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STUDENT SHOP ACCESS AND INVENTORY CONTROL IN THE COLLEGE OF ARCHITECTURE AND ENVIRONMENTAL DESIGN SHOPS

A Senior Project submitted to

the Faculty of California Polytechnic State University,

San Luis Obispo

In Partial Fulfillment

of the Requirements for the Degree of

Bachelor of Science in Industrial Engineering

by

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I. Abstract

The Cal Poly College of Architecture and Environmental Design shops, directed by David Kempken, give the opportunity for thousands of students to use the "Learn By Doing" philosophy and operate various machinery, tooling, and devices to complete projects inside and outside of the classroom. These students are able to check out tools and machinery to complete these projects on a weekly basis. This report will discuss the complexities and shortcomings of the current database system, FileMaker Pro, that is used for these transactions. The report will furthermore discuss the design and methodology of replacing this system with an improved integrated software or database designed specifically for this shop. Within this report is the senior project of IME fourth year students Chris Chen, Kevin Gallagher and Ryan Mattel. Two academic quarters have gone into the research, design, testing, analysis and recommendation of a proposed system using Microsoft Access to vastly improve the CAED shops. This proposed database will cut the current lost tooling of almost 350 tools per year, and drive down costs and processing time of each transaction by 50 percent. With the help of Technical Advisor Karla Carichner, and Project Sponsor David Kempken, the project is completed and a final proposal and product have been presented to the CAED shops based on the following research and analysis.

II. Introduction

The subject of this report is to discuss the implementation or improvement of the system in which Cal Poly Shops check in/out materials, tools, and machinery for student use on campus. There is a possibility with the current system that students may check out equipment, tooling, or machinery that they are not properly trained for. In addition, lots of tooling goes missing, as there is a large human error gap in the current check in and out system.

The College of Architecture and Environmental Design shops currently use a system called FileMaker Pro. It has become quite apparent that this system does not reach the expectations of the department. The system does the bare minimum, but can be attributed for many of the fallacies in data records and lost tooling. FileMaker Pro makes the entire check-in/ out process slow and inefficient. When students would like to check items out, the desk clerk must manually input repetitive student info. To make matters worse, these clerks are not always readily available. Furthermore, while doing time studies in the shop, it was alarming to see that over 40% of transactions within the shop are never even recorded in FileMaker Pro. During busy shop hours, long lines build up, causing crowding on the shop floor. Students become frustrated with lines or when nobody is working the checkout desk. When students leave their materials there without checking with a clerk, the tools are effectively lost in the system. Our proposed system will shorten the process time by removing unnecessary typing and data input. The system will also pair each individual tool to the person who checks it out, instead of merely the type of tool.

Our project sponsor, David Kempken, brought this situation to our attention, referencing his shop directly as a starting point. He is the head of the College of Architecture and Environmental Design (CAED) shops and has run into many of these checkout inconsistencies.

He has stated his displeasure with the system as it is frequently unable to provide the transaction records of each student's rentals, safety qualifications, and overdue items. The objectives for this research and project solution are as follows:

1. View a student's current checked out and overdue items.
2. Compare a student's desire to check out tooling or machinery with qualification and training.
3. Provide safety justification backed by hard data of students checking out materials without proper training.
4. Provide economic justification and numeric data to support the argument that money is lost due to misplaced, stolen or overdue items.
5. Automate and streamline the process to decrease processing time.
6. Create a new database that is more accurate and user friendly.

The objectives stated above will be accomplished through researching best practices, experimentation, prior knowledge from IME courses, and close contact with our customer(s). There was constant contact with our Technical Advisor, project sponsor, and potential users (students) to assure we were solving the problem to their standard. Some IME courses were great resources to help find solutions to the problems faced in the shop. Process Improvement and Fundamentals has given us the steps to approach any process, and given tools to analyze systems. Data Management and System Design provided a background of databases, and how to create one for any system.

The final deliverable consists of the relevant justifications, as well as the designed and proposed alternative solutions. The programs are an improvement upon the current old and manual process, or a complete revamp with an integrated program outsourced to another

development. There are many ways to go about solving this problem, each with advantages and disadvantages. Each alternative includes the important economic, academic, and safety justification necessary to support each potential solution. The means to arriving at each solution includes research and discussion around best practices utilized across Cal Poly and other campuses. Through this research, we analyze and compare each possible alternative against one another. Data involving cost, safety ratings, and academic benefits are utilized to rank the possible options. Experimentation and free trials to test each alternative also come into practice to determine which system will work best with Cal Poly shops. A close relationship and transparency with David Kempken helped to assure the approval of the shop lead.

We begin the report by covering background and a literature review on the pertinent research utilized throughout this project. Next, the design and methodology chapters discuss in detail how we compared each possible alternative to test and justify which is the best direction to follow. Lastly, the results and conclusion chapters wrap up the report, stating final findings as well as a summary and conclusion with recommendations to the shops moving forward.

III. Background and Literature Review

Figure 1

The College of Architecture and Environmental Design currently has a student body of 1,900 students split into five different majors. These majors are all heavy advocates of Cal Poly's famous motto "Learn by Doing". Professors often assign projects that involve designing and building models of varying magnitudes. This CAED Shop location is where many of these projects are completed. The shop currently maintains approximately 1000 active users annually. These users are constantly working on projects for classes or constructing objects for leisure. David Kempken currently monitors the shop with the help of his employees, also known as Redshirts. Redshirts are current Cal Poly students who have had experience working in the shop and maintain the expertise to teach other students how to safely work in this environment. The Redshirts are also in charge of the shop's front desk, where students can rent out tools for their projects. To check tools in and out, the Redshirts use a digital database called FileMaker Pro, which has proven to be problematic. In discussions with David, as well as the support team, it has become apparent that there is a wide dissatisfaction with the current software. He is not able to quantify it by providing many statistics or hard data to show system failure, but he has made it apparent that the team is unhappy with its performance at this point. Our project finds a replacement for this database that can meet all the shop's needs.

