Final Design Report

MobilERP

By Anthony Fata

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1. Introduction

1.1 Project Overview

MobilERP is a multi-part system that increases the traceability of parts throughout the manufacturing process. MobilERP is a versatile system that is designed to work with almost any manufacturing process. It is a Mobile Enterprise Resource Planning because it uses a smart phone app to help trace the parts as it goes through a manufacturing process. This system contains three main components, a desktop application, a database, and an android app. These three components will be used in conjunction to trace parts as it goes through manufacturing in order to ensure everything is in order, as well as being able to keep records and other information that managers might find important.

1.2 Stakeholders

There are a multitude of people who may be interested in this system. The main target is manufacturing plants that use old paper trails, or are unsatisfied with their current ERP system. Larger manufacturing plants, or processes that use a lot of steps will also find this system useful as it will prevent parts from being lost in the manufacturing process. Managers and administrators will also find this system useful because it will allow them to find exactly what they need, and know where things are being bottlenecked/lost which will help them make the right decisions. Operators will find this system simple and will be able to do their job more efficiently, increasing throughput of any given process. Since the system is versatile, almost any manufacturing process can be used, as well as any amount of processes a given manufacturing plant has.

1.3 Goals and objectives

There are various goals I have set for myself during the creation of this senior project. Because this project is mostly self driven, the goals I have set for myself reflect what I want to take out of the project myself and are denoted in the table 1.
1.4 Outcomes and Deliverables

The end result will be the functional prototype of three separate components. A database schema, an android studio project file, and an eclipse file. These outputs will be prototypes that will act as a foundation to continue the development of this system if it takes off. Since the outcomes are prototypes, they will be limited in terms of looks and functionality, but will act as a good starting point for anybody who wants to continue the development of MobileERP.

Ideally, any company will be able to purchase the license to use this software which will cover the costs of the database as well as the administrative costs, plus a little profit on the side. Someone would be assigned to administer the program and train the customers into how to create tables and start the initial tables so customers will be able to apply this system to any of their manufacturing needs.
2. Background and Original Idea

I came up with the idea for this project after interning at a manufacturing plant my freshman year of college. The system they used was powerful, but very old. There was a lot of parts to keep track of, lots of processes that existed, and lots of employees and operators involved. The most surprising part, was that they were still using paper to keep track of the manufacturing. This actually lead to some issues which I saw, missing parts, parts going through wrong processes, and various other employee errors that could have been avoided. My idea for this project was to make an electronic way for managers and employees to keep track of where parts are in the process using the convinces of a smartphone application.

Originally, this idea was going to use a RFID device in order to help maintain the part identity. However, things changed, so instead a barcode scanner app will be used. Each part will have a barcode associated with it that will be used by the employees to manage the parts as they go through the parts. The system will use three components, a simple Smartphone app, a database and a java program to make this idea become a reality. The rest of this document will denote the design, as well as give more details onto how the components work together in order to create a system.
3. Project requirements
Since the project is mostly software based there is very little engineering specifications associated with
the system. Instead, there are various software requirements that were originally envisioned in creation
of the system. As the quarter went on, some decisions had to be made in order to reduce the workload
and allow the competition of this project. Some requirements were changed in the middle of
development, and some were not completed, but rather replaced as the quarter went on. The project
requirements and the results can be seen in table 2.

<table>
<thead>
<tr>
<th>Requirement Number</th>
<th>Project requirement</th>
<th>Completion Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>The system must be an ERP app built on an Android device.</td>
<td>Mostly completed; The ERP system and app were split up</td>
</tr>
<tr>
<td>2</td>
<td>The system must incorporate RFID technology into the system</td>
<td>Failed. Replaced with requirement #5 midway through development</td>
</tr>
<tr>
<td>3</td>
<td>The application must be versatile and adaptable to most manufacturing processes</td>
<td>Completed.</td>
</tr>
<tr>
<td>4</td>
<td>The application, for demonstration purposes, must mimic PCB assembly processes</td>
<td>Partly completed, the mimic exists locally but not in the final demo's server.</td>
</tr>
<tr>
<td>5</td>
<td>The system must use a barcode scanner to track the parts.</td>
<td>Completed</td>
</tr>
</tbody>
</table>

Table 2: Project requirements
4. Design Development

There were many design considerations during development of this project. From the beginning, it was known that a mobile application was going to be used as well as a database. The use case was also already known, as denoted in figure 1. These were the starting base and were considered heavily when designing the overall system. The database design was the beginning focus, it was important that the schema be determined and set in stone before any design of the mobile application. There were several iterations of the database, as it was difficult to find a fine line between enough tables, and not enough tables. A backend was developed with a console interface that would later expand to a fully functional GUI.

