

# AN AUTOMATED TRAINING AND TESTING SYSTEM FOR PRODUCTION LINE ACTIVITIES

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## 1. ABSTRACT

An employee testing and training software packages is being developed at Ohio Northern University as a senior design project for a local automotive manufacturer in order to satisfy QS-9000 manufacturing specifications. This software will be used primarily by trainees, who are new employees with an education ranging from a GED to a Bachelors Degree, and by current employees who have not yet been trained on a specific work duty (work instruction). A presentation system allows user to read and review work instructions containing text, pictures, photographs, diagrams, audio, and/or video media. A test system provides assessment of the retention of a trainee's knowledge of said instructions by quizzing the trainee both during and after the presentation of the work instructions. A training materials test creation system allows administrators to assemble training materials in a presentable format. An authentication system allows users to gain access by sliding their company identification card. A persistence mechanism allows for the storage and retrieval of testing materials. A user rights management allows the specification of certain users as administrators. The software package is designed to store training materials and test results over a network, with the code framework allowing for future expansion of the system. Finally, a well documented data storage schema allows training logs and quiz results to be fetched. This all-software solution is being developed on the Microsoft .NET Platform using combinations of the languages supported therein. Additionally, training data is stored using Microsoft SQL Server 2000, per the manufacturer's request. Support for various media is provided in the .NET Framework. The allocated budget for this project is \$25,000 and is scheduled to be deployed in April 2006. Ultimately, the goal of this project is to create an automated computer-based training system which provides consistent and autonomous training among employee. Additionally, it helps to assure that employees have retained information presented to them, improves the quality of products made at the manufacturing facility, facilitates information retrieval of employee training records, and better conforms to QS-9000 manufacturing specifications.

## 2. PROJECT SPECIFICATIONS

The automotive manufacturer client provided several specifications regarding the training module, authentication, database, development platform, and training media presentation.

### 2.1 Training Module

A training module consists of two parts: a set of work instructions and a set of quiz questions following the presentation of said work instructions. Work instructions detail a specific manufacturing process. Work instructions are presented in a step by step, slide by slide, format. Each slide can contain text and other media (pictures, audio, and video). After the trainee has viewed slide of the work instruction the system presents a series of quiz questions.

### 2.2 Authentication

All employees have an identification card that is unique to each employee. This number stored on the bar code is the only means of identifying employees using the system. When a user scans a barcode from his or her identification card, the database will use the ID number from the card to fetch the user's information (name, department *etc.*). If the information for that number exists in the training database, *i.e.* the user has previously accessed the training system, the user's information is pulled from the training database. The client then checks if the user has administrative rights; if so, the client then presents the user with a set of administrative options. If the user is new to the system, the testing client fetches the data from the main employee database and creates a new entry in the training system for the employee. By default, new users do not receive administrative rights; rather, they are given a standard set of user options.

### 2.3 Database

The automotive manufacturer client provided a Microsoft SQL Server 2000 schema of their current employee database. Every testing client is directly connecting to the database server, with no intermediate server application for connection pooling of any type. For the purposes of protecting the integrity of the master employee database and protecting the privacy of the employees, the system stores all training records separate from the master database.

### 2.4 Development Platform

The automotive manufacturer client uses Microsoft .NET for development of all internal programs. Hence, the software is being developed in C#.

### 2.5 Training Media Presentation

The training system must present documents over the network. All trainees and trainers must be able to access training modules over the network and present the documents page by page in a clear and concise manner. Administrators have access to create, modify, delete or add new training modules to the system. Trainees have permission to access and view every training

module, but not access to the training module creation environment. Once a training module completes testing the trainee, the client software stores the results of the test and the training module's unique identifier into the database. The system must note the changes among multiple versions of work instructions because multiple revisions of the same work instructions count as separate modules. For example "WI: 1, Revision A" is not equivalent to "WI: 1, Revision B;" this is necessary for compliance with QS 9000 manufacturing specifications.

