KNOWLEDGE ASSESSMENT SELF REVIEW (FORM KA02)

IPENZ ENGINEERS NEW ZEALAND

Name of Applicant: ______________________ **Membership number or date of birth:** ______________

Section One

Important Instructions and Guidance

Carefully read the following instructions and guidance. They are designed to assist you in providing in providing a portfolio of evidence that best demonstrates the comprehension and application of your engineering knowledge to Washington Accord equivalence.

Section One – Instructions and Guidance

- Familiarise yourself with the definition of '*complex engineering problems'* (Appendix One) as you are required to demonstrate you can apply your engineering knowledge to solve complex engineering problems.
- Identify the '*engineering discipline and field'* (Appendix Two) you will provide evidence of your comprehension and application of engineering knowledge in.
- The knowledge assessment is based on Washington Accord knowledge profile. This form is designed to capture information to assist the evaluation of your evidence

Section Two – Knowledge Profile

- As you do not have a formal engineering qualification that formally benchmarks to a Washington Accord accredited degree, it is essential that you demonstrate that you have acquired an equivalent level of knowledge.
- The Context and performance indicators provide guidance on the evidence to be provided
- Consider each element of the knowledge profile, including the context statements and performance indicators. Summarise key aspects of your knowledge under each element and how this has been developed through academic study, on-job learning and/or continuing professional development. It is important you use the performance indicators and complexity definitions to enable you to describe your knowledge and how it has been developed.
- When describing how your educational program contributed to your development, focus on the more advanced pieces of work you did, the knowledge you needed in order to perform that work, and the abilities you needed in order to apply your knowledge in an engineering context.
- The word document is formatted to allow you expand a text box if required.
- Write your material in the first-person using 'I' or 'me' instead of 'we' or 'us'. This makes it easy for the assessors to see what your personal contribution was.

Section Three – Evidence of Application of Knowledge

- Describe 3-4 engineering projects or activities (Work/Study Episodes) that you have been involved with, which demonstrate your ability to apply your engineering knowledge to solve complex engineering problems. Think of activities where you have had to apply a high level of engineering knowledge – such as some analysis that you have done, work you have done in scoping a problem and then developing a solution or design. What engineering models did you use? What assumptions were made in the development of the model and how did you test the model was relevant in the way you used it?
- For engineers with limited practical experience post-graduation, project work undertaken during your study is likely to be one of the best ways of illustrating the application of your knowledge. As well as projects conducted within university or college, you may be able to draw on any industry experience required as part of the educational program.
- You are required to include actual samples of your work – calculations, analyses or reports that you have personally undertaken - to substantiate your work/study episodes.
- Write your material in the first-person using 'I' or 'me' instead of 'we' or 'us. This makes it easy for the assessors to see what your personal contribution was.
- The word document is formatted to allow you expand a text box if required.

Section Four – Supplementary Evidence

- You are required to submit a certified copy of your academic transcript(s) (formal record of papers taken and grades received) if you have not submitted to IPENZ already.
- Summarise your work history but include a representative sample of specific engineering projects or activities that evidence the development or application of the knowledge profile.
- Rather than listing all your CPD activities, provide details of those activities that have extended your professional engineering knowledge in your discipline and field and have assisted you to develop the knowledge profile of a professional engineer. A summary of all relevant activities – including those going beyond the most recent 6 years - will assist knowledge assessors in assessing your engineering knowledge. Assessors will be looking for how any gap between your qualification and a Washington Accord qualification has been bridged by your CPD.
- The word document is formatted to allow you expand a text box if required.

Section Five – Payment

- The fee for a knowledge assessment is NZ$1,351.25 GST incl. Please complete your credit card details.
- Send all documentation to address advised

What happens next?

The knowledge assessor will review your portfolio of evidence to determine the need for further challenge tests. This will involve an interactive assessment, that you will need to make yourself available for, either via tele or video conference and may also involve a series of challenge tests that may include one or a combination of:

- an oral and/or written examination
- a work simulation
- a case study

Your knowledge assessor will be in touch with you to discuss the next steps.

SECTION TWO – KNOWLEDGE PROFILE

Element One

A systematic, theory-based understanding of the natural sciences applicable to your discipline (e.g. calculus-based physics)

Context

All engineering fields are rooted in one or more of the natural sciences. In a broad context, natural science is separated into physical and biological sciences. Physical sciences include chemistry, calculus-based physics, astronomy, geology, geomorphology, and hydrology. Biological sciences involve living systems and include biology, physiology, microbiology, and ecology.

Washington Accord graduates are expected to be able to apply this knowledge of the natural sciences to solve complex engineering problems in their discipline.

Performance Indicators

- Fundamental quantitative knowledge underpinning nature and its phenomena.
- Knowledge of the physical world including physics, chemistry and other areas of physical or biological science relevant to your discipline
- Knowledge of key concepts of the scientific method and other inquiry and problem-solving processes;
- Application of knowledge from one or more of the natural sciences to the solution of complex engineering problems relevant to your discipline.

Summarise your knowledge of the natural sciences relevant to your discipline and how it has been developed through formal study, on-job learning and/or continuing professional development. Note: please cross reference to your academic transcript(s) and continuing professional development records, as appropriate.	**Provide annotations to your supplementary evidence (document and page number)**
I was appointed as team lead engineer for this project.	Episode 1, pages 16, clauses 1.1
My role was to develop an electronic device capable to perform six dilutions in one session; costing less than 300$ & faster than manual process.	Episode 1, pages 16, clauses 1.2
I was appointed as electronics engineer for this project	Episode 2, pages 21, clauses 2.1
I was an opportunity to develop a low-cost scale with multiple properties	Episode 2, pages 22, clauses 2.1
I worked as field application engineer in this project	Episode 3, pages 26, clauses 3.1
I was given an opportunity to develop a low-cost solution to produce output Voltage of 12.8V with 400mA of current @ full load	Episode 3, pages 26, clauses 3.2
After in depth study I defined the hardware topology as a main microcontroller that would be un charge of performing all calculus & algorithms	Episode 4, pages 30, clauses 4.2

Element Two

Conceptually-based mathematics, numerical analysis, statistics and formal aspects of computer and information science to support analysis and modelling applicable to your discipline

Context

Branches of mathematics applied in engineering include arithmetic, algebra, geometry, trigonometry, calculus, differential equations, numerical analysis, optimization, probability and statistics, simulation, and matrix theory. Engineers apply mathematics in a wide variety of functions typically carried out in engineering organisations such as planning, design, manufacturing, construction, operations, finance, budgeting, and accounting.

Washington Accord graduates are expected to be able to apply this mathematical knowledge to solve complex engineering problems in their discipline.

Performance Indicators

- Knowledge of mathematics, statistics and numerical methods that supports the development or application of models that replicate 'real world' behaviours
- An understanding of the assumptions behind theoretical models and their impacts in the development and use of those models
- Ability to organise and analyse a data set to determine its statistical variability;
- Knowledge of trigonometry, probability and statistics, differential and integral calculus, and multivariate calculus that supports the solving of complex engineering problems
- Ability to apply differential equations to characterize time-dependent physical processes

Summarise your mathematical knowledge relevant to your discipline and how it has been developed through formal study, on-job learning and/or continuing professional development. Note: please cross reference to your academic transcript(s) and continuing professional development records, as appropriate.	**Provide annotations to your supplementary evidence (document and page number)**
I studied the properties of the touch display screen and developed a software for the calibration of the received touch screen.	Episode 1, page 17, clause 1.4
When developing the display touch screen matrix, I used my Algebra background & developed the idea	Episode 1, page 18, clause 1.5
I developed an additional circuit to integrate the memory with MCU	Episode 2, page 22, clause 2.4
I used a logic analyser from SALEAE for high speed signals	Episode 2, page 23, clause 2.4
I implemented the RCD clamp circuit added up capacitor & resistor to reduce the pikes	Episode 3, page 27, clause 3.4
I calculated acceleration torque and load torque	Episode 3, page 28, clause 3.5
I used an external IC to perform calculus at hardware level	Episode 4, page 31, clauses 4.4
I implemented calculus to convert the measured signal in grams	Episode 4, page

	33, clauses 4.5

Element Three

A systematic, theory-based formulation of engineering fundamentals required in the engineering discipline

Context

Engineering fundamentals provide the knowledge base for engineering specialisations and represent a systematic formulation of engineering concepts and principles based on mathematical and natural sciences to support applications.

The core areas of engineering fundamentals knowledge include fluid mechanics, statics and dynamics, electric circuits, solid mechanics, thermodynamics, heat transfer, mass transfer, and properties of materials.

Washington Accord graduates are expected to be able to apply this knowledge of engineering fundamentals to solve complex engineering problems.

