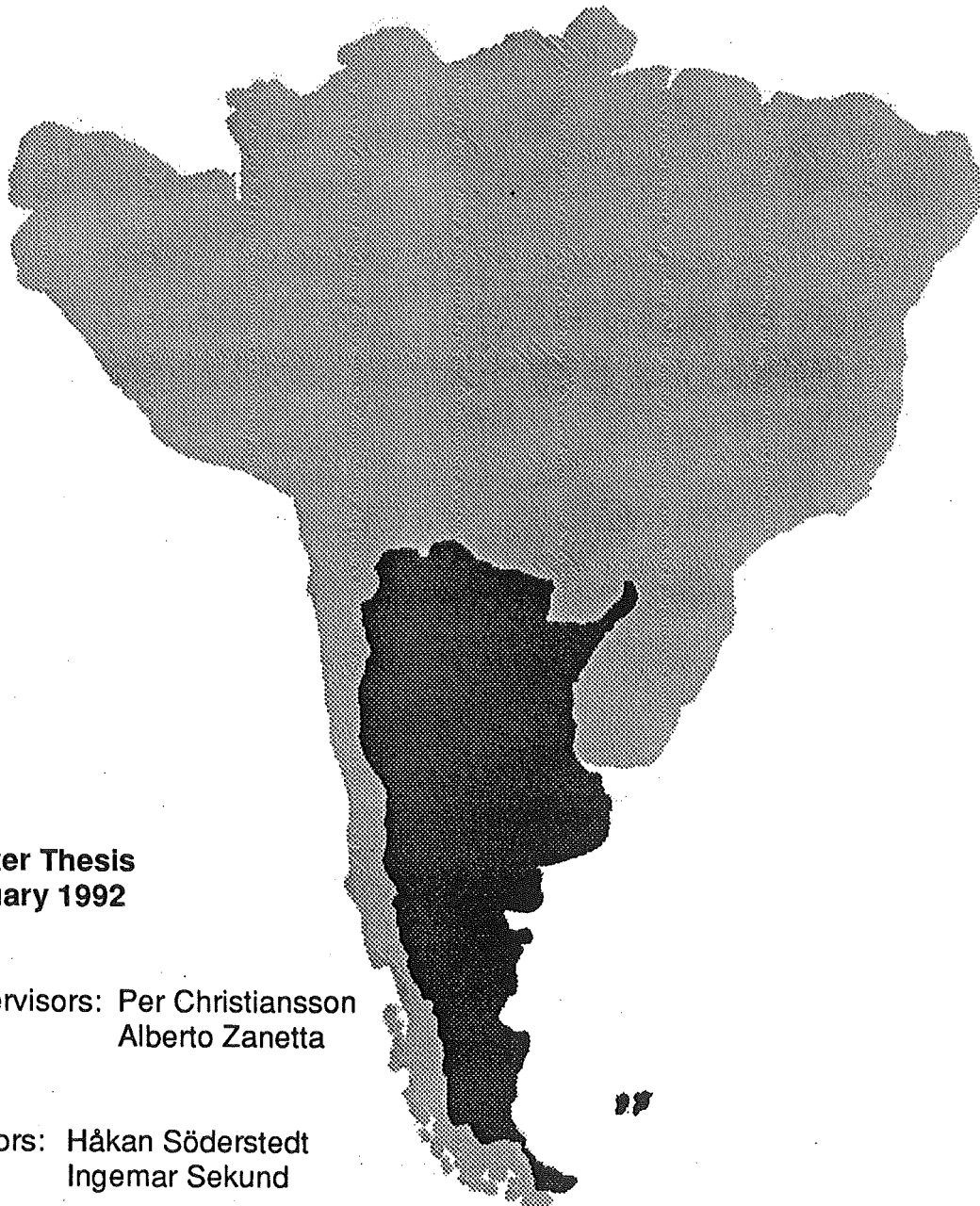Department of Structural Engineering

Introduction of new technique in Argentina
- Multimedia in training & education

Master Thesis
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Abstract

We have searched for different possibilities to introduce Multimedia at a welding company in Argentina. We decided to create a training system. Our system should teach an unskilled user how to use a rather complex expert system for welding.

In this paper we discuss the design and implementation of a multimedia training system. We also include an evaluation of the software tools used in this project, mainly Linkway, SoundBlaster, Topas and Storyboard.

Some constraints were put on the development work, by the company, due to hardware and software limitations. A PC environment was pre-scribed. It was also very hard to buy software on the open market.

The system is easy to use and has a friendly user-interface. It contains multivariable choices to provide the user with a multitude of options. One of the main design ideas is a map, as a general concept through the whole system. This map is a tool for both browsing and mindmapping.

The conclusions contains important elements in the design, analyses of software tools and the evaluation of multimedia technique at a welding company.

Preface

This report is the documentation of the master thesis project "Introduction of new technique in Argentina". The work comprises the design and the implementation of a training system using multimedia technology. The work was carried out during the summer 1991 at Cometarsa Inc., a welding company in Buenos Aires, Argentina.

In completing this work we owe a great deal to all of the employees at Cometarsa, especially to Mr Alberto Zanetta managing director, Mr Pablo Pettinaroli engineer and Denise Ferreyra personal manager. We would also like to thank our supervisor Per Christiansson, Assoc. Prof, Department of Structural Engineering at Lund Institute of Technology who was our link to Sweden during the stay in Argentina and later our adviser during the report writing.

Some parts of the work was carried out together with Marc Van Haren (USA) and Thor Lunde (Norway).

Lund, Sweden
January 1992

Ingemar Sekund

Håkan Söderstedt

Contents

1. Introduction

1.1 History

Why Argentina? The reason for Evert Taube* was Senoritas, La Pampa and Rio de la Plata? For us it was a great challenge to learn about a different culture and to work with a new technique together with Latin American people. Through IAESTE, an international association for student work exchange, we arranged a project in Argentina.
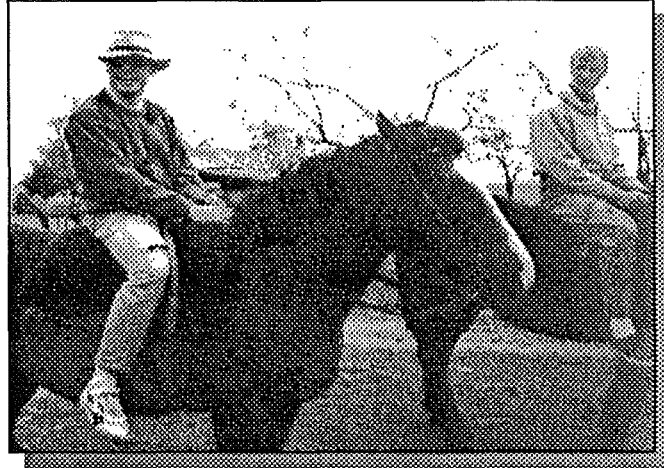

Figure 1.1 Gauchos on La Pampa.

The project carried out in Buenos Aires, was about an introduction of new technique. We worked on an expert system/multimedia project for a period of twelve weeks. Working with the latest technique in a country such as Argentina is special because of the lack of new software and hardware. At this time the company also struggled with financial problems.

Cometarsa, where the project was carried out, is a welding company which produces large steel constructions. About two years ago the company started to introduce computers in different areas. One project that started at that time was to create an expert system for welding. The first edition is running today but the user interface is not sufficient for todays requirements. Only the experts can use the system properly. Our mission were 1) to introduce the technique and tools available to build training systems and 2) to build a training system as a bridge between the expert system and an unskilled user.

This paper assumes the reader to have some previous knowledge of the technology of multimedia and of the use of computers and computer software.

First, we will give a shorter description of the company, the expert system and multimedia in order to provide the reader with an overview of the paper. Then, we will discuss the process of creating the multimedia training system, from the initial "research" to the final

* Evert Taube (1890-1976),Swedish writer, ballad-singer, composer and artist.

implementation. Afterwards, we will summarize our thoughts about the tools used in our project and about the multimedia future at Cometarsa.

1.2 Purpose with this paper

The main goal of this paper is to document the process of the creation of the training system for the Sistema de Soldadura expert system in the form of a multimedia application. It is purely an example -- a particular case of the application of multimedia to the development of a training system. But with this example, we hope also to shed light on more general ideas: 1) to show how to create a training system in the form of a multimedia application, and, even broader, 2) to tell something about how to create multimedia applications in general.

1.3 Introduction to multimedia

In this section we want to describe some of the keywords used in this paper and also to give a smaller definition of multimedia and hypertext. We don't claim to cover this area completely but the goal is to give an explanation good enough to understand this paper.

Hypertext

Ted Nelson is the creator of the term "hypertext". In a letter (in June 1987) , he stated "I define hypertext simply as non-sequential writing.". Given this broad definition, hypertext is any form of writing or reading which is done non-sequentially or non-linearly. A hypertext system allows the user to *link* information together and thereby creating trails through associated materials. A link connects words or sentences in one electronic document with related information in another document. The words or the sentences in general called *nodes*. The nodes in the picture above are pages in a document.
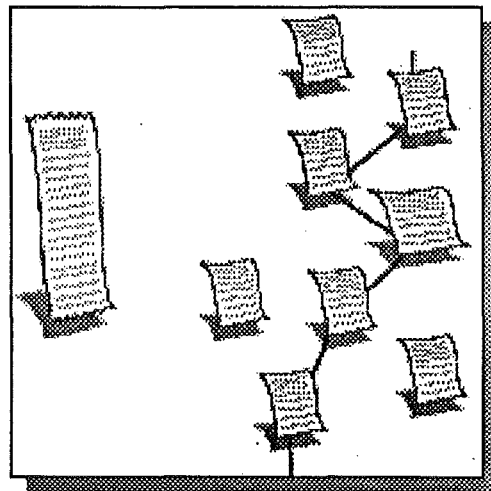
Figure 1.3.1 Ordinary text and
non-sequential text.

Multimedia

Multimedia incorporates several media types - text, graphics, audio, animation, video - in a single computer document; sound and/or motion are integral to a true multimedia project, see figure 1.3.2.
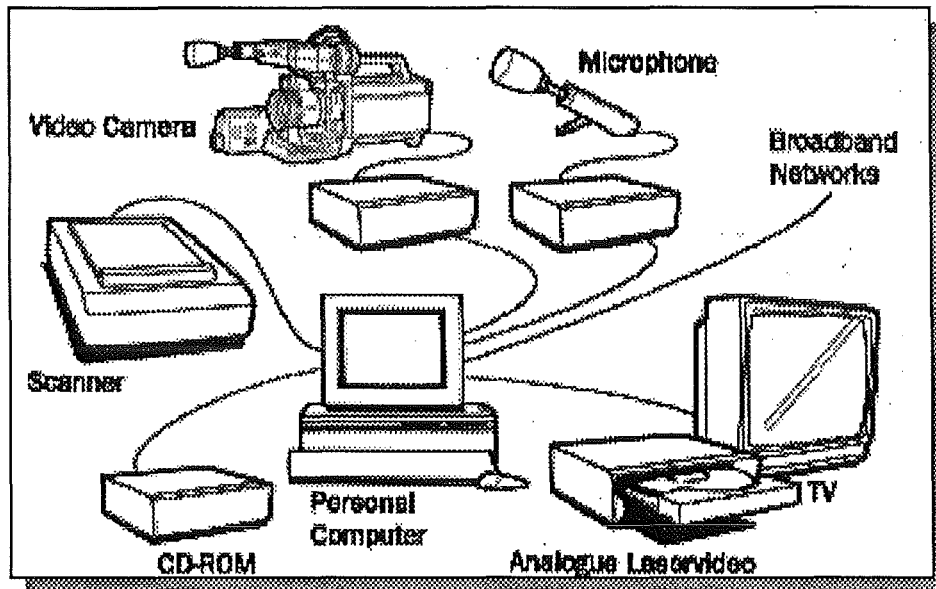
Figure 1.3.2 Different multimedia equipement.

What distinguishes multimedia from film or video is interactivity. Computerbased multimedia allows the user to determine the pace and the path through ever-branching options. Multimedia developers must be much more than programmers, video producers, and audio wizards. They also have to be interface designers able to knit together several media into easy-to-navigate documents.

When the difference in the definitions between hypermedia and multimedia is vague we will, in this paper, use multimedia as a united name for both of them.

Hypermedia

If we now keep in mind the definition of hypertext and instead of only linking non-sequential text and sentences also link other media (represented in the nodes), such as graphics, video, spreadsheet, animations and voice. In short, users of hypermedia systems can link together information of any media type supported by current technology, see figure 1.3.3. One can say that hypermedia is a non-sequential media and doesn't have to include text. For example one can create a hypermovie, a film where the viewer decide which story to follow.
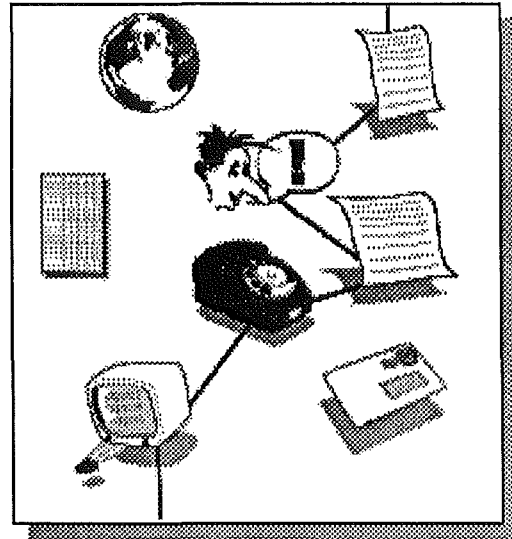
Figure 1.3.3 Hypermedia links together medias of differente kinds.

Expert system

An expert system behaves as a human expert would with a particular problem. An expert is a real test for machine intelligence, because the machine must duplicate a human's response in formulating the best possible solution to a usually ill-defined problem - one of the areas in which humans uniquely excel the computer. In short, an ideal expert system must be able to match a human's thinking ability. Today expert systems are widely used in a variety of highly specific applications. For example, the diagnosis of diseases, the analysis of organic chemicals, financial portfolio analysis, and battlefield management are all areas in which highly organized, efficient computer expertise can be in aid of humans, particularly when the problem is too complex for human expertise to be applied directly.

1.4 The company

1.4.1 Facts about Cometarsa

Cometarsa was established in 1949 by Mr Agustin Rocca and is one of the companies in the Techint organisation. Cometarsa's plant occupies a permanent staff of 500 people and is located in Campana (province of Buenos Aires), on the banks of the Paraná river, 70 km away from

Buenos Aires, see figure 1.4.1.

Cometarsa produces "costume made" equipment mainly for the domestic market even though it tries to reach international acceptance. The main product today is hydro mechanical equipment for hydro electrical power stations, such

Figure 1.4.1 Map over Argentina,Buenos Ares and the location of Cometarsa.

as radial gates, spiral chambers and predistribution rings of turbine-pumps. Other products are equipment for the industrial and the petro-chemical process and for the nuclear industry.

1.4.2 Philosophy as related to new information technology

As mentioned above Cometarsa's computer history is fairly short. The company is now working hard on expanding and improving their information systems in several areas. The intention is to build up a good internal and external information flow, from quality assurance of welding to material ordering system and selling statistics. The work information flow has improved a great deal with the expert system and Autocad drawings in recent times. Another goal is to integrate these systems as they grow within the company. Right now the company wants to improve their knowledge about information technique by introducing multimedia technique, for training and presentations.

1.5 The expert system

In this section we will describe how the expert system is designed and the general goals for the system. We will do this by answering the questions why and how the system has got its present design. There are three main reasons for the use of the expert system today.

1.5.1 Reasons for the present design

Why?

The first reason is to produce a WPS-form. The WPS-form is a welding Procedure System form that standardise all the joints welded at the company. This is the output from the expert system which specifies the information required in the welding process.

How?

