Senior Project

Proposal

**Project Proposal Template with Instructions**

**(v 1.3)**

in partial fulfillment of

TECH 4943

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# Executive Summary

*The executive summary should be done after you have written the rest of this document! The point of the executive summary is that the person reading the document should be able to a) understand a high level what the objectives of the project are, b) determine if the logic behind the project makes sense and c) determine if they want to keep reading. For your* ***project proposal*** *(your final report executive summary will be slightly different), the executive summary should be an attempt to sell the reader on the worth of your project. This should be a two or three (at the most) paragraph overview of what your project will do, why you are the one to do it and what the value of the project is.*

*Some don’ts for your executive summary are:*

* *Get too detailed – your reader can read the rest of the proposal if they want more info.*
* *Use flippant or cliché terms/phrases – you run the risk of not being taken seriously.*
* *Dwell on only one part of the project – you need to briefly discuss your entire project in broad brush strokes.*
* *Get too long winded – remember, this is a SUMMARY. If it helps, think of this as an abstract.*

Designer QR Codes are all around us, even if we don’t necessarily notice them. There exists, however, the potential that the code designer has inadvertently disenfranchised a segment of the QR Code consuming public by generating a code that cannot be read by a specific brand/model of phone or with a specific mobile app. This research project intends to investigate the varying types of damage intentionally introduced to QR Codes during the design process to determine if the code can be read, and by what percentage of the scanning population.

This project will obtain various designer QR Codes with differing types of damage and will conduct a survey that will determine which phones and mobile apps are able to read, or not read, each of the sample designer QR Codes. The results will be tabulated and analyzed based on the types of damage, the phone and the mobile app used. The final report will discuss what types of damage run the risk of preventing mobile scanning and will be targeted at both designer QR Code developers and the marketing professionals who would be commissioning the work.

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Document Versions

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1.0 5/8/2018 Initial version

1.1 6/4/2018 Added sample text

1.2 8/29/2019 Updated/Separated blank template

1.3 9/9/2022 Removed appendices B and C and made into separate documents

# Introduction

*The introduction segment of your proposal should lay out the reason that your senior project should be approved. In short, you are making a case for the validity of the project – that it shows a combination of what you have learned while in the Department of Engineering Technology and that you are able to combine the various topics into something that is greater than the sum of the parts.*

*In general, your proposal will show why your project is worthy of being a senior project and what you plan to achieve. It will then go into how you expect to achieve your stated objectives in increasing levels of detail via the technical plan and the discussion of the necessary facilities, equipment and materials. This proposal will then back out of the details, providing a way to prove you succeeded before providing a summary set of arguments as to the educational worth of your project.*

*It should be noted that most of your citations will be in this part of the proposal. Remember, you are trying to show the reader why your project is important and should be allowed. By citing the works of others (i.e. journal articles, industry magazines, etc.) you are showing that you are a) aware of what others are doing and b) that you are doing something that expands on what has been done previously. As we are Engineering Technology, most of what we do is the application of existing concepts and ideas. We are not generating new knowledge, but instead are taking existing solutions and either using them in new ways or in more efficient ways. Your arguments for why you make the various decisions within the remainder of this document should be based on your research into the topic(s) – which is primarily spelled out in the introduction.*

*So as to provide sample content to this senior project proposal template, research that has been previously undertaken by Dr. Berisso will be used. In the future, additional versions of this document with other types of senior projects may be added.*

QR Codes are all around. One only has to open a magazine, newspaper or look at a bulletin board to see them. One of the reasons for their adoption and use is their inherent ability to auto-correct any errors found within the symbol. As indicated by continuing purchasing trends, smart phone usage and proliferation has been skyrocketing. Within the United States and Europe, the inclusion of Quick Response (QR) Codes in marketing and promotions has been on a continual rise resulting in a desire by graphic designers and artists to create aesthetically pleasing symbols, often call designer QR Codes. Denso's support and the fact that they advocate LogoQ is quite probably the single most compelling argument in support of the existence of this movement. The result of this intersection between the goals and trends is that QR Codes are being generated that may or may not be scannable by the majority of the cell phone equipped public resulting in lost opportunities and disgruntled consumers.

One only has to follow any of the numerous QR Code related Linked-In groups to see not only the level of interest in designer QR Codes, but the vast range of knowledge by those involved. Recommendations abound in terms of what is and is not allowed, what is scannable and what is desirable. Furthermore, any number of people are promoting themselves as experts, leaving the novice unable to determine who is right and who is wrong when contradicting opinions appear. Web pages and blogs are no better. Advice ranges from “all QR Codes should be printed at a size of no larger than one inch” (WebScan, 2011) to “a half an inch bigger for every foot farther away you expect the person to be.” (ShareSquare, 2010).

QR Codes that have been altered from their nominal black and white look for promotional purposes, so called designer QR Codes, have become the topic de jour among many marketing proponents. Placing logos, adding color pallets or stretching the symbol are all traditional methods of generating designer QR Codes. Sites and blogs can be found from both camps – those for QR Codes and those against them. Those that are against the use of QR Codes primarily cite their poor performance, a lack of standardization among cell phone scanning software, or the lack of consumer education as the prime reasons for avoiding QR Codes. The proponents of QR Codes cite the fact that as many as 1 in 7 web searches are being initiated from mobile devices (Trinity Digital, 2012) and that QR Codes are easily integrated into brand awareness campaigns.

During the generation of designer QR Codes, the graphic designer has a number of options in how they can modify the symbol. The four of the methods of distortion imposed to the sample images used in this study were modifying the contrast, consumption of the error correction codewords, incurring fixed pattern damage and causing grid non-uniformity.

1. Modified contrast is accomplished by altering the color of the dark modules from black. In an ideal symbol, the theoretical contrast should be 100%, where the background is pure white and the modules are pure black. As other colors are selected, the result is that the difference between the dark modules and the white background decreases. A simple analogy of the difficulty this produces would be in trying to read something that was printed in pale yellow or light gray on a white background (ISO/IEC, 15415:2004).

2. Consumption of the error correction codewords results in the potential situation where the bar code scanner software would be unable to reconstruct a message. Imagine trying to read a word that was so misspelled that the reader could not even guess as to what the original word or message was. This is often done by placing a logo into the middle of the symbol. By design, QR Codes have four levels of error correction; L (7%), M (15%), Q (25%) and H (30%). The result is that if more than the indicated amount of errors are embedded into a symbol for a given error correction level, the Reed-Solomon error correction algorithm will not be able to compensate (ISO/IEC, 18004:2000(E)).