To begin research we considered the campus centers that shared similar operations involving students. The targeted functionalities and necessities are renting out equipment, reserving or signing up for classes and rooms, and cross-checking student history. The Cal Poly Recreation Center was the first place we visited. We met with Assistant Director, Nancy Clark, and discussed the current program ASI uses to check in students, rent equipment and more. The Recreation Center is managed by Associated Students Incorporated (ASI), which is a separate entity from the university. They use a system called InnoSoft Fusion, which is used by other on-campus programs within ASI. One of these programs is the craft center, which runs InnoSoft Fusion to administer operations. InnoSoft Fusion has been performing well for ASI since its initial implementation. According to their 2015-2016 annual report, "[InnoSoft Fusion] offers more functionality to staff and self-service features to customers". Another more manual on-campus system we looked at was the Electrical Engineering building where students can rent out electrical and circuitry equipment. This whole system is conducted in person, where students write their name and check a box that has the equipment they need and then give it to an employee to hold on to until they deliver the equipment back. This system does not encompass the variability that CAED shops have on a day to day basis. Within the CAED shops, the transaction numbers and bandwidth needed is extremely volatile. However, the electrical engineering department does mirror a similar customer base and user population.

Various other Cal Poly shops on campus provide similar systems for their students across other engineering and technical majors. Mustang 60, the library, and the other engineering shops use programs such as Microsoft Access and WebCheckout. WebCheckout has worked well for many shops across campus with similar needs. It has the ability to add and delete student records, check databases for inventory, and rent out equipment. WebCheckout centers in on the

Classroom Technology department which allows it to serve the whole campus. Cal Poly's Media Resource Center produced a video to shed light on how much their front desk operations have improved since implementing WebCheckout into their system. In the past, the Media Resource Center has used outdated systems and even programmed their own system using FoxPro. Administrators and operators agree that WebCheckout has been a major improvement and praise the features and interface of the system. Tom Sciortino, a Media Resource Center employee and operator of WebCheckout, states that he has been "really happy with the way the card swipers and the bar code readers connect seamlessly with WebCheckout." The connection of a card reader and barcode scanner into the system is a critical aspect for front desk operations. WebCheckout is an able candidate for the CAED shops, but the company's primary customer base is audio visual centers.

Connect2 is another integrated system that has been implemented in several universities, including Cal Poly. This system stands as another viable outsourcing option, but will cost the shop around 20,000 dollars to implement. WebCheckout and Connect2 both fulfill the requirements as possible programs to implement, but Cal Poly's Information Technology Services declined to move to this new option. A large part of this refusal is due to the inadequate amount of bandwidth available for this specific IT department.

Although it seems the lack of bandwidth may create problems, we feel it is still important to research some of these larger scale integrated software databases. On Connect2's website, there is a case study about how the system has affected Cal Poly's Customer Technology Support Department. Danielle Veatch, a CTS technician, only had positive things to say about Connect2. The CTS department oversees approximately 1500 items, which is similar to the number of tools in the CAED shops. All the transactions had been made and reported manually

due to the department not finding a system that could meet expectations. The manual approach led to miscommunication and many errors throughout the system. Danielle was then tasked with finding a new integrated database that would revise the system. She decided to go with Connect2 and instantly noticed the improvements of using this system. The two leading improvements that Connect2 contributed were providing an online self-service reservation system and an overdue item policy. The self-service system has proven effective, as 60-70% of all transactions are done online before arriving at the front desk. This improvement, along with a user-friendly interface, has improved the processing time at the front desk from a range of 5 to 10 minutes to under one minute. This shortened transaction time has led to an increase in throughput of customers being processed. The late return fee policy has also boasted improvements to the process, reducing the number of late items at any given time from 30 to 3. This system appears to be a great fit for the shops, but there is still the issue of cost and bandwidth that is withholding taking action on this project.

Libraries are another type of university center that benefit from implementing integrated systems. There are many services needed in libraries, such as book rentals, room reservations, academic equipment checkout, etc. Every library has their own system that helps keep track of all these transactions. Koha is an integrated system that specializes in library services, and is defined as Open Source Software (OSS). Koha is one of the only OSS systems that offers cloud computing which is beneficial to any library and centers that are not using manual systems. A case study by Bowen University reports that “placing Koha on the cloud provides such advantages of cost saving, flexibility and innovation, user centric, openness, transparency, interoperability, representation, availability anytime anywhere, connecting and conversing, and creating and collaborating”. The library believes that Koha has made a positive impact on the

library based on all the functionalities it can execute. There is still the issue of bandwidth with systems like these that can halt implementation. The case study states that inadequate bandwidth is “a major issue in many automation projects.”

Microsoft Access is another database that may be implemented into the CAED shops front desk. In his article, “Microsoft Access 2003”, Richard V. Dragan lists Microsoft Access as “the most powerful workgroup database solution” and says it is a better choice than FileMaker Pro. Access is currently being used by many of the engineering shops in building 41 on Cal Poly’s Campus. This system has been discussed, and is believed to be a possible model to design a new database from. If some changes are made, and the format is manipulated to fit that of the CAED shops, then most of the requirements may be met. Dragan also states that Access is an effective prototype for any database application. The ability to access a database and check students in and out can be encompassed through these pre-existing systems, however, we feel there is a better option. Fortunately, our group has experience working with Access, as our Data Management course focused on using this type of database. We created a customized database from scratch that matches David’s preferences and presented it to him to use for his shop. The program was able to be completely specialized to the problem at hand. All verbiage, functionalities and options are what is sought after for the shops. Access is a shareable database, but the IT department will need to support the implementation at the front desk. The department server will have to take on this additional data, but this is a fairly small undertaking. The

database may also be stored on a local drive, but it will be up to the IT department to decide. IT support remains the largest uncertainty with this possibility.

Functionalities:	FilemakerPro	Microsoft Access Database	Connect2, InnoSoft Fusion	WebCheckout
Checkin/out	Y	Y	Y	Y
Safety Documentation	Y	Y	Y	N
Barcode	N	Prototype	Y	Y
PolyCard	Y	Prototype	Y	Y
Online Reservations	N	N	Y	N
Bandwith Available?	Y	Y	N	N

Table 1

Table 1 is an overview of the three discussed data basing options. The functionalities of each system are listed, and a cross comparison of what is available is shown. FileMaker Pro and Microsoft Access are the cheapest options that the shop could implement, but are missing some key features that could improve the process. The databases WebCheckout, Connect2, and InnoSoft Fusion, all fall in the category of outsourcing systems. This bracket represents purchasing an outside program and team to install this expensive software. The largest downfall with these systems is the monetary cost, and bandwidth needed. The IT department has expressed that it will not be able to maintain such a large system. The outsourced options provide the most functionality, all of which will have shorter processing times and will provide barcode and Cal Poly ID scanning capabilities. The Access Database has the ability to do these same functionalities once the prototype is updated to version 2.