Performance Indicators

- Ability to define key factual information in core areas of fundamental engineering knowledge relevant to your engineering discipline
- Evidence of sufficient depth of knowledge of engineering fundamentals to demonstrate an ability to think rationally and independently within and outside a chosen field of specialisation
- Evidence of sufficient breadth of knowledge of engineering concepts and principles to allow subsequent professional development across a broad spectrum of engineering
- Ability to apply knowledge of engineering fundamentals to solve complex engineering problems relevant to your discipline

Summarise your knowledge of the core engineering fundamentals (as listed above) and how they have been developed through formal study, on-job learning and/or continuing professional development. Note: please cross reference to your academic transcript(s) and continuing professional development records, as appropriate.	**Provide annotations to your supplementary evidence (document and page number)**
I created a good math model to do the job & the created code was suitable	Episode 1, page 17 clause 1.4
I developed embedded software for the microcontroller	Episode 1, page 19 clause 1.10
I developed an embedded code in the microcontroller to analyse the image buffer	Episode 2, page 24 clause 2.5
I designed & developed almost 70% of the low-level drivers of the product	Episode 2, page 25 clause 2.9
I calculated the transformer specification & provided layout reference	Episode 3, page 28 clause 3.6
I used eDesignSuite software for developing the electronic schematic	Episode 3, page 29 clause 3.9
I used MISRA-C development guidelines for the development of software	Episode 4, page 35, clauses 4.9

Element Four

Engineering specialist knowledge that provides theoretical frameworks and bodies of knowledge for the accepted practice areas in the engineering discipline; much is at the forefront of the discipline

Context

In addition to a broad understanding of fundamental engineering principles, professional engineers are required to develop specialised engineering knowledge to support their practice. This may be aligned with traditionally defined fields of specialisation such as structural, industrial or geotechnical engineering; coherent combinations of such traditional areas; or more recently emerging fields such as software, biomedical or mechatronics engineering.

Advancing technological knowledge and complexity means that technical specialisation is increasingly necessary for an engineer to remain abreast of technological development throughout their career.

Washington Accord graduates are expected to be able to apply this engineering specialist knowledge to solve complex engineering problems.

Performance Indicators

- Evidence of sufficient depth of knowledge to support practice within one or more recognised field of engineering
- Evidence of a systematic understanding of the coherent body of knowledge related to a particular field of engineering; its underlying principles and concepts; its usage and applications; and analytical and problem-solving techniques
- Ability to apply specialist engineering knowledge to solve complex engineering problems

Summarise your specialist engineering knowledge and how it has been developed through formal study, on-job learning and/or continuing professional development. Note: please cross reference to your academic transcript(s) and continuing professional development records, as appropriate.	**Provide annotations to your supplementary evidence (document and page number)**
Since the motor was getting heat-up; after some in depth analysis I changed the motor & the circuit for proper operations	Episode 1, pages 17, clauses 1.4
I did my research & finalized to use IC TEA 3716 from STMicroelectronics in the circuit for seamless operations	Episode 1, pages 17, clauses 1.4
I worked on software & hardware for a new mechanical thermal printer	Episode 2, pages 23, clauses 2.4
I changed the printing algorithm in the microcontroller	Episode 2, pages 24, clauses 2.4
I increased the dissipation area of IC to make it cooler during operations	Episode 3, pages 27, clauses 3.4
I did some changes in the feedback circuit to solve the leakage issue	Episode 3, pages 28, clauses 3.4
I did slight adjustment in the code and the communication started working properly	Episode 4, pages 32, clauses 4.4

Element Five

Knowledge that supports engineering design.

Context

The design process – the root of engineering – is the process of devising a system, component or process to meet desired needs. Engineering design is a systematic process that involves problem definition and scoping, research, analysis, option development and selection, modelling to predict future performance, detailed design and testing. Importantly, it also involves communication of the outcome in a way that enables the design solution to be realised.

Washington Accord graduates are expected to be able to apply this knowledge of the design process to solve complex engineering problems.

Performance Indicators

- Ability to undertake research and analysis to support the design process
- Ability to investigate a situation or the behaviour of a system and identify relevant causes and effects
- Ability to develop from first principles and construct mathematical, physical and conceptual models of situations, systems and devices, with a clear understanding of the assumptions made in development of such models
- Application of technical knowledge, design methods and appropriate tools and resources to design components, systems or processes to meet specified criteria
- Ability to analyse the pros and cons of alternative design options to support the development of an optimised design alternative
- Ability to analyse the constructability or manufacturing feasibility of a project or product
- Experience of personally conducting a significant design exercise, providing evidence of the consideration of various realistic constraints, such as safety, reliability, ethics, economic factors, aesthetics and social impact.
- Ability to apply appropriate design methods in solving complex engineering problems

Summarise your knowledge that supports engineering design relevant to your discipline and how it has been developed and applied through formal study, on-job learning and/or continuing professional development. Note: please cross reference to your academic transcript(s) and continuing professional development records, as appropriate.	**Provide annotations to your supplementary evidence (document and page number)**
I did research about current solution for the problem, figured out the best solution for the problem	Episode 1, page 16, clause 1.3
I understood technical requirements for the project, the necessary hardware & useful embedded microcontroller software	Episode 1, page 16, clause 1.3
I used KEIL Software to generate the source code	Episode 1, page 17, clause 1.6
I was responsible for choosing best SDRAM memory for the application	Episode 2, page 22, clause 2.3
I was accountable to develop the display interface in collaboration with a Chinese company & developed the embedded software	Episode 2, page 22, clause 2.3
I identified customer specifications for the source supply	Episode 3, page 27,

I used CNC machine knowledge to use ball screw nut mechanism for filling I developed the embedded software for the application	clause 3.3 Episode 3, page 27, clause 3.3 Episode 4, page 31, clauses 4.3

Element Six

Knowledge of engineering practice in the engineering discipline

Context

Engineers require knowledge of a broad range of tools and techniques relating to technical (measurement, modelling, drawing, design), business (financial management, project management) and interpersonal (communications, teamwork) aspects of modern engineering practice.

Washington Accord graduates are expected to be able to:

- Create, select and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modelling, to complex engineering problems, with an understanding of the limitations.
- Apply knowledge of management principles and economic decision making as part of the management of engineering projects
- Function effectively as an individual and as a member or leader in diverse teams
- Communicate effectively with both technical and non-technical audiences

Performance Indicators

Tools and technologies:

- Awareness of critical issues affecting current technical and professional practice
- Awareness of current tools of analysis, simulation, visualisation, synthesis and design, particularly computer-based models and packages, and competence in the use of a representative selection of these
- Appreciation of the accuracy and limitations of such tools and the assumptions inherent in their use
- Knowledge of materials and resources relevant to the discipline and their main properties and ability to select appropriate materials and techniques for particular objectives
- Knowledge of a wide range of laboratory procedures relevant to the discipline and a clear understanding of the principles and practices of laboratory safety
- knowledge of current types of systems, equipment, information technology, and specifications that accomplish specific design objectives

Communication:

- write correspondence that clearly and concisely communicates facts and circumstances related to a project, product or process
- plan, prepare and deliver an oral presentation, with appropriate visual aids and other supporting materials
- communicate effectively with both technical and non-technical individuals and audiences

Engineering management principles and economic decision making:

- apply appropriate tools and techniques to monitor project schedules and costs

Team work:

- Operate as an effective team member or leader of a multidisciplinary team

Element Six

Knowledge of engineering practice in the engineering discipline

Summarise your knowledge in each of these core areas underpinning engineering practice and how it was developed through formal study, on-job learning and/or continuing professional development. Note: please cross reference to your academic transcript(s) and continuing professional development records, as appropriate.	**Provide annotations to your supplementary evidence (document and page number)**
I decided to use an evaluation board from NXP because the complexity of the development of a board with more than 2 layers	Episode 1, page 19, clause 1.10
I had two meetings with the teachers where I discussed about the work, the deadline and the necessities	Episode 1, page 20, clause 1.13
I designed some parts of the electronics schematics such as the thermal printing interference, display interface & memories interface	Episode 2, page 25, clause 2.9
I reported to my manager on daily basis in form of spreadsheet	Episode 2, page 25, clause 2.12
I followed UL standards for the transformer	Episode 3, page 29, clause 3.10
I generated a report for the client after developing, prototyping & evaluating the solution	Episode 3, page 29, clause 3.11
Based on equations I implemented a calibration process	Episode 4, page 33, clauses 4.5

Element Seven

Comprehension of the role of engineering in society and identified issues in engineering practice in the discipline: ethics and the professional responsibility of an engineer to public safety; the impacts of engineering activity: economic, social, cultural, environmental and sustainability

Context

Engineers design artefacts (facilities, structures, systems, products and processes) that are intended to meet a societal need, but which typically impact on individuals or groups in different ways. As a result, design and decision-making processes must take account of often conflicting stakeholder needs. An understanding of this societal context and the ethical obligations that the engineer has in service of society are critical components of engineering practice.

Washington Accord graduates are expected to be able to:

- Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice
- Understand and evaluate the sustainability and impact of professional engineering work in the solution of complex engineering problems in societal and environmental contexts.

