CAREER EPISODE 1

a) Introduction

CE 1.1

The project that has been enlightened in the aforeside career episode is the optimization of the lap shear strength during bonding of those materials which are dissimilar. I performed the project tasks during the fulfillment of my masters of engineering degree from Deakin University.The activities on this work was initiated by month year and completed by month year.

b) Background

CE 1.2

The main aim is the optimization of the lap shear strength which is adhesively bonded through the selection of the relevant parameters that are fit. The objectives associated with this project were the accomplishment of the relevant tasks of the project through enhancement of lap shear strength through different parameters.

CE 1.3

The parameters that were considered in order to attain the requisite goal included the adhesive thickness parameter, adhesive type in between 0.5 mm to 1mm, the roughness range of surface was kept within 0.2 to 0.8 micro meter, the surface energy was enriched for adhering to the incorporated adhesive. The outcomes acquired from the project were then considered the deliverables on the basis of the parameters that were considered. This project has been implemented for the acquisition of the maximum strength value of the lap shear which can be further incorporated for the designing of the solar car for Deakin.

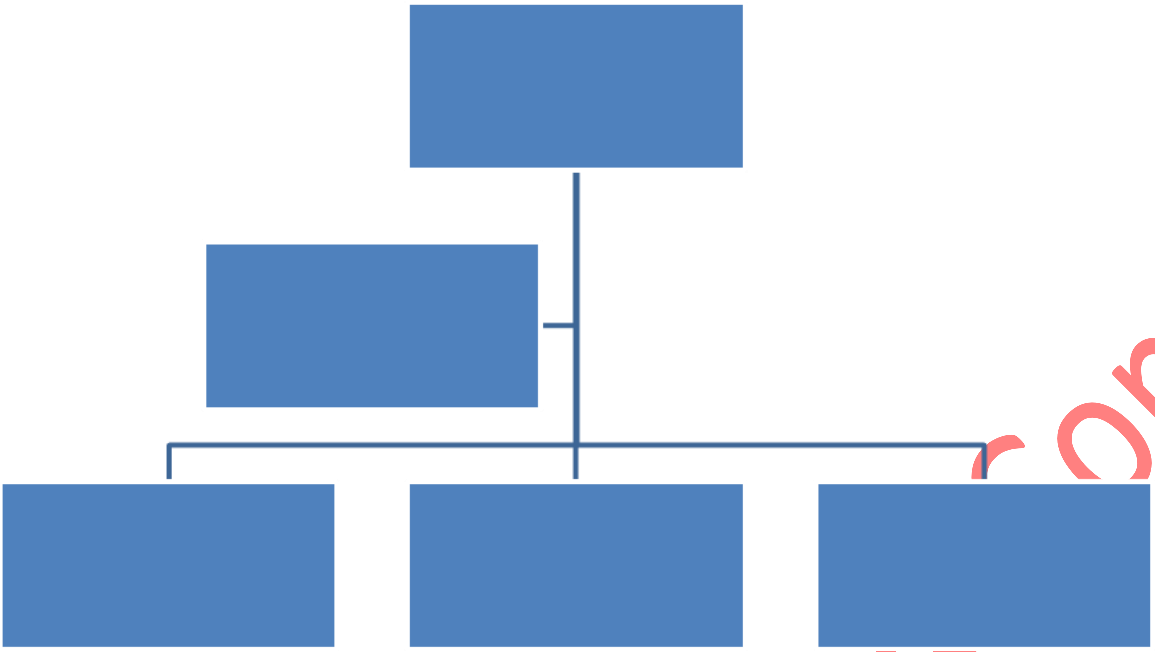
CE 1.4

The tasks that were conducted were the following

- Designed and manufactured the plastic material
- Designed the metal sample
- Prepared the surface by pre-treating the steel sample
- Pre-treated the surface of the plastic by sanding the relevant surface

CE 1.5

Project Hierarchy



c) Personal Engineering Activity

CE 1.6

The first step in the methodology comprised of the design and manufacturing of plastic material. I conducted design of plastic on the three dimensional CAD software which included Fusion 360 and SolidWorks. I specified the dimensions to 101 mm x 25 mm x 5 mm approximately which were also in accordance with ASTM d5868. I then exported the CAD file to the three dimensional printer which was Intamsys Funmat HT which employed Fused Deposition Modeling process to conduct manufacturing procedure. I varied the different parameters of the printing process which included thickness of the layer as well as infill percentage. This was followed by the designing and manufacturing process of the metal for which I specified the dimensions of 101 mm and 25 m for length and breadth. I exported the sample .dxf file to the waterjet cutter and made use of a steel sheet of approximately 5 mm thickness for the specific experiment. For the selection of required adhesive I employed araldite since this material could bond both plastic and the metals. The curing duration for the acquisition of the highest value of strength was total 24 hours.