A major theme throughout many of these possible solutions is the ability to use a barcode scanner. Most companies deal with item accountability by using barcodes to identify all of their tools. Using barcodes is a form of Automated Data Collection (ADC) which provides many benefits for the system that uses it. Jeff Lebow, a writer for IIE Solutions, shares the many benefits of using a barcode system in his article “Planning and implementing a successful barcode system: A project primer”. Some of the benefits include faster data entry, less room for human error, and labor savings. The seconds saved from scanning instead of typing add up

quickly, and not to mention all the time saved from removing room for human error. The average human makes a data entry error once out of every 300 characters. With a barcode system, the amount of error decreases to zero.

A more recent technology used for Automated Data Collection, Radio-Frequency Identification (RFID), is now being used frequently for company equipment. Using RFID technology can potentially be involved in dealing with the lost or stolen tools issue. Placing RFID chips on tools would let the shop know exactly where the tool is at any point in time. This technology is very effective, but it does come with some downsides. Bruce Eckfeldt, a business coach and consultant, points out in "What Does RFID Do for the Consumer?" that it is important to consider consumer privacy when implementing RFID technology. Using RFID can be viewed as an invasion of privacy, which is an ethical dilemma. For the CAED shops in specific, it is extremely important to keep student information private. With any database system involving students, there is a large risk for losing personal information. The other problem is that RFID is very expensive, being that it is a new, innovative technology.

Finding the best match to compare the current state of the CAED shop was crucial in this literature review. Establishing case studies and model programs with similar transactions per

Figure 2

day, user amounts, customer bases, and budget helped mold the direction of this project. It is very important to keep the ITS department in mind throughout the research, design, and testing portions of this project. We must remain within scale of the capabilities for this department and assure the support will be there. One of the original setbacks encountered when proposing these outsourced solutions was not considering the ITS department enough. The ITS department is not always able or willing to implement a new program, especially when it believes the current system is fine the way it is.

The last portion that is extremely important throughout the research, methodology, design, and implementation or recommendation of the final solution is safety. Safety of students is at the forefront of everyone's mind that works in these shops. Furthermore, the liability that

comes with allowing students to utilize these machines can be extremely detrimental if things go awry. In the article, "Preventing Liability in Vocational Education Classes," liability and safety issues are brought to the attention of public schools. As discussed within the Case Law portion of the case study, there are many issues with machine related instances. The article goes into detail about the idea of negligence and what will or will not hold up in court. The system that is chosen or improved on Cal Poly's campus must assure the student body and administration that there will be no such negligence. There cannot be any missteps or opportunity for a student to injure himself or others. Accidents happen all the time, and it would be a horrible thing if the accident were to directly relate and fall back on a program.

This CAED shop, along with all the other shops located at Cal Poly, is an essential part of the curriculum for many students. Students learn about a topic in their lecture, and then they can put what they have learned into action through the shops. These shops symbolize Cal Poly's "Learn by Doing" motto and help create learning opportunities that other universities do not provide. "The Learn Better by Doing Study" surveyed 1,840 teachers ranging throughout all education levels. This study reported that 99.4% of these teachers believe that students benefit from doing activities and 94.5% of teachers would have their students do more activities, given a sufficient amount of time and resources. The conductors of this study believe that hands-on learning is fundamental to education, especially due to the rate at which technology is advancing. This method of learning is a valuable aspect of this university that sets us apart from others, so anything we can do to help improve this is worthwhile.

IV. Design

Currently, the CAED shop uses an outdated FileMaker Pro software to record tool transactions and student information. There is plenty of room for human error and the system is not very secure. FileMaker Pro consists of a manual data entry, in which a desk clerk scans Cal Poly ID's to check tools in and out. The user interface is hard to work with and navigation proves to be slow and tedious. These tools, however, are not individually identified. For example, as it currently stands, when a student checks out a hammer, there is no way to tell which of the hammers the student has checked out. Furthermore, when three students check out hammers and two are returned, there is no record to find out who has the last hammer, and in what sort of condition it was rented out or returned.

Figure 3 displays FileMaker Pro's user interface that an employee will look at when checking a tool out for a student. The large number of tools, combined with the outdated user interface, make it very difficult to look for tools and is time consuming to scroll through. It becomes especially time consuming when students want to check out tools that have lots of specifications. For example, in Figure 3 the employee wants to check out a "Drill, Right Angle "Shorty" Drill Battery" and there are 23 different types of items that start with the word "drill". After conducting time studies, we

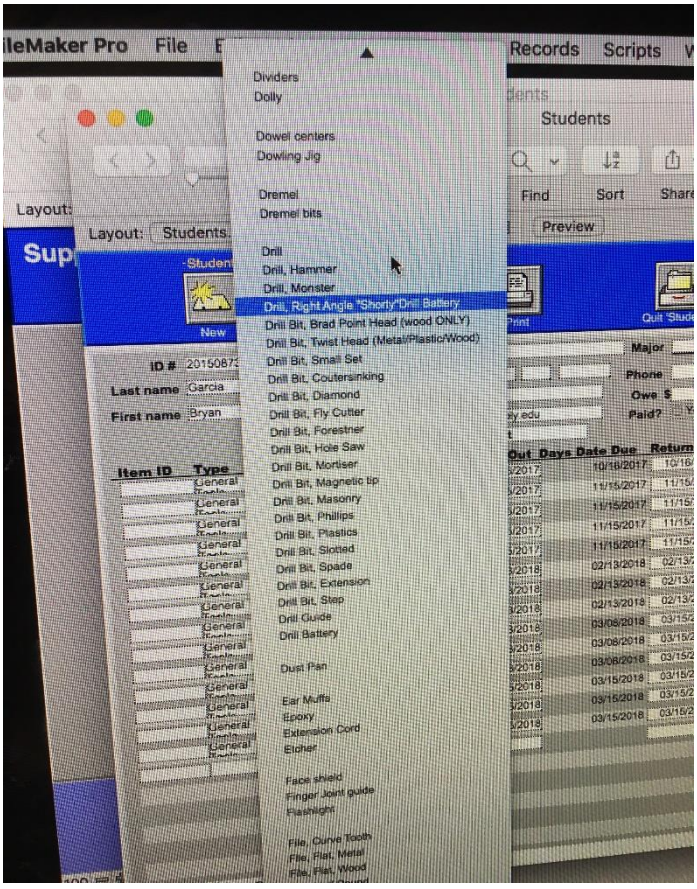

Figure 3

came to find out that the amount of time it normally takes to pinpoint a tool on FileMaker Pro ranges from 5 to 25 seconds depending on the tool.