Performance Indicators

- Demonstration of ethical behaviour in accordance with ethical codes of conduct and established norms of professional conduct
- Evidence of making ethical decisions and regulating one's own professional conduct in accordance with a relevant code of ethical conduct
- Implementation of appropriate health and safety practices
- Application of safe practices in laboratory, test and experimental procedures
- Awareness of the social and environmental effects of their engineering activities
- Awareness of sustainable technologies and sustainable development methodologies
- Ability to identify risks as a consequence of engineering compromises made as a result of project or business constraints, and understanding of techniques to mitigate, eliminate or minimise risk
- Knowledge of appropriate risk management techniques used to assess the accuracy, reliability and authenticity of information
- Understanding of the role of quality management systems tools and processes

Summarise your knowledge of the role of engineering in society and how it has been developed through formal study, on-job learning and/or continuing professional development. Note: please cross reference to your academic transcript(s) and continuing professional development records, as appropriate.	**Provide annotations to your supplementary evidence (document and page number)**
After getting the mechanical device, I analysed it & checked the viability of using a low torque stepping motor	Episode 1, page 18, clause 1.7
I used MISRA-C development guidelines in all firmware for the development of embedded software	Episode 1, page 18, clause 1.9

I followed all the basic safety standards I performed many tests on the development process For safety purpose I isolated the source supply I executed FAT & performed numerous tests I used online resources to study Altair 05T-800 Datasheet I used embedded software IDE to compile the embedded code in C language	Episode 1, page 20, clause 1.12 Episode 2, page 24, clause 2.6 Episode 2, page 25, clause 2.11 Episode 3, page 29, clause 3.7 Episode 3, page 29, clause 3.8 Episode 4, page 34, clauses 4.6

Element Eight

Engagement with selected knowledge in the research literature of the discipline

Context

Research and broader lifelong learning capabilities are essential if the engineer is to remain up-to-date with rapidly evolving scientific knowledge, technology and engineering tools critical to engineering practice

Washington Accord graduates are expected to be able to use research-based knowledge and research methods as part of the investigation of complex problems in their discipline

Performance Indicators

- Advanced knowledge in at least one area within your discipline, to a level that engages with current developments in that area
- Understanding of how new developments relate to established theory and practice and to other disciplines with which they interact
- Describe advancements in engineering research and technology and science in a particular area of engineering practice;
- Review research articles pertaining to a project component typically encountered in a specific area of engineering design;
- Choose topics most appropriate for continuing education to increase depth of technical knowledge pertinent to the specific area of engineering practice
- Commitment to lifelong learning.

Summarise your research knowledge and how it has been developed through formal study, on-job learning and/or continuing professional development. Note: please cross reference to your academic transcript(s) and continuing professional development records, as appropriate.	**Provide annotations to your supplementary evidence (document and page number)**
For the development of Algebra, I took help from internet & central library	Episode 1, page 19, clause 1.8
My knowledge in centrifugal pump helped in resolving issues while performing commissioning & troubleshooting.	Episode 1, page 21, clause 1.14
I got guidance from my peers & colleagues throughout the project work	Episode 2, page 24, clause 2.7
I used my knowledge of Analog & Digital electronics in this project execution	Episode 2, page 25, clause 2.13
For Analog electronics applications I used my learned knowledge from university studies	Episode 3, page 29, clause 3.12
I used the knowledge gained from datasheets and manuals for the project development	Episode 4, page 34, clauses 4.8
I used my Analog & digital electronics knowledge	Episode 4, page 35, clauses 4.12

Section Three - Evidence of Application of Knowledge

In this section you are required to provide evidence of the application of your engineering knowledge using 3-4 engineering projects or activities (Work/Study Episodes) that you have been involved with.

Provide a general overview of the scope or parameters of each project or activity, your role in it and the particular challenges or complexities involved. Then describe, in narrative form, how it provides evidence of the application of different aspects of your engineering knowledge. Cross reference to the relevant elements of the knowledge profile in the right hand column.

You are also required to complete the Knowledge Matrix to summarise the contribution to knowledge demonstration made by each project. The work/study episodes are expected to provide at least 2 examples of the application of each knowledge element.

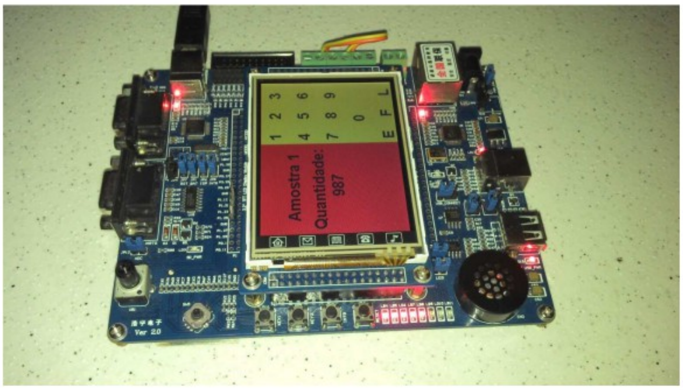
Work Episode 1	Element
Overview of the project Project Title: Dilution & Mixing Device for Automatic Preparation of Solutions & Standards Dates of Project: 2014 Name of Organization: Federal University of ABC Location: Santo Andre, Sao Paulo, Brazil My Role: Engineering Student	
Background **1.1** Federal university of ABC is a renowned Brazilian institution with most part of the academic body holding Ph.D. It was recognized as the unique Brazilian University with impact factor in scientific publications above average according to SCImago Institutions Rankings (Source: http://www.scimagoir.com/). The university and the engineering courses were created in 2005. The project was the last requirement to get my engineering diploma. I was appointed as team lead engineer for this project. After an intense research, I found a lack in the Brazilian market, where there was not any electronic device able to automatically, with good accuracy and repeatability, prepare some chemical process like chemical solution dilution in a reasonable price/amount for a small company or laboratory.	One
Objective of the Project **1.2** Due to high cost of equipment to execute chemical analysis, the main purpose of the project was creating a good solution with a budgetary price, able to attend small industries in laboratories in Brazil. My role was to develop an electronic device capable to perform six dilution in one session, costing less than $300 and faster than a manual process.	One
Roles & Responsibilities **1.3** ➢ Research about current solution for the problem, figuring out the best resolution for the problem. ➢ In charge of all electrical and electronic development, since the first scratch to the final version. ➢ Understand technical requirements for the project, the necessary hardware and useful embedded microcontroller software. ➢ Having meetings with teachers and other colleague, working on the project's deadlines ➢ Develop the hardware, including all electronic schematics and layout. ➢ Develop the embedded software for the microcontroller in C language. ➢ Prototyping the solution ➢ Preparing test documentation for the machine ➢ Presenting the functional solution for the public	Five Five
Complexities (using the complexity definitions) and challenges of the project **1.4** **Problem 1** **Bad Precision of the Resistive Touch Screen Display** Although touch screen displays are very useful, there are many problems regarding the precision of these displays. Before purchasing the display, I had researched a lot about their specs, and it seemed	

appropriate. However, when the display was received, I realized that the precision was not enough for my project due to many problems such as electronic noise, etc. I had to develop a software to calibrate the touch screen. Using Algebra knowledge learned from university, I developed a software to get the raw data from the display and store it in a structure. After that, a function in C was created by me to convert these values in display points using a transformation matrix. After some research & working, I finally had a good math model to do the job and the code created was suitable.

TWO

TWO

Below is a photo from the display in a standard screen:



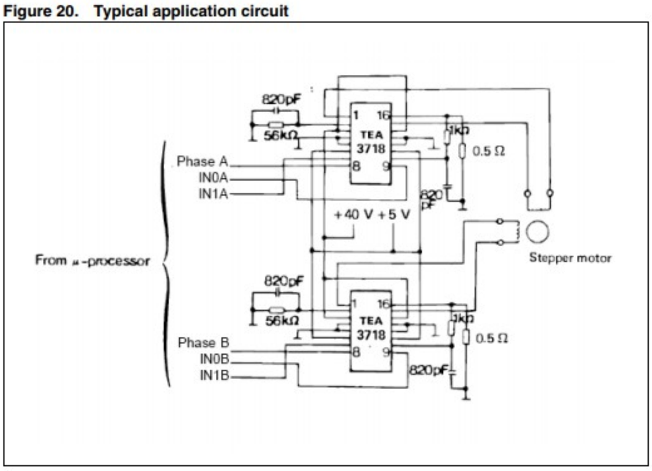
Problem 2
Brushless DC electric motor resolution
Because I was working in parallel with the other team, I had no mechanical part for the infusion pump ready, so, I could not run any performance test for the first circuit, that was one 28BYJ-48 motor (unipolar and 900 g.cm) and the ULN2003 as motor IC driver. After receiving the mechanical dispositive from my colleague, I ran some tests, and the motor did not have enough torque to generate the movement. Also, the motor and the driver were heating up, achieving more than 100ºC. So, I had to change for a new motor, and a new circuit. Changing the motor to 23LM-C004-60 (bipolar and 7 kg.cm), I had to elaborate a new circuit. After discussing with teacher and my company colleagues, I found appropriate IC TEA3716 from ST Micro (Datasheet: https://www.st.com/resource/ja/datasheet/tea3718.pdf). Considering the page 16, I found a good reference for the circuit:

Four

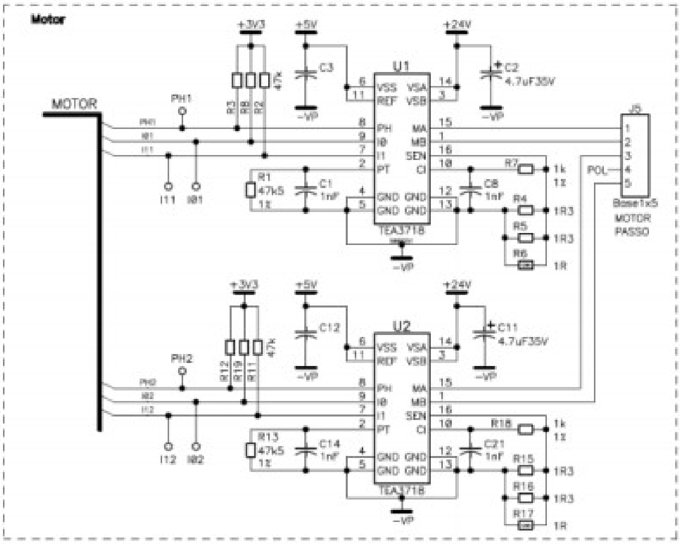
Four

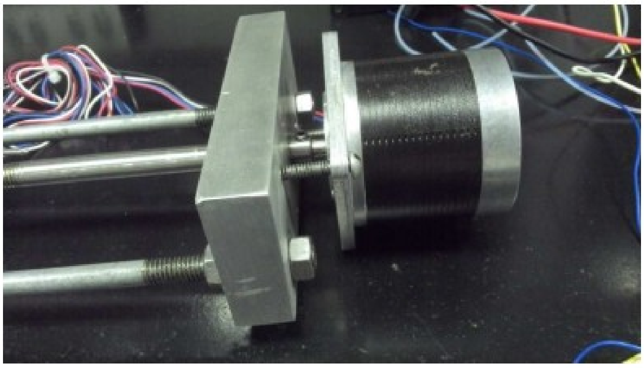
4.4 Typical application

Figure 20. Typical application circuit



After some tests, I finished the work proposing a function circuit, and after prototyping, it was working properly. You can see the photo below for the circuit and the motor:





How does this project demonstrate application of your engineering knowledge?