By using dBase and Clipper, a database manipulating language, it is possible to get access to information about welding stored in the databases. The databases contain information about tools, materials and specified joints in the welding process. By choosing the right set of menus and put in exactly the right figures about the joints, it is possible to produce a WPS-form. However, to carry these steps through, and what is more, to put them in right order is a rather complicated procedure and it requires an expert to fully understand all the steps that have to be done. The reason for this is mainly depending on the bad user interface within the expert system, but also on the planning of the system, it is not carried out from the users point of view.

Why?

The second reason is to increase the quality control in the welding process. This will reduce the failure rate at the end of the production line. This is of great importance in the welding process because failures in the final products can be very expensive.

How?

An increased quality control can be obtained by storing information about previous failures, and process it at a later occasion. Another effect of this feedback is that weak links in the production process can be identified and adjusted.

This feedback is carried out by storing failures on three stages.

stage 1: The number of times a certain standardised type of joint has failed.

stage 2: Specification of the kind of failure for each type of failed joint.

stage 3: All the joints are grouped together depending on the type of failure. The reason is to search for the most frequent failure.

Why?

The third reason is to make the welding process more effective. This is done by focusing on the material-consumption and work time for

each joint.

How?

The WPS-form consists of an ABC-curve. The ABC-curve is a classification of the joints depending on how important they are. The most important joints are classified as A-class and the least as C-class. The welder now knows where to make the most effort, put in more material etc. This classification is done by counting size and position of the joint.

1.5.2 The expert system design

The system is composed of a series of menus divided in seven different parts. See figure 1.5.1
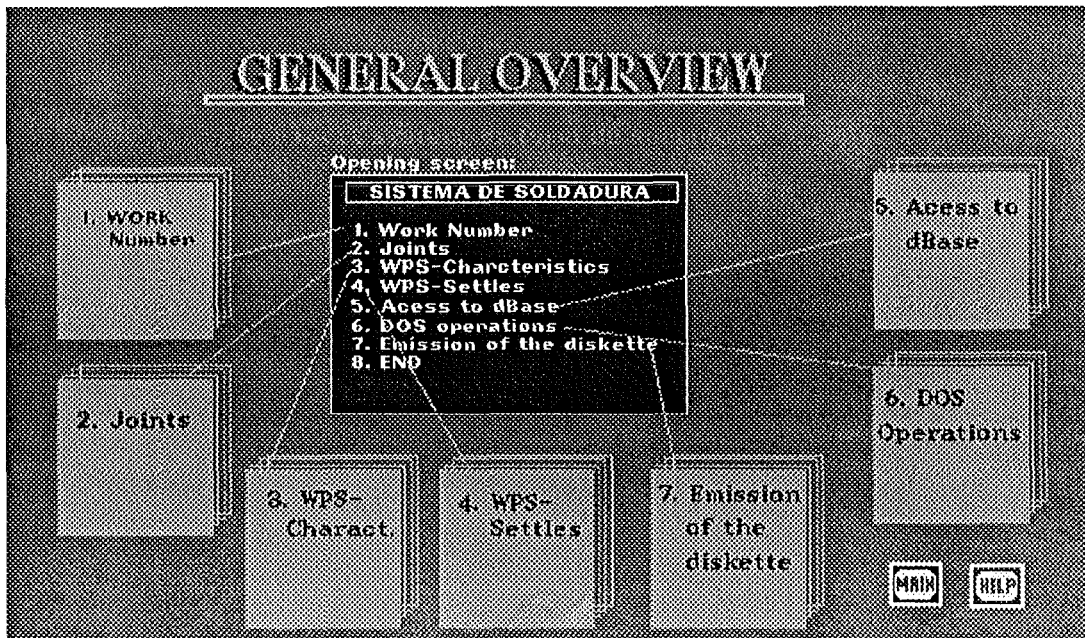

Figure 1.5.1 Overview of the expert system as a screendump from the training system.

Part 1: Work number

Three identifications for the job are entered:

    -- the work number (any number)

    -- the work name (the destination of the job)

    -- the costumer's name

Part 2: Joints

In this part it is possible to:

- -- enter all data (length, material, temperature....) about the joints within the same work number.
- -- view, modify, print and present the characteristics of the different joints.
- -- generate and view the ABC-curve (the ABC-curve is a classification of the joint depending on how important it is).

Part 3: Characteristics

This part is only for experts. Here an expert can create or modify a joint and store it in the database.

Part 4: WPS-figures

In this part one views, modifies or prints the WPS-figures (the final product used by the welder).

Part 5: Access to the master database

The master database is accessed here. In this database information about tools, materials, currents and temperatures are stored.

Part 6: DOS operations

In this part, normal DOS operations are enabled. It is possible to copy, erase and restore DOS files, such as the main program, particular jobs or the master database.

Part 7: Emission of the diskette

This part, when completed, will enable the emission of the master database to the costumer. This service has not yet been implemented.

2. Work process: Design

2.1 Introduction to work process

To reflect the nature of the design and implementation-process we used, we have divided this part of our paper into three main sections: 1) Creating the Design, 2) The Design, and 3) Implementing the Design. Each of these main sections is discussed below.

The first section, Creating the Design, is the "research" section. Here we discuss the goal-oriented preparation which preceded the actual

production of our multimedia application -- the training system. Although we do not specifically concern ourselves with multimedia here, we discuss the things we need to know about a subject before trying to apply multimedia to it. We hope to show the importance of determining the goals of the multimedia-application before creating the system.

The second section, The Design, is the "planning" section. Here we discuss the design structure of our training system in light of its goals as we decided in the "research" section. Showing how our research affected our planning, and what the results of that planning were, we hope to shed light on the relationship between the goals of the multimedia system and how it should be designed.

And finally, the third section, Implementing the Design, is the "creating" section. This is a technical discussion of multimedia, and how an application is created. Here we discuss how we created the system -- how we used the tools available in implementing the plan we created above.

2.2 Creating the design

Step 1:

Defining the goals of the training system--what is to be taught and to whom?

Before we begin to design a training system, we must know the goals of the training system; why we create the system will affect how we create it. So, asking ourselves why we create the system, we find ourselves with two questions to answer: 1) what skill is it that we wish to communicate to somebody in and 2) who is that somebody we wish to train in this skill? We must define the subject and the audience. When we have decided what is to be taught and to whom, we will know the goals of our training system.

What is to be taught. The reason for defining the subject -- or what is to be trained --, is pretty intuitive. The subject of the training system will determine the base of information which the training system will be "about." It tells you, "This is where to get all your information." In this case, what we wish to teach is the use of the expert system, Sistema de Soldadura, and in particular, to show the best (and simplest) way to produce a WPS form.

To whom. The reason for defining the audience, and the amount of effect this has on the training system, may not be quite as obvious, but yet knowledge about your end-user is of great importance.

Figure 2.2.1 It is important to define the end user.

Knowing your intended audience helps you to decide how much and what information that is appropriate to offer the user, and in what manner to present the information.

Knowledge about the end-user will determine the proper amount of information to offer. An expert does not need explanations of basic details, which would bore him. In addition, an expert may desire more (and not entirely necessary) information simply out of interest. A novice, on the other hand, will require the opposite: more basic details, as the subject is new to him or her, and no unnecessary information, which would only serve to confuse.

Knowledge about the end user will also determine the style of the presentation. That is, although two systems may offer exactly the same information, they may use different terms, or a greater amount of words and "time" to explain that information. An expert do not want to put up with verbose language or elaborate details. A novice may need that style of teaching to understand the ideas being taught.

With this in mind, we decided upon constructing the system to account for the range of end users represented by the following extreme types: from welders without computing experience, to engineers without welding experience.

Step 2:

Organizing information--using these goals to decide how to teach what.

Once we have decided what we want the user to learn, we have to choose what information to give to him or her in order to learn it. We must organize our information. We knew from the start that the task (="goal") was to teach the end user the easiest way to produce a WPS form. But first we must learn about the expert system, in order to be able to teach the easiest way to use it.

Gathering information. A large part of the design process is to gather all the information the system will use. In this case we had to learn all about the expert system for welding (written in Spanish!). In particular, we studied all of the different options that the expert system allows. We had to learn what each page (menu) in the system was for, where one could go from that page, and the results of this action. To achieve this goal, we created a "map" of the system, which detailed the logical layout of the program.

Choosing the proper information to teach. Our second step was, using the knowledge we had gained above, to decide what information was essential for using the expert system. First, we had to decide exactly which menus the user actually has to understand and use in order to produce a WPS form. And then, we had to decide what information needed to be taught in order to explain their use. The design of the training system must concentrate on teaching the use of these menus -- that is, to understand all the necessary information, and at a level appropriate for the range of end users which we defined above. This involves teaching the meaning of difficult terminology that the menus use, and how to enter the appropriate inputs in the menus.

In addition to knowing how to make the expert system work, we also thought that it was important for the user to understand why he or she wanted to make it work. In order to create a WPS form, one should know what its function will be once created. Because of this, we decided that the user of the training system should be given a general idea of how the output from the expert system works in the welding process.

2.2.1 Thoughts about the design: The navigation problem

When users move around in a network of information, there is always a risk that they may become disoriented or have trouble finding their way to the information they need. And this problem increases with the size and complexity of the network. (Unfortunately, it is usually the

large and complex networks that contain the most interesting or useful information.) So a good navigational system must be set up to help the user understand where he or she is in the network of information and how to get where he or she wishes to go. We will discuss a few methods for doing this -- for solving the "navigation problem."

One simple way for the user, not to get confused or lost in the system, is to remove the requirement for any active navigation at all. By providing "guided tours" through the hypertext medium, the system ensures that the user will follow a good path. This method, however, limits the user's ability to create his own bearing. But in some applications, this is the only solution. The advantage of guided tours compared to tourist guided tours is that the hypertext reader can leave the guided tour at any point and continue browsing through any other links that seem interesting. When the reader wants to get back on the tour, it suffices to issue a single command to be taken back to the point where the tour was suspended.

Another way to solve the navigation problem is to give the user a map. (Our implementation utilized a map which demonstrated a certain path through a complicated expert system.) The problem with creating a map for the user is in deciding the appropriate scale, as there is always more information to offer than may fit on the screen. One possible solution to this is to show a fisheye view, demonstrating the range of the information space in one single overview, and then allowing views of varying levels of detail. In our system, we chose to use both of these methods.

2.3 The design: The training system in four (4) main sections.

In the designing of a house, one must decide which rooms will be needed, and how they will fit together to make up the entire house, and one must also decide how to design each room to fulfil the needs required by the house. The designing of this training system is a little bit like that. This training system has two levels of design: the design of the overall structure of the training system, and the design of each section of the training system.

To mirror this bi-level design process, the discussion of each section of the whole will be described in two ways: first, the rule this section plays in the design of the whole, and second, the design of the section itself.

By "design," here, we mean how the system will be approached by the user -- that is, what it looks like and how it is used --, and not how it is created by the authors.

As we analysed the expert system, it became obvious that a good training system should be divided into four main sections. The four main sections were General overview, Description part, Training part and Dictionary. The four sections were then integrated into one system, allowing the user to choose which section he would like to enter and use.

2.3.1 First section : General overview

The reason:

This section was devised to give the end user an overall, general idea of the welding process, and where the use of an expert system falls in this process. It may not be immediately obvious what putting information into a computer has to do with welding a joint. Different users have different needs. Some users may need only to learn a little bit about the training system to understand the expert system, as they already know all about the company, welding, and expert systems. Other users may already know all about the company and the welding process at Cometarsa, but may not know anything about expert systems or how they fit into the process. Other users may need all of the information provided here, as they are just now being introduced to the whole process. Whatever the needs of the user, this section quickly and effectively offers an explanation of the goals of this expert system.

Functional description:

The original concept was to divide the general overview into four different parts: 1) an overview of the company, 2) an overview of the welding process, 3) an overview of the expert system, and 4) an overview of the training system. An explanation of each follows.

1. The overview of the company gives information about it and can serve as subtle propaganda. One implementation could be a picture presentation with sound. However it is implemented, it should represent the company and the products and services that it offers in a positive and impressive way.

2. The overview of the welding process gives an introduction to how the company works the way it does. This should be rather complete, beginning with blueprints and all the way to the actual welding, including where the expert system falls in the process. It should discuss all of the most important stages in the production process at Cometarsa.

3. The overview of the expert system explains what the system is, why one may be useful, and how this one in particular will be used in this case. Showing each menu of the expert system, this overview explains what the user is able to do with it.

4. At last, the overview of the training system itself explains why there is a training system for the expert system, and how this training system is to be used. Each section of the training system is briefly described. (This section, the overview of the training system, is not unlike this part of our paper. It explains what each section of the training system is used for, and how it is used.)

Design description:

Part 1 and 3, the overviews of the company and of the expert system were the only two of the four parts designed for implementation and implemented. (The other two were functionally designed, but due to time constraints, never surpassed that stage.)

The overview of the company is nothing more than a show. A computer slide presentation, moving from screen to screen in a predetermined, story-like manner. Swedish rock 'n' roll accompanies the display of pictures of the company and its products on the screen.

The overview of the expert system has one main screen which gives the user access to information about eight sub-topics of the main topic: the expert system. The overview's main screen shows a picture of the first menu in the expert system and representations of all the other screens or menus which one can reach from this first menu. By clicking on one of these representations, the user will be presented with a pop-up window with a textual description of the functions of the screen represented, and will hear this description spoken aloud. See figure appendix A3 and A4.

2.3.2 Second section: Description section

The reason:

The expert system is very large and complex. To understand everything about the expert system means a great deal of work. Therefore, we attempt to offer only the information which the user really needs. This "description" section highlights the most important menus and options offered by the expert system, and teaches what the inputs should be for each screen.

Functional description:

This part teaches what the inputs should be for each screen by supplying information for each input field. The user can freely move to any menu in the expert system, and to any field in that menu, and be given access to the information supplied about that input field. This is a complicated section of the training system, and it is here most of the work has been done.

Design description:

Each screen in this section of the training system has almost the same format. Each contains a flowchart on the left side of the page, a representation of a menu in the expert system on the right side of the page, and an instruction window just above the menu representation. See figure appendix A5.

Flowchart. The flowchart allows the user to access each of the different menus. By clicking on any section of the flowchart, one can move to the expert system menu which corresponds to that area of the "map," and while at a particular menu screen, the appropriate section of the flowchart is highlighted, informing the user exactly where he is in the system. So, this helps the user to navigate through the different menus of the expert system, and it teaches the user how to best move through the expert system.

Expert system screens. These screens look exactly like the screens available in the expert system. If the user requests information about any of the input fields, he or she may click on that field in the menu and a picture or text pop-up will appear, with descriptive information.

On-line help. There is a button on each screen which allows the user to "exit" to the on-line help. The entire screen become the help menu, offering an explanation of how to use the help and four different help item options (as well as a "return" button, taking the user back to the start of the description). Each help item is one page, showing only the chosen items in the locations where they appear on each page in the description section of the training system, and a textual explanation of the use of the items.

2.3.3 Third section: Training section

The reason:

After studying the information offered in the description section (above), there may still be some confusion in the user's mind about

how the expert system really works. He or she may not be familiar enough with all of the different inputs required by the expert system and the different outputs it creates. The goal of this training section is to get rid of this doubt. This section tests the user to see if he or she has learned how to create a WPS form.

(As the goal of this section is to simulate the production of a WPS form to test the user's knowledge, its structure must be distinct from that of the description section. The "description" section contains a lot of information which is not only unnecessary, but confusing, for the simulation of the production of a WPS form.)

Functional description:

In order to test the user's understanding of the different input fields, this section simulates the use of the expert system, using predefined example problems. The user creates a WPS form, as in the real expert system, for these examples. What makes this useful, is that it forces the user to make the proper input, and if the input is wrong, it explains why.

Design description:

This is almost the same as the "description" part above, with a general map, the menus, and the explanation screens. This part was not completed, so its exact design is not carried out.

2.3.4 Fourth section: Dictionary

The reason:

The expert system uses many difficult terms and many unexplained anagrams, so for the uninitiated, understanding what the items in the menus are can be a difficult task. This section aims at providing a quick-lookup reference for these terms.