Several problems arise with FileMaker Pro, as hundreds of tools are reported as lost every year (around 350 from February 2017 to February 2018). As stated, one of the largest reasons for this lack of accounting is the simplified and outdated system in place. The most complete list of inventory items found can be seen in Table 2. Table 2 is a sample sized screenshot of the data provided for lost or misplaced tools.

Tool Type	Date Check Out	Date Check In
Drill Bit, Twist Head	09/23/2016	
Safety Glasses	09/30/2016	
File, Flat, Wood	10/04/2016	
Glue, Wood	10/05/2016	
Saw, Hand	10/10/2016	
Shears	10/12/2016	
Shears	10/12/2016	
Grinder	10/13/2016	
ViseGrip All Purpose	10/13/2016	
Safety Glasses	10/14/2016	
Safety Glasses	10/14/2016	
Extension Cord	10/14/2016	
Square, Speed	10/14/2016	
Saw, Band	10/14/2016	
Tape Measure	10/14/2016	
Gloves	10/14/2016	
Gloves	10/14/2016	
Saw, Jig	10/15/2016	
Square, Speed	10/18/2016	
Drill Bit, Twist Head	10/18/2016	

Table 2

Once again, the system does not state who has the tool, or which “Tape Measure” or “Extension Cord” is missing. This not only makes it difficult to run the shop, but provides obstacles in the research taken to compare current state data to future state.

It is difficult to establish a current and future empirical data comparison, as FileMaker Pro does not provide many records or data. As it stands, the current system does not keep a live count of what specific items are checked out to which specific user, how long items may be checked out for, or even a record of items in inventory. However, upon request, a support team

member was able to provide some data of lost items and a compiled record of transactions per day. Screenshots of some of this data can be found in Figure 4 and Table 3.

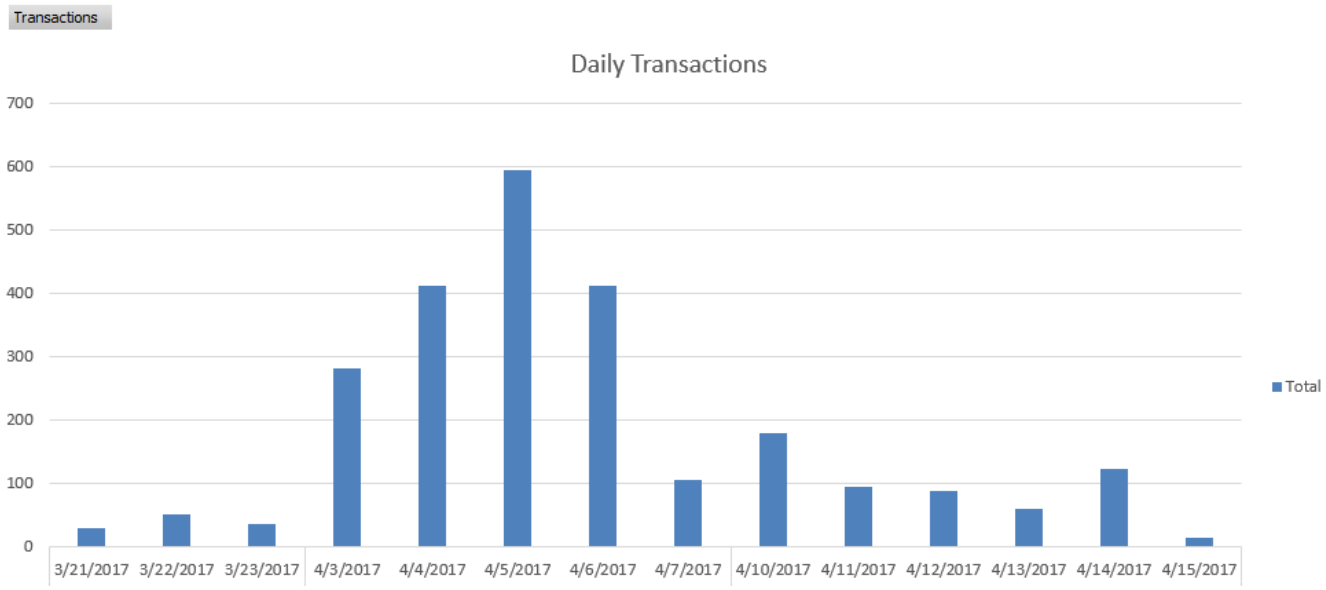

Figure 4

Figure 4 is a graph showing the amount of transactions per day in a random time frame between 3/21/2017 and 4/15/17. The X axis represents individual days and the Y axis represents the amount of transactions recorded on that given day. The transactions from this time frame ranged from less than 50 to almost 600 transactions, which supports the idea that the transaction count on a day to day basis is extremely volatile. Class project due dates can determine the amount of student transactions that occur, as certain weeks have a much higher volume of transactions than others.

					Retail Cost	
Row Labels	**Count of Drill**				Low End	High End
Air compressor	1	300	600		300	600
Shears	7	35	45		245	315
Snips, Aircraft	1	10	12		10	12
Snips, Standard	3	8	10		24	30
Square, Speed	10	5	10		50	100
Square, T	1	8	13		8	13
Staple Gun	2	10	20		20	40
Surform	2	3	4		6	8
Tape Measure	10	2	6		20	60
Tape, Masking	1	2	2		2	2
ViseGrip All Purpose	3	80	160		240	480
Wire Clippers	2	10	25		20	50
Wrench, Box	3	15	20		45	60
Wrench, Crescent	4	7	23		28	92
(blank)					$5,908.35	$12,735.00
Grand Total	**347**					

Table 3

Table 3 includes a sample snapshot of the CAED Shop's lost tools list, or what FileMaker Pro reports as lost. The list is comprised of almost 350 lost or stolen items dating from February 2017 to February 2018 and was provided to us by the CAED Shop support team. The lost tools range from five-dollar safety goggles to hundreds of dollars for air compressors and drills. This list was used to calculate an estimated cost of lost tools within in the past year. The estimated monetary loss within that year time frame ranges from about 6,000 to 12,000 dollars. A snapshot of the calculated cost range for these lost tools can also be seen in Table 3 whereas the full table can be found in Table 7 in the appendix. The cost range of these items were calculated using low market to high market retail prices.