### 3. PROJECT DEVELOPMENT

#### 3.1 Database

In order to have the functionality to create modules, record test records, and set user restrictions the database was created using three tables. The automotive manufacturer client provided a schema of its existing associates (employee) database and attached will be the training database in the form of three extra tables. The first table, "users," defines the permissions for specific users in the database. It contains two fields, "can\_approve," and, "can\_edit." Users in this table are only users who either can edit/create existing training modules or can approve a training module for use. Changes to training modules, before they can be used on the factory floor, must be approved by a manager or engineer. However, there is a greater set of users who can edit a module, but should not be able to commit those changes for use. The "tm\_results" table records the completion of training modules for each user. The last table, "modules," keeps track of what modules are in the system. If a training module file (which is discussed in the next section) exists on the network share, it will not actually be functional in the system unless it also exists in the database and has been approved. Additionally, the database keeps different versions of modules as separate entries.

#### 3.2 Persistence Layer

Initially, it was intended that training modules be stored as serialized objects into a file. Once that solution was implemented, however, it was evident that the memory overhead was extremely impractical. Images added to the slides of the presentation consumed large amounts of memory, and overhead associated with the process of byte level serialization consumed as much as four times the amount of memory of the images themselves. A different plan of attack was implemented as a combination of a Zip style archive containing all multimedia data, and an XML file describing the layout and presentation of each slide. The system stores all images and XML files into a zip file, and various parts of the training module are loaded into memory as needed.

#### 3.3 Graphical User Interface

The graphical user interface had to be designed to work with the underlying structure of the project. The graphical user interface was created to be easy to use for those of all computer backgrounds, yet powerful enough to complete all client specifications.

### 3.4 Module Editor

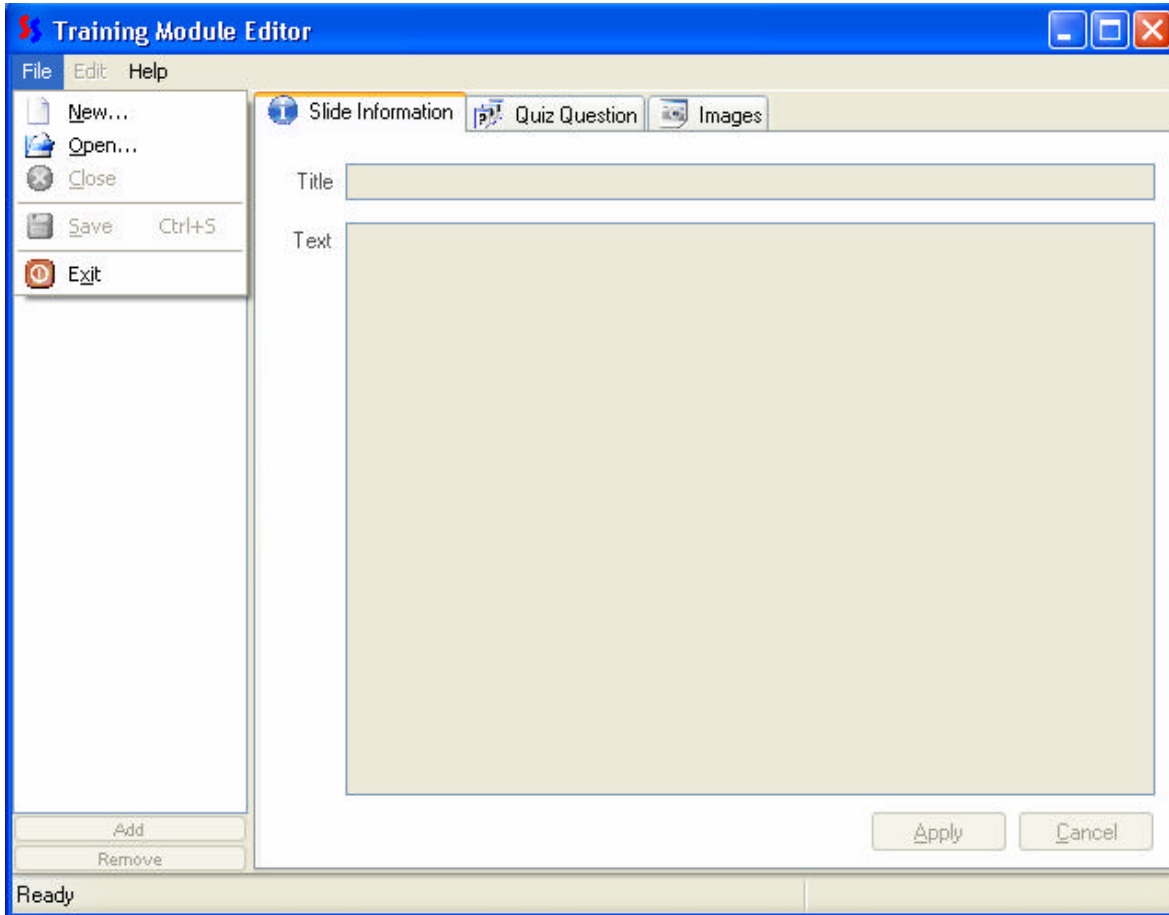


Figure 1: Training Module editor.