1.5
Engineering Calculations

- When developing the display touch screen matrix, it was necessary to implement the matrix translation for the raw data. Using Algebra background as well as an excellent article from professor Carlos Vidales, I could develop the idea.

- The liquid dosage in the process was established in a relation: $ld(s) = k * \frac{ds}{dt}$, where the variable represents the steps, ld is the liquid dosage and k is a constant to correlate the process in an integer number. After some lab measurements, I obtained the best value for the constant K, and I could develop the software.

- Based on the internal crystal of the microcontroller, I had to calculate the main PLL for the Microcontroller, and established the timers for the UART and Interruptions. Using the datasheet from the LPC1768, I could develop the embedded software to perform these actions.

Two

1.6
Software Used
Keil uVision:

Embedded software IDE. I used it to generate the source code for the microcontroller. Furthermore, the IDEA was used to debug the source code, helping to figure out bugs and issues in the code.

Five

Altium:

Schematic and Layout IDE. I used it to design the electronic schematic for the Step Motor Driver. Also, this software was used to generate the board layout. **1.7** <ins>Engineering Testing</ins> Many testes were executed by me, depending on which part of the project I was working at the moment, some examples: **Motor circuit:** A – After getting the mechanical device, I analyzed it and checked the viability of using a low torque stepping motor, which was inefficient. B – After working on the new motor circuit, I tested it and it worked properly. **Display:** A – In the process of developing the matrix code to transform the raw data in efficient information, several tests were made to achieve the best solution. **Middle and End Solution:** Close to the middle of project, I did a full test, with the mechanical and the electronic parts working together, trying to figure out any issues. I found some issues with motor resolution that I fixed after. Close to the deadline, many testes were made to evaluate the full solution in real cases. One important test was carried out in one of the climate chambers in the university, where I realized that the system was working properly, even in high temperatures.	**<ins>Seven</ins>**
1.8 <ins>Resources Usage</ins> From teachers & colleagues I got recommendations for the embedded software development and the hardware for the step driver. From Internet and books, I read some articles and papers, which helped me in the development of algebra, and also getting some software and hardware references.	**<ins>Eight</ins>**
1.9 <ins>Implementation of special technique</ins> In the development of the embedded software, I used the MISRA-C development guideline in all firmware.	**<ins>Seven</ins>**
1.10 <ins>My Creative innovation</ins> **Microcontroller Embedded Software in C:** I developed the embedded software for the microcontroller, creating both the high and the low-level drivers for the application such as GPIO's drivers, USB driver, RS232 drivers and for the high-level part, display interfaces	**<ins>Three</ins>**
Electronic Schematic: Because of the complexity of developing a board with more than 2-layers, I decided to use an Evaluation Board from NXP, running a Cortex-M3 processor LPC1788.	**<ins>Six</ins>**

However, it was necessary to add external functionalities like the driver for the motor, so, using electronic books as reference and datasheets, I designed the schematic for the project through the software Altium.

1.11
Engineering Standards Followed

I followed following codes

- MISRA-C
- UL Standards

1.12
Safety

-
Because the project was a prototype, it was not necessary to follow any specific Safety rule but I still **Seven**

made sure that all the basic safety standards are met passably.

1.13
Project management

There were two meetings for month with teachers, where I discussed about the work, the deadlines, the necessities, etc... With my mechanical colleague, I had weekly meetings to discuss the project. **Six**
Being the project author, I was the leading since the beginning. So, I coordinated the development of the mechanical dispositive, checking my colleague’s deadline dates. For the electronic development, being responsible for everything, I lead all discussions.
It was necessary to generate a quarterly report, where I had to discuss about the project’s deadlines, issues and necessities. In the end of the project, it was necessary to create a full documentation about the project, explain all the functions and how to set up the machine.

Presentations

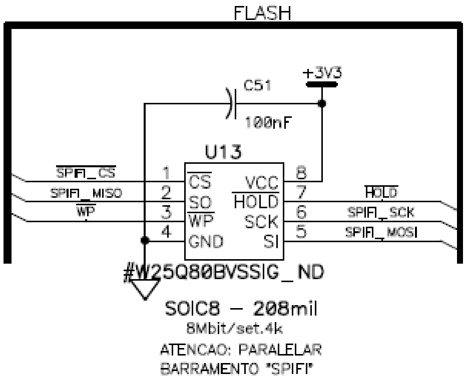
There were several seminars and fairs where I presented the project, most part of them were chemical events, where I exposed the machine to them.

1.14

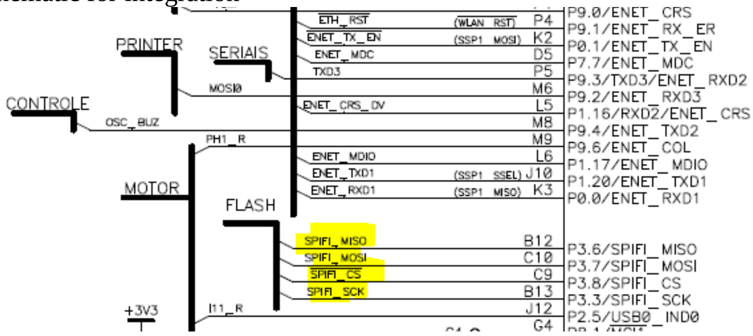
Application of Engineering Knowledge

I have used my Analogical and Digital Electronics knowledge to develop a full project from scratch. In the end, the dispositive worked properly and attended the expectations. It is important to point that many part of the Digital Electronic is made by C Code through microcontroller, which helped in the development of the project. Summarizing the activities: ➢ In the university I had several classes about project organization, which helped me to accomplish project's deadlines. ➢ Using Algebra, I could perform a translation matrix for the display ➢ Using Analog Electronics, I could develop a step driver motor ➢ Using Digital Electronics, I could develop the embedded software for the microcontroller, as well as control a variety of peripherals and protocols. ➢ Testing, Evaluating and Reporting the project ➢ Elaborate a full report for the coordinators **1.15** Knowledge gained & my personal contributions This project was successfully completed as per schedule As the responsible person for the electronics parts of the project, I was involved since the first scratch to the final report. I studied many books, researched many web links, and ran many try-outs to accomplish a good project. I oversaw all the project, involving deadlines, hardware, embedded software and final presentation. There is a public link about the project - https://www.youtube.com/watch?v=JAqiPK7-QVM I attended an Embedded Systems Conference, which helped me to develop my firmware and hardware skills. I also attended a Design with Freescale course, which helped me to get some evaluation boards and a guideline for the development of the step driver circuit. Learnings from the project were ➢ How to control properly a step motor ➢ How to develop low level drivers for microcontrollers ➢ How to develop an interface for a LCD Interface ➢ How to generate electronic schematics and layouts through a professional software like Altium	**Eight**
Work Episode 2 **Overview of the project** Project Title: Prix 4 Uno Light Dates of Project: April 2015 to December 2015 Name of Organization: Toledo do Brazil Location: Sao Bernardo Do Campo, Sao Paulo, Brazil My Role: Electronics Engineer **Background** **2.1** Toledo do Brasil is the leading company offering solutions for hardware, software and services for weighting process in Latin America. The company started in 1901, founded in Ohio-USA. Furthermore,	**Element** **One**

in 1932 they have started their operations In Brazil. After few years in 1988, a Brazilian business man bought the company, therefore the company started being 100% Brazilian. The company has more than 100 different types of solutions, and more than 30 engineers (electrical and mechanical) working in its behalf, and there are more than 1800 employers around Brazil. I was appointed as Electronics Engineer for this project. I was allotted an opportunity to develop a low-cost scale, but with a variety of electronics resources like a high-speed thermal printer, Ethernet, External SRAM Memory to store more than 10 thousand of products and a new ADC, with a lower cost than the current solution. **Objective of the Project** **2.2** There was a huge market gap for what we called automation scales for supermarkets in Brazil. On this kind of product, the scale must weigh the product properly and calculate the final price based on the item's information previously stored. Also, the scale must store all the transactions & send this information for a server. You can see bellow one photo about the project after going to production:  **Roles & Responsibilities** **2.3** ➢ I was in charge of having meetings with electronic components distributors, trying to figure out the best Cortex-M3 Microcontroller for the application. ➢ I was responsible for choosing the best SDRAM memory for the application. ➢ After getting the new printer module from the mechanical engineers, I had to calculate its electrical current consume, developing the integration in the embedded software in a low power mode. ➢ I was in charge of developing the display interface in congregation with a Chinese company and developing the embedded software ➢ I was in charge to develop the low-level drivers of the microcontroller and its interfaces such as Ethernet, UART, GPIO's, and timers, ADCs, SPI and I2C. ➢ I had to trial perform functional tests in the solutions on weekly bases. ➢ I had to elaborate the product documentation for both internal and external customers. **<u>Complexities (using the complexity definitions) and challenges of the project</u>** **2.4** **Problem 1** **Microcontroller without Internal Flash Memory** After an in depth research I informed my boss that the best solution was using a new microcontroller (Cortex M3 – LPC1830 from NXP) due to be the lowest cost solution. On the other hand, this microcontroller does not have any internal memory, so, I had to develop an additional circuit to integrate the memory with the MCU. Memory – High Speed Interface	**<u>One</u>** **<u>Five</u>** **<u>Five</u>** **<u>Two</u>**