Functional description:

The functional design is very simple. The user may read and hear the definitions provided for the terms in the dictionary by clicking on the word for which he wants an explanation. It is meant to be very "shallow" to allow the user quick access to one word and then to go back.

Design description:

There is simply one real page, with all of the available words appearing on it. Clicking on a word brings up a text pop-up window and plays a voice file which reads aloud the definition found there. See figure appendix A21.

3. Work process: Implementation

3.1 Implementing the design

After having created a design for the training system, we needed to begin on its realization. This section of our discussion of the project focuses on the actual use of the software in the creation of the training system. We will try to offer specific cases of how to use the software which we will use for those readers who may be interested to use the same tools (as limited as they may be), and, more generally, inform about general implementation techniques using authoring software.

This section will be divided into two parts: first, we will give a fairly complete description of the software tools used in the creation of the training system, and then we will discuss how each part of the implementation was done, using these tools.

(The second part is a little bit like "this is how we did what we planned to do using the tools we had." Consequently, an understanding of the second section requires a knowledge of "what we planned to do" and "the tools we had." That is to say, one needs to know about both the first section to follow, "Software summary", and the section above, "Design".)

3.2 Software summary: Description of tools

The following software tools were available to us for the creation of our training system:

    -- Linkway, from IBM

    -- TOPAS, from XEROX

    -- Sound Blaster, from Creative Labs, Inc.

    -- Story Board, from IBM

Although some of these tools are adequate in their own right, none is a very professional multimedia tool, and we had to integrate these software ourselves to create a useful tool. A great deal of time and effort were invested in figuring out how to use each software and how to use them all in conjunction with each other. The result was the creation of what was, for our purposes, a functionally adequate tool. It was not the kind of tool we had hoped for, but as our choice was between using this tool or doing nothing, we were happy to begin our project.

The software tools summary is divided into two parts: first, a description of the purpose and functioning of each tool, and second, a discussion of how the tools can (and cannot) be integrated to create a multimedia system.

3.2.1 The individual software tools

Linkway

Purpose. We used Linkway as the main environment to create the training system, and within this, used other software for particular tasks, such as sound and animation. All the software together are integrated into one global system. (Again, in the discussion of Linkway, we will assume that the reader has some familiarity with the philosophies behind multimedia, and hypertext, in particular.)

Functioning. Linkway is a not so recent and fairly simple hypertext tool. Unfortunately, it falls somewhat below the standards of present-day authoring systems. But as a hypertext tool, it offered us the ability to establish nodes of information necessary to create our multimedia system.

In Linkway, one works with four different levels of items, which are (from smallest to largest): 1) objects, 2) pages, 3) folders, and 4) applications. It is possible to put objects on a page, pages into folders, and folders into applications. Let's begin our discussion of these items with the smallest, and build our way up to an application.

As we mentioned above, objects are placed on pages. There are three different kinds of objects one can create on a page:

1) pictures -- used to create the pictographic design of the page,

2) text fields -- used to create alphanumeric designs on the page, and

3) buttons -- serve as tools for carrying our different functions of a hypertext system, such as switching to a different page, popping up a text or picture window, calling a DOS command, or doing certain combinations of these things.

One special type of button called a script button allows more than one function to be executed with only one click. Three important script commands are goto, dos, and retrace. To switch to a different page in the same folder, you give the script-command goto followed by the page number. The script command dos followed by a DOS command in quotation marks will "exit" to DOS, execute the command, and return to Linkway. The command retrace takes you back to the page and folder from where you came (before reaching the present page).

The pages serve as the nodes in the hypertext network. There are two kinds of pages: basepages, and regular pages. The "regular pages" simply serve as the nodes of the hypertext network in that folder. The basepages are a little more complicated.

There is one basepage in every folder, and this basepage is "present" in every other page of that folder. By "present" in the other pages, we mean that it is the design background for all other pages, and its buttons are accessible from every other page as well (as long as nothing is placed "above" them on the regular page). The purpose for having such a page may become clearer below in our description of the use of this software in the creation of the training system.

Folders are logical collections nodes (pages), each with its own basepage (which may be left blank), and an application (the entire system) contains one or more folders.

Linkway provides various development tools for creating and editing these items.

Topas

Purpose. Topas provides the capabilities to create and play animations.

Functioning. Topas can import files from AutoCAD or CAD 32 in ".dxf" format. All animations done in Topas are rendered--that is, the images are made to look like 3-dimensional objects with surface structures. Therefore, the pictures used in creating the animation must have surfaces.

Surfaces can be created either during the drawing process in AutoCAD, or in either AutoCAD or Topas from wireframe objects created in the CAD systems. The process for creating surfaces on an existing wireframe object (designed in the CAD systems) is a substantial piece of work, both difficult and time-consuming. Superimposing these surfaces is easier done in AutoCAD than in Topas, as Topas does not facilitate the polygon-finding process, but

even in AutoCAD it is a difficult job, especially for polygons with non-linear edges.

To display an animation created in Topas, one can call the function "playmvy" from a DOS command line with the name of the animation file as a parameter.

Sound Blaster-Voxkit

Purpose. Sound Blaster contains a few different kinds of tools all dealing with sound. One of these tools is voxkit. Voxkit allows one to make and play files of digital recordings. We used this voxkit tool to record speech and music and to play these recordings at selected points in the main application, done in Linkway.

(Other tools available in Sound Blaster are FM Organ, a computer synthesizer which allows you to play, record, and replay music, and SB Talker, which attempts to read aloud (in English) ASCII text files. In order to play a file created in FM Organ, one needs to enter the organ program first, and then use function keys. Because of this, we were unable to use this tool to automatically play music files. And the quality of speech produced by SB Talker is too poor to be used in a serious presentation.)

Functioning (of voxkit). The Sound Blaster kit contains a sound card which enables the software to deal with sound input and output. To input sound, analogue sound must be recorded from a microphone (or as output from a recorder) into the input line of the sound card. And the output from the computer must go to speakers hooked up to the output line of the sound card.

Voxkit contains software to record and play sound. Recording may be done at different sampling rates, ranging from 0 to 13000 Hz; the higher the sampling rate, the better the recording (and the larger the file). Playback of these files may be done by passing a parameter to an executive file at a DOS command line. In addition, playback may be: paused, using the space bar; aborted, using the ESC key; and executed without any output to the screen, by passing an additional parameter to the function.

Story Board

Purpose. The main function of Story Board is to display graphics screens in a programmed sequence, called a "story." This is useful in the creation of picture presentations. These picture presentations, with limited user interaction, can be implemented in a multimedia system

for the display of linear, "story-like" information.

Functioning. The pictures to be used in Story Board can either be created in a drawing program which is provided, or be imported from other paint programs or picture-capturing applications. Stories are created with the use of a basic programming environment and language designed specifically for this use.

The Story Board story-writing language provides limited control blocks and conditional statements, and it provides functions for displaying pictures (and changing them in different ways), using DOS commands, allowing user input, and playing sound effects.

3.2.2 The integration of the software tools

As Linkway served as the main environment of the training system, our goal was to discover in what ways we could use (i.e. execute) other software functions from within Linkway. These capabilities and limitations in part affected the final design of the training system, as our implementation was limited in various ways.

Capabilities

Script buttons allow for the execution of a series of commands, almost like a little program. These commands are defined in Linkway. It is possible that we do not know all the available commands to put into the script files, as we do not have a manual for this software. However, we did manage to discover quite a few of these commands. (Script buttons are discussed briefly above in the Linkway section of the software summary, chapter 3.2.1.)

Among these script commands, there is one which allows for the direct execution of DOS commands. This is the only possibility in Linkway to utilize other software tools. In effect, what happens when the "dos" command is used, is first that the state of the Linkway application is saved, then the command executed, and finally the control flow returned to Linkway where it left off. This method of running other software functions was sufficient for the display of Topas animations and for the playing of Sound Blaster sound files.

Playing sound files using Sound Blaster is very simple. Linkway's only output is the screen, and as Sound Blaster's vplay command -- the function for playing its digitally recorded files -- can be used without affecting the video display, there was no interference between these

outputs. When the state of Linkway is brought back to active memory, it is as though nothing have changed.

Playing Topas animations is a different story. Calling the "playmvy" function (which displays the animation) automatically alters the resolution mode to 320 x 200, plays the animation, and then returns to Linkway without changing the resolution mode back to 640 x 480 and 16 colours, which is that of Linkway. In addition, Linkway does not save the screen information when it "exits" to DOS, so at the end of the animation, the screen is simply blank. To avoid these problems, one must call the animation command, change the screen back to Linkway resolution after the animation is complete, and then "return" to the page where Linkway left off, which will display the page to the screen again.

Limitations

Script file functions. Script files do not allow one to play sound files and do pop-up windows at the same time, something which we deemed desirable in a multimedia presentation. This is because script files do not contain a command for displaying pop-up windows, presumably because a button with this function already exists. (We are not entirely sure of it as we do not have a manual for this software. At least we did not discover such a command.) If they contained such a command, we could pop-up the window, play the sound, and then hide the window after the sound was completed. But, as far as we know, no such function is available. (In order to simulate this, we created pages which were nothing more than pop-up windows, and to show the window and then play the sound, we needed only to have the script file go to the appropriate page, and then start the sound file. But the drawback from this "trick" method is that it could be done only from the basepage. Any other page would disappear first to allow the fake pop-up window page to appear, ruining the effect of the pop-up window. This will be discussed further below in the section "Implementation-use of the tools", chapter 3.3.)

Memory limitations. Another limitation was the inability to run large programs from Linkway, due to memory limitations. (As mentioned earlier, the Linkway application stays resident, in main memory, while the DOS command is executed, and if the command is too large to both hold the Linkway application and run the DOS command, this cannot be done.) Showing Story Board stories requires too much memory to be shown from Linkway, making it necessary to run such applications separate from the main Linkway application. The same goes for SB Talker, part of the Sound Blaster kit. (Although,

admittedly, running this function from Linkway in a training system is not really all that desirable, it is though disappointing that it could not be done.)

Paint and Import limitations. Unfortunately, Linkway allows the use of only the pictures made in the Linkway paint program itself for the pages. This would not be a problem if the paint program provided were a good one, but it is quite poor. For this reason, the page designs in Linkway are severely limited in their style and difficult to make both well and quickly.

Processing limitations. In general, no two functions can be run at the same time, as there is only serial processing available. For this reason, one cannot show animation and play sound at the same time, allow for input and run sound at the same time, or do anything else which requires coprocessing. Although not necessary, such things would make a less-static, more lively presentation style possible.

3.3 Implementation: Use of the tools

In much the same way that the design part of this paper concentrated on each of the sections of the training system at a time, this section will discuss the actual implementation of these designs using the software one section at a time. Within each section there will be a discussion of how each different task was done to make it work the way it did.

3.3.1 The whole thing

The system contains six folders. The first, the main-screen, is one single page containing four choices to separate folders. The sixth folder is an on-line help for the description section. These folders are connected with simple "link" buttons, specified by both folder name and page number.
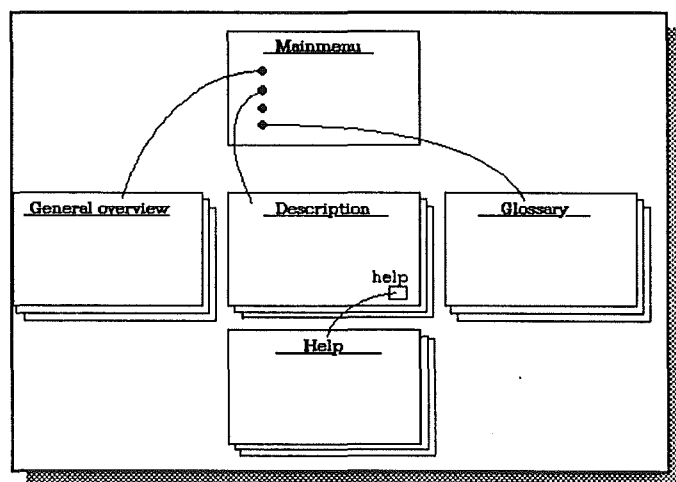

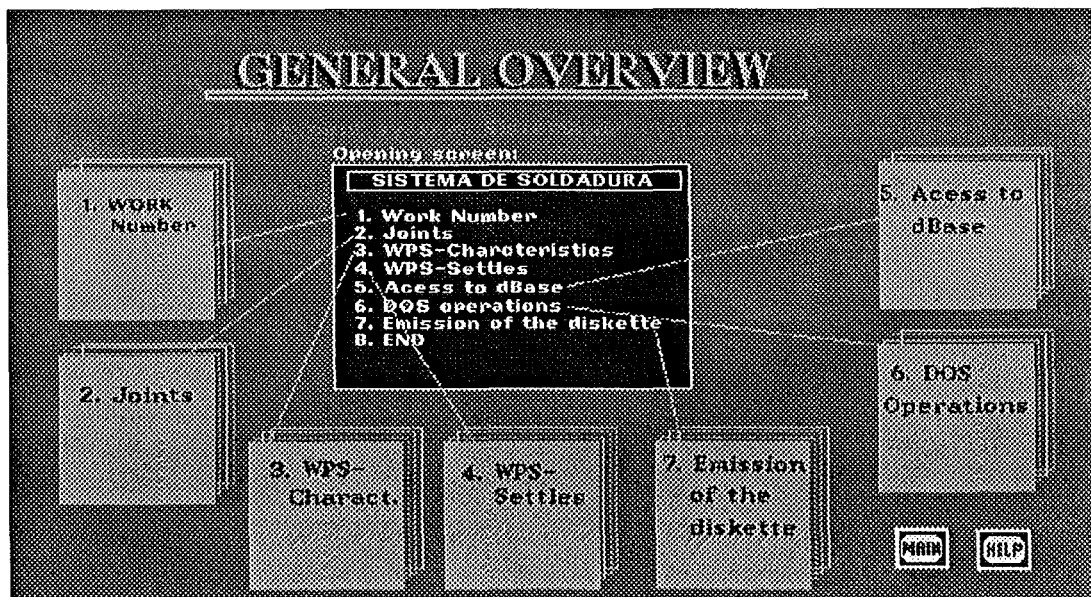Figure 3.3.1 Folder overview for the training system.

Figure 3.3.2 Main screen of the General overview

3.3.2 The general overview

The general overview is divided into four parts: 1) an overview of the company, 2) an overview of the welding process, 3) an overview of the expert system, and 4) an overview of the training system. The goals are then fulfilled to provide the end user with an overall, general idea of the welding process, and to show where the use of an expert system is appropriate in this process, as we discussed earlier in the design part,

Because of time limitations we were only able to carry through two of the four parts, the expert system overview and the company overview. An explanation of each follows.

The expert system's overview consists of a single folder in which the basepage is designed as a map over the expert system and each page within the folder has a description of each particular part of the map, see figure 3.3.2. The map on the basepage includes script buttons with two commands: a goto, and a dos executable command to play a soundfile. The goto command brings up the appropriate description page above the basepage. This description page contains the text that defines each particular part of the expert system and a "return" button. This page acts as a pop-up text window. The command "dos" is used to execute the program Vplay, the voxkit tool in SoundBlaster, which takes the name of the appropriate soundfile as a parameter. This program plays the voice file while the text window is still on the

screen.

The company overview is created in StoryBoard as a sequence of pictures brought up on the screen in a predefined order, i.e. not interactive, and also with a limited display time. The reason for doing this as a non-interactive picture sequence is mostly because of the problems that we faced with integrating StoryBoard and Linkway. It was not possible to execute Storyboard files from within Linkway because of memory limitation. The goal with this part had to be redesigned to only present the companies product as a slideshow and also to introduce an easy way to handle pictures for presentations. The main part of this job was to capture pictures, which was carried out at, as far as we know, the only multimedia producing company in Buenos Aires, Weber & Ferro. At this company we got access to equipment for handling video such as videoboard and image capturing software.