Figure 1 shows the module editor. To create a new training module one must first select “File->New”, name the new module, and select the location that the training module is to be saved. The saving directory can be customized by the manufacture to arrange and order the training modules to their specifications. This allows for easy retrieval of specific work instructions in the system. Through “File” on the menu bar the user can also open an existing training module to edit, save and close the current training module that is open, and exit the program.

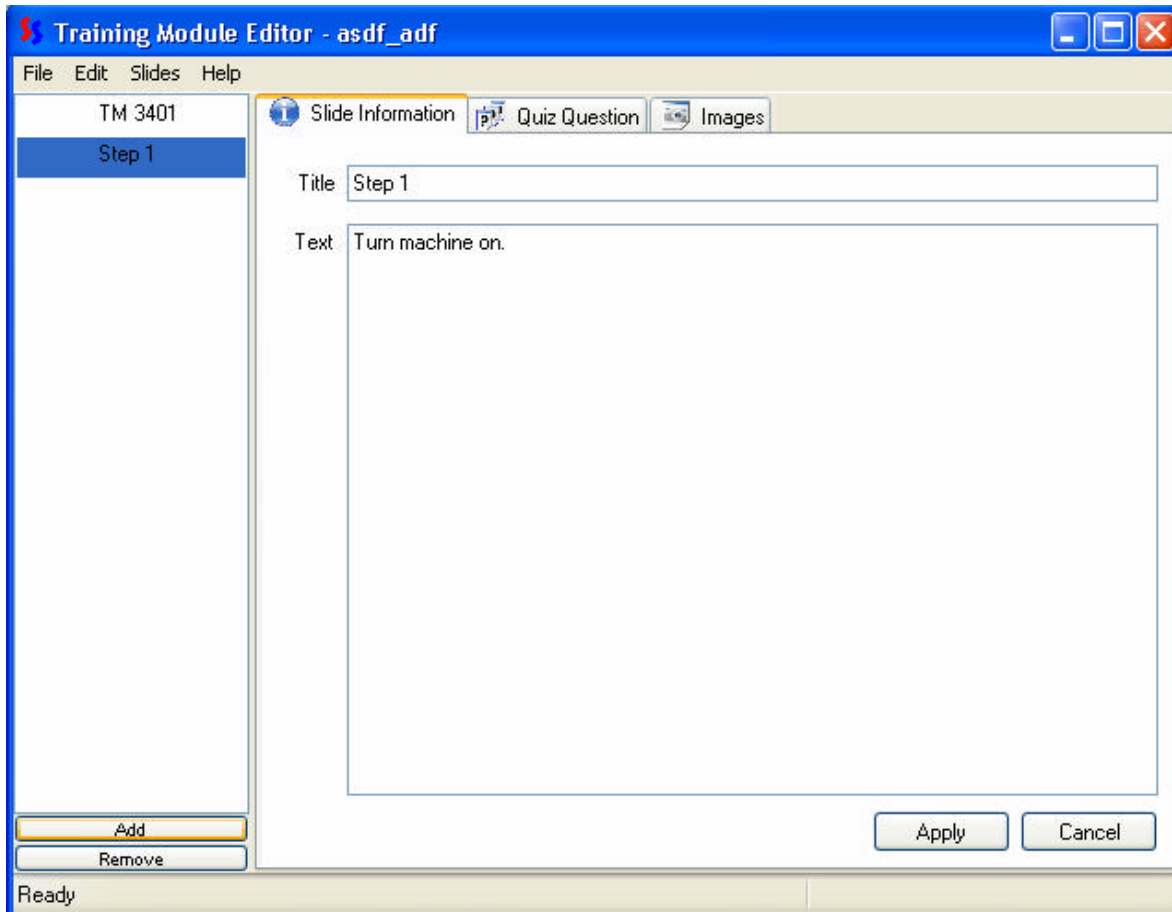


Figure 2: Training Module editor, Slides

Slides are added or removed from a training module by clicking the “Add” or “Remove” buttons at the bottom of the slide manager section. Figure 2 demonstrates an addition of a new slide titled “Step 1”. Slides can also be dragged and dropped to change the order. Every slide has the capability of having text, a question, and images.