3. Fixed pattern damage can be achieved through the alteration of the module shapes (the nominal shape is square) or by altering the color of the modules to the point where the bar code scanner in unable to distinguish the difference between the module and the background. This would be analogous to removing all formatting and punctuation from a sentence, resulting in an inability to determine where a message started, stopped and what it was trying to say. If spelling errors were added as well, one could easily imagine the issues in trying to read the message (ISO/IEC, 15415:2004).

4. Imposed grid non-uniformity is the intentional skewing of the symbol’s shape. The bar code scanning software is looking to see if each individual module in the overall grid of the symbol is occupied (turned on – aka black). If the grid is sufficiently skewed, the determination of which module is on and which module is off becomes increasingly difficult. Common methods seem to include forced perspective, skewing or ripples/waves. An analogy of this might be in trying to do a crossword puzzle where the horizontal and vertical letters are no longer above or next to each other (ISO/IEC, 15415:2004).

The question that is left to the designer or graphic artist who is trying to determine what can and should be done in terms of using designer QR Codes can most easily be summed up in the question “will it work?” Will the modifications that are made to a QR Code, be it changing color, modifying the shape or removing entire parts of the symbol result in a symbol that cannot be scanned. This study investigates the ability of cell phones to scan various designer QR Codes. By testing the ability of a smart phone equipped public to scan various designer QR Codes, the goal of this research was to determine what sort of success rate various types of designer QR Codes would achieve. These results will then be compared to the results with traditional bar code scanners.

# Qualifications

*Your project needs to be related to at least one of your fields of study. The qualifications section should discuss and argue that you have the necessary qualifications to actually execute this plan. This should be done by indicating the classes you have taken or by providing evidence of a sufficient depth of knowledge in the outside skills you are bringing to the project that directly relate to its success. If significant elements of your project are not reflected in at least one of your fields of study do not include them in your project unless you can show that you have the necessary skills and knowledge to complete the project. Classes referenced within the qualifications section should include upper level classes only. The only exception is a lower division class that is not a part of the Engineering Technology core. Since EVERYONE is expected to know how to use MS Word and MS Excel, including TECH 1010 should not be included in this discussion.*

*For example, if your project involves programming, you need to provide sufficient evidence that you have the necessary programming skills to achieve the project. This is not to say that you have to already know how to program in the language that will be used, but you need to provide the faculty (class professor(s), technical advisor and FOS lead) with the confidence that you will be able to learn the programming language within a reasonable amount of time such that you will actually finish your project on time.*

*Another example might be if you are going to simulate a manufacturing line. While a certain amount of time is expected to be dedicated to learning a simulation package, you need to be able to show the faculty that you are talented enough with learning new software that you will not a) need your technical advisor to functionally spend an entire semester teaching you the software or b) that you will end up having a failed project because you couldn’t figure out how to make the software do what you want.*

*In this section we have our first table. Please note that “Table x” is of the style “Table title” and the rest of the table name/descriptor is of the normal style. Additionally, please note that there is no extra space after the table number and description.*

The primary skills required to conduct this project include an in-depth understanding of how QR Codes work, how bar code scanners work, an understanding of basic statistics and an understanding of computer programming. Classes that have been taken that account for these skills are laid out below in Table 1 and a list of externally acquired skills is listed in Table 2.

Table 1. Qualifying classes.

|  |  |  |  |
| --- | --- | --- | --- |
| *Class* | *Title* | *Applicable skills* | *Semester/year taken* |
| TECH 4999 | AutoID Applications | Bar codes (QR Code), bar code scanners (interfacing, configuration, selection, etc.) | Spring 2016 |
| TECH 2261 | Data Structures | Database design, data structures, software development | Spring 2014 |
| MATH 4461 | Intro to Statistics | Mean, mode, median, standard deviation, sample size selection, regression, etc. | Spring 2015 |

Table 2. *Additional experience.*

|  |  |
| --- | --- |
| *Years of experience* | *Skill set* |
| 23 | Bar codes, bar code system development, database design, etc. as a project engineer at Applied Tactical Systems and as an independent consultant |
| 25 | Computer programming. Languages used include Visual C#, Visual Basic, TCL/TK, LISP, Java, JavaScript |

## Personnel

*It is quite probable that you will not need this section. The personnel section should only be included if there are additional personnel that are related to your project. In this section you will need to provide a case for why the listed personnel are needed (e.g. special skills that are beyond the scope of your project, regulations, safety, etc.). If you are doing this project for your boss at work, you would NOT include them here, but if you were doing a project where you had others reporting to YOU, they would go here. Likewise, if you have a partner for your project, you would not include them here.*

*For example, if your project required a college technician to do something that was beyond the scope of your project, you would include them here. If your project includes observing production workers at a local company, you would include them in a general sense (e.g. listing them as production shift x on the bottling line) and indicate that they are the ones trained and authorized to use the equipment.*

So as to include as large a cross section of cell phone types and differing user demographics, volunteers from the University of Memphis will be used to conduct all of the actual testing. The only requirement that volunteers must meet is that they own a cell phone capable of scanning QR Codes. Sex, major, age and self-declared level of technical competence will be selected but will not be used for selected or excluding potential testers.

## Personnel Management Plan

*If your project has a personnel sub-section, you need to have this sub-section as well. If you do not have a personnel section, as discussed above, you can also delete this sub-section.*

*This section will discuss how you plan on managing or interacting with the personnel listed above. For example, if you need Mr. Davison to accomplish a high voltage wiring item for your project (e.g. connecting a new robot), you need to discuss the process in which requests will be made and what information he would need in order to accomplish his job.*

*If you are working with a local company to improve the ergonomics of a work cell, you need discuss how you obtained their participation in the project. If they are direct reports to you, indicate as such. If you are visiting a local company, you will need to provide a written acknowledgement from the company representative you are working with indicating their agreement with your plan.*

Volunteers will be provided with a short survey that will collect demographic information, the mobile application being used and the mobile device being used (e.g. cell phone, tablet). Simple written instructions will be provided and the tester will be allowed to scan as many surveys as they want so long as they are using different mobile applications each time. Volunteers will not be directly watched or supervised beyond the initial instructions. This will allow the testers to self-determine how much to do and for how long. The time required for each survey is approximately five minutes. As such, obtaining volunteers is not expected to be a problem.