3.3.3 The description section

The description section consists of two folders. One is the description and the other is an on-line help. The description folder's base page is itself the mainscreen. It contains as mentioned in the *design* two main parts 1) the flowchart and 2) the expert system screen. It should also contain an instruction window and an on-line help. This base
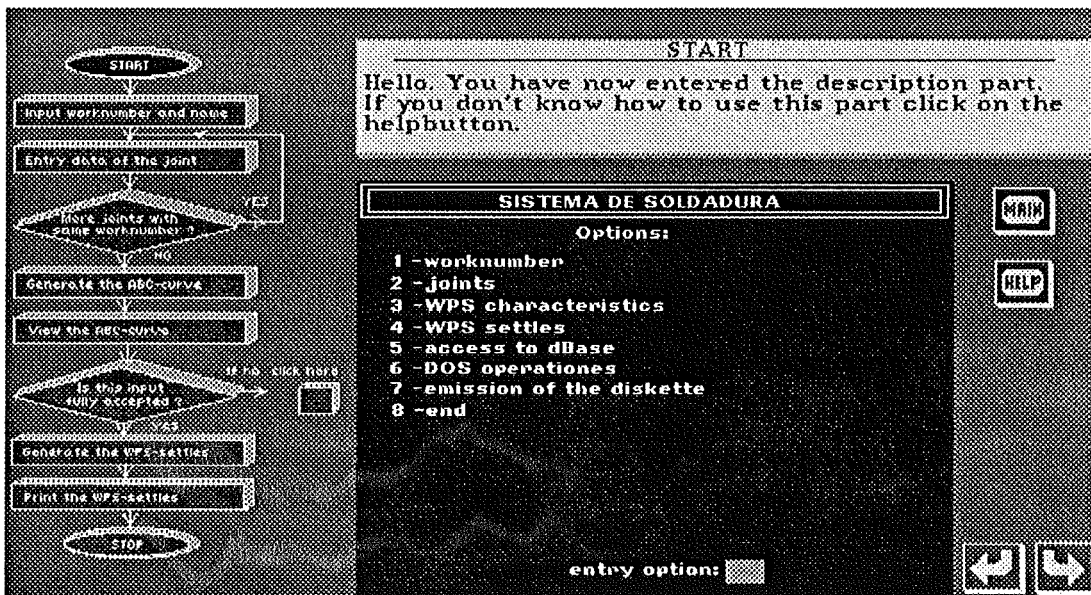

Figure 3.3.3 Main screen of the description section showing the flowchart on the left side and the blue expert system screen on the right side.

page's picture is copied to all the other pages, and two modifications are done. First the box in the flowchart, that belongs to that page, is highlighted. And then the text is written in the instruction window and on the expert system screen. The pages are connected with buttons in two ways. The first is the next/previous page buttons down in the right hand corner of the screen. The second is a hidden "goto" button on every box in the flowchart. This button is linked to the page belonging to that box. Two more buttons are available on every page. One is a link back to the main screen and the other to the on-line help folder. The next implementation step was to write description texts and picture pop-ups and connect them to the input fields on the expert system screens. Linkway does not admit to add the command "dos" to a text or a picture pop-up. Therefore sound couldn't be implemented together with the text explanations.
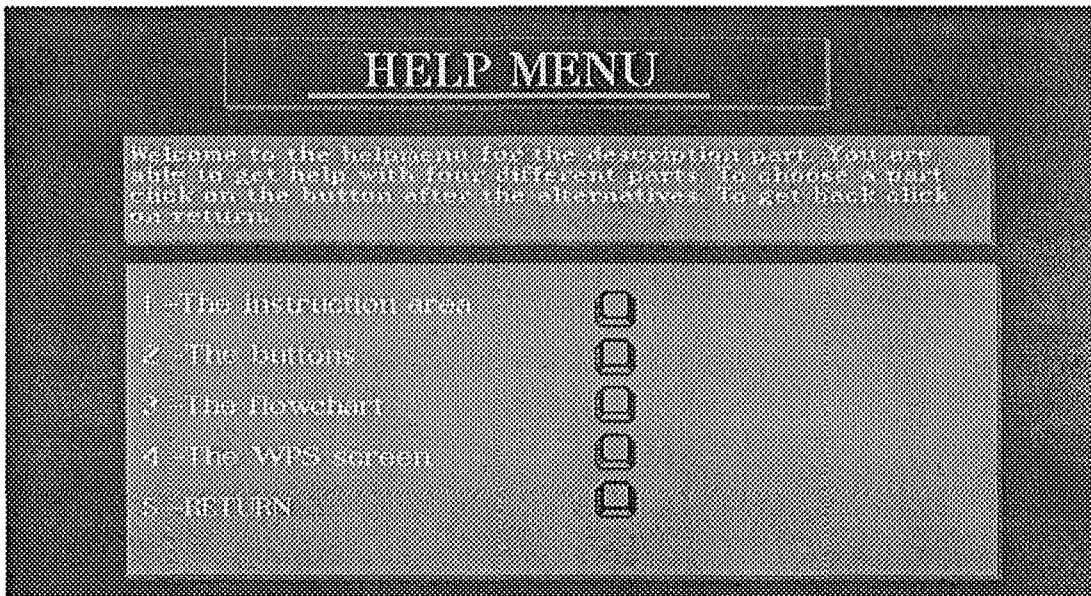

Figure 3.3.4 Helpmenu for the description section of the training system.

The on-line help folder has no base page and is, as designed, divided into four help areas. The mainscreen on the first page contains pictureless "goto" buttons which bring up the appropriate page with help instructions. This latter page contains text and pictures explaining difficulties, and a "return" button, see figure 3.3.4.

3.3.4 The training section

This part has not been implemented due to time limitation.

3.3.5 The Dictionary

The dictionary folder's base page is itself the main screen, see figure 3.3.5. It contains pictureless script buttons which include two general commands: a goto, and a dos exactable command to play a sound file. The "goto" command brings up the appropriate page above the basepage. This page contains only a small window with a distinct background colour, some text, and a "return" button, and this page acts as a pop-up text window. The command "dos" is used to execute the program vplay from the voxkit tool in Sound Blaster, which takes the name of the appropriate sound file as a parameter. This plays the voice file while the text window is still on the screen. Then the "return"
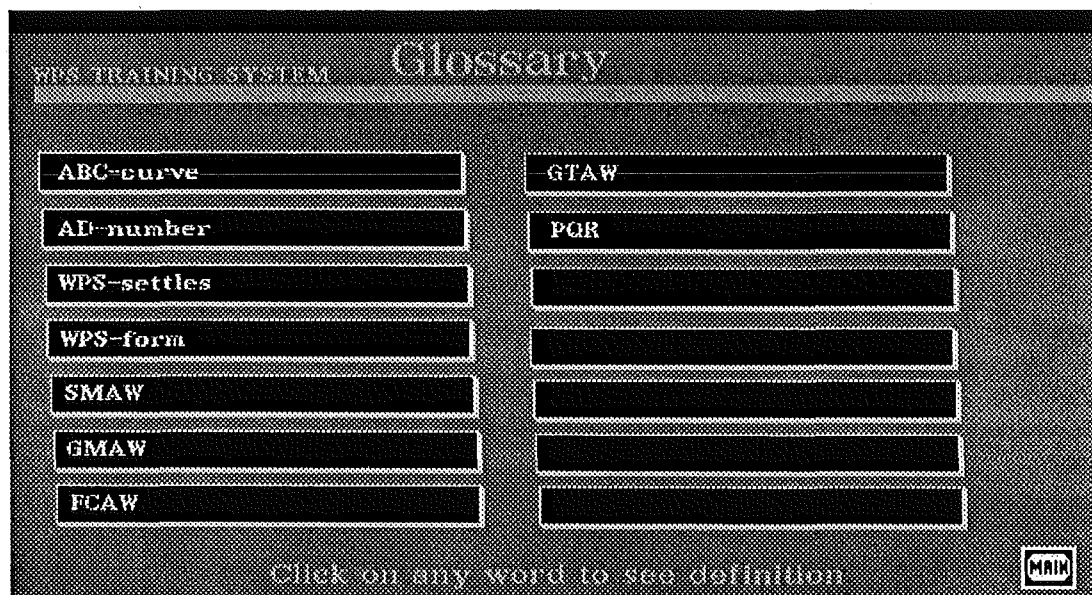

Figure 3.3.5 Main screen of the dictionary part of the training system.

button is available for use, and it is a script button that utilizes the script command "retrace."

4. Summary & results

In this section we will summarize the most important results obtained in the development of this project. We will present the results in a condensed way with few details.

Summary:

The goal has been to show the usefulness of multimedia technology at a welding company. This was accomplished by designing and implementing a training system. The training system aimed to educate an unskilled welder to use a welding expert system.

The first step was to gather all information in order to design the system. This resulted, in the end, in a system that was flexible, where the user should be able to choose his own way through the training procedures. The system should be easy to use. Therefor we made the user interface simple and we also decided to build the training system shallow to make it easy to navigate in.

The second step was to implement the design. The tools (software and hardware) available narrowed a lot of the ideas and thoughts we got during the design. Because of this we focused the implementation on the use of the different software in as many ways as possible. We also pointed at the capabilities and the limitations with the software used.

Results:

Multimedia is useful also for a welding company such as Cometarsa. Education, training and presentations are areas where this technique can be of great importance. A first step, rather simple, could be to use the technique for presentation of new products. Another consideration is to make the company well prepared to meet the future with multimedia tools.

The most expensive part in a multimedia project, is always to structure, gather and convert the information to a useful form, and put it into the system. Therefore the hardware cost is off less importance when planning a multimedia project. Within reasonable limitations, choose the best equipment available to fulfil the necessary demands of your system.

Consider the "easy to use factor" as very important when choosing authoring tool for multimedia development. The reason for that is high requirements on update capabilities on multimedia systems. The software should also be fast to learn otherwise the threshold to start developing multimedia systems will be too high.

Linkway, the hypertext tool that were used in this project, is not good

enough and should not be used in future projects. This software has serious limitations. It is hard to integrate with other software and is very far from the "easy to use" that we recommend.

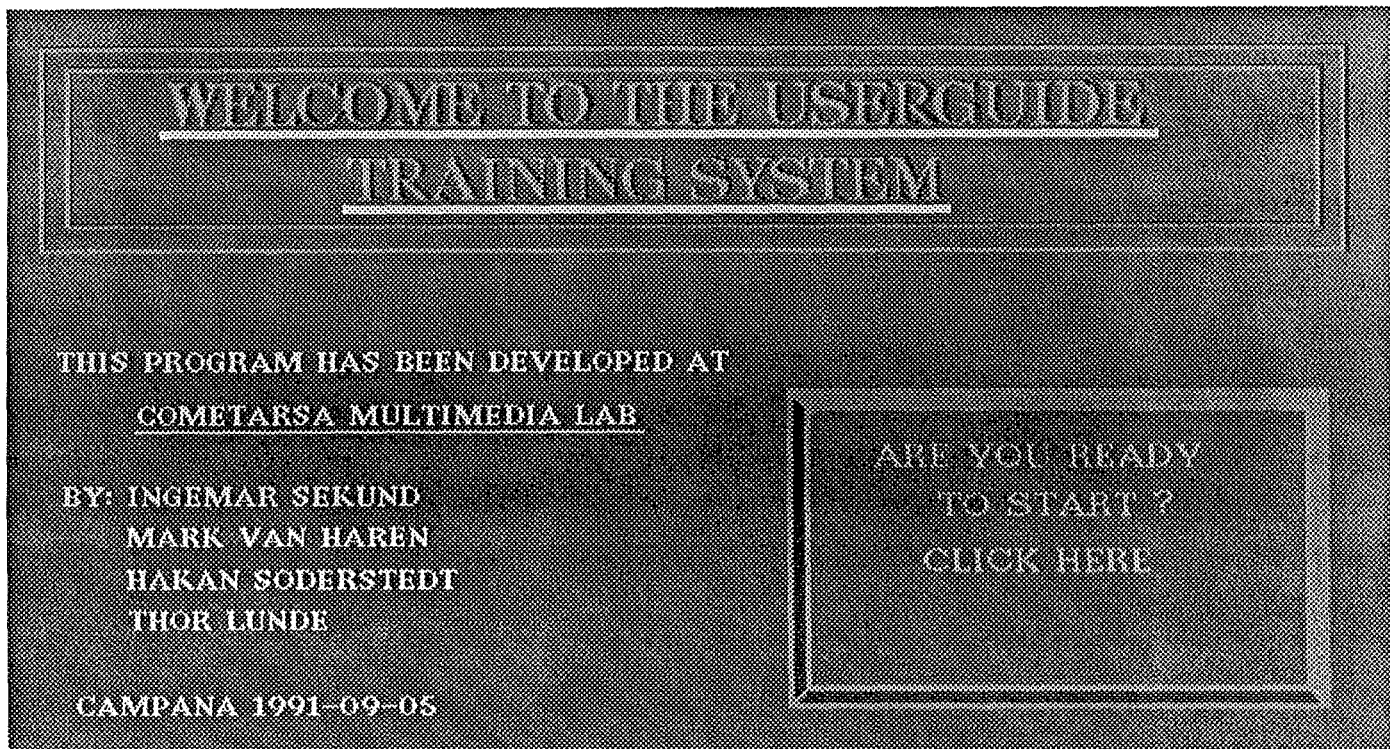## Sample screens of the userguide training system
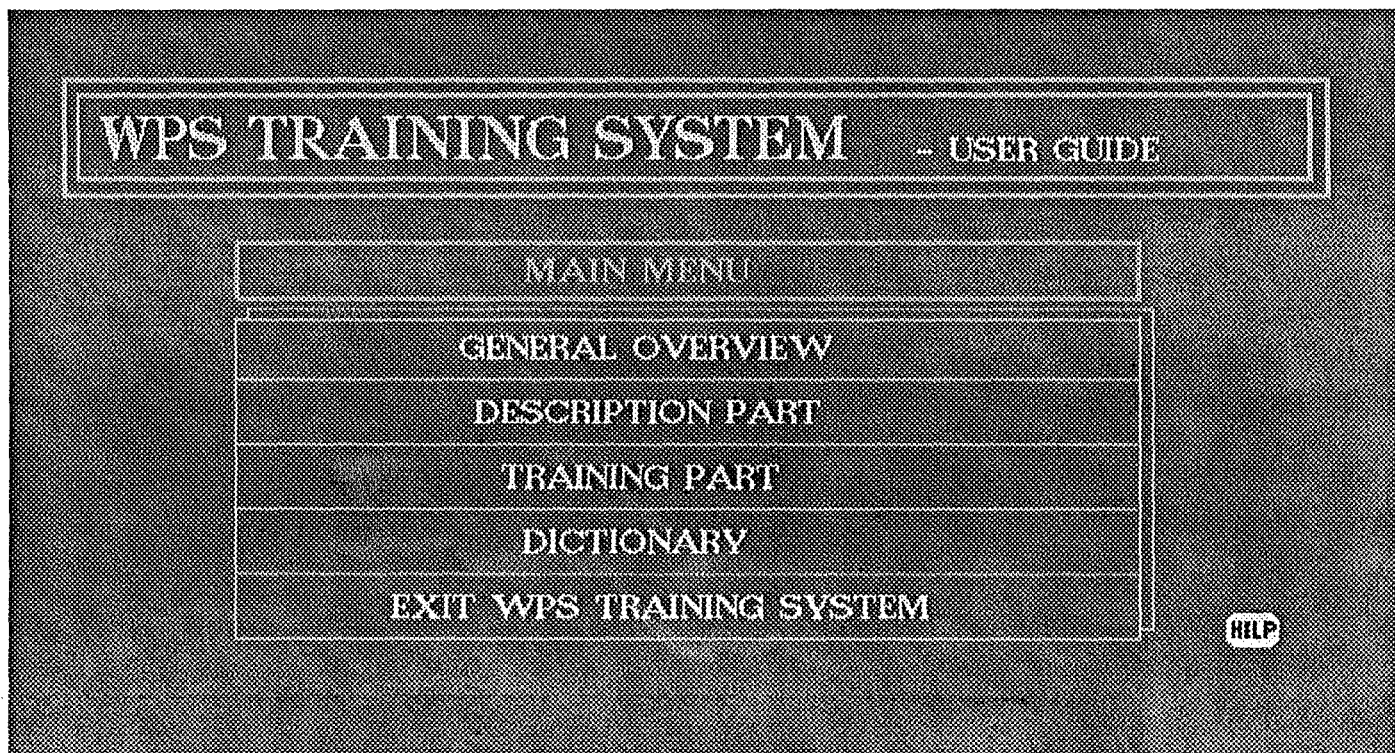