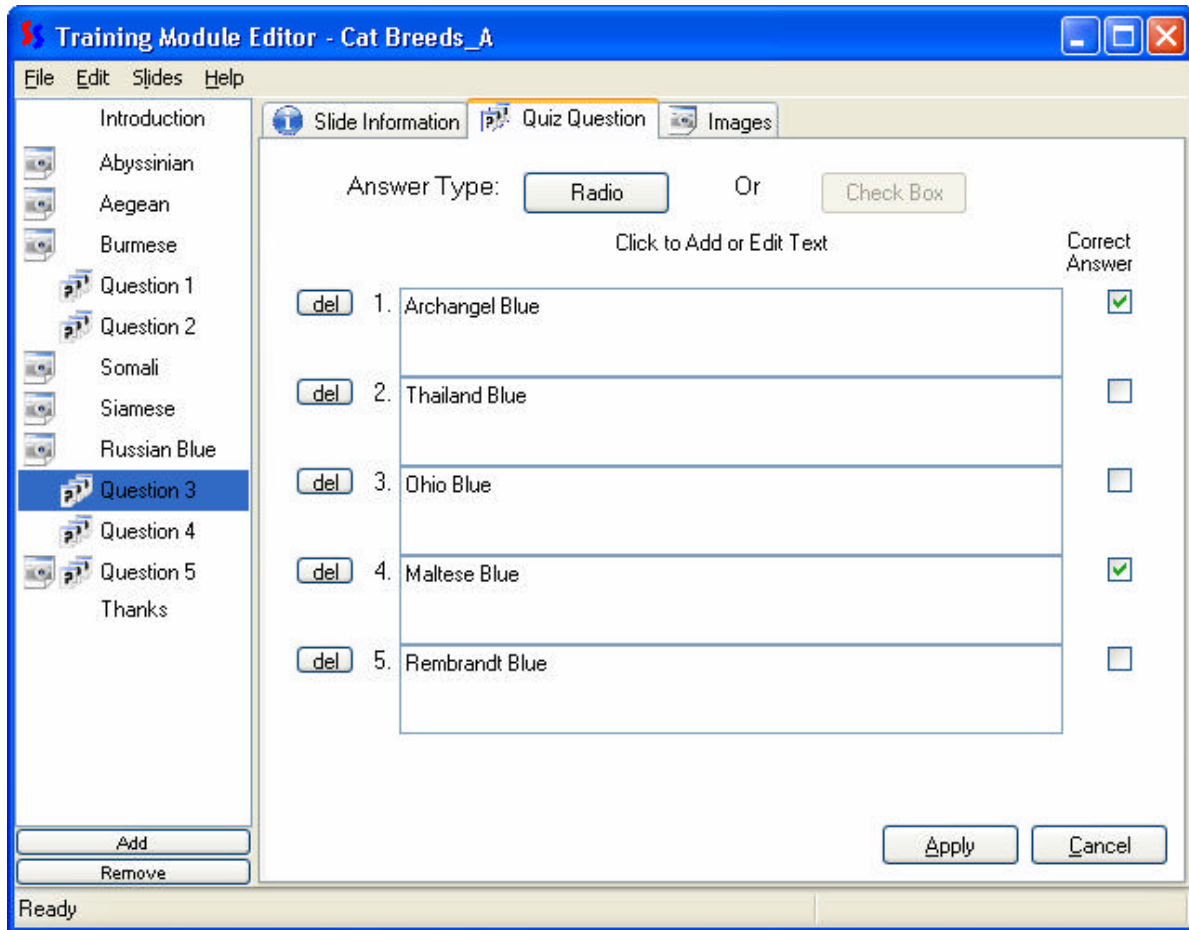


Figure 3: Training Module editor, Quiz Question

If a question is desired on a slide the user should select the “Quiz Question” tab. There are two possible question types which include “Radio” and “Check Box”. Selecting a question type of “Radio” only allows for one correct answer, while “Check Box” may have multiple correct answers. A limit of five possible answers is placed on the system for each question. Figure 3 shows an example of four possible answers to the slides question.