# Objectives

*The objectives section should list what the objectives of the project are. What are you trying to accomplish? This section should include a brief introduction as well as incorporate a discrete list of things you are trying to achieve. This list should contain the two or three things – at most – that you are attempting to accomplish. A list of more than two or three objectives normally indicates that you are either a) biting off more than you can practically accomplish or b) that you do not have a solid grasp of what you are trying to do. From your list of objectives, a clear and concise list of what will be delivered upon the completion of your project (your deliverables). This list could be a couple of items or a longer list, depending on your objectives.*

*For example, your objective could be to create a low-cost security system. The deliverables might be to produce a solution using a single board computer that had window sensors, internal motion sensors, motion activated video archiving, the ability to turn on exterior lights, call the police, to archive all events and make the entire system mobile device accessible. Note how there is only the single objective (creating a low-cost security system), but that there are multiple components and functions that will be delivered (and demonstrated) at the end of the project.*

This project has one primary objective and two secondary objectives. The primary objective is to determine what levels and types of designer “damage” can be applied to QR Codes while still allowing them to be decoded. The two secondary objectives of the study are to determine if a) specific mobile applications are more sensitive to designer “damage” and b) if specific mobile devices are more sensitive to designer “damage.”

The deliverables for this project will be as follows:

1. Methodology for selecting designer QR Code specimens
2. Survey instrument for administering the test
3. In-depth statistical analysis of results
4. Set of recommendations as to what sort of damage, and what amount of damage can be introduced into QR Codes, organized by target demographic (phone type, gender, age range, etc.) along with a comparison of the mobile results against a traditional bar code scanner

# Limitations

*Within the scope of the Senior Project, limitations are things that are outside of your control. For example, if the Hass vertical mill or the robot you are working with goes down, you have no control over this. However, from a strictly technical point, self-imposed limitations (e.g. the system will only work over a LAN connection, no more than 5 simulation options will be investigated, all parts will be made of mild steel, etc.) are delimitations as the only reason these items are limitations is that you have selected them to be as such. Having said this, you will be allowed to include both within this section, but you MUST address both limitations and delimiters separately within this section.*

*Your review of limitations to your project will show the faculty (class professor(s), technical advisor and FOS lead) that you have thought out not only the real-world applications of your project, but many of the “what if” scenarios that could occur. This shows that you are able to plan (and will help with your planning) and that you are not suffering from tunnel vision as related to your project. If there is a high level of probability that one of the limitations to your project will impact your ability to complete the project, you will need to either have a plan in place to address the issue or you will need to redesign that segment of the project such that the potential for the event occurring has little to no impact on the completion of your project.*

*Examples of a valid limitations might be that we don’t have a 5th axis for the Hass, that server space for 1 petabyte of data storage on campus is prohibitively costly or that testing across twenty different cell phone manufacturers for a software solution is impractical. Likewise, declaring that material deflection testing beyond a specific weight or not being able to do radio signal testing in a true anechoic chamber would be valid limitations as the college may not have a way to safely test your product at a real-world weight or in a large enough anechoic chamber.*

*For any delimiters, you will have to provide a convincing argument as to why the faculty should allow its inclusion. For example, if you are doing a project that would normally be wireless, but you state a delimitation is that you will only test in a wired environment, you will have to defend why YOUR project shouldn’t also be wireless. Likewise, if you project is the development of an injection mold and you chose to only produce wax molds, you would have to provide sufficient reasoning for why you didn’t or couldn’t at least make an aluminum mold as is already done in TECH 4571.*

*Examples of invalid limitations and delimitation might include:*

* *Not using a wireless connection because the microcontroller you selected doesn’t have the ability*
* *Not producing enough parts to do a reasonable statistical study (at least 5 items is usually a good idea)*
* *Not testing with enough data to do “load testing” for software*
* *Not generating enough different simulations for manufacturing line projects*
* *Not collecting a sufficiently random data set for time and motion studies (due to either your time or access to the facility)*
* *Not creating the correct tooling/grippers/work holders for a robotics project*

Due to the BYOD nature of this project, the number of limitations and failure points is fairly small. For any given volunteer, should their phone break, lose its charge or should they decide to stop testing for any number of reasons, all that is needed is to find a new volunteer. And as mentioned previously, since the scanning of any given survey is expected to only take about five minutes, there are no expected issues in finding enough volunteers. Table 3, lists the identified limitations to the study and the anticipated corrective actions that would be undertaken to prevent the issue from

Table 3. *Project Limitations.*

|  |  |
| --- | --- |
| *Limitation* | *Corrective Action* |
| Loss of access to MiniTab (e.g. license is terminated) | Long-term loss of MiniTab access is not anticipated. However, should it occur, an alternative statistical analysis package will be found. |
| Loss of bar code verification ability | Should the bar code verifier become unavailable, 3rd party verification may be attempted. In the worst case, a manual evaluation and coding of the symbol damage will be attempted. |
|  |  |

The only delimitation that has been included in this study is the number of samples to be tested. While an increased number of samples could be included, it has been determined *a priori* that keeping the number of test symbols to 20 will ensure that the required test time is kept a minimum, while still allowing for a reasonable cross-section of induced errors. Furthermore, initial searches for “designer QR Codes” resulted in limited results for some types of errors and it was decided that the development of custom codes was outside the scope of the project.

# Technical Plan

*The Technical plan provide DETAILS on how the project will be done from a technical standpoint. A significant portion of this section should include the justifications for your selections of technology being used. You MUST be able to defend why you are making the technical choices outlined in this section. If you cannot justify the reason(s) for your selections, your project will probably be rejected and you will be required to select a new project, or at least develop a new technical plan.*

*This section will cover the technical details of how the project will be accomplished. Although not every technical detail is expected to be worked out in TECH 4943, major decisions on methods, materials, and methodologies should be researched and decided upon while planning the project. And while you may end up changing what is was proposed in your technical plan, the faculty (class professor(s), technical advisor and FOS lead) will be using the information in the technical to help gauge whether they feel you will be able to accomplish the plan or if you need to re-evaluate your approach.*

***Software Design*** *– Discuss the platform, programs and/or languages to be used (e.g. Raspberry PI running Linux, with PHP, Apache and MySQL; WinServer2012 + MS SQL Server + IIS, etc.), how the various programs, non-standard libraries, scripts, databases, and applications will be used within the system to complete the project. Discuss major issues with user interfaces/user experience (UX), web site designs, basic system security, etc. A Block or System Context Diagram (or similar) MUST be included. As a part of the finished proposal, the student MUST have a mock-up of the UX, an initial database scheme and have the anticipated hardware platform identified. A detailed testing plan MUST also be included.*