Another monetary issue that requires attention is the underutilization of qualified employees or "Redshirts". These Redshirts are trained to help on the shop floor, operate machinery, and teach students how to properly use equipment. With that being said, these same Redshirts are being paid to take care of the check-in and checkout duties of tooling as well. This takes them away from the job they should be doing, and wastes the valuable resource that is their

skills on the shop floor. We recorded time studies and in an hour's time, Redshirts were in the check-in/checkout area for only around 50 percent of the time.

The improved design of this system includes all proper specifications and functionalities of a proposed solution to the original problem statement. It will include the ability to scan items by barcode, or manually enter numbers to simulate this functionality. It will also be able to assign each specific checked out item to a student. Employees will also have the option to create reports of inventory count and lost/overdue tool information from the desktop computer. The metrics that were used in reaching this decision stemmed out of conversation with David Kempken as well as our own evaluation of the system. Knowledge and skills learned in statistics and data analytics classes provided the necessary tools to complete sufficient analysis. Processing times, throughput and lost items remain some of the key performance indicators in the testing of the current and future states.

Different alternatives were thought of when proposing a final solution to David. One option is to keep the current FileMaker Pro software in place. A benefit to choosing this option is that there is no risk of losing more money and there will also be no transition time or additional training needed for employees, as everything would remain the same. There is no additional risk in this option, however, there is little to no room for improvement. One of the biggest problems with FileMaker Pro is the lack of ability for the system to adapt to newer standards. The software is old and there are very few people at Cal Poly that are familiar with the software or have the technical background needed to customize the user interface, making it extremely difficult to work with. One of the main drawbacks with FileMaker Pro is that it is very difficult to form reports or export reports to Excel. There is only one support team member within the CAED shop who knows how it works and even he has explained how inconvenient and complicated it is

to form these reports. If this option is chosen, we highly recommend that the CAED shop implements a barcode system or any type of system that would allow them to distinguish between tools. The CAED shop already has a barcode scanner on hand, but have yet to label or assign barcodes to any of the tools. Doing this would eliminate the current problem that certain tools are indistinguishable from each other in the database. This would help keep track of student transactions because it would be able to assign a specific tool to a student rather than assign a type of tool to a student like the current system does. In fact, we suggest that a barcode system or something similar be implemented in the CAED shop no matter which alternative is chosen.

Another alternative would be to implement an integrated system such as InnoSoft Fusion, Connect2, or WebCheckout. Using an integrated system that is made for front desk operations similar to the shop can be very profitable. WebCheckout and Connect2 are both currently being used on Cal Poly's campus and have been reported of lowering the processing time for transactions. The processing time saved raises the throughput of the system, which is a major key performance indicator. Connect2 also has a solution to late or missing equipment that drives down the number of late tools. The system implements a late fee that incentivizes students to turn their equipment in on time. This will save the shop from losing money from tools and add revenue anytime a student turns in his or her tools late. Connect2 also has a unique self-service feature that lets students reserve equipment online without being in the shop. With this feature implemented, students would not need to worry about tool availability. The self-service system would also increase the throughput at the front desk, and take more work off the Redshirts shoulders. These systems are also user friendly and are capable of using a barcode scanning system paired with a Cal Poly ID scanner to attain top notch system performance and security. The barcodes help keep tools accounted for and decrease the amount of money lost from

misplaced tools. Though a system like this would provide lots of helpful features and capabilities, outsourcing one of these software programs is expensive. For example, the cost of implementing Connect2 would be 20,000 dollars with an additional 2,000 dollar annual maintenance fee. The base version of WebCheckout is 500 dollars per month, which amounts to a 6,000 dollar annual cost. InnoSoft Fusion does not publicly provide pricing information, but after talking to the employees at Cal Poly Recreation Center, we know it is not cheap. Assuming one of these systems would decrease lost tools by 66%, the payback period would be around of seven years with Connect2 and never for WebCheckout. The problem with WebCheckout would be that it actually would cost more than it would save. The assumptions made about the improvements come from talks with David as well as research done on the software through their websites.

Lastly, another option would be to implement a database that we developed within Microsoft Access. One advantage to this option is that the database we designed maintains all the same check-in/checkout capabilities that FileMaker Pro has, as well as customizable tool information and the ability to access student safety records and tool rental history. Another improvement Microsoft Access provides is the ability to customize and improve the database in the future. Customizing and improving the Access database is a lot easier to do than with FileMaker Pro. FileMaker Pro is an outdated software and very few people in the CAED shop have the technical background or the familiarity with the system required to customize it. There are some features that an outsourced system provides that the Access database does not have. The way it is currently constructed, data entry into the Access database is manual, however, it is possible that an updated version of this database could automate data entry via Cal Poly ID scanner and a barcode scanner. The Access database would not be able to handle the self-service

reservations that one of the outsourced systems, like Connect2, could provide. Consequently, using the Access database would not be as efficient as an outsourced system in terms of transaction processing time. Another thing to note is that the Access database does not have the capacity that one of these outsourced systems provides. The whole database would be an Access file with a maximum capacity of 2 gigabytes. After a certain amount of time, someone must clear the database of students who no longer attend Cal Poly in order to not exceed the data capacity. This problem may also be addressed by linking tables to other database files. Using this strategy is time consuming, and is unique to Microsoft Access. The outsourced systems do not have this issue. Being that the implementation process consists of us simply transferring the Access file to the CAED Shop desktop computer, the only cost that would come with implementing this is the time dedicated to newly train the employees. This results in a payback period of less than a year, assuming that the database would reduce the number of lost tools.

Table 4 displays the calculated loss per year of every option we have access to. The CAED Shop expects to lose money from lost tools every year, but these different alternatives show that it is very possible to decrease lost tool count.