Figure A1: Opening screen

Figure A2: Screen for selection of the available options

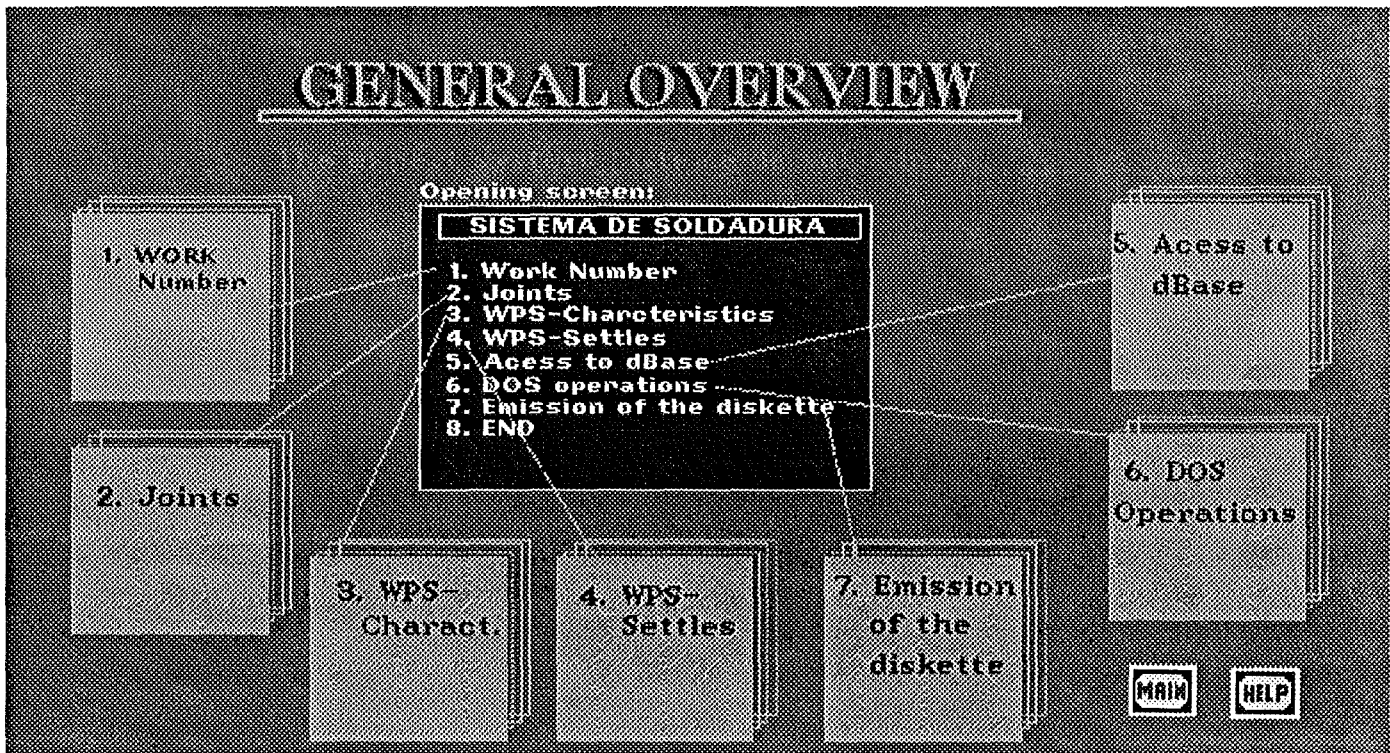## Sample screens of the userguide training system

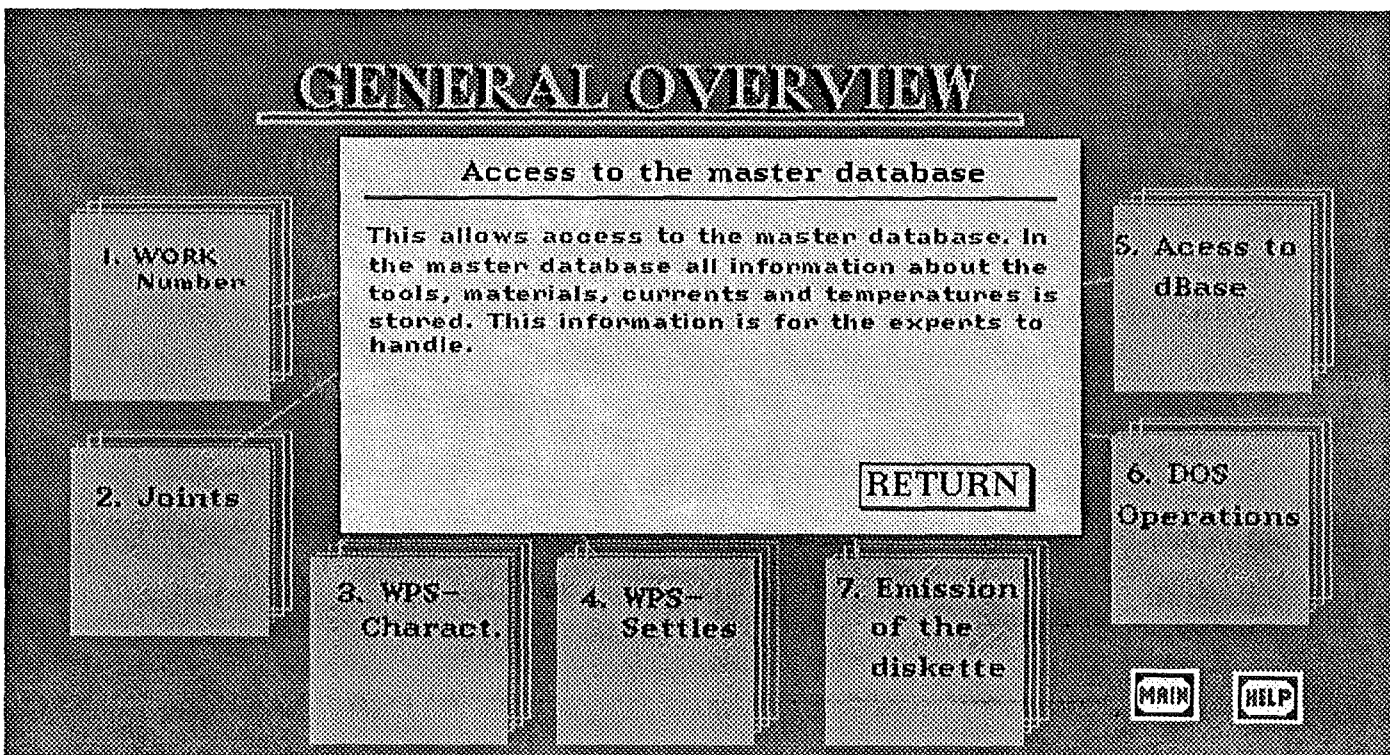Figure A3: Screen for selection of overview information of the expert system.

Figure A4: Text pop-up with information about chosen option.

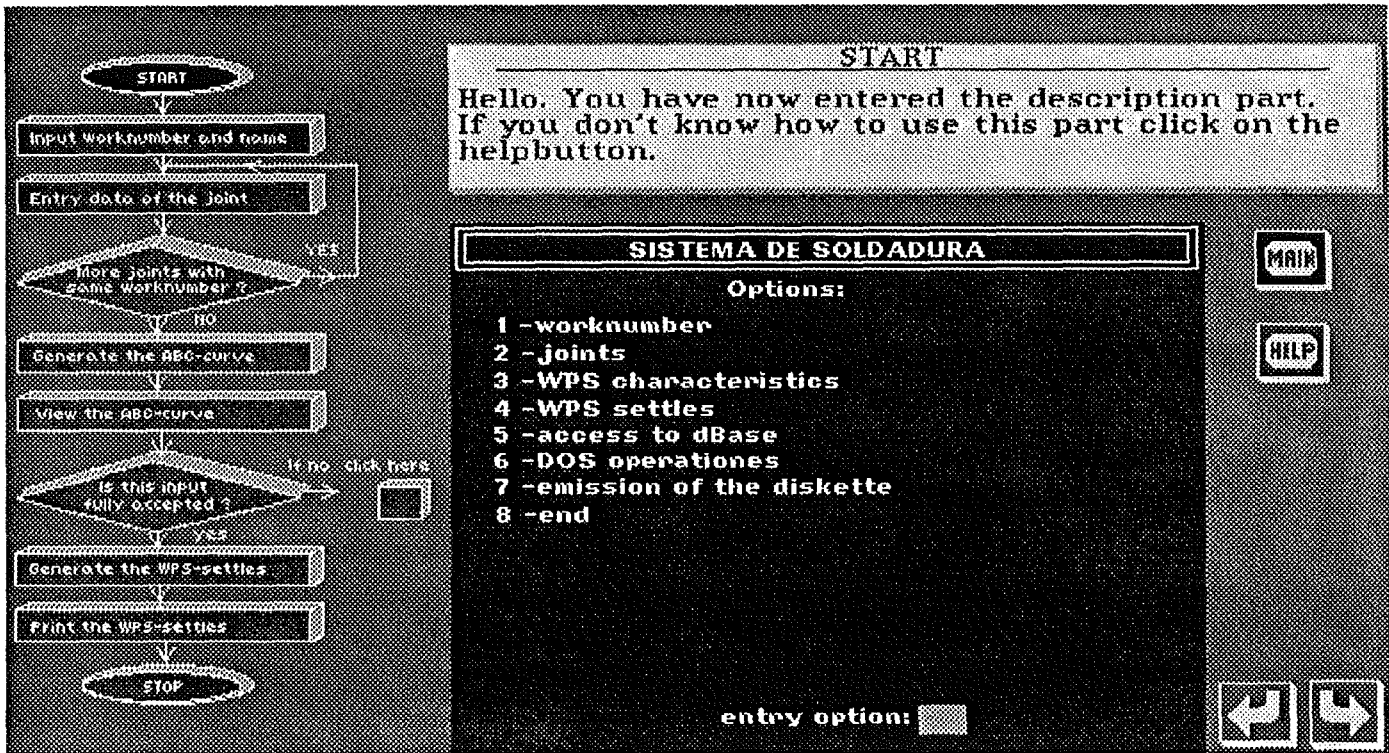## Sample screens of the userguide training system

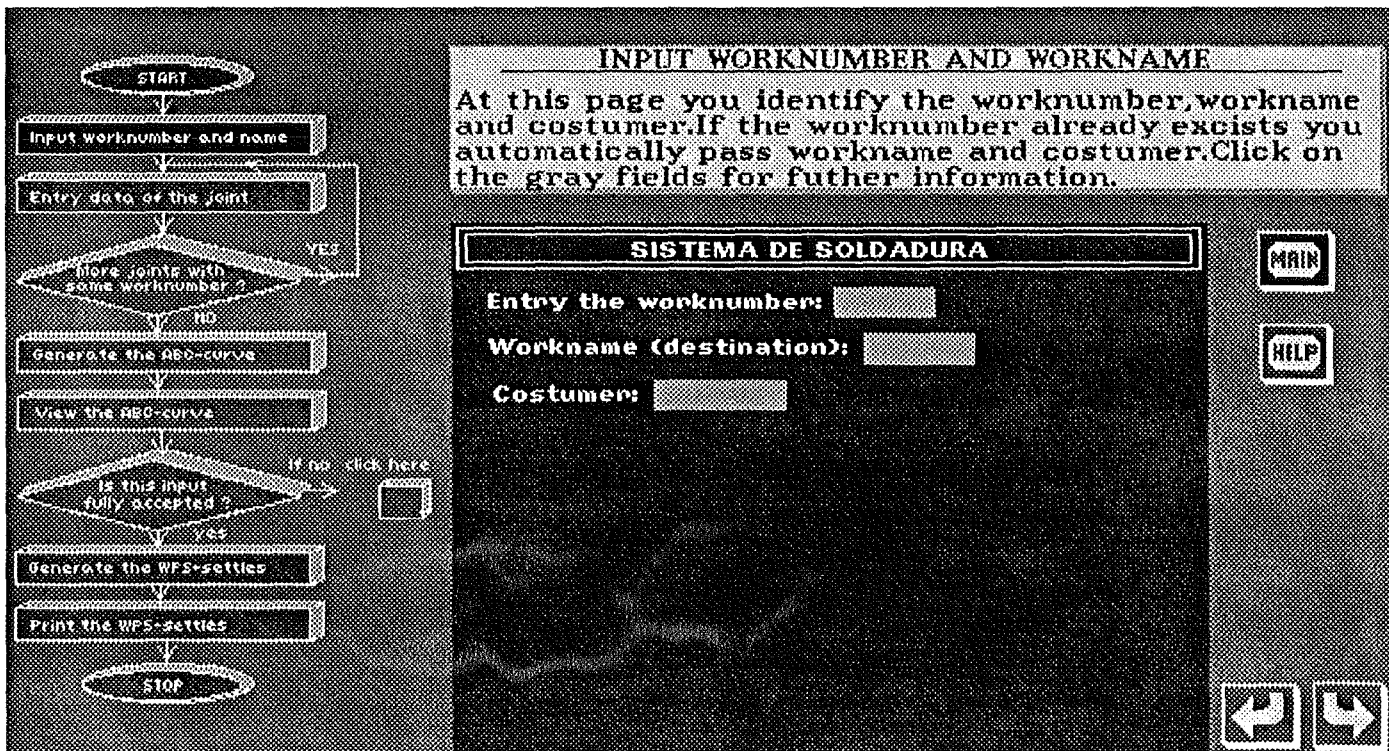Figure A5: Opening screen in the description section.