Microcontroller Schematic for integration



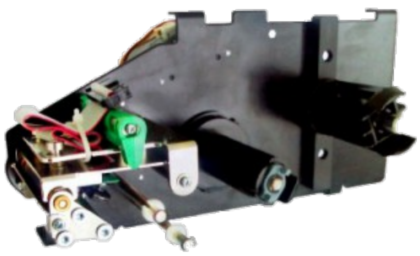
However, being a new microcontroller, I did not have much information from the supplier (NXP) or even on the Internet. After assembling the first prototype, I realized that the circuit was not working properly. To solve this issue, I had to use a Logic Analyzer from SALEAE, which works like an oscilloscope for high-seed digital signals. After 1 week of working in this problem, I figured that the problem was in the SPI controller from the microcontroller, so, I developed a new low-level driver in C language. After that, the circuit worked properly.

Two

Problem 2
New Thermal Printer

A new mechanical thermal printer was selected by the mechanical team, so, I worked on the hardware and software implementation. The company used to work with ROHM Thermal heads, however they decided to change for a new brand called APS, which had lower prices but more current consume. You can see below one photo from the APS printer:

Four



Below is a photograph from a thermal label

The company also would not like to change the Main Source Supply, so I realized that I had a problem because I would have to change all the printing method. So, I decided to change the printing algorithm in the microcontroller. Using an oscilloscope to measure the current consume in each strobe from the new head printer, I developed a method to just turn on the strobes when they were necessary, instead of turning all of them at the same time. It was hard to develop this algorithm, and I spent almost 3 weeks developing it, but after this time and some tests, this part of the product was ready. **Problem 3** **Microcontroller Abort Exception** There were some situations where the microcontroller stopped to work properly, and the application crashed. Sometimes, this issue was caused by some code implementations inside interruptions, which was really hard to find out. Researching in a technical material from the Compiler provider, Keil, I have learnt that it was possible to analyze these situations considering a register from the Microcontroller. The register was the **R14,** and to figure out why the application crashed I had to check the last value from this register and subtract 8 from this value. After that, I had the address that it caused the problem. So, I had to analyze the code generate in Assemble, and check what instruction had created the bad situation. This technique helped me to analyze and figure out solution for many problems in the development stage.	**Four**
How does this project demonstrate application of your engineering knowledge? **2.5** Engineering Calculations **Thermal Strobes** After some tests, I checked that each dot could consume approximately 35 mA when turned on in the maximum power. I found this value after many tests using an oscilloscope. Being practical, this situation would generate a possible pick current of (35 mA * 448), because 448 is the maximum number of dots, so it would demand almost 15 amperes. Because the company would not like to change their 5 Amperes source supply, I had developed an embedded code to solve the problem. Analyzing the specifications, I found that I had to turn on up to 112 dots in each session. After that, I developed an embedded code in the microcontroller to analyze the image buffer, checking the quantity of necessary dots, and developing "virtual" strobes, where I split the printing session. I spent some weeks developing this software, however after ready, I realized that I could print a black line without changing the source supply with a minimum time increase.	**Three**
2.6 Engineering Testing I performed many tests on the development process. It was a weekly session to evaluate the last week implementation.	**Seven**
2.7 Resources Usage Because the company had more than 3 engineers working in the same area than mine, I always reached them to get some guidance for some issues with hardware or embedded software. There were weekly meetings, where we could share about the status of our projects, and also sometimes teach or learn about electronics.	**Eight**
2.8 Implementation of special technique In the development of the embedded software, I used the MISRA-C development guideline in all firmware. For the electronics schematic the company had some internal rules. I developed the first product in the company using a flash less microcontroller.	**Seven**
2.9 My Creative innovation	

Microcontroller Embedded Software in C: I designed and developed almost 70% of the low-level drivers of the product (GPIOs, UART, Ethernet, Timers, SPI and I2C). I also worked in the high-level interface with customer through developing the menus and Display interfaces, always in C language for the microcontroller. **Electronic Schematic:** I designed some parts of the electronics schematics such as the Thermal Printer Interface, Display Interfaces and Memories Interfaces. I have used the software Altium to develop these interfaces. **2.10** <u>Engineering Standards Followed</u> I followed following codes ➢ MISRA-C ➢ UL Standards ➢ INMETRO (The National Institute of Metrology, Standardization and Industrial Quality) standards for weight scales **2.11** <u>Safety</u> - All components selected should be ROHS. To keep the project safe, the source supply was isolated. When handling any electronic dispositive, I had to use an anti-static wrist strap. **2.12** <u>Project management</u> There were weekly meetings with my boss and colleagues to discuss the company's projects. I was reporting to my manager daily in the form of spreadsheet. Having developed some relevant areas of the project, I lead some discussions and definitions about the project. I also had to discuss with the other teams (Marketing and Mechanics) and established the project's deadlines. After finishing the project, I developed the operations manual for the project. I also had to perform some tests with competitors' products to ensure that I had the best project on my hands. **2.13** <u>Application of Engineering Knowledge</u> I have used both Analog and Digital Electronics on the project, which helped me to increase my knowledge. I also have implemented difficult tasks like the flash less MCU, the new printers, new memories, where I obtained many good information **2.14** <u>Software</u> **Keil uVision:** Embedded software IDE. I used it to generate the source code for the microcontroller. Furthermore, the IDEA was used to debug the source code, helping to figure out bugs and issues in the code.	<u>**Three**</u> <u>**Six**</u> <u>**Seven**</u> <u>**Six**</u> **Eight**

Altium:

Schematic and Layout IDE. I used it to design the electronic schematic for the Step Motor Driver. Also, this software was used to generate the board layout.

2.15

Knowledge gained & my personal contribution

Project was successfully completed. As the responsible person for the many parts of the project regarding electronics parts of the project, I was involved from scratch to the final report. I have also researched deeply about the best standards to add up in the project. I did many important roles, and the company received a good project in a short time.

Learnings from the project are as below

- How to develop an application using a Flash less MCU
- How to develop a good printer's module
- How to interface a Cortex-M3 MCU with a SDRAM

Work Episode 4

Element

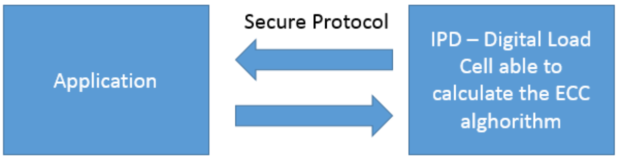
Overview of the project

Project Title: IPD – Digital Load Cell
Dates of Project: October 2015 to March 2016
Name of Organization: Toledo do Brasil
Location: Sao Paulo, Brazil
My Role: Electronic Engineer

Background
4.1

Toledo do Brasil is the leader company about solutions for hardware, software and services for weighting process in Latin America. The company started in 1901, founded in Ohio-USA. Furthermore, in 1932 they have started their operations In Brazil. After a few years in 1988, a Brazilian business man has bought the company, therefore the company started being 100% Brazilian. The company has more than 100 different types of solutions, and more than 30 engineers (electrical and mechanical) working in its behalf, and there is more than 1800 employers around Brazil.

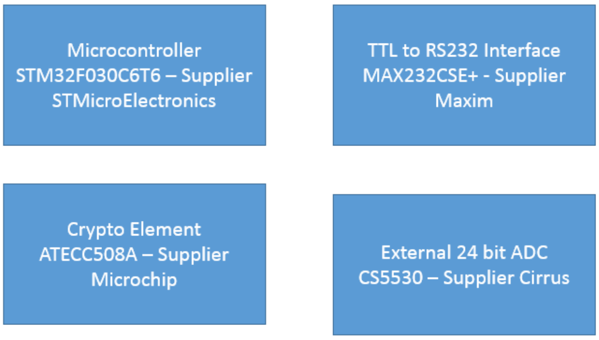
The National Institute of Metrology Standardization and Industrial Quality (INMETRO) that is a Brazilian federal autarchy that is in charge to certify metrological devices. The INMETRO had identified a rising number of frauds in the market of Gas Dispensers. Therefore, some cheaters had created sophisticated devices to injury customers including external electronic devices to intercept and change the signal, corrupting these devices. These issues with Gas Dispensers alarmed the INMETRO for other markets including weight scales. Hence, the INMETRO started to study some possible implementation to avoid cheaters to possible corrupt weigh scales, and they developed a new regulation that was named as RTM. On this new regulation, they weigh scales companies had to develop a digital load cell able to measure the electrical signal, calculate the weight and prices (if they were applicable that moment) and deliver it through a secure protocol using a complex cryptography technique that is the elliptic curve cryptography (ECC). Based on the specification above I developed the graph below to help the comprehension:



The ECC is based in public and private keys, where a message pass through a signature process using a private key, which it is exclusive, generating a hash number. In the real life, a customer could fill in in an INMETRO app or website the weight and prices displayed in the weight scale, and check if the hash value displayed in the app was the same the displayed in the scale, checking the authenticity of the message. Also, there were other features like a secure process to program the memory of the microcontroller and a special menu in the equipment where customer could check in field if the embedded software was trustable.