***System / Networking Administration*** *– (Dan and Jim?) Discuss hardware and software to be used. If programming is required, discuss languages used (including why). Include a brief discussion of anticipated network issues (port blocking, usage of sandbox, requisite permissions, etc.). A Block or System Context Diagram (or similar) MUST be included. A detailed testing plan MUST also be included.*

***Microprocessor / Microcontroller*** *– (Dan and Todd?) Process diagram, system diagram, block diagram or other appropriate overview MUST be included. This block diagram should include all inputs and outputs and any desired communication interfaces. A plan for how the intended signal processing (filtering, buffering, transformations, etc.) to be accomplished needs to be included. Plans for how the system will be housed, any necessary custom PCB to be produced and how the system will be both calibrated and tested is required. Justification of the selected hardware platform MUST be included.*

***Automation & Control System*** *– Describe the process or system to be controlled, what types of controls, sensors, transmitters and actuators will be used and how they will be implemented. Process diagram, System diagram, block diagram or other appropriate overview should be included. Plans for system calibration and the capturing of performance analytics must be included. If lab equipment is being used, the coordination of and any necessary access limitations (e.g. no one else can be using robot x and its vision system) to the effected equipment MUST be addressed and included.*

***Mechanical Systems / Product Realization*** *– Include early sketches of product, materials to be used, and manufacturing methodology (e.g. CNC, welding, 3D printing, laser cutting, etc.). Materials selection should include a justification for their selection. A list of necessary equipment, and it’s applicability to the process, is needed along with evidence of the student’s ability to use the equipment also needs to be included. A fully realized 3D CAD model/assembly MUST be completed and a part of the final proposal.*

***Operations Strategy & Lean Principles*** *– (Carl?) Real-world projects (hypothetical projects will not be allowed) require a letter/email from the company for which the work will be done, agreeing to the project’s scope of work and deliverables PRIOR to project approval. A current state analysis with real information (production rates, actual times, standard work times, etc.) MUST be completed as a part of the final proposal. Evidence of competency (beyond listing a class that used it) with any simulation software must be provided. If simulation software is to be used, evidence of a basic level of competency in the software (beyond being able to open it up and create an initial file) including its reporting functions and range of capabilities MUST be demonstrated as a part of the proposal.*

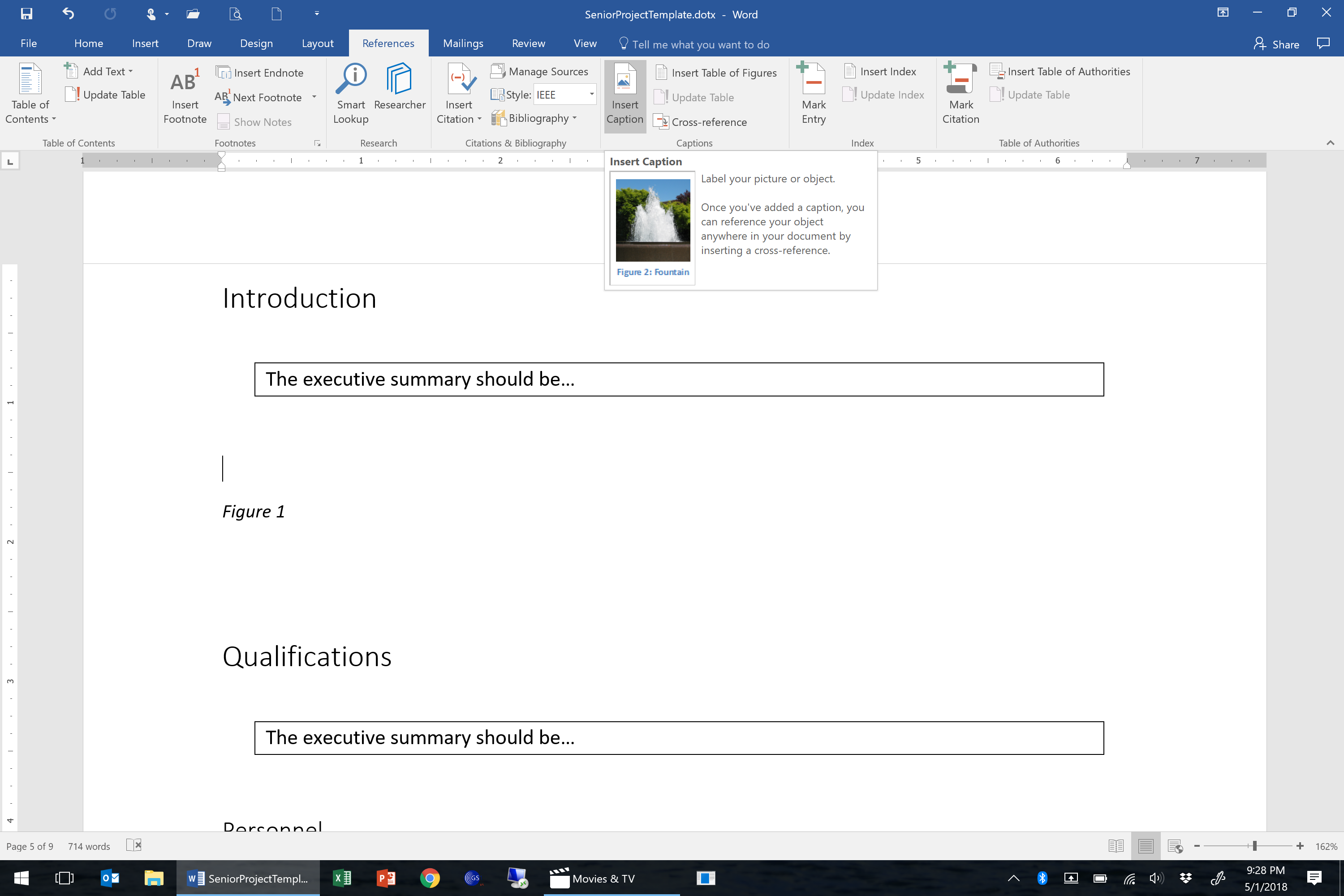
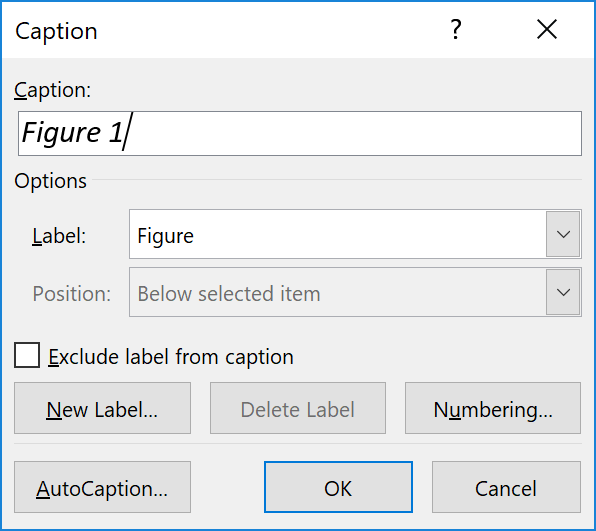