Process A

Step 1 → Step 2 → Step 3

Results get logged on phone and sent to database

Figure 1 Use case for mobile ERP

While I was developing the database, I was also playing around with Android Studio. I have never made an app before, so I thought it would be a good idea to get my feet wet before continued design of the application. During this time, I also got to figure out the UGrokJIT RFID reader [1], which was originally intended to be used instead of the barcode scanner during later development. The reader was never purchased, but the way it was used was very similar to the barcode scanning library [2] which
was used in the final development. Once I figured out how to get android studio to work and create my own app, it was time to start working on the finished product.

Sometime during this stage it became clear to me that putting too many features on the mobile app would just leaving confusion for most of its users. This is when I decided to split up the majority of the features into a separate desktop application. The small percent of people who need to know all the information will still be able to see it, and all the operators and users of the application will not be bogged down by unnecessary information that will slow down and limit their job.
5. Final Design

5.1 Top-level Design

In the end, the three components were created to work together as shown in figure 2. Each was designed independently with some things in mind. It was imperative that I consider all possible processes as well as a system that was as modular as possible. At any point, the database should be able to be changed, the scanning method used could also be changed, and the front end GUI could be changed. This system supports multiple employees, all being able to push their process results into the database.

![Figure 2: Top level design](image)

5.2 Database Design

The overall schema used can be shown in figure 3. There are multiple tables that help keep track of the parts and where the parts are going, as well as who is working on them. Almost every table has a foreign key, allowing only valid values to be inserted as well as preventing accidental deletion. Each table has important information that will help keep the parts organized and allow traceability to
exists. Employee name, the station they are operating in, the partlist that the part is associated with, and the process used are all just examples of what is kept track of when parts enter the system. The database also supports multiple paths, processes, parts, and materials; Creating a versatile database that can be used for almost every manufacturing process. Once initially constructed, some values have to be added through the front end application and then the system should take care of itself.

Figure 3: Database Schema

5.3 Application Design
The front end application was designed to be robust and powerful, being able to create, delete, and view the tables that are inside the database. Demo of the front end can be seen in figure 4. The front end was designed to be very versatile and adapt to each table that is added. This means that
adding another table to the database will require very little modification of the code which would still allow the front end to function. The front end will be able to see all the results of each table, delete certain rows, and add new values into each table. The managers would be able to see each part in the "parts" table and track the progress. There is also a detailed process table, which allows each process to be viewed individually and keep track of the steps involved for each process.

5.4 Mobile App Design

The mobile app uses a very simple scroll interface. Once logged into the database, the user of the app has various options which change the progress of the part inside the database. The user simply has to scan the barcode, then enter an operation. Once the barcode is scanned, if the id is not in the database the user can input the values so it enters the database. If it is already in the database, the user can choose to start or end the task that it is currently at. The changes will be reflected inside the database. Each app is independent of each other, meaning multiple people can change the database values at the same time. Figure 5 displays the activity that controls
5.5 Cost

The entire project was done for free, since there is only software involved I was able to create it on my own machines and cell phone. The database I used was also free, but very limited. If this were in a much bigger scale, the cost of the system would depend on two important factors. The database must be maintained, backed up, fast, and reliable. Finding one of these costs money, which varies based on the scale and chosen database. The other important factor is the manpower needed to manage all the tables and the initial creation. This should take only several hours, but requires a lot of careful planning and digitalization of every process. These two things combined will cost money if taken to a large scale, but for all practical purposes in this prototype, there was no cost associated with the creation of this project.
5.6 Environment, Safety, and Ethical concerns