Costs					
	Current Condition		**Alternative 1**	**Alternative 2a**	**Alternative 2b**
Product	FileMaker Pro		Microsoft Access Database	Connect2	WebCheckout
Upfront Cost	Free - Currently in Use		Free Program, Designed Internally	Costly, Outsource Installation	Costly, Outsource Installation
	$0.00		$0.00	$20,000.00	$0.00
Yearly Cost	Current IT Support/Maintenence		Current IT Support/Maintenence	Outsource IT Support/Maintenence	Outsource IT Support/Maintenence
	$0.00		$0.00	$2,000.00	$6,000.00
Lost Tool Cost	$6,000.00		$3,000.00	$1,000.00	$1,000.00
Yearly Incurred Cost:	$6,000.00		$3,000.00	$23,000.00	$7,000.00
Year 1	$6,000.00		$3,000.00	$23,000.00	$7,000.00
Year 2	$12,000.00		$6,000.00	$26,000.00	$14,000.00
Year 3	$18,000.00		$9,000.00	$29,000.00	$21,000.00
Year 4	$24,000.00		$12,000.00	$32,000.00	$28,000.00
Year 5	$30,000.00		$15,000.00	$35,000.00	$35,000.00
Year 6	$36,000.00		$18,000.00	$38,000.00	$42,000.00
Year 7	$42,000.00		$21,000.00	$41,000.00	$49,000.00

Table 4

An optional add-on to any of the three alternatives is to create a new position dedicated to managing check-in and checkout procedures. This position needs much less training than Redshirts and is tasked with managing the check-in/checkout procedures. This is beneficial because the Redshirts can focus on assisting students in the shop, while not having to worry about the students waiting in line for a Redshirt to check a tool out for them.

Table 5 shows the monetary value of what an additional desk clerk would cost the shops. At a very baseline cost, the desk clerk will be 210 dollars for a 20-hour work week.

Optional Add On	Additional Employee
Variable Cost	Hourly Wage
	$10.50
Weekly Cost (20 hr work week)	$210.00

Table 5

This addition will help regardless of the system chosen. The payback period of our chosen Access system will be the first quarter of installation. The system is expected to save money immediately, as the new system improves the shop's ability to account for lost items, and track them down. The new employee will also benefit the shop on more than a monetary level. The desk clerk will provide subjective benefits, and is going to allow for the Redshirts to commit efforts elsewhere.

After evaluating the different options, we suggest that the CAED shops implement our self-developed Microsoft Access database. This database has all the main functions that the FileMaker Pro software provides, as well as extra features, such as additional lost tool information and student records. Microsoft Access is also a great option because it is highly customizable compared to FileMaker Pro, which is important because it can easier adapt to new situations or unexpected problems. It provides basic functions like exporting reports to Microsoft Excel with one click, compared to having only one person who knows how to create reports with

FileMaker Pro. An outsourced system, such as InnoSoft Fusion, Connect2, or WebCheckout may have more features and capabilities, but the costs outweigh the benefits, especially when the CAED Shop has had trouble in the past getting financed for system upgrades.

The Access database that we designed has many capabilities. Employees can easily add students to the database by simply typing in their first name, last name, and Cal Poly email as shown in Figure 5.

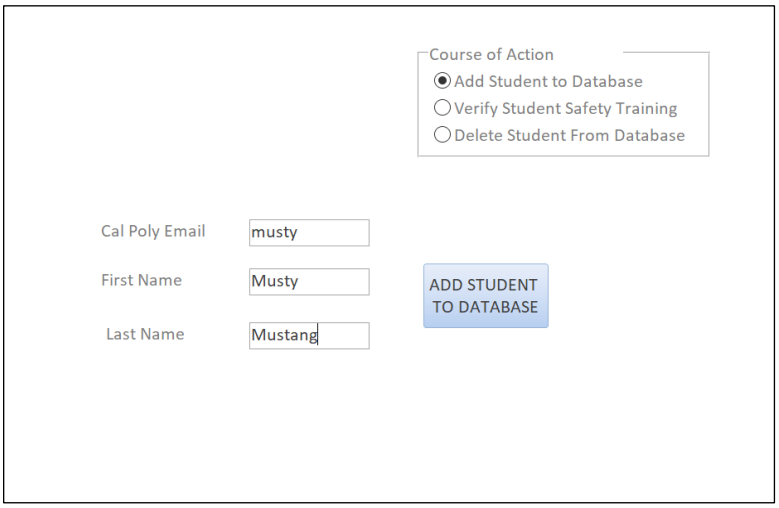

Figure 5

If a student wants to check out a tool, the employee can search for the tool by barcode or tool type and then check it out. The display of this is shown in Figure 6. Table 6 shows how the list of checked out inventory would look like.

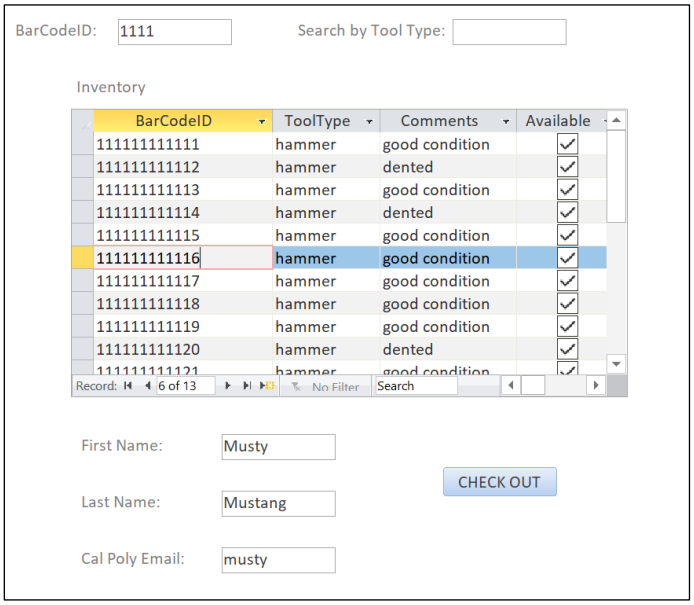

Figure 6

CheckedOut

BarCodeID	Tool Type	Comments	CalPolyEmail	FirstName	LastName	Available	DateCheckedOut
111111111116	hammer	good condition	musty	Musty	Mustang	☐	3/12/2018
121323143223	nut	good condition	rymattel	Ryan	Mattel	☐	3/12/2018
129573956193	drill	dented	kgall	Kevin	Gallagher	☐	3/12/2018
532153215533	drill	good condition	cchen74	Chris	Chen	☐	3/12/2018

Table 6

If a student wants to check his or her tool back in, the employee can search for that tool based off tool barcode or Cal Poly email. The computer display is shown in Figure 7. An advantage of searching by Cal Poly email is that the employee can see all the tools the student currently has checked out.