Figure 1. Inserting captions

. This is an example of how the caption for a figure or table should be inserted into your document. Doing it this way will allow for the automatic numbering of the figures and tables. Also, note that just the word “Figure” and the number are italicized. Additionally, please note that “Figure” should be fully left justified and not indented.

To determine if designer QR Codes would work, the seemingly innocent question of “can a majority of the smart phone enabled public that scan designer QR Codes read the symbols” was asked. And while it was quickly realized that this seemingly innocent question was layered with complexity and quickly expanded beyond the initial goal of the research – will a given designer QR Code scan – for the purposes of this paper only the overriding question “will it scan” was investigated.

To answer this, various designer QR Code symbols will be selected and a simple survey will be created. The research question that is being asked is “what percentage of the public will be able to scan each symbol.” Numerous symbols will be obtained from QRArts and Azon Media and will be assembled based on the types of distortions that were imparted to the symbols. The symbols will be identified as having up to four different types of modifications imposed on them during the design process. Figure 2, shows some example symbols that were used. These modifications or distortions to the original image are:

• Modified contrast

• Consumption of the error correction codewords

• Fixed pattern damage

• Imposed grid non-uniformity

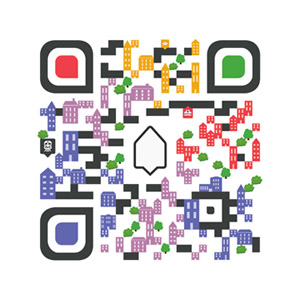
  

Figure 2.Sample QR Code symbols used.

Fixed pattern damage (left), fixed pattern damage and modified contrast (middle) and modified contrast (right).

All symbols used within the test will be placed on a LVS 9510 Bar Code Verifier to help quantify the levels of damage listed above. It is expected that some of the symbols will not verify as the bar code verification process includes the use of a red filter that will render any red within the QR Codes as white, which would potentially prevent the verifier from decoding the symbols. However, since it is believed that many of the mobile applications do not adhere to this limitation, the inclusion of symbols that cannot be verified will still be pursued.

The surveys will collect the tester’s age, sex, level of technical competence, mobile device being tested and mobile app being tested. For each QR Code scanned, there will be check boxes so that the tester can indicate if the symbol a) decoded, b) decoded with the correct information and c) how difficult they felt the decode effort was (0-5 scale). Results will be manually collected and input into MiniTab for analysis. To ensure sufficient power for the statistical analysis of the results, a minimum of 30 surveys for mobile device/mobile application combination will be collected.

# Facilities, Equipment and Materials

*This section should only contain those items that are relevant to YOUR project. Facilities and equipment refer to significant items that are owned by someone other than yourself. Equipment in the department would be included here, but the use of a laptop or computer (unless it is a department or campus server) would not be included. The same goes for specialized software (e.g. NX or MiniTab). Common software such as MS Office, Visual Studio and MS Project or MS Visio should not be included. Materials are smaller, significant items that you will be purchasing. For example, an Arduino board or a specific shield would be included here, but simple AA batteries, jumpers, paper and would not be included.*

*For example, if you are doing a project that includes the use of the Hass vertical mill, you would include both ET112 and the Hass as required facilities and equipment. If your project includes the use of a Raspberry Pi, you would leave the “facilities” out of this section – including the removal of it from the section header – and include the Raspberry Pi as a material. Along these lines, if you needed to use the sandbox network in ET207, you would include that as a facility, but if you just need any wireless access, that would be not be included.*

*Conversely, for software projects while there may not be a bill of materials, there should be a list of necessary software, plug-ins/libraries that are necessary for the completion of the project. Additionally, the system platform (e.g. server OS, implemented services, etc.) needs to be addressed.*

In general, this project will require a minimal amount of equipment due to the bring your own device (BYOD) nature of the data collection plan. Test volunteers will bring their own cell phone or tablet. Table 4, shows the list of university owned assets that will be used as a part of the project and Table 5 lists the facilities used during the test.

Table 4. University owned equipment & software.

|  |  |  |
| --- | --- | --- |
| *Item* | *Description of use* | *Location* |
| LVS 9510 Bar Code Verifier | This will allow for an ISO/IEC compliant grading of the QR Codes to be used in the study. | ET226 |
| HP M452 Color Laser Printer | All surveys will be printed in full color from the same printer to ensure consistency of the printed colors. | ET203 |
| MiniTab 18 | MiniTab will be used to perform the statistical analysis of the results. | umapps |

Table 5. Facilities.

|  |  |  |
| --- | --- | --- |
| *Location* | *Description of use* | *Level of usage* |
| Engineering Technology Building, rm 226. | The LVS 9510 Bar Code Verifier is stationed in the lab along with the software. The unit is not portable, and the software must be used on the computer it is currently installed on. | Minimal access will be required as only one initial set of symbols will need to be verified. |

# Plan of Work

*The plan of work will outline not only your best guess timeline, but will show that you have researched items such as lead times on items being purchased or sourced out. A failure to sufficiently plan for lead times could easily result in a key component to your project not being available until two weeks before your project is due, leaving you virtually no time to do your project. Once again, you are defending your choices and decisions in this section. If your plan of work doesn’t show a realistic grasp and understanding of the reality of what your project will entail, you will find yourself having to redo your project proposal until the faculty are convinced that you understand what is involved.*

*For example, if you are using software that isn’t part of one of the classes you have taken or that you have not used before, you need to include both time to learn the software, but also a discussion of the efforts taken to date to get you to a point where you are able to intelligently talk about the time requirements. Likewise, if you plan on using a programming language that you are unfamiliar with, you need to include both a discussion of how much time you anticipate needing to learn the language and evidence that you have already begun the process and are able to intelligently discuss the pros, cons and limitations of the selected programming language.*

*For Gantt charts, put a higher level chart in this section and include a detailed Gantt chart as an Appendix. Since the detailed Gantt chart will most likely be significantly wider than the higher level version, print the detailed Gantt on a “B” sized sheet of paper (11”x17”) and “z-fold” it so that it correctly fits in your binder. Alternatively, you could print out a collapsed version of the Gannt chart and then print out each of the stages or sub-groups at a separate printout that fits on a single “A” sized piece of paper.*

Work for this project has been broken down into four stages or sections with varying sub-activities. These stages are the development of the survey tool, actually conducting the survey, the analysis of the results and the development of the final report. Since this project is extremely linear in nature, there is no single critical path and the breakdown of components is easily viewed within the Gannt chart.