Objective of the Project
4.2

The main goal of the project was to implement the solutions provided from INMETRO in a new project. So, I had to study cryptography algorithms, discuss with microcontrollers suppliers about their products, define the necessary hardware for the equipment and implement the embedded software for the solution. Also, I had to present Toledo's solution for the INMETRO team to validate the concept. Due to the low resolution of the microcontroller ADC, after some meetings, I and my team decided to use an external 24-bits ADC in the project. This IC had been used in others company's projects as well. After a deep study about the problem, I defined the hardware topology as a main microcontroller that would be in charge to perform all calculus and algorithms. Although I tried to implement the ECC cryptography through software in the microcontroller, I realized that the performance was improperly slow, so, I decided to use an external IC to calculate the ECC algorithm and store the secure keys. Also, I added up a TTL to RS232 IC, to convert the TTL signal (logic level) to a RS232 signal. **One**



Roles & Responsibilities

4.3

- Discuss with INMETRO's team the concept of the project **Five**
- Lead the searching team for the best IC's for the project
- Work in the electronic schematic for the solution
- Develop the embedded software for the application
- Discuss with IT team and PC developers the interface to write the private key inside the Crypto IC
- Evaluate the solution, providing weekly reports to the higher management
- After the first prototype was ready I needed to demonstrate to my company's directors and colleagues

- Speech in the INMETRO's summit meeting about Toledo's solution

Complexities (using the complexity definitions) and challenges of the project

4.4
Problem 1
Implementation of the ECC Cryptography

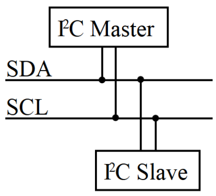
Two

Due the necessity of a cost-saving solution for the problem, I tried to implement the ECC cryptography in the microcontroller throughout software. To do that, I used the software framework easy-ecc, which is an open-source code without dynamic memory allocation for microcontroller. Although after some changes I could use this library in my code, I realized that the performance of the code running a low-cost Cortex-M0 was too slow, being not acceptable for the application. I believe this is how the hard mathematic is involved in the process. I also tried to implement other solutions without success. After a meeting at INMETRO, I realized that others weight scales suppliers had also tried to implement the solution in software without success and they also had security issues with the key storage process. After this meeting, I decided to use an external IC that could perform the calculus in a hardware level and being a trustable solution for the key storage process. After some research, I found the IC ATECC508A, which was primarily used as security IC for IoT applications. I spoke with the Microchip Engineer in Brazil and I got an Evaluation board to perform some tests in the solution. After outstanding results with the IC throughout the test process, being a fast and trustable solution for the problem, I informed my bosses about the results, and we decided to move forward with this solution instead a software solution.

Problem 2
Implementation of the communication between the microcontroller and the security IC

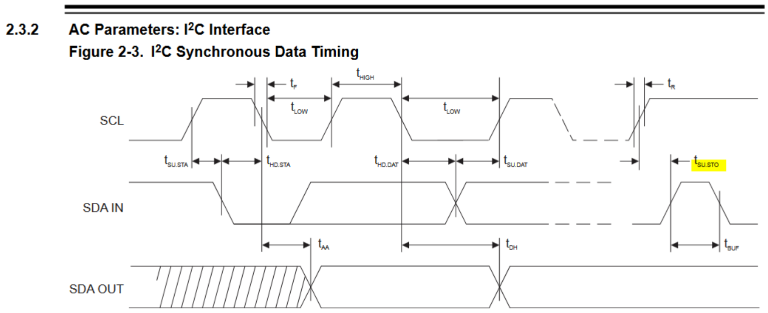
Four

After decided to use the crypto IC ATTEC508A and check the IC working in the evaluation board from the supplier, I got some samples to prototype the solution at Toledo's project. After the first prototype was ready, I tried to communicate the crypto IC with the chose microcontroller that is the STM32F030C6, however without 100% success. Furthermore, I checked that sometimes the IC communicated with the microcontroller, but sometimes don't, creating an issue with this communication. After speaking with the Microchip's Engineer in Brazil, I got a recommendation to analyze and debug the wire that connected the Crypto IC and the pins from the microcontroller. The I2C protocol was selected, so I had to analyze to two pins: clock (SCL) and data (SDA).



To perform the tests, I used the Logic Analyzer LOGIC8 from the company SALEAE, which works like an oscilloscope with a feature to analyze and interpret digital signals like UART, I2C, SPI and others.

After some tests in the laboratory, I figured out that the LOGIC8 could interpret the signal, so, the problem was on this side, in the low-level driver for the microcontroller. This was strange, because I had used the low-level driver generated by the software CubeMX that is the official framework from STMicroelectronics for their microcontrollers and I also had used this low-level driver with others IC's successfully. However, considering the ATTEC508A datasheet, I checked that generated Stop Time by the crypto IC in the protocol was slightly different from the expected in my driver. After a slight adjust in my code, the communication started working properly.



How does this project demonstrate application of your engineering knowledge?

4.5

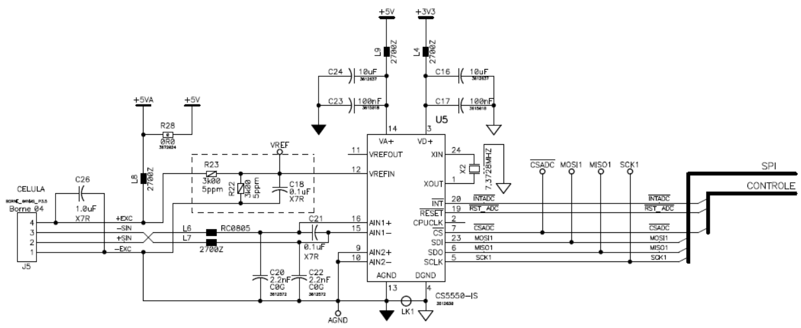
Engineering Calculations

Two

After the development of the project for the mechanical load cell from the company's mechanical engineers, I was informed that this load cell would have a linear comportment throughout their capability. Based on this information, I had to implement the calculus to get the electrical values from the Analog to Digital Converter circuit and implement a routine to convert this value in grams.

Example of a Load cell

Below is an implemented circuit to the ADC, where the Load Cell has 4 wires that were directed connected to the inputs from the ADC. The ADC, which is responsible to convert the electrical signal to a digital value, sent the measured electrical value through SPI protocol



After getting the value, I used a Second Order IIR Filter, using a cut frequency informed by the mechanical engineer team.

I had to implement the calculus to convert the measured signal in grams. Using a First Order Polynomial regression, I could implement a function to extrapolate two points in a curve in the form

$$f(x) = Ax + B$$

Based on Algebra classes, the method for a linear extrapolation with two points is

$$f(x) = y1 + \frac{x - x1}{x2 - x1}(y2 - y1)$$ Where x1, x2 are the measured values and y1, y2 the expected values. Based in the fact that the first value expected is zero kg, the equation became: $$f(x) = \frac{x - x1}{x2 - x1}(y2)$$ Where x is the value to be analyzed, x1 is the measured value without load, x2 is measured value with the reference load and y2 is the value of the reference load in kilograms. Based on this equation, I implemented a calibration process where the user has to use one trustable weight as reference for the process. There were two required steps. Firstly, the microcontroller had to measure the value without load. On this process, the system could get the x1 value, remembering that this value represents zero grams. Secondly, the microcontroller had to measure the value with a reference load. On this process, the system could get the x2 value and define the value of y2. As an example:	**Six**

Variables	x1 = Measured signal without load	x2 = Measured signal with reference load	y1 = Desired value without load	Y2 = Desired value with reference load
Value	1000	9000	0 g	15000 g

The equation that would represent this extrapolation would be:

$$f(x)g = \frac{x - 1000}{9000 - 1000}(15000\ g)$$

C standard implementation:

```
Span = (float)(ApliedWeightKg)/(float)(MeasuredValueWithLoad-MeasuredValueWithoutLoad);
NormalizedValueKg = (float)(Value-MeasuredValueWithoutLoad) * Span;
```

4.6
Software Used
I used
Keil uVision:

Embedded software IDE that was used to compile the embedded code in language C. Furthermore, the IDE was used to debug the source code in real time, helping to figure out bugs and issues in the code.