MobilERP is heavily software based and because of this it has very little impact on the environment. Additional power consumption, as well as database maintenance are factors that can contribute to the environment but are mostly beyond the control of this system. There are possible safety and ethical concerns involving this system though. Firstly, there is no currently way to "verify" whether or not an employee did the job correctly besides trusting what they say. This can cause problems in the manufacturing process, and can possibly cause problems in any process by allowing parts that don't meet the standards get through. Secondly, phones are steal able which would cause a problem if the manufacturing process revolves around the cell phone. Increased cell phone use on the job could potentially cause safety hazards, by distracting or limiting an employee to do their job correctly and safely.

6. Testing

A bunch of functional tests were executed to test the MobilERP system. Once a feature has been added, it has been tested for each edge case as well as basic operation. Once all the components were put together, a functional test of all three components were used. Not all of the tests passed, meaning future development is in order to fully bring up the potential of MobilERP. The test's performed and the results are shown in table 3.
<table>
<thead>
<tr>
<th>Test Number</th>
<th>Test Performed</th>
<th>Test Criteria</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Database Schema</td>
<td>Database gets created successfully</td>
<td>Success</td>
</tr>
<tr>
<td>2</td>
<td>Database Dependencies Correct</td>
<td>Can not create foreign key values without a proper id.</td>
<td>Success</td>
</tr>
<tr>
<td>3</td>
<td>Database Keys consistent</td>
<td>Schema can be transferred between servers and still function</td>
<td>Success</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Mobile Application Test</strong></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Internet connection</td>
<td>Can successfully connect to the internet and update values on the database.</td>
<td>Success</td>
</tr>
<tr>
<td>5</td>
<td>Barcode Scanning</td>
<td>Can successfully scan values of barcode of various types.</td>
<td>Success</td>
</tr>
<tr>
<td>6</td>
<td>Functionality</td>
<td>Can start a task, create a new task, end a task.</td>
<td>Success</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Application Test</strong></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>View databases</td>
<td>Test if the database tables are viewable inside the</td>
<td>Success</td>
</tr>
<tr>
<td>9</td>
<td>Add to table</td>
<td>Test if the application can add new values inside the table</td>
<td>Success</td>
</tr>
<tr>
<td>10</td>
<td>Delete from table</td>
<td>Test if the application can delete old values from the table</td>
<td>Success</td>
</tr>
<tr>
<td>11</td>
<td>Process editing</td>
<td>Be able to view a process, create a new process, and</td>
<td>Success</td>
</tr>
<tr>
<td>12</td>
<td>Multiple paths in process</td>
<td>Be able to support multiple paths</td>
<td>Success</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Integration Test</strong></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Everything can connect to database</td>
<td></td>
<td>Success</td>
</tr>
<tr>
<td>14</td>
<td>The system works together</td>
<td>Be able to create a new part, add it to the database, and view the changes</td>
<td>Success</td>
</tr>
</tbody>
</table>

Table 3: Test results
7. Conclusion

There are a multitude of things this project can do. Since it is a prototype, a lot of the features I want to add did not make it into the final revision. Things such as database security, a more convenient and eye pleasing mobile application, and other features like user accounts and a web-based front end did not make it into finished product. Still, the potential is there, a lot of things can be done in the future that could make this system an actual product. Some things I would have done differently would have been a more hands on design, and instead of designing each section individually I look at the big picture from the beginning.

This Project taught me a lot about android development and pushed all the skills I learned throughout college to the test. The programming components consisted of event driven development, GUI, Java, database functions, threading, and even some networks. It was nice to create a project that put everything I learned throughout college to the test so I can prepare myself for the future.

8. References


Photos used

http://ll-us-i5.wal.co/dfw/4ff9c6c9-5a1f/k2-_0c707dda-329b-44cf-9f40-5956574bdd08.v1.jpg-0452e305b22721a07fd9cfa32f64e33216b4480f-optim-450x450.jpg

https://encrypted-tbn2.gstatic.com/images?q=tbn:ANd9GcTnz4DAUE_gZfJkt-LqGxLzchOgHlVjkknSU1vM3lvkjxh3ICDE5CYOPoE