Completion of this study is expected to take approximately 50 days as shown in   
Figure 3. As can be seen, the development of the survey and the final report will be the longest segments. Appendix A shows the individual break downs for each stage of the project. Of the steps in the survey development, the only item of concern is obtaining permission for any designer QR Codes that are not in the public domain. However, experience with obtaining permission from some of the initial images has shown that the designers are more than happy to allow their images used, so if some designers resist providing permission, it is anticipated that there will be enough images from other sources.

  
Figure 3. Gannt chart showing overview of significant stages of the project.

# Evaluation of Objectives

*The evaluation of objectives section must show how you will show that your project was a success. Based on the objectives and deliverables listed in the previous sections, you must have a quantitative way of showing your project succeeded. This needs to be more than a series of pictures, CAD model or physical part that was produced. If your project is the reorganization of a manufacturing line, you would need to include a list of the metrics that are being collected that would show what sort of improvement was achieved. If your project was the generation of a mold, you would need to explain how the mold and the finished parts would be measured to show compliance with the part prints.*

***Software Design*** *– Discuss the test plan, tying the functional deliverables and functionality to the plan. Include a discussion of the unit testing plan and how error trapping will be addressed. Develop a UI/UX checklist or acceptance plan that shows that the UI/UX has been sufficiently designed and is user friendly. Quantitative tests for system responsiveness/speed and data accuracy/integrity should be included as necessary.*

***System / Networking Administration*** *– Discuss how you will show that the system/network is performing to the proposed levels in your technical plan. For example, if you are developing a solution that tracks MAC addresses, have a method in place that shows that all connecting MAC addresses are being correctly logged and acted upon. Have a method in place to show how the system is resistant to spoofed MAC addresses. Include a testing methodology for demonstrating that the network speed of your project is up to the task. If your project is supposed to encrypt network data in a new and faster way, include a discussion on how the network traffic will be analyzed to both show the correct encryption is being included, as well as the fact that the unencrypted data at the receiving end is uncorrupted and being received at an acceptable speed.*

***Microprocessor / Microcontroller*** *– Discuss how you will show that the microprocessor is performing as laid out in this proposal. Include quantitative tests showing that the range of functionality is being achieved and that the results are accurate within the specified ranges. A plan for testing, within reason, the limits of any analog inputs as well as showing that the calibration routines work correctly MUST be included. For example, if your system is monitoring water quality, include a discussion of how you will show that the water quality is within the ranges indicated as well as having a discussion of how you will prepare your range of samples (e.g. creating samples that are both higher and lower than acceptable limits). If dangerous materials/chemicals/conditions are to be used, a safety plan needs to be included in this section.*

***Automation & Control System*** *– Discuss how you will demonstrate both acceptable and unacceptable behavior within the system. Have a plan for how demonstrate that the system is correctly handling “bad” parts. If data collection is a component of your project, include a plan for showing how you will qualitatively prove that the data is being accurately being collected, transmitted and analyzed. For example, if your project is to sort parts based on a machine vision solution you will need to have a plan for how you will generate the “bad” parts. You will also have to include a plan on how you will demonstrate the accuracy of the system (how many times BOTH Type I and Type II errors occurred).*

***Mechanical Systems / Product Realization*** *– Discuss how you will quantitatively demonstrate that your solution/product has met the stated objectives. This is more than just the “built” item or even a set of items.*

*For example, if your project should be able to support a given weight, include how you will test it to at least 10% beyond the stated objective. If you are generating a mold or a process, provide a plan that will show that the mold or process is repeatedly producing valid parts (i.e. within specified tolerances). A discussion of sample sizes and potential tests (e.g. gage R&R, X-Bar & R, etc.) needs to be included.*

*If you are doing a product realization project for which you are proposing how the product is to be manufactured, you need to ensure that your evaluation methodology includes references as to how you will be generating your data (machine costs, space costs, processing time, indirect costs, etc.) so that when your final project is completed the information you present can be validated. It is realized that many of the evaluation items may be more along the lines of a check list (e.g. were there real price quotes, did cycle times make sense given the proposed equipment, etc.).*

***Operations Strategy & Lean Principles*** *– Discuss how you will quantify the results from your project. For projects with real-world companies, this needs to be more than a statement that you did the project or even that the project results were implemented (which they don’t have to be). What metrics are being collected and how will they be analyzed (and what is considered a success or failure). If improvements in time and motion studies are a component, a discussion of the statistics to be used to determine if an improvement was achieved needs to be included. Discussions of sample sizes (and no, a sample size of one is not acceptable). For simulation based projects, the number of tests, iterations within a given set of test parameters and the planned statistical analysis of the results needs to be included.*

As previously discussed, this project has one primary objective and two secondary objectives. Table 6, shows the objectives and deliverables and the proposed method in which their level of success are to be evaluated.