Seven

Altium:

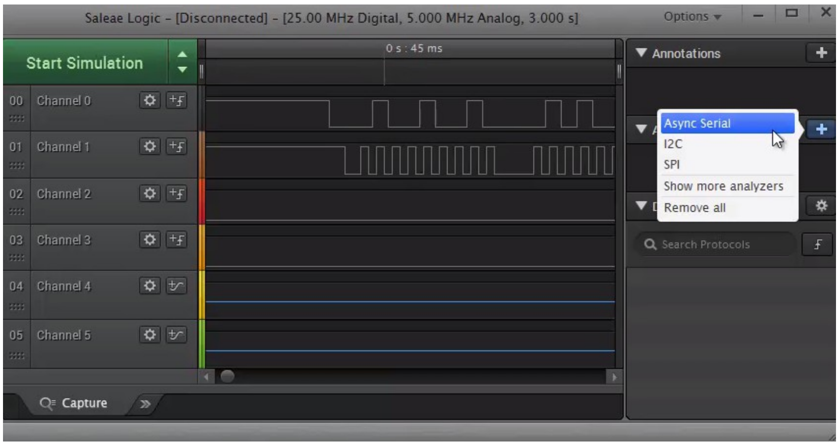
Schematic IDE. I used it to design the electronic schematic for some part of the project.

STM32CubeMX:

Framework from STMicroelectronics was used to generate low-level drivers, pin configurations and startup code including bootloaders

SALEAE Logic:

The SALEAE Logic works like a Digital Oscilloscope, being a good source to analyze and interpret the measured signals.



4.7
Engineering Testing
Many tests were made on the development process. It was a weekly session to evaluate the last week implementations.

4.8
Resources Usage
I got a good guidance from Internet, where I could find the datasheets, user manuals from the suppliers that I used in the development. I also spoke with Senior Engineers in my team to get information about embedded software and hardware.

Eight

4.9
My Creative innovation
In the development of the embedded software, I used the MISRA-C development guideline in all firmware. For the electronic schematic the company had some internal rules.

Three

4.10
Engineering Standards Followed

I followed

- MISRA-C
- UL Standards
- INMETRO (The National Institute of Metrology, Standardization and Industrial Quality) standards for weight scales
- RTM – Cryptography and Security Standard

4.11
Project management
There were weekly meetings with my boss and colleagues to discuss the company projects. Having developed some relevant areas of the project, I leaded some discussions and definitions about the project. I was also in charge to be the main contact with INMETRO's team, being responsible to lead the discussions as well as present Toledo's solutions

I have developed numerous reports to demonstrate the implemented solution to INMETRO. I also had to prepare reports for my manager and for the company directors.

Presentations

I had to present the solution in several meetings at INMETRO as well as in seminars about security. I also had to deliver speech in some internal fairs and conferences at Toledo, providing information for the team. **4.12** <u>Application of Engineering Knowledge</u> I have used both Analogic and Digital Electronics on the project, which helped me to increase my knowledge. I also have used algebra and math skills learned from University. **4.13** <u>Knowledge gained & my personal contribution</u> The project was successfully completed in the expected deadline without any big issues. I have lived the opportunity to lead one important project at Toledo, so, I gained experience to deal with tough tasks. I also elevated my technical skills because I had to learn about cryptography and how to solve difficult task using limited resources due the solution should be cost-effective. Furthermore, I had to speak in several events about the implemented solution, which helped me to improve my skills as well. As main contact for several parts of the design, I implemented important parts of the embedded code as well as the used hardware. I leaded several meetings and I also figured out the best hardware solutions throughout the development of the solution.	<u>**Eight**</u>

Knowledge Matrix

Knowledge Element	W/S Episode 1	W/S Episode 2	W/S Episode 3	W/S Episode 4
1. Application of knowledge from one or more of the natural sciences	1.2, 1.3	2.2, 2.3	3.2, 3.3	4.2, 4.3
2. Application of knowledge of mathematics	1.5	2.5	3.5	4.5
3. Application of knowledge of engineering fundamentals	1.4, 1.6, 1.7	2.4, 2.6, 2.7	3.4, 3.6, 3.12	4.4, 4.6, 4.12
4. Application of specialist engineering knowledge to solve complex problems	1.4	2.4	3.4	4.4
5. Application of knowledge of design methods to solve complex problems	1.4, 1.7	2.4	3.4	4.4
6. Application of knowledge of key elements of engineering practice	1.14, 1.15	2.14, 2.15	3.6, 3.12	4.6, 4.12
7. Role of Engineering in Society	1.12	2.12	3.11	4.11
8. Application of advanced knowledge in an area of your discipline	1.4, 1.6, 1.7	2.4, 2.6, 2.7	3.4, 3.6, 3.12	4.6, 4.12

SECTION FOUR – SUPPLEMENTARY EVDENCE

Academic Transcript(s)

Please attach a certified copy of your academic transcript(s) if you have not already supplied one to IPENZ

WORK HISTORY SUMMARY

List your employment history starting from your most recent employment and then chronologically back to the start of your first job.

Ref No	Name of Employing Organisation	Position Title	End mm/yy Start mm/yy	Key responsibilities, activities undertaken, major achievements and/or projects. These should relate to your practice area description.
1.	Doosan Heavy Industries & Construction (EPC Business Group), Seoul, South Korea	Assistant Manager,	Present Start at 05/11	• To carry out detailed technical review of the specifications for water treatment packages (like water treatment Plant, waste water treatment plant, sewage treatment Plant etc.) from the owners ITB (Invitation of Bids) document and finalize the owner's technical requirements for the treatment process. • To prepare the key technical specification for the Basic design of water treatment Plant ,waste water treatment plant, sewage treatment Plant •
2.				

Ref No	Name of Employing Organisation	Position Title	End mm/yy Start mm/yy	Key responsibilities, activities undertaken, major achievements and/or projects. These should relate to your practice area description.
3.				
4.				
5.				
6.				

CONTINUED PROFESSIONAL DEVELOPMENT (CPD) ACTIVITIES SUMMARY

DESCRIPTION OF ACTIVITY AND LEARNING. **Please record all relevant CPD activities (eg. short course, conference, reading, technical lectures, formal study towards qualification, research, discussion groups, workshops, symposia, voluntary service roles) that have extended your professional engineering knowledge and have assisted you to develop the knowledge profile of a professional engineer. Describe the learning outcomes and how these have contributed to your acquiring a Washington Accord level of knowledge..**					**Was Formal Assessment involved?** **What was the outcome?**
Date(s)	**Actual Hours**	**Form of Activity**	**Title of activity**	**What was the knowledge you acquired?** **How have you applied this knowledge in your engineering practice?**	
10/Feb/2006	6	Program	Education Program on Suez's Technologies water and waste water treatment ,by Director Technical, Suez, Gurgaon India	• Basic and design details of Pulsator (sludge Blanket clarifier) • Basic and design details of Aquazur V filters Benefits to my work • Developed an understanding of the advanced clarification and filtration technologies used by Suez for various water treatment facilities • Developed understanding of standing of Suez technology in the Indian water Market.	
29/Aug/2007	8	Program	Training program on "Ultrafiltration and MBR membrane systems" by "Mr. Satish Chilekar" New Delhi ,India	• Fundamentals of UF membrane ,MBR systems • Membrane Construction features • Membrane Performance • Membrane design parameters • Scaling and Fouling in membrane systems • Membrane cleaning processes Benefits to my work • Developed an in-depth understanding about the design and working of Membrane systems used in the water Treatment Industry. • Had good interactions with other water professionals in the same field from various companies at the training programme and expanded my network	No.

<table>
<tr><th colspan="5">Description of Activity and Learning.
Please record all relevant CPD activities (eg. short course, conference, reading, technical lectures, formal study towards qualification, research, discussion groups, workshops, symposia, voluntary service roles) that have extended your professional engineering knowledge and have assisted you to develop the knowledge profile of a professional engineer. Describe the learning outcomes and how these have contributed to your acquiring a Washington Accord</th><th rowspan="2">Was Formal Assessment involved?
What was the outcome?</th></tr>
<tr><th>Date(s)</th><th>Actual Hours</th><th>Form of Activity</th><th>Title of activity</th><th>What was the knowledge you acquired?
How have you applied this knowledge in your engineering practice?</th></tr>
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SECTION FIVE - PAYMENT

KNOWLEDGE ASSESSMENT (LEVEL 2) FEE PAYMENT

Assessment Fee (incl GST) in NZD	**NZ$1,351.25**	Please send a receipt ☐

CREDIT CARD DETAILS:

Visa ☐ Bankcard / Mastercard ☐ American Express ☐ Diners Card ☐

Credit Card Number

Name on card **Expiry Date** **CVV**

Cardholders Signature ________________________

WHERE TO SEND COMPLETED DOCUMENTS

Send the completed form and associated documents to the **IPENZ Membership Manager** at one of the addresses below:

Courier Address:	IPENZ National Office, Level Three 50 Customhouse Quay Wellington 6011 New Zealand	**Postal Address:**	IPENZ National Office PO Box 12-241 Wellington 6144 New Zealand