Figure A6: Screen for identification of the user.
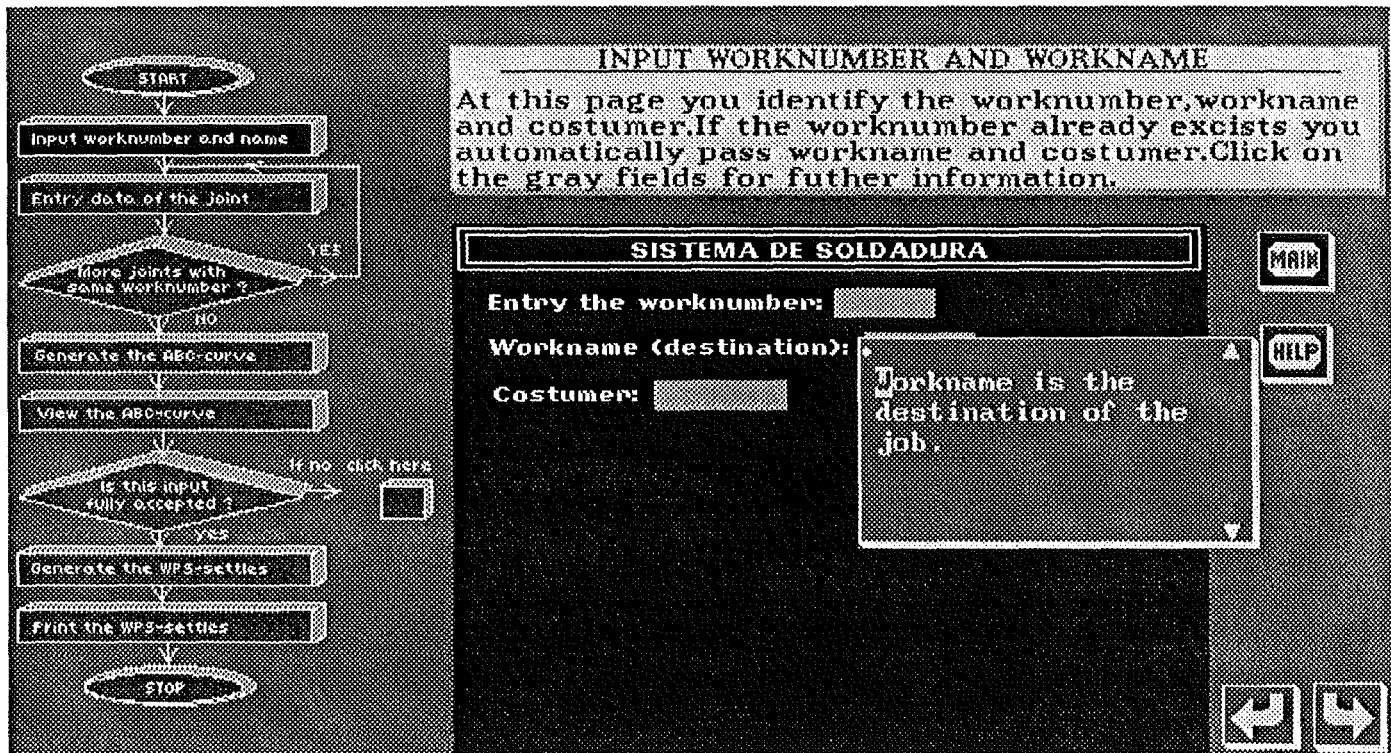
Sample screens of the userguide training system

INPUT WORKNUMBER AND WORKNAME

At this page you identify the worknumber,workname and costumer.If the worknumber already excists you automatically pass workname and costumer.Click on the gray fields for futher information.

SISTEMA DE SOLDADURA

Entry the worknumber:

Workname (destination):

Costumer:

Workname is the destination of the job.

MAIN

HELP

Figure A7: Same screen as previous including text pop-up.

ENTRY DATA OF THE JOINT

This is the submenu under: 2 -joints.
To make all the inputs entry 1

JOINTS

Options:
1 -entry data of the joints
2 -generate the ABC-curve
3 -present the joint
4 -modify the joint
5 -print a list of the joints
6 -view number of joint,WPS and PQR
7 -view the ABC-curve
8 -assign a 5 digit number and preheating temp
9 -list the joints in procedure-groups
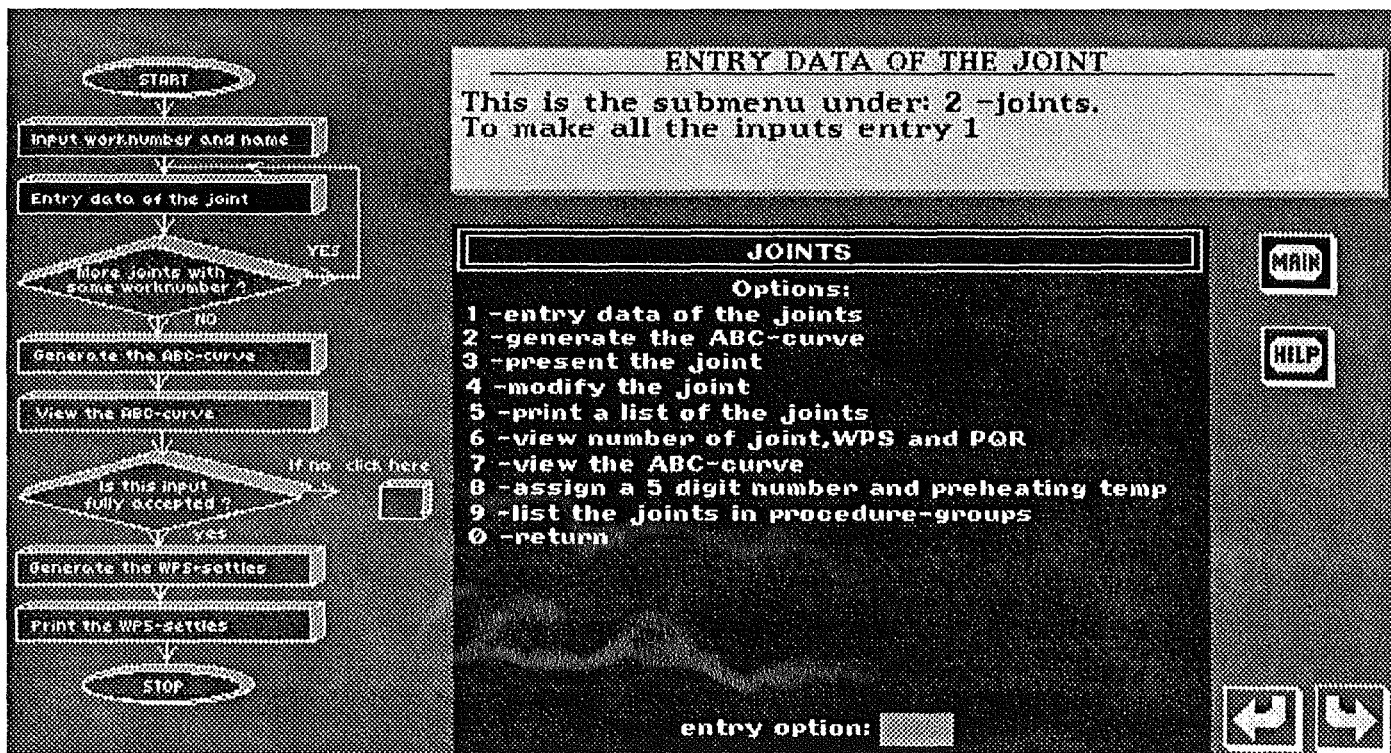0 -return

MAIN

HELP

entry option:

Figure A8: Screen for data input.

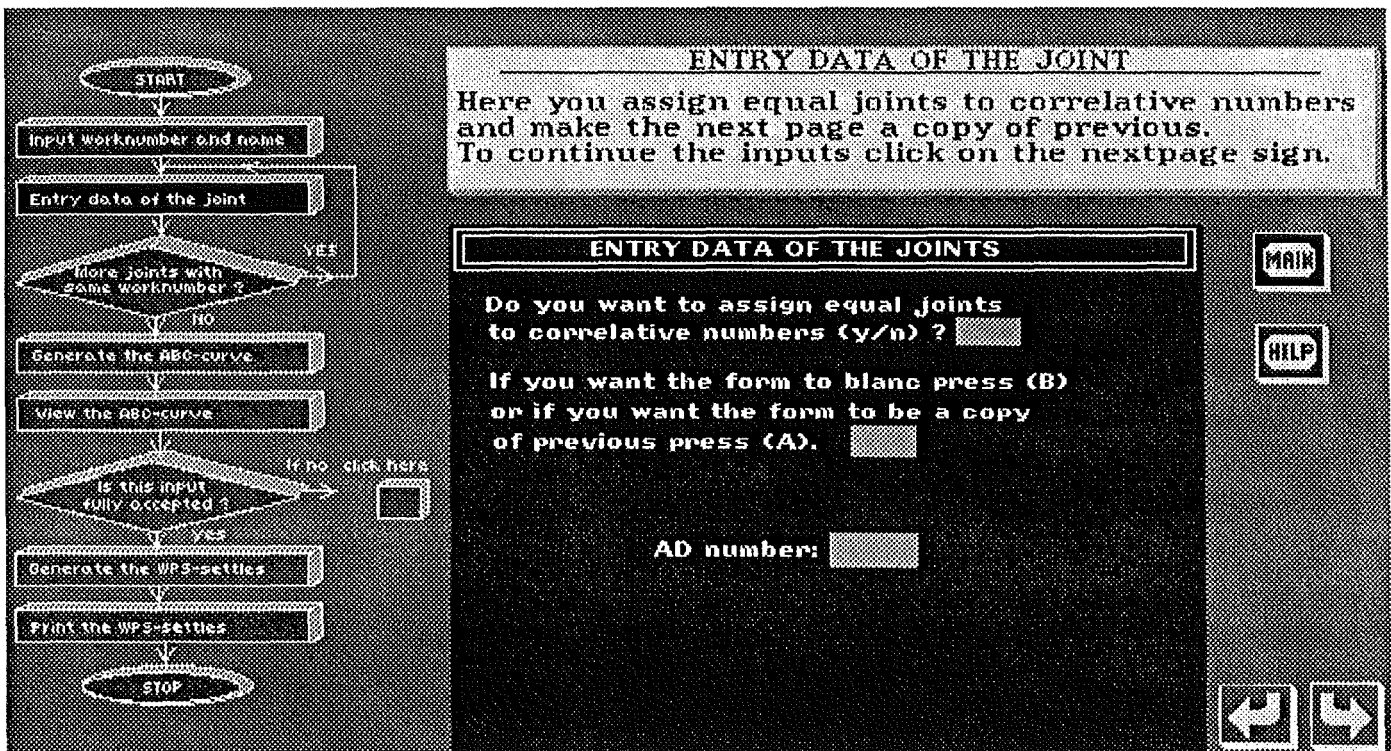## Sample screens of the userguide training system

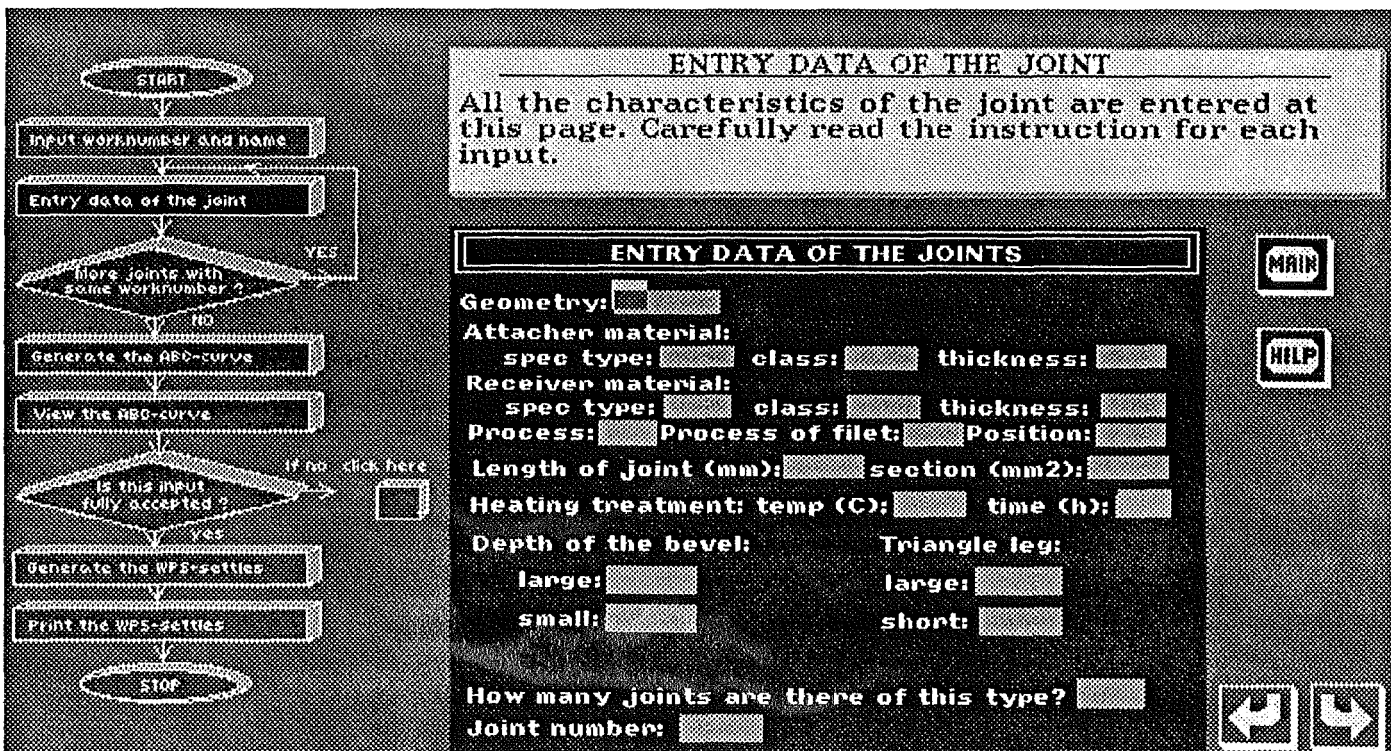Figure A9: Screen for data input.

Figure A10: Screen for data input

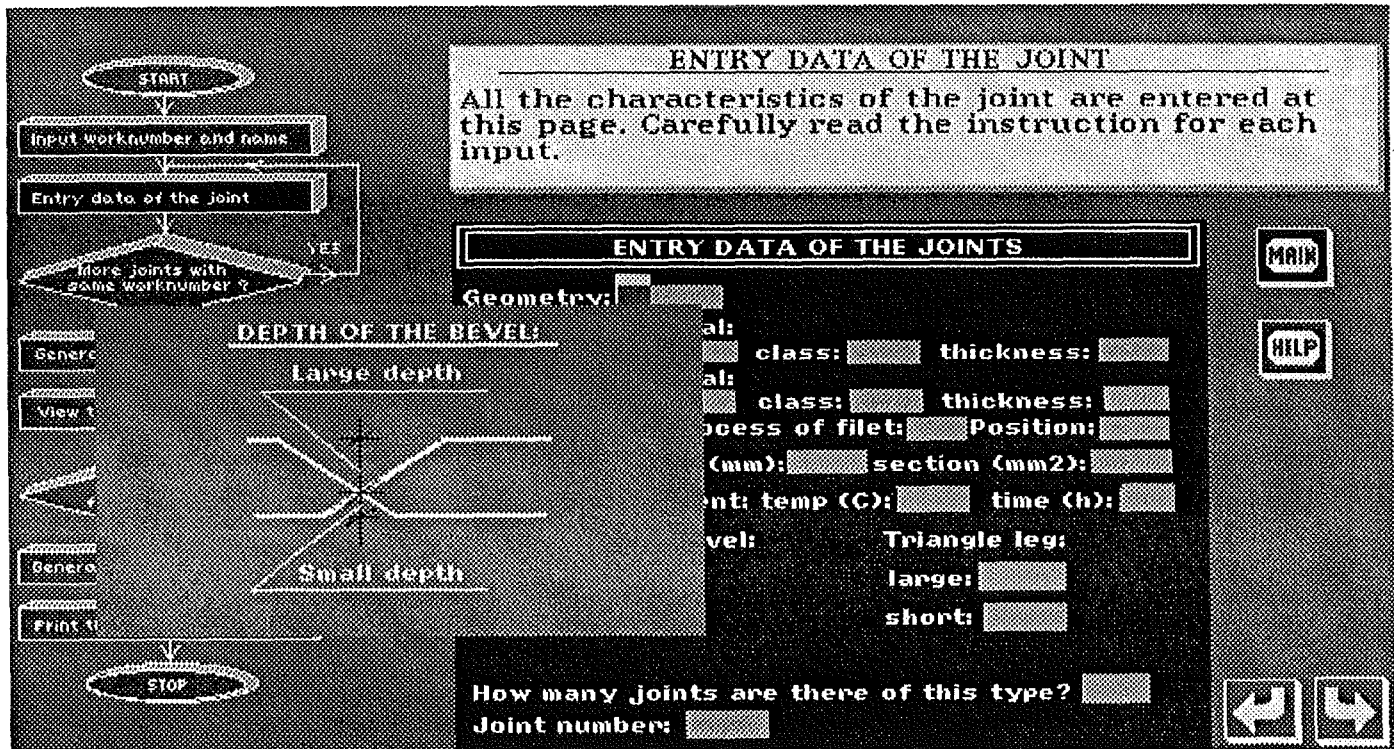## Sample screens of the userguide training system

Figure A11: Same screen as previous including picture pop-up.