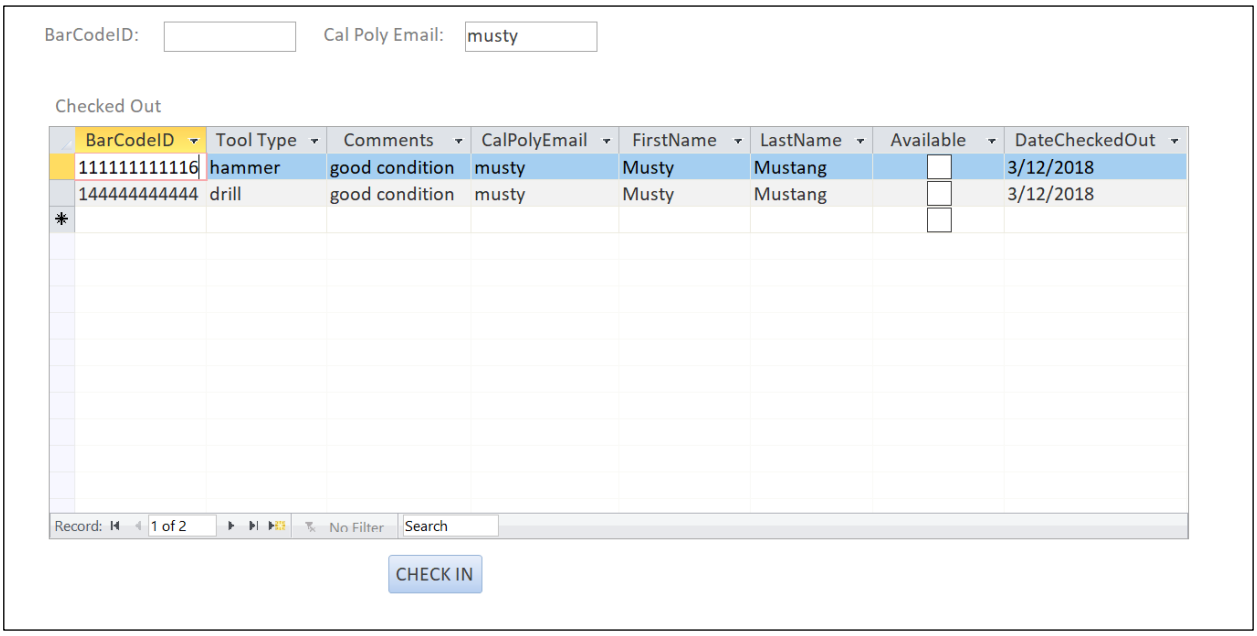

Figure 7

The only remaining addition will be an update including a barcode scanning capability. With this and the Cal Poly ID card scanner implemented with a potential version 2, the prototype will become a primary system to be used at full capacity. Necessary changes have been made to provide all functionalities expected from the full version, however, as stated, barcode and ID scanners will remain a part of the second version.

Furthermore, regardless of the chosen alternative, we find it will be very beneficial to employ a new desk clerk employee. The cost of this type of employee would come to under 250 dollars per week. This employee will be paid minimum wage and will complete 20 hours of work on average. This will allow David to schedule these desk clerks 4 hours each day to cover the busiest times, and relieve pressure on the Redshirts. We also suggest that the CAED Shop

labels or assigns barcodes to all its tools to better track items moving forward. The implementation of a barcode scanner or some other way of tracking specific items can go a long way in managing inventory and recording student transactions.

V. Methodology and Results

The design for the prototype has been established and is complete. The system has been brought to David Kempken and tested. David was excited about the prototype and sees it being extremely helpful. We have gone through multiple tests and trial runs to assure the program can handle all the expected functionalities and operations. Our system has withstood test runs of adding and deleting students to and from the system, qualifying them for machine usage and attaching the proper safety qualifications to their profiles. Our system has also been successfully tested to check-in and checkout tools to various student profiles that have been added to the database. There has not been testing done for the code involved with scanning to auto populate any fields based off a barcode scanner, as that will come during the summer. It has been stated that this summer, were this solution to be implemented, there will be an overhaul of the inventory. This will include labeling each individual tool with a barcode to be scanned and associated with its transactions. David provided us with some comments, concerns, and possible updates and additions. Some considerations that were made revolved around the exportation of data. The default file format will be in Excel, and a template may be created to streamline this even further. Shop employees will be able to handle the new process easily.

It is expected that checkouts will take 50% less time with the proposed solution, and there will be a live inventory record of what is checked out, to whom, and when it is due back. This decrease in processing time was calculated through discussions with David, reports from the possible alternative websites online, as well as trial tests with the created prototype. A reduction in check-in/checkout times by over 50%, an accurate data record of all transactions and qualifications, and the ability to create Excel reports of this data will be key metrics in proving the success of the project.

In the future, this Access database can be modeled to have even more functionalities. These include automation of student information using the Cal Poly ID scanner and the implementation of a barcode scanner to track tool transactions.

VI. Conclusion

The Cal Poly College of Architecture and Environmental Design shop has a consistent problem of accurately keeping records of misplaced rented tooling and machinery. This issue has been directly addressed by the research, analysis and design of a prototype and proposed integrated database solutions. There were various solutions discussed in this report, all focusing on current, or future integrated databases. The most plausible solutions are listed below:

- Upgrade and refine the current solution
- Integrate an internally designed Microsoft Database
- Integrate an outsourced database program such as Connect2 or InnoSoft Fusion similar to the software ASI uses

After researching costs of implementation and maintenance, as well as the bandwidth support available from IT services, we reached the conclusion that outsourcing these large databases prove to be too costly. Furthermore, although the current system works to some extent, our skill set learned in Data Management courses allowed us to design our own database specifically for this CAED shop. Therefore, we proposed to internally design a database prototype.

This proposed solution was designed in Microsoft Access and has the capabilities and functionalities desired by David Kempken and the Cal Poly shops. Some of the main functionalities include checking students in and out with tool rental, as well as updating their safety qualifications. It was also important to allow all of this to be done by scanning Cal Poly IDs to retrieve student information confidentially, as well as associating each tool to the student renting via a barcode scanner. While the current database does not have this capability, it is possible that these features can be added in when implementing the database.