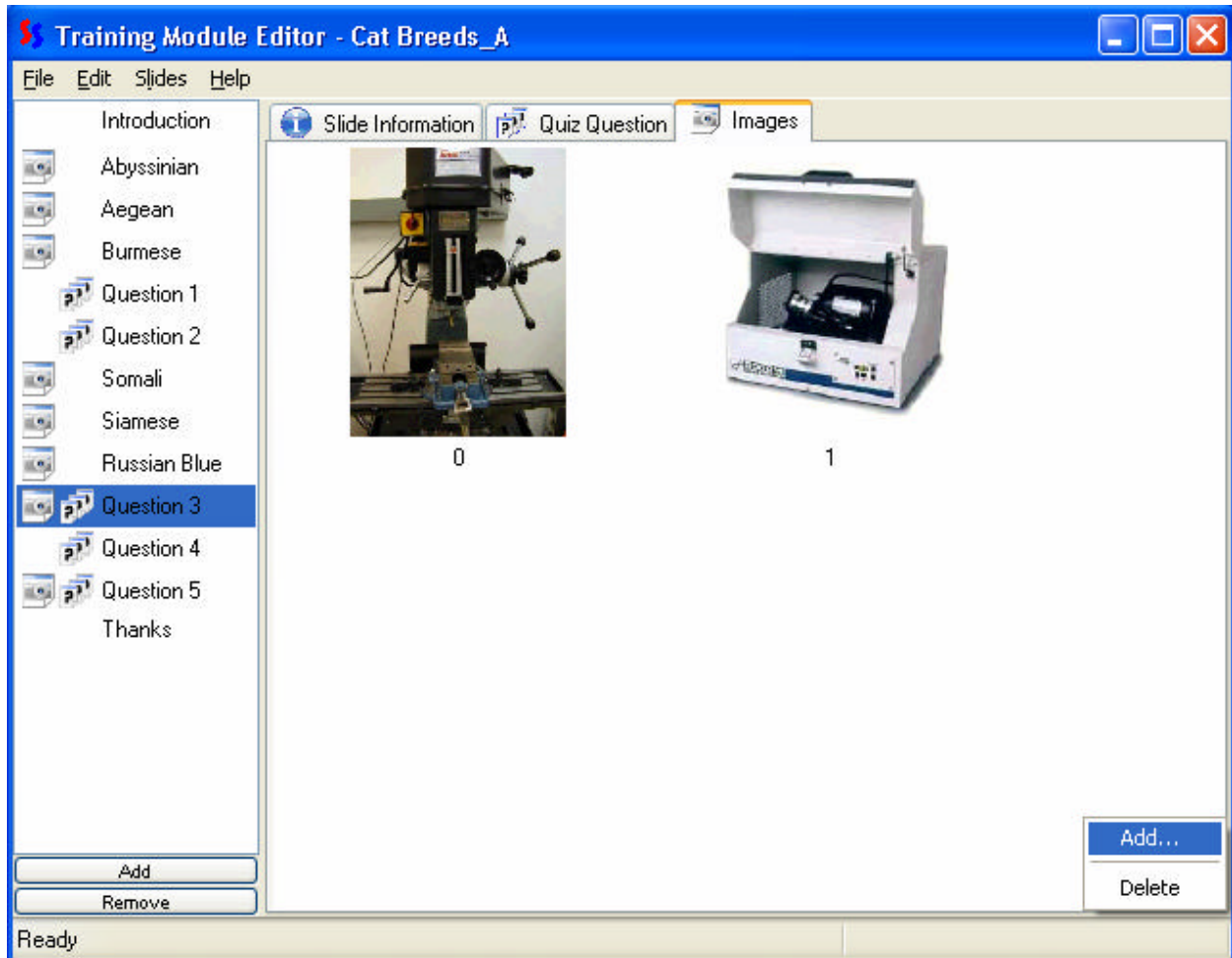


Figure 4: Training Module editor, Images

To add images on a slide the user needs to select the “Images” tab. Adding images is as simple as browsing, selecting, and uploading the desired images. Figure 4 illustrates this.