Table 6. List of objectives and deliverables and how they are to be evaluated.

| *Objective/Deliverable* | *Evaluation Method* |
| --- | --- |
| Determine what are the max levels of “damage” that a QR Code could withstand while still being able to be read by mobile devices | A report that shows and discusses the types and levels of damage done to a QR Code and whether the QR Code could still be read. A series of charts that break down the types of damage, the types of mobile devices, the differing mobile apps used and the read percentage for each.  There will be both a high level discussion (with general suggestions of what to and not to do) and a detailed discussion of the results.  This objective should be evaluated based on the quality of the reported results. |
| What mobile applications are the most sensitive to “damage” | A report that breaks down the read percentage for each application along with an analysis of the results.  This objective should be evaluated based on the quality of the reported results. |
| What mobile devices are the most sensitive to “damage” | A report that breaks down the read percentage for each device type along with an analysis of the results.  This objective should be evaluated based on the quality of the reported results. |
| Development of a methodology for selecting QR Code specimens | The final report will include a section that describes the method in which QR Code samples were found and selected.  This deliverable should be evaluated based on the quality of the reported methodology. |
| Development of a survey instrument for administering the test | The final report will include a copy of the survey tool developed as an appendix.  This deliverable should be evaluated based on the presence and quality of the survey instrument. An emphasis on the removal of bias and the ease of use of the instrument will be the primary subjective components of the evaluation. |
| Development of appropriate, in-depth statistical analysis | A report that includes a statistical breakdown and analysis of the collected results.  This deliverable should be evaluated based on the effective and appropriate use of statistics in analyzing the results obtained. |
| Set of recommendations, by demographic, as to the types and levels of damage that can be applied to QR Codes while still allowing them to be read | A report that includes a set of recommendations, by demographic and type of damage. The exact breakdown of the numbers and types of damage will be made once all QR Code symbols have been collected and approved for inclusion.  This deliverable should be subjectively evaluated based on the logical breakdown of the demographics and types of damage. |

# Summary

*The summary should be a recap of your arguments for why your project is worthy of being a senior project and why you are the correct person for the job. Do NOT just copy and paste your previous arguments. This is the last thing you are leaving your reader (the professor(s) responsible for TECH 4943, the FOS lead and your technical advisor) with. If you leave them with a lot of unanswered questions and concerns, your project will not be approved. Conversely, if you leave them looking forward to seeing how you solve the problem you have presented, then your proposal has a good chance of being approved.*

*This section can be a couple of paragraphs. It doesn’t have to be multiple pages; in fact it probably shouldn’t be more than two or three paragraphs or you run the risk of opening yourself up to additional questions and concerns. Remember, this proposal is worth a significant portion of the TECH 4943 grade. If you don’t produce something that is convincing and of sufficient quality and detail you can still fail TECH 4943 – even if your technical advisor has approved your project! And if you don’t pass TECH 4943, you WILL be administratively dropped from TECH 4945.*

Designer QR Codes can be readily found in colleges, on billboards, in magazines and numerous other locations. What is not is known, however, is to what extent the QR Codes are unreadable. This project has proposed a method for quantifying the readability of designer QR Codes with varying types and levels of damage. Given the researcher’s background in bar codes, the proposed timeline for completion of the project should be easily met, resulting in a final report that is potentially useful to everyone from marketing experts to the local babysitter who is trying to drum up some business. In terms of the design of the experiment, the proposed methodology is sufficiently robust that it should pass scrutiny in a traditional, educationally oriented peer-review process, yet practically significant enough that users of designer QR Codes will want to know the results. The objectives of the project, determining how robust QR Codes are to intentional damage, determining what mobile apps are the most susceptible to damage and determining if specific mobile devices are more susceptible to damage, are readily evaluated. Finally, the tools and time frame for conducting the study are respectively readily available and reasonable.

# References

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# Appendix A – Detailed Gantt Chart



# Appendix A – Instructions for Writing the Project Proposal

## Introduction

This document is a culmination of the efforts of faculty in the Department of Engineering Technology towards the improvement of the formal Senior Project Proposal that is submitted at the end of TECH 4943. This document is intended to be a “living document” in that it will continue to be updated and improved over time as mistakes, omissions and oversights are identified. If the reader finds mistakes, notices items that are confusing/incomplete or in general has suggestions for the improvement of this document, please submit them to the TECH 4943 professor(s) for consideration and inclusion to this document.

## Instructions for Using This Document

The goal of this template is two-fold. First off, it is intended to provide the student with an electronic template that contains all of the formatting for the Senior Project Proposal, preventing the student from having to worry about ensuring that they have correctly captured the formatting details that are required for the Proposal/Final Report. The second goal is to provide the student with information on what is expected for each section of the document as well as provide some examples that, while not all inclusive, should be sufficient to provide a basis for extrapolation for anything that might be missing.

Within each of the sections are two components; instructions on what is expected within the section and some sample content so that the student can better understand what is desired for the section. When generating the Project Proposal/Final Report, all items that have been included in the bounding boxes (including the one on the cover page), as well as the sample content, should be deleted. However, the section headings and any sub-headings should be left in the document. By doing this the student will be assured that their finished document is still correctly formatted with the necessary headings, sub-headings and automated components (Table of Contents, Table of Figures, Table of Tables). And while the student is expected to be able to generate such a document from scratch on their own, this document is being provided to allow the student to concentrate on the content, not the formatting.

Prior to beginning their Project Proposal, the student should read through this entire document, including all appendices, so as to ensure that they are including the correct content. Since this document has been provided at the beginning of the TECH 4943/4945 class sequence, there remains no reason that the submitted documents should not fully conform to the expected standard in terms of formatting and content.

## General Comments and Thoughts About a Senior Project Proposal

The point of the senior project is to show that the student is a) able to synthesis new ideas and adapt existing skills to new problems, b) plan for and approach a problem in a systematic and logical manner (i.e. using the scientific method) and c) be able to explain, discuss and report on the solution(s) to the problem. The senior project is NOT a glorified lab activity or lab manual. The subjective “quality” of the senior project tends to drift from one faculty member to another, but were the student to ask multiple faculty members about what constitutes a “good” senior project, the phrases “culminating experience”, “aggregation of skills” and “expansion on topics covered in class” will most likely be heard.

One consideration that the student should take under advisement is that while an exploration of a topic that was not covered in class is encouraged, the selection of a project for which the student will have to learn a number of skills around which the project will center is often a recipe for disaster. For example, if the student has little to no programming experience, selecting a project that is 70% programming will most likely result in a project that the student and the faculty are disappointed with. However, if the student has sufficient metal machining experience , selecting a project that revolves around iterative mold designs – with a goal of determining which design is best – would be a good choice.

It behooves the student to have some serious discussions with the professor(s) that will be the technical advisors for the project. The discussions should center around the skills that the student has, the skills that the student lacks and an honest appraisal of the amount of time that the student will have. For example, if the student has a full time job and a young family, would it be realistic to anticipate spending 10-20 hours per week in ET112 on just the project? If the in-lab time is not practical, a project in which the student did more with simulations (e.g. using virtual machines, finite element analysis (FEA), simulation software, etc.) might be a better choice. Remember, the faculty’s goal is for the student to succeed AND have a sufficiently robust project. More often than not, the reason for push-back by faculty is not because of the quality of the project, but because of concerns over setting the student up for failure.