The estimated savings of the program will decrease processing time to check out a tool by 50 percent, and will greatly decrease the average of 300-350 lost tools per year. There will be a self-generated, accurate report of every tool checked out, which will link each specific tool to a student by their Cal Poly email and name. This report can be exported at any time in the form of an Excel document. Upon completion of the second version of the prototype, and successful installation, our project will be concluded.

A last recommendation is to hire a new employee type. It is in the best interest of the shops to hire a desk clerk that focuses on assisting students in the shop with the checking in and checking out duties. This will allow Redshirts to focus on the shop floor, where their specific skill set will be valued most. This additional employee will be paid minimum wage, and requires minimal training. At shifts ranging 10-20 hours a week we are forecasting no shortage of applicants for this position. Through this addition, there will no longer be tools left out because nobody was tending to the checkout computer. Therefore, further decreasing the amount of lost or misplaced tools.

Our solution has received the approval of our Project Sponsor, David Kempken, and will fulfill each requirement we set to accomplish. This project gave us the rare opportunity to utilize direct skills learned here at Cal Poly to give back to the school. We have learned much about communication, project execution, and the difficulties of trial and error. We have improved on our ability to learn from our mistakes, and have gained valuable insight to take with us on our future endeavors.

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VIII. Appendix

Row Labels	Count of Drill			qty	low	hi	sum lo	sum hi
Air compressor	1	300	600	1	300	600	300	600
Air Grinder	1	35	80	1	35	80	35	80
Air Hose	5	20	20	5	20	20	100	100
Awl	1	4	5	1	4	5	4	5
badge, wood shop	6	1	1	6	1	1	6	6
Belt, Sanding	1	10	15	1	10	15	10	15
blank	3	5	5	3	5	5	15	15
Cable Cutter	1	30	45	1	30	45	30	45
Calipers	2	20	60	2	20	60	40	120
Center Punch	1	10	10	1	10	10	10	10
Chisel, Brick	2	10	10	2	10	10	20	20
Chisel, Cold	2	10	25	2	10	25	20	50
Chisel, Wood	7	10	10	7	10	10	70	70
Clamp, Bar	4	15	30	4	15	30	60	120
Clamp, Jorgensen W<	2	15	30	2	15	30	30	60
Drill	24	60	130	24	60	130	1440	3120
Drill Bit, Brad Point H	3	1	1	3	1	1	3	3
Drill Bit, Forestner	1	3	3	1	3	3	3	3
Drill Bit, Hole Saw	1	4	5	1	4	5	4	5
Drill Bit, Masonry	1	4	10	1	4	10	4	10
Drill Bit, Phillips	1	2	5	1	2	5	2	5
Drill Bit, Small Set	4	10	20	4	10	20	40	80
Drill Bit, Spade	2	1	2	2	1	2	2	4
Drill Bit, Twist Head	23	6	13	23	6	13	138	299
Ear Muffs	2	5	15	2	5	15	10	30
Extension Cord	8	20	45	8	20	45	160	360
File, Flat, Metal	2	5	7	2	5	7	10	14
File, Flat, Wood	1	4	6	1	4	6	4	6
File, Half Round	2	7	11	2	7	11	14	22
File, Round	3	5	10	3	5	10	15	30
File, Square	1	4	6	1	4	6	4	6
Gloves	3	5	30	3	5	30	15	90
Glue, Wood	3	5	15	3	5	15	15	45
Goggles	4	10	45	4	10	45	40	180
Grinder	11	20	60	11	20	60	220	660
Hammer, Ball Pein	4	15	30	4	15	30	60	120
Hammer, Claw	15	15	25	15	15	25	225	375
Hammer, Maul	2	30	45	2	30	45	60	90
Hammer, Roto	1	300	450	1	300	450	300	450
Hand Punch	1	30	80	1	30	80	30	80
Hole reamer	1	10	15	1	10	15	10	15
Knife, Utility	3	20	40	3	20	40	60	120
Level, 2'	1	15	20	1	15	20	15	20
Mallet, Raw Hide	1	10	20	1	10	20	10	20
Mallet, Rubber	4	5	5	4	5	5	20	20
Mallet, Wood	3	3	5	3	3	5	9	15
Measuring Tape	1	2	6	1	2	6	2	6
Pliers, Slip Jaw	2	3	10	2	3	10	6	20
Pliers, Linemen's	1	10	15	1	10	15	10	15
Pliers, Needle Nose	1	5	9	1	5	9	5	9
Punch	2	10	10	2	10	10	20	20
Ratchet	1	13	20	1	13	20	13	20
rivit tool	3	10	25	3	10	25	30	75
Router	2	60	90	2	60	90	120	180
Ruler, 12"	1	1	3	1	1	3	1	3
Ruler, 18"	4	1	3	4	1	3	4	12
Ruler, 24"	1	1	3	1	1	3	1	3
Ruler, 36"	1	1	3	1	1	3	1	3
Safety Glasses	67	0.05	10	67	0.05	10	3.35	670
Sander, Belt	3	60	120	3	60	120	180	360
Sander, Palm	6	40	75	6	40	75	240	450
Sander, Random Orbi	13	25	40	13	25	40	325	520
Saw, Band	1	150	700	1	150	700	150	700
Saw, Box	3	15	20	3	15	20	45	60
Saw, Circular	2	40	80	2	40	80	80	160
Saw, Hand	1	10	20	1	10	20	10	20
Saw, Jig	4	40	100	4	40	100	160	400
Sawzall	1	80	130	1	80	130	80	130
Screwdriver, Slotted	2	6	12	2	6	12	12	24
Shears	7	35	45	7	35	45	245	315
Snips, Aircraft	1	10	12	1	10	12	10	12
Snips, Standard	3	8	10	3	8	10	24	30
Square, Speed	10	5	10	10	5	10	50	100
Square, T	1	8	13	1	8	13	8	13
Staple Gun	2	10	20	2	10	20	20	40
Surform	2	3	4	2	3	4	6	8
Tape Measure	10	2	6	10	2	6	20	60
Tape, Masking	1	2	2	1	2	2	2	2
ViseGrip All Purpose	3	80	160	3	80	160	240	480
Wire Clippers	2	10	25	2	10	25	20	50
Wrench, Box	3	15	20	3	15	20	45	60
Wrench, Crescent	4	7	23	4	7	23	28	92
(blank)					#####	#####	#####	#####
Grand Total	**347**							
	total cost range		1907.1	3974				

Table 7