CE 1.7

I then commenced with preparation of surface for which I firstly pre-treated the surface of the steel. For this I used a sandpaper of 60 grit composition for the requisite sanding of the bonding length of the specific surface. I carried on this process for about 1 minute and then employed acetone for the cleaning of the surface of the metal. I then pre-treated the surface of the plastic by sanding the relevant surface using sandpaper of 60 grit for a total duration of 1 minute. To commence with the joining of the adherends I used araldite to join them in a lap position. I managed to maintain the thickness of the bondline through various ways which included the deployment of packing shims for metallic washers which were composed of differing thickness values. I clamed the relevant samples together for the implementation of a constant value of pressure on the bond for a total of 24 hours in order to achieve the highest value of strength.

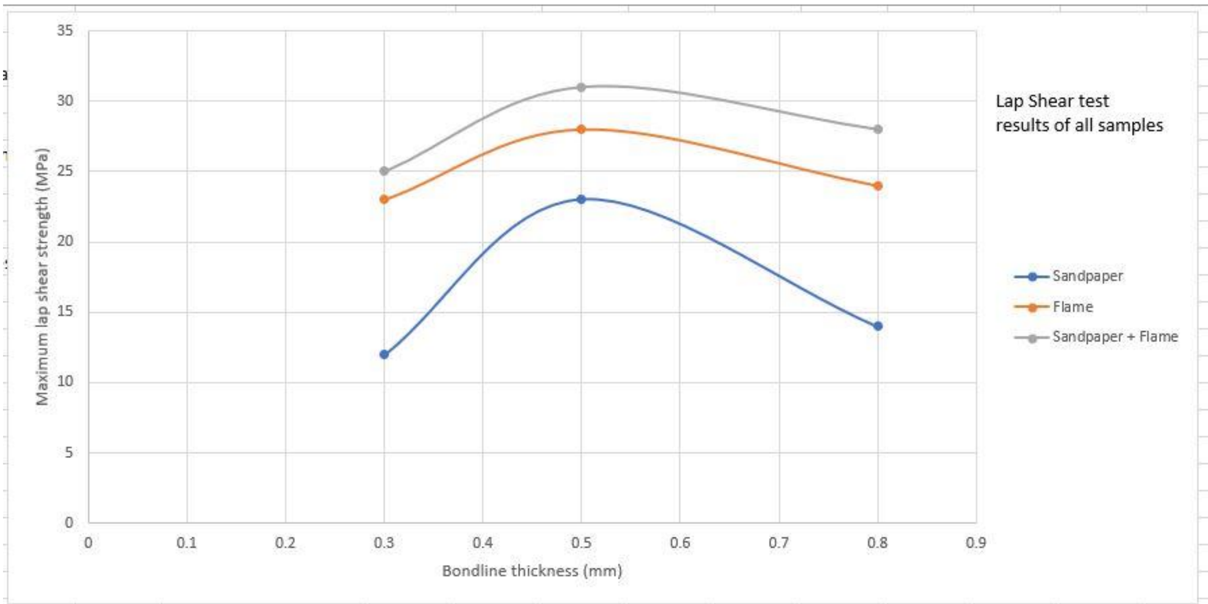
CE 1.8

After curing the requisite samples for a total of 24 hours I then calmed the samples into the specific fixtures of the Instron testing machine. During this testing procedure I ensured that the samples have been clamped and pull is conducted through bringing about an adjustment in the fixture knobs. After proceeding with the clamping of the samples I specified the parameters for testing in the testing machine and acquired the output that was desired. I managed to conduct the analysis of the sample that had been tested through the observation of the specific samples and conducting a comparative analysis of the data with the set of data that had been acquired from the literature review. Along with this I also conducted a risk assessment in which I listed the hazards, potential consequences of a specific technique or procedure that was implemented followed by listing the relevant control measures as well as risk rating. The procedures that I listed were three dimensional printing, metal cutting, preparation of the surface, testing of the roughness of the surface, bonding of the materials as well as testing of the tensile strength.