### 3.5 Module Presentation

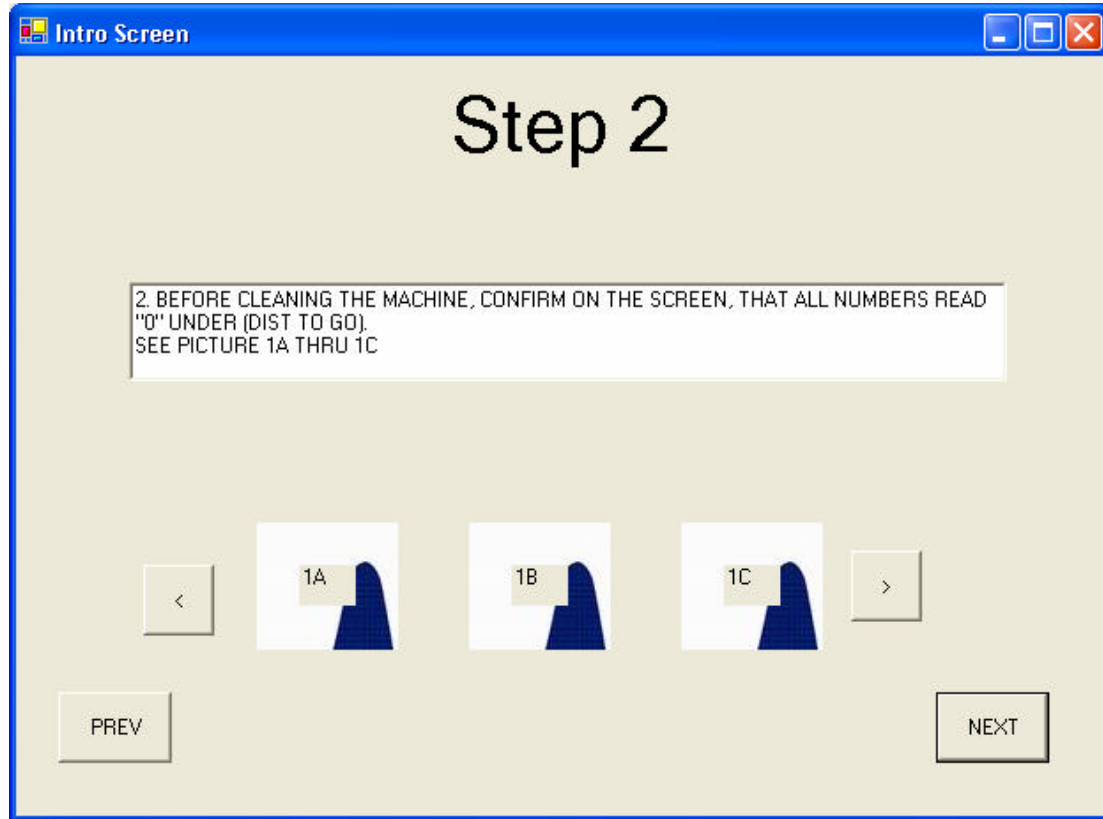


Figure 2: Module Display.

Figure 2 shows how a training module looks when presented to a trainee. The trainee must view every picture in full screen detail before proceeding to the next slide. This is accomplished by simply clicking on the image thumbnail at the bottom. The amount of text presented is limited, so the user does not have to scroll through text on a slide. The trainee can navigate the training module with the “PREV” and “NEXT” buttons.

#### 4. OPERATIONAL FLOW/ DESCRIPTION

The operational flow for all employees starts the same. To log onto the system the employee scans his or her identification card. If a trainee scans successfully into the system, the trainee can then select the desired training module from the appropriate category. The trainee then takes the training module and completes the questions. Once all of the questions are answered correctly, the trainee has successfully completed the training module and the module’s completion is recorded. The trainee can then take another training module or exit the system. If an employee logs into the system that has administrative rights they can create, edit, or take a training module.



## 5. CONCLUSION

Currently the data structure has been finalized along with the method for rendering the data structure in the GUI. The process in which we store and retrieve data has been completed (the persistence). A beta version of the Module Editor has been fulfilled and has yet had any major testing completed. The functionality of the barcode reader has also been completed. Future plans include: well documenting code and ensuring code is open for extension, but yet closed for modification, wrap the GUI and the data base together, and produce the Module Player. Once completely finished, the system will be tested by individuals of different computer background knowledge. Once sufficient testing has been carried out the system will be presented to the manufacture with a MSI installer for installation from CD, prompt installer for storage of work instructions, prompt installer for database information, SQL scripts to set up database, and thorough documentation to help maintain and allow future expansion of the system. The employee testing and training software package is not yet fully finished, but is scheduled for deployment in April 2006.