## Grammar and Writing Style

The Project Proposal is expected to be a formal research type report. As such, proper grammar is expected. Sloppy writing can lead to confusion and uncertainty with the reader. Since a part of the goal of the proposal, and ultimately the final report, is to provide documentation that would allow someone else to reproduce the project, confusion or uncertainty runs the risk of the reproduction being done incorrectly. It is suggested that the reader bring drafts of their report to the university writing center for assistance with basic grammar and flow. However, it needs to be remembered that the people in the writing center tend to be from non-engineering disciplines. This means that they may not be able to assist with the technical content of the proposal. If the TECH 4943 professor allows/requires draft versions of the proposal to be submitted during the semester, it is imperative that the student respond to any feedback that is made to the proposal. In general, the professor will indicate those items that are suggestions, which should be considered but do not necessarily need to be changed or corrected. However, items that are indicated as being incorrect or in need of changing must be addressed or the final proposal may not be accepted resulting in either an incomplete grade, until the changes are made, or the outright failing of the class.

As can be seen in *Appendix B – Project Proposal Grading Rubric*, poor grammar is being heavily penalized. The reader will notice that there seem to be two styles of writing within this document. Content within the bounding boxes (content with a boarder) is written informally and makes use of first and second person pronouns. This was done because those sections are intended as instructions and reminders to the reader as to what is expected for each of the sections. The “sample” content, as well as the content in this appendix are written using third person pronouns. When writing the Project Proposal, only use third person pronouns as indicated in the grading rubric. A failure to do so will quickly result in a significant loss of points (two points every time “I”, “me”, “my”, etc. are used).

## Project Proposal Content

Well in excess of 40 hours have been invested in this document by the faculty members of the department. They have included those items that are felt to be important parts of the final proposal. As such, a failure to include the applicable items contained in each of the sections within this template will result in either a significantly reduced grade or the outright rejection of the final Project Proposal, resulting in a failing grade for TECH 4943. In many of the sections of the template, field of study (FOS) specific requirements have been broken out so that the student is made aware of the section specific expectations for their FOS. In these instances, the requirements for the other FOS can be ignored. However, it would still behoove the student to read the requirements for the other FOS areas as there is often overlap in the necessary components and the more complete the proposal the more likely it is to be approved.

Remember, the Project Proposal is the student’s attempt at convincing the TECH 4943 professor(s), their technical advisor and the FOS lead that the proposed project is worthy of being considered a Senior Project. The argument that the project is of sufficient rigor has to be made via the document. Once graduated, the student will often find themselves in the position where they have to make the case for why an idea should be pursued by their employer. And while a full formal proposal such as this one may not be made, all of the components of this proposal will need to be in whatever written communication is made.

It should be noted that the Project Proposal and Final Report grading rubrics have been attached as additional appendices. Included in both of the rubrics are point deductions for grammar and “professionalism.” The reason that these items are listed as deductions is that both items are expected. Points are not being awarded for providing a document that uses correct grammar and that looks professional; it is assumed that the student will do these items. For example, if feedback is provided indicating that the student needs to change something in their documentation and it is not done in the final version, then points will be deducted. Furthermore, it should be realized that as more mistakes are found within a document, the more closely it will be looked at. This is just human nature. Likewise, if the presented documentation is put together in a sloppy manner, the reader will assume that the content was done in a sloppy manner and the faculty member grading the document will unconsciously be looking for other errors. So it pays for the student to submit something that is professional looking.

The final consideration for the Project Proposal is that it can be considered a contract between the student and the faculty advisors (and specifically the technical advisor) in terms of what the student will be delivering at the end of TECH 4945. Significant deviations from the Project Proposal need to be accompanied by written agreement between the student and both the technical advisor AND the professor(s) of record for TECH 4943. When this happens in industry, a term the student will often run across is the “change request.” This is a formal document that the “customer” sends to the “designer” requesting a change in what was originally agreed. Should the student promise “A”, “B” and “C” in the Project Proposal but submit a final report that contains “B”, “C” and “D” without the evidence that the change was accepted by the technical advisor and the professor(s) of record for TECH 4945, the project will most likely be rejected

## Figures, Tables and Formulas

The use of figures, tables and formulas should be limited to instances where they aid and assist the reader in understanding what is being discussed. Don’t just put them in for the sake of having them. Additionally, they should be able to stand on themselves, without a lot of additional text explaining them. Figures should be included and designed so that they are easily read or viewed. Use of contrasting colors is important in that the use of yellow or light gray on a white background will detract from the overall quality of the proposal (or of anything that you write) since the reader will be caught up in trying to decipher the image and not paying attention to what you are trying to say.

The same goes for tables. Make sure that the design of the table is such that it is easily read and that the reader can follow along without having to struggle. Use of boarders should be done judiciously, including them when it helps to view the table, but left off when it is just there for the sake of being there. Background colors are the same.

Formulas should be included if following the logic of the formula is not easily done in the text. If all you are showing is that the reader has to add or multiple a bunch of values, just say that. Don’t waste the time and space with an equation. If, however, the use of an equation makes reading easier, be sure to use the equation editor in MS Word. Trying to manually type the equation will just result in a sloppy looking document.

## References and Bibliographies

As you should remember from your writing classes, references are citations by you, of work done by others. Bibliographies are also references to the work of others, but are not necessarily cited within your proposal. Regardless of which you are required to use, you will need to ensure that your listed items are current and relevant to your proposal. We are in the Engineering Technology discipline, not the History of Technology discipline. As such, while you can reference older items as a way to show a trend, most of your references should be to work that is only a few years old. Telling the reader all about the state of the mobile computer industry in 2012, during the 2018-2019 academic year is pointless. Too much has changed for the information from 2012 to be relevant.

## Appendices

Appendices should include material that is either too expansive and verbose for the body of the document (e.g. copy of a survey, fully detailed Gantt chart, custom source code). Appendices should be used sparingly – don’t put something in an appendix just because you can. For example, we don’t need a printed copy of the user manual for a part of your project. At most, you might consider putting copies of some of the relevant pages in, but that would be the most. Single page data sheets can be a good item to put in the appendices if there is sufficient cause, such as extensive details about the performance characteristics for a sensor. However, if you have a normal, every-day thermometer with no special features, don’t put the data sheet in your proposal just to have a larger document. Doing so will actually result in a REDUCTION in your grade!