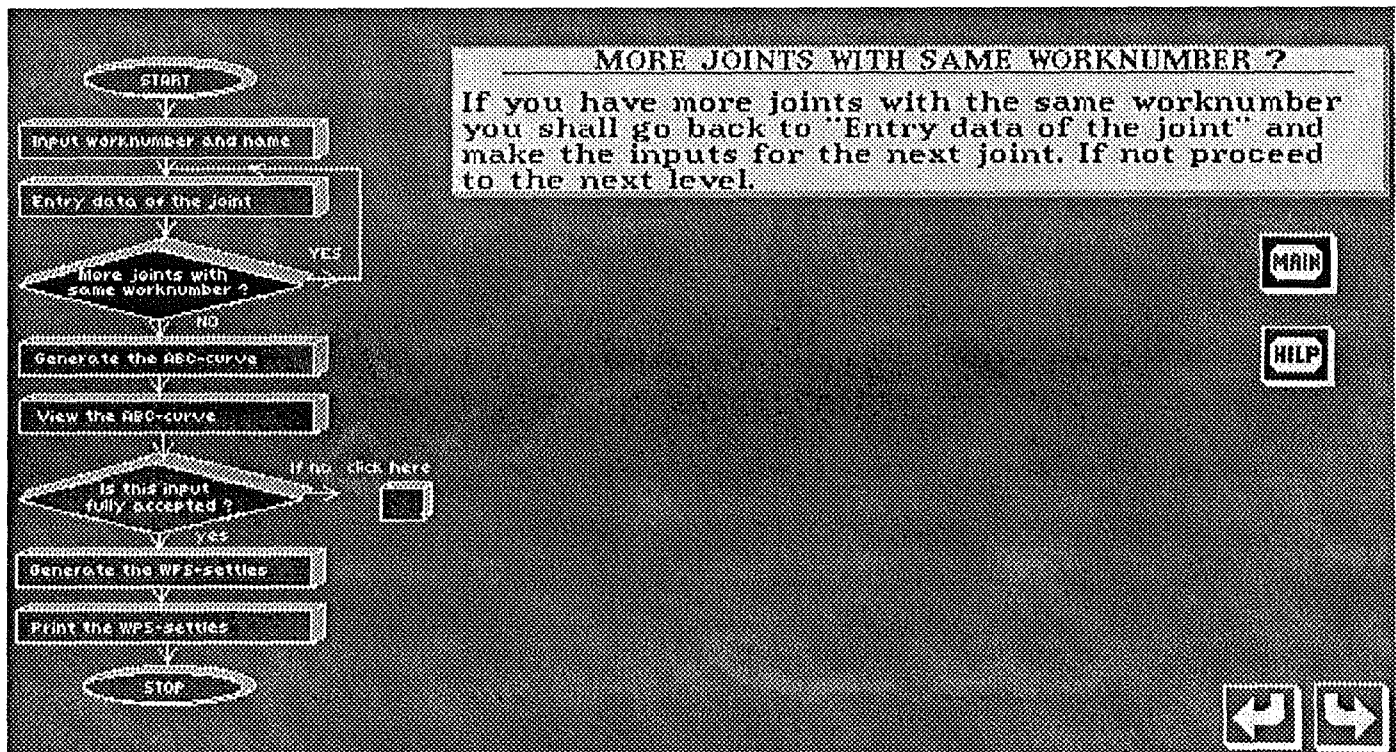Figure A12: Screen where the user chooses if he/she has made all inputs.

Sample screens of the userguide training system

Figure A13: Screen to generate the ABC-curve.

Figure A14: Screen to view the ABC-curve.

Appendix A

Sample screens of the userguide training system
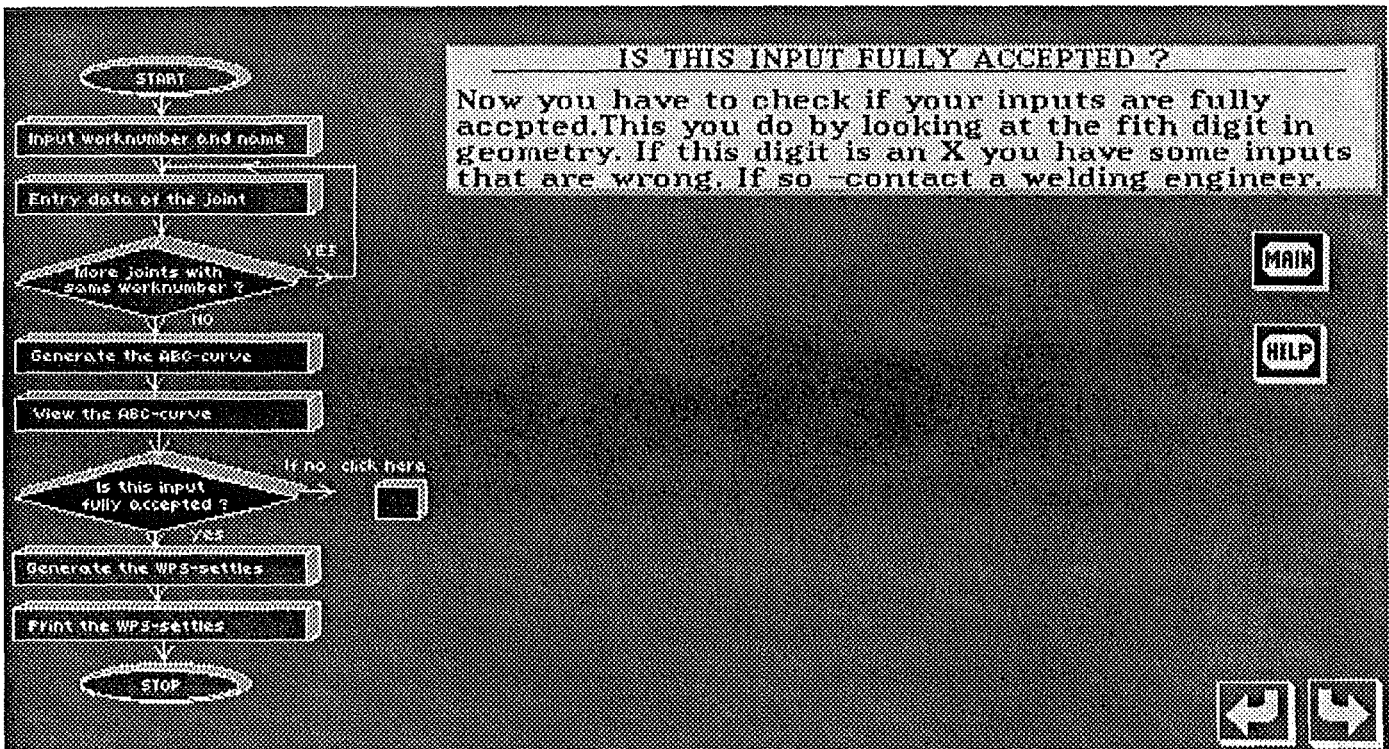
Figure A15: Screen where the user tests if the inputs were accepted.
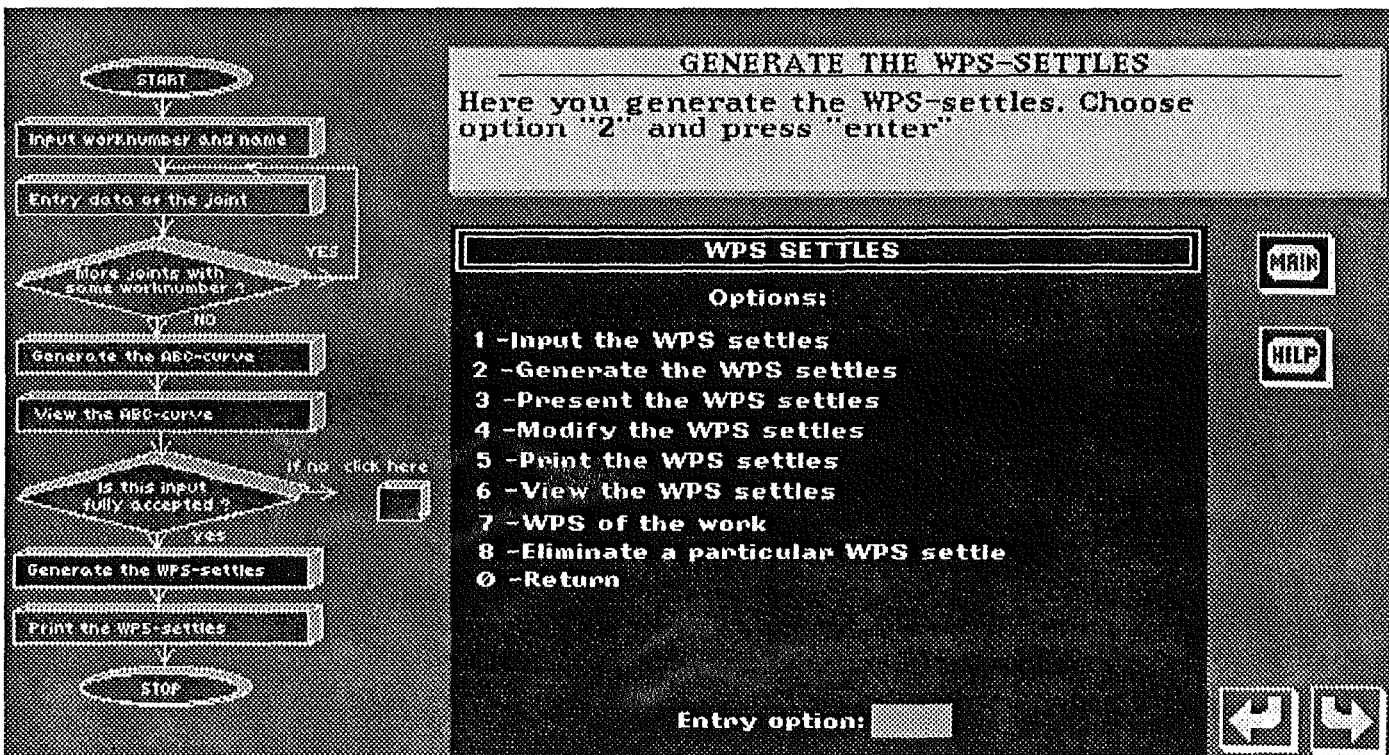
Figure A16: Screen to generate the WPS-settles.

Sample screens of the userguide training system
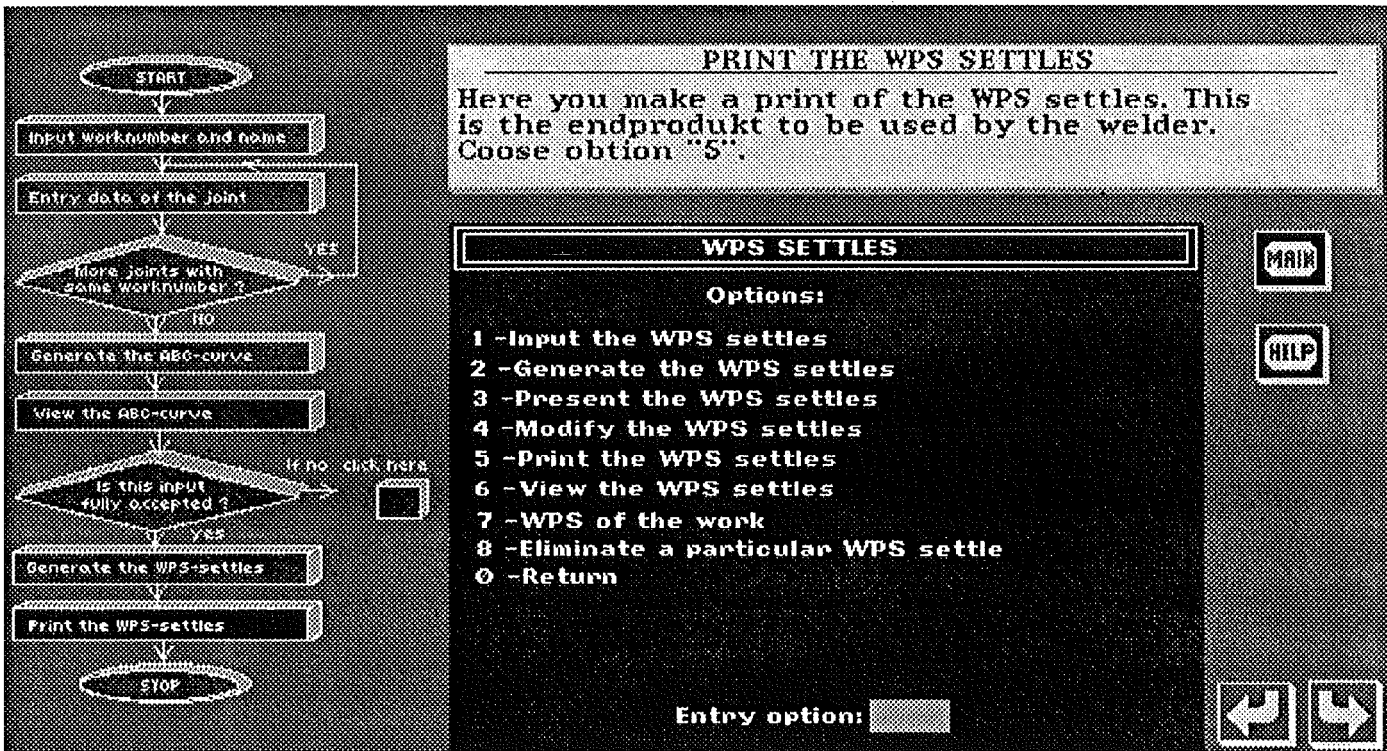
Figure A17: Screen to print the WPS-settles.
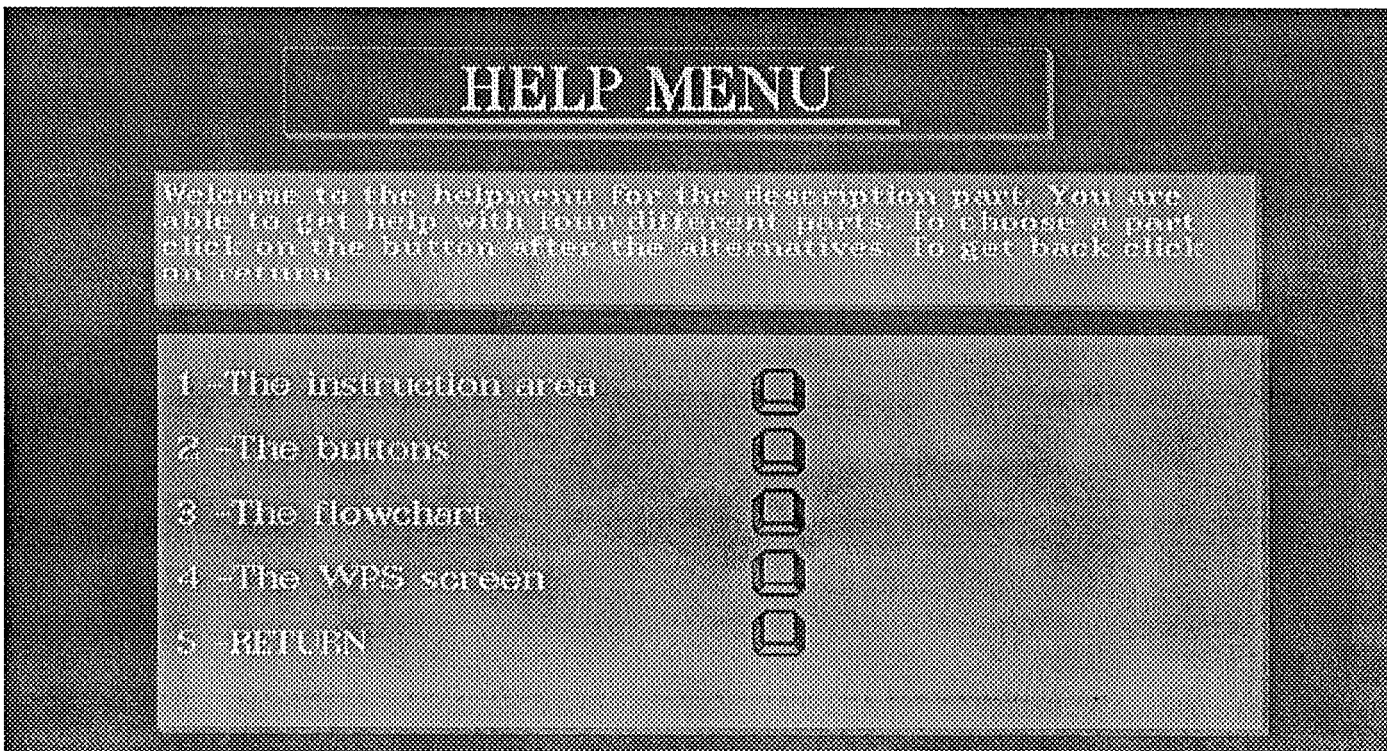
Figure A18: Screen which shows the help menu for the description section.