Appendix One

COMPLEXITY DEFINITIONS

COMPLEX ENGINEERING PROBLEMS

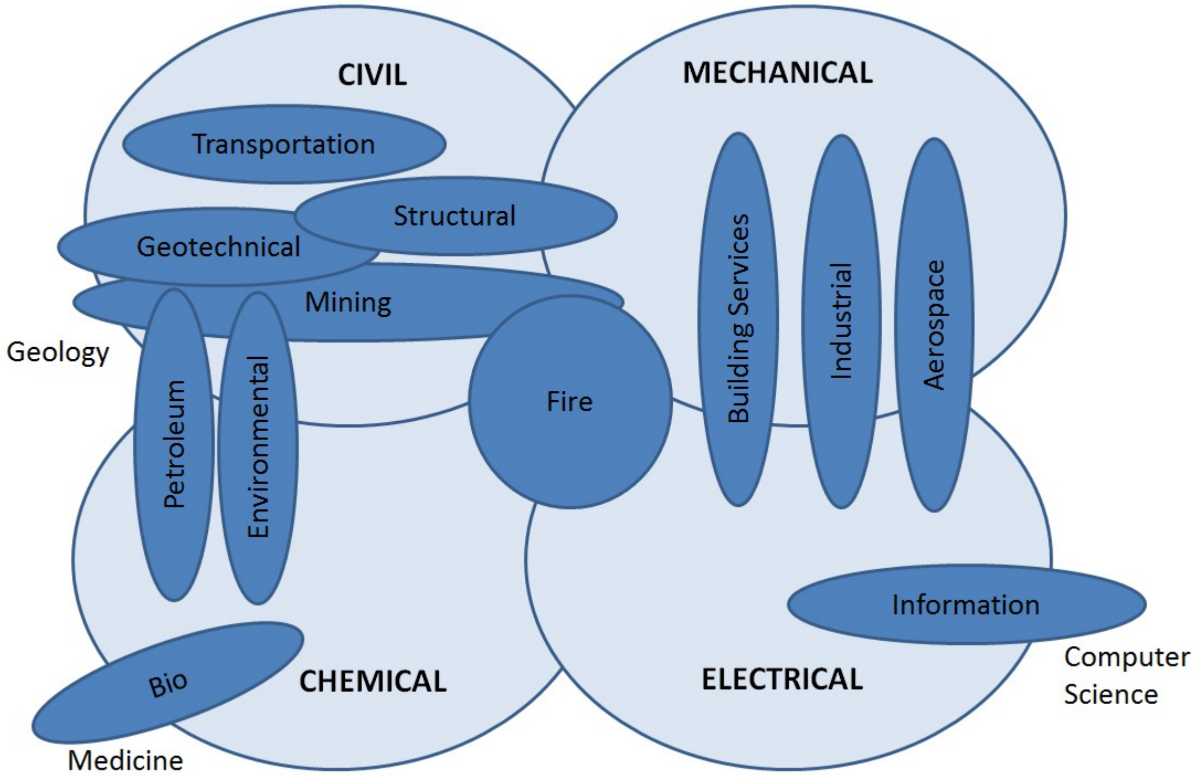
Complex engineering problems have some or all of the following characteristics:

- Involve wide-ranging or conflicting technical, engineering, and other issues;
- Have no obvious solution and require originality in analysis;
- Involve infrequently encountered issues;
- Are outside problems encompassed by standards and codes of practice for professional engineering;
- Involve diverse groups of stakeholders with widely varying needs;
- Have significant consequences in a range of contexts;
- Cannot be resolved without in-depth engineering knowledge

APPENDIX TWO

DISCIPLINES AND FIELDS OF ENGINEERING

Engineering practice fields are loosely defined terms and are used as an indication of the nature of engineering work carried out by engineers practising in an engineering field of practice. The following diagram is a graphical display of the relationships between the various fields and the four core disciplines. Some fields may extend into other fields of scientific endeavour.



AEROSPACE ENGINEERING

Aerospace engineering is the design, development, and production of aircraft (aeronautical engineering), spacecraft (astronautical engineering) and related systems. Aerospace engineers may specialise in aerodynamics, avionics, structures, control systems or propulsion systems. It may involve planning maintenance programmes, designing repairs and modifications and exercising strict safety and quality controls to ensure airworthy operations.

BIO ENGINEERING

Bioengineering draws heavily on the Chemical Engineering discipline and involves the engineered development of raw materials to produce higher value products, using biological systems (biological catalysts). The description also encompasses the general application of engineering to biological systems to develop new products or solve problems in existing production processes. As examples, bioengineers are found in medical research, genetic science, fermentation industries and industries treating biological wastes.

BUILDING SERVICES

Building Services engineering is the application of mechanical or electrical engineering principles, and an understanding of building structure, to enhance all aspects of the built environment from air conditioning and mechanical ventilation, electrical light and power, fire services, fire safety engineering, water and waste services, data and communications, security and access control, vertical transportation, acoustics and energy management.

CHEMICAL ENGINEERING

Chemical engineering is concerned with the ways in which raw materials are changed into useful and commercial end products such as food, petrol, plastics, paints, paper, ceramics, minerals and metals. Often these processes are carried out at large scale plants. Research of raw materials and their properties, design and development of equipment and the evaluation of operating processes are all part of chemical engineering.

CIVIL ENGINEERING

Civil engineering is a broad field of engineering concerned with the, design, construction, operation and maintenance of structures (buildings, bridges, dams, ports) and infrastructure assets (road, rail, water, sewerage). The Civil engineering discipline underpins several engineering fields such as Structural, Mining, Geotechnical and Transportation engineering, in which civil engineers often specialise. General Civil engineers are likely to be competent to undertake work that relates to one or more of these areas.

ELECTRICAL ENGINEERING

Electrical engineering is the field of engineering which deals with the practical application of electricity. It deals with the aspects of planning, design, operation and maintenance of electricity generation and distribution, and use of electricity as a source of energy within major buildings, industrial processing complexes, facilities and transport systems. It includes the associated networks and the equipment involved such as switchboards, cabling, overhead lines/catenaries, earthing, control and instrumentation systems.

Areas of specialisation within the wider electrical engineering discipline, such as electronics and telecommunications are usually concerned with using electricity to transmit information rather than energy. For this reason electronics and radiocommunications/telecommunications are captured under the field of Information Engineering.

ENGINEERING MANAGEMENT

The Engineering Management practice field is used by engineers who manage multi-disciplinary engineering activities that are so multi-disciplined that it is difficult to readily link their engineering practice with any other specific practice field. Project managers, asset managers and engineers working in policy development are likely to use the 'Engineering Management' field.

ENVIRONMENTAL ENGINEERING

Environmental engineering draws on the Civil and Chemical engineering disciplines to provide healthy water, air and land to enhance human habitation. Environmental engineers devise, implement and manage solutions to protect and restore the environment, within an overall framework of sustainable development. The role of the environmental engineer embraces all of the air, water and soil environments, and the interactions between them.

FIRE ENGINEERING

Fire engineering draws on knowledge from the range of engineering disciplines to minimise the risk from fire to health and safety and damage to property through careful design and construction. It requires an understanding of the behaviour of fires and smoke, the behaviour of people exposed to fires and the performance of burning materials and structures, as well as the impact of fire protection systems including detection, alarm and extinguishing systems.

GEOTECHNICAL ENGINEERING

Geotechnical engineering involves application of knowledge of earth materials in the design of structures, such as foundations, retaining walls, tunnels, dams and embankments. Geotechnical engineers assess the properties and performance of earth materials such as their stability and strength, and the impact of groundwater.

INDUSTRIAL ENGINEERING

Industrial engineering is the application of mechanical and electrical engineering principles to the design and operation of production equipment, production lines and production processes for the efficient production of industrial goods. Industrial engineers understand plant and procedural design, the management of materials and energy, and human factors associated with worker integration with systems. Industrial engineers increasingly draw on specialised knowledge of robotics, mechatronics, and artificial intelligence.

INFORMATION ENGINEERING

The field of Information engineering is based on the Electrical engineering discipline but also draws heavily from Computer Science. Three areas of further specialisation can be identified:

Software engineering - The development and operation of software-intensive systems that capture, store and process data.

Telecommunications engineering - The development and operation of systems that encode, transmit and decode data via cable systems (including fibre optics) and wireless systems (radiocommunications).

Electronics engineering - The design, development and testing of electronic circuits and networks that use the electrical and electromagnetic properties of electronic components integrated circuits and microprocessors to sense, measure and control processes and systems.

MECHANICAL ENGINEERING

Mechanical Engineering involves the design, manufacture and maintenance of mechanical systems. Mechanical engineers work across a range of industries and are involved with the design and manufacture of a range of machines or mechanical systems, typically applying principles of hydraulics (fluid control), pneumatics (air pressure control) or thermodynamics (heat energy transfer). Mechanical engineers may specialise in the Building Services or Industrial engineering field.

MINING ENGINEERING

Mining engineering involves extracting and processing minerals from the earth. This may involve investigations, design, construction and operation of mining, extraction and processing facilities.

PETROLEUM ENGINEERING

Petroleum engineering is a field of engineering relating to oil and gas exploration and production. Petroleum engineers typically combine knowledge of geology and earth sciences with specialised Chemical engineering skills, but may also draw on Mechanical engineering expertise to design extraction and production methods and equipment. Petroleum engineering activities are divided into two broad categories:

Upstream - locating oil and gas beneath the earth's surface and then developing methods to bring them out of the ground.

Downstream - the design and development of plant and infrastructure for the refinement and distribution of the mixture of oil, gas and water components that are extracted

STRUCTURAL ENGINEERING

Structural Engineering is a specialised field within the broader Civil engineering discipline that is concerned with the design and construction of structures. Structures might include buildings, bridges, in-ground structures, footings, frameworks and space frames, including those for motor vehicles, space vehicles, ships, aeroplanes and cranes, composed of any structural material including composites and novel materials.

TRANSPORTATION

Transportation engineering is a specialised field of practice in the civil engineering discipline relating to the movement of goods and people by road, water, rail and air.

A Transportation engineer might specialise in one or more of: pavement design, asset maintenance/management, construction/project management, traffic operations and control, transportation planning and systems analysis, freight transportation and logistics, road safety, railways or public transport systems.