Sample screens of the userguide training system
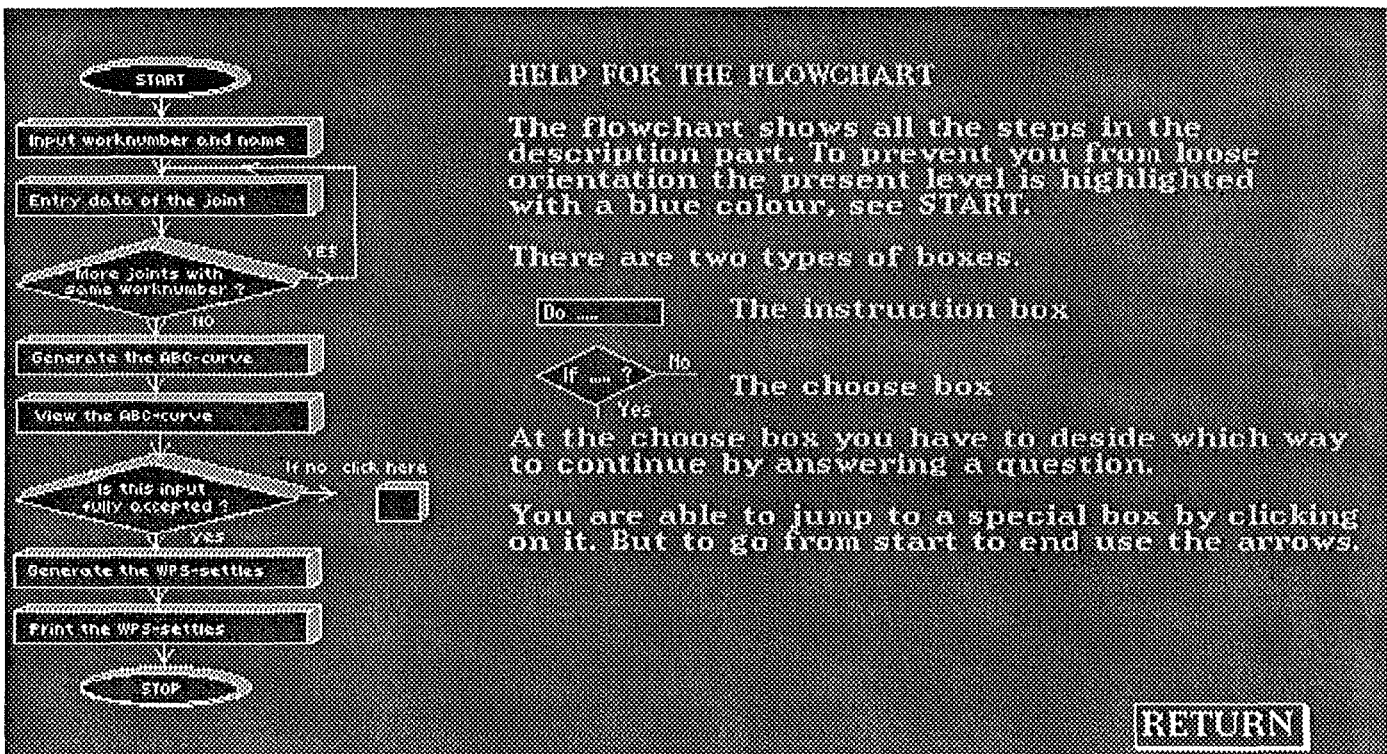
Figure A19: Screen for the explanation of the flowchart in the help menu.
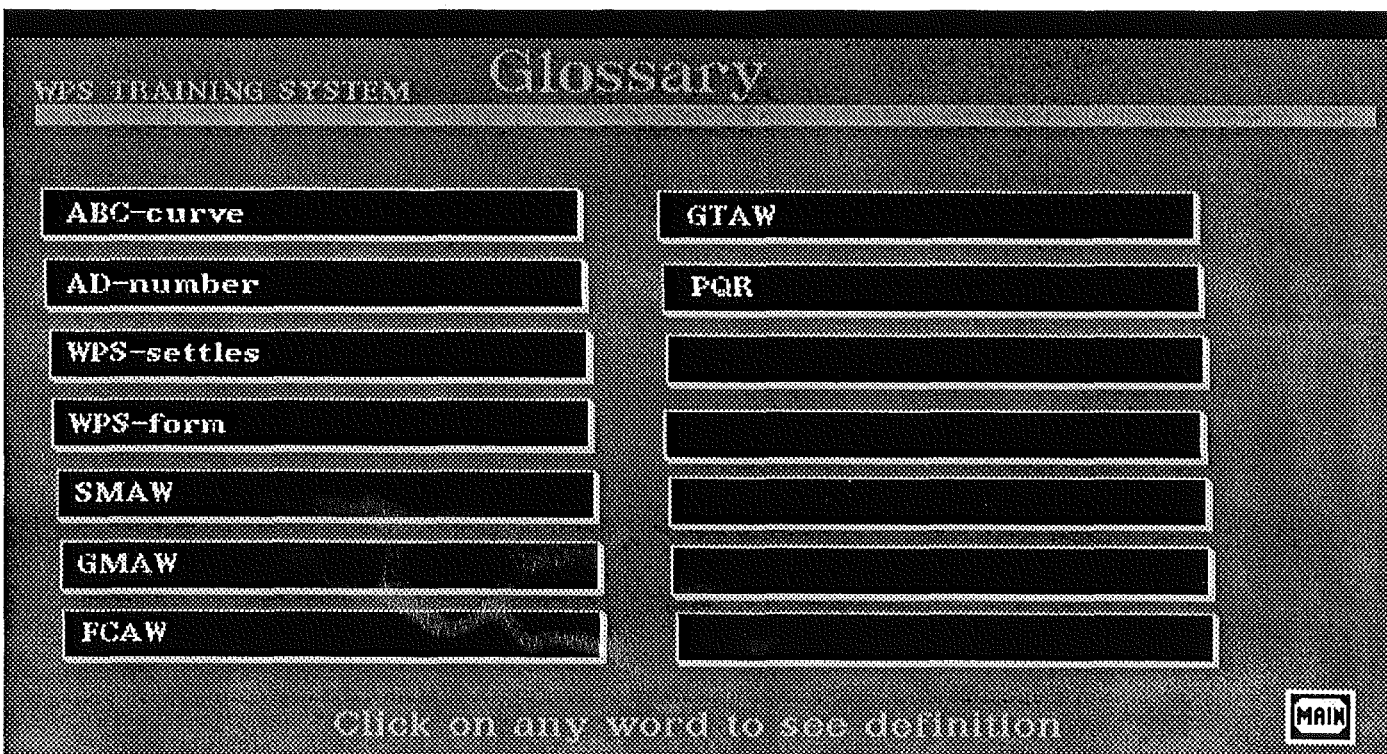
Figure A20: Main screen in the dictionary.

Sample screens of the userguide training system
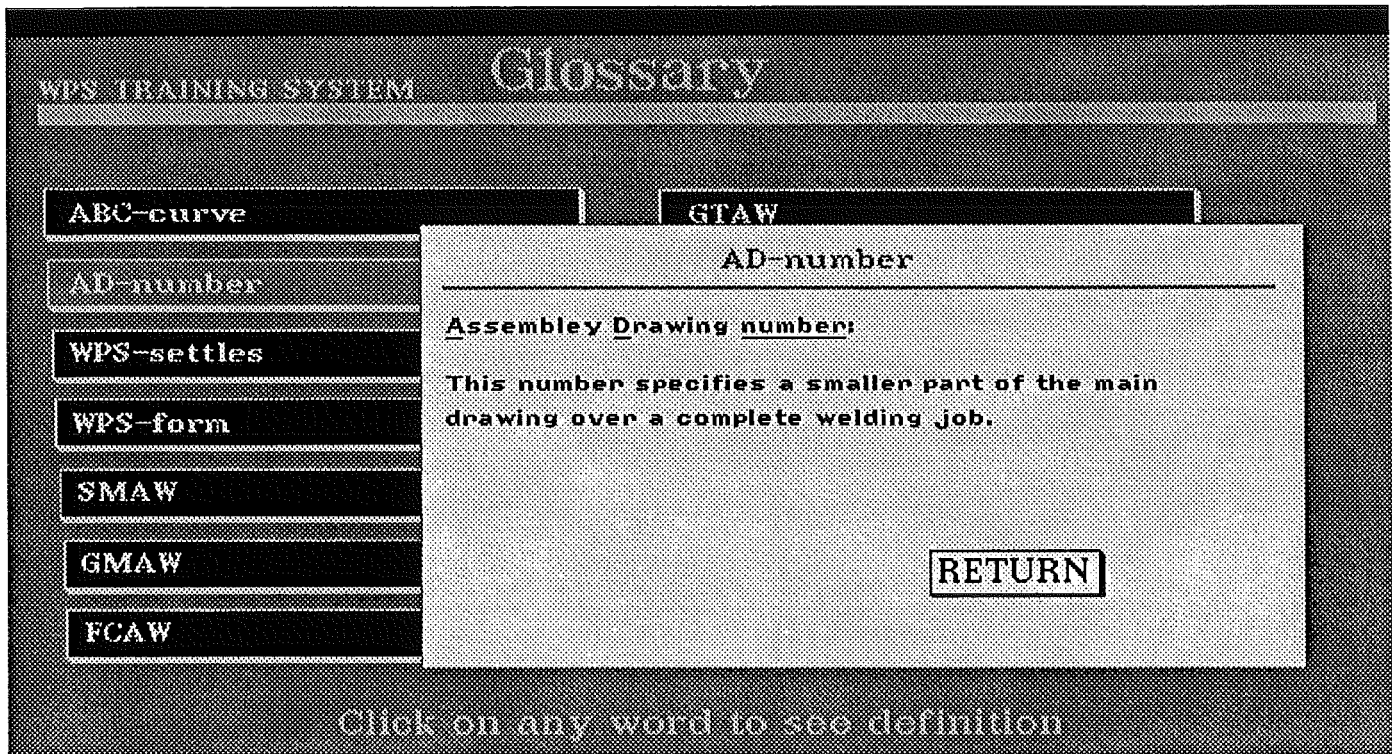
Figure A21: Glossary with text pop-up explanation.

Welding proceeding system form: part 1

ESPECIFICACION DE
PROCEDIMIENTOS DE SOLDADURA
QW-261.1.Section IX ASME Boiler and Pressure Vesel Cove

COMETARSA
S.A.I.C.   WPS N°: 39/01   Hoja N°: 1

N° de Obra: 2000   Obra: sweden   Cliente: ingo
Fech. Emisión WPS: 19/06/91
Rev. N°:0   Fech. Revisión:19/06/91   Avalado por PQR N°:
Proceso: SMAW
Tipo: MANUAL

DISEÑO DE JUNTA:
    Unión: A TOPE   Penetración: TOTAL
    Bisel: EN "V"
    Carac. Sold.: CON REPELADO Y CONTRASOLDADO
Respaldo: NO   Mat. Respaldo: Tipo: N.A.   Grado: N.A.
Metal: Metal No Fusionable: No Metálico: Otros:

METAL BASE (QW-403)
    N° P: 1   N° G: 1   ∞ N° P: 1   N° G: 1
    Mat 1: Esp. Tipo: SA-36   Grado:
    Mat 2: Esp. Tipo: SA-516   Grado: 60

    Prop. Quimicas y Mecánicas:

    . . . .
    . . . .

    Rango de Espesores
    Metal Base: Bisel: 20/ 20   Filete: N.A.
    Diam. Caño: Bisel: Filete:

Obs: . . . .

METAL DE APORTE (QW-404)

	FCAW	GTAW	GMAW	SMAW	SAW
Espec.N°(SFA)				5.1	
AWS N°				E7018	
N° F				4	
N° A				1	
Dimens. (mm)				3,25/4/5	
Ran.Mac Bisel				20/ 20	
Soldad. Filet				N.A.	

Fundente-Electrodo (clasific.): N.A.   MARCA FUNDENTE: N.A.
Inserto Consumible: N.A.   OTROS: . . . .

DISEÑO DE JUNTA (QW-402)   *SECUENCIA DE SOLDADURA*

Welding proceeding system form: part 2

ESPECIFICACION DE
PROCEDIMIENTOS DE SOLDADURA
QW-201.1.Section IX ASME Boiler and Pressure Vasel Code

COMETARSA
S.A.I.C.   WPS N°:   39/01   Hoja N°: 2

POSICIONES (QW-405)   TRATAMIENTO TERMICO (QW-407)
   Posición del Bisel: 1G   Temp. (°C): 620
   Prog. de Soldadura: N.A.   Tiempo (Hs.): 1
   Posición del Filete: N.A.   Otros: . . . .
   Otros: . . . .

PRECALENTAMIENTO (QW-406)   GAS (QW-408)
   Temp. Prec. Min (°C):10 sobre T.A   Gas   Mezcla   Caudal
   Temp entre Pasadas Max(°C): 350   Protección: N.A.   N.A.   N.A.
   Mant. Prec. Post-Sold: N.A.   Complement: N.A.   N.A.   N.A.
   Otros: . . . .   Respaldo: N.A.   N.A.   N.A.

CARACTERISTICAS ELECTRICAS (QW-409)
   Corriente (CC/CA): CC   Polaridad: +
   Amperios (rango): Ver tabla oper   Voltios (rango): Ver tabla oper
   Electrodo de Tungsteno: N.A.
   Modo de Transferencia: N.A.
   Vel. Avance del Alambre (m/min) : N.A.

TECNICA (QW-410)

	FCAW	GTAW	GMAW	SMAW	SAW
Cordón o Costura:				CORDON	
Dim. Tobera de Gas (mm)				N.A.	
Oscilación Max. :				N.A.	
Dis.Tub.Cont.-Pieza(mm)				N.A.	
Pas.Simp./Mult por lado				MULTIPLE	
Elec. Simple o Multiple				N.A.	
Vel. de Avance (cm/min)					
Martillado:				N.A.	

   Limpieza Inicial y Entrepasadas: CEPILLADO
   Método de Repelado de Raiz: GAC - AMOLADO Y CEPILLADO
   Otros: . . . .

OPERACIONES

OPER N°	PROC SOLD	MAT. APORTE CLASIFIC.	DIAM (mm)	GAS PROTECCION TIPO	Lt/min	CORRIENTE ELECTRICA TIPO	POL.	INTENS. Amper	TENS. Volt	VEL. DE AVANC
J A K	SMAW	E7018	3,25	N.A.	N.A.	CC	+	100-140	23-27	
	SMAW	E7018	4	N.A.	N.A.	CC	+	140-180	24-28	
	SMAW	E7018	5	N.A.	N.A.	CC	+	180-250	24-28	
K+1	AAC	CARBON	8	N.A.	N.A.	CC	+	450 APR		
K+2 a N	SMAW	E7018	4	N.A.	N.A.	CC	+	140-180	24-28	

APROB.	COMETARSA	CLIENTE
	Firma y fecha	Firma y fecha

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