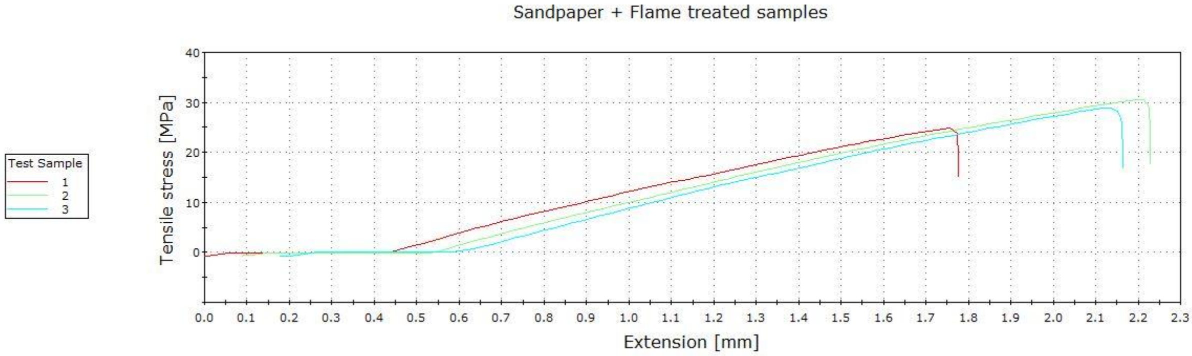
CE 1.9

After carrying out the relevant testing procedures and comparative analysis I proceeded with the acquisition of the results. I tabulated the maximum level of shear strength that was acquired from the different bondlines as well as treatments of the surface for a total of nine samples.

I plotted the results of the ultimate shear strength parameter that had been incorporated after the conduction of proper testing procedures on all the samples. I also managed to acquire the proof of the results that had been acquired from the BlueHill software of the Instron testing machine. I specified the tensile stress parameter on the y axis. This parameter was actually the lap shear stress since the tension methodology had been implemented on the Instron testing machine.



Graph 1

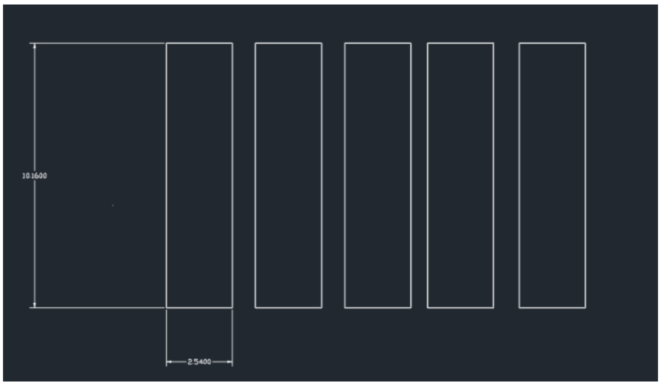


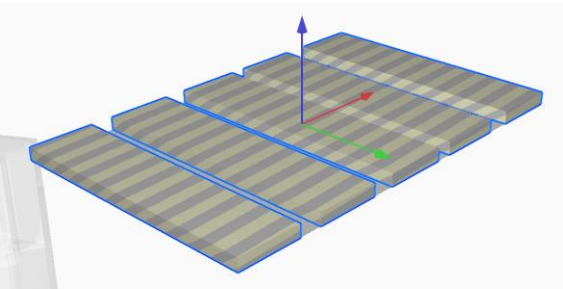
CE 1.10

I concluded from the acquired testing samples that the bondline of approximately 0.5 mm was effective in relevance with the strength for treatments for pre-surface which was also followed by 0.8 mm as well as 0.3 mm bondlines respectively. I inferred that the bondline value of 0.3 mm was thin for the development of requisite adhesive characters in the bond and that the shear strength parameter decreased in compliance with the increase in the bondline value from 0.5 mm to 0.8 mm respectively. I concluded that the main reason for the decrease in shear strength was due to the increase in the overall elastic features due to the specific thickness of the bondline for the carrying of specific load in comparison with the 0.5 mm thickness. I also inferred that the deformation of the plastic material is initiated by the thin bondline of value of 0.5 mm in comparison with the thick value of bondline of 0.8 mm. I also observed that the flame treatment in compliance with the abrasion of the sandpaper comprised of a high value of shear strength due to the overall increase in the energy of the surface supported by the roughness of the surface. I found the results that were obtained from the flame treatment to be optimum in comparison with the results that were acquired from the sandpaper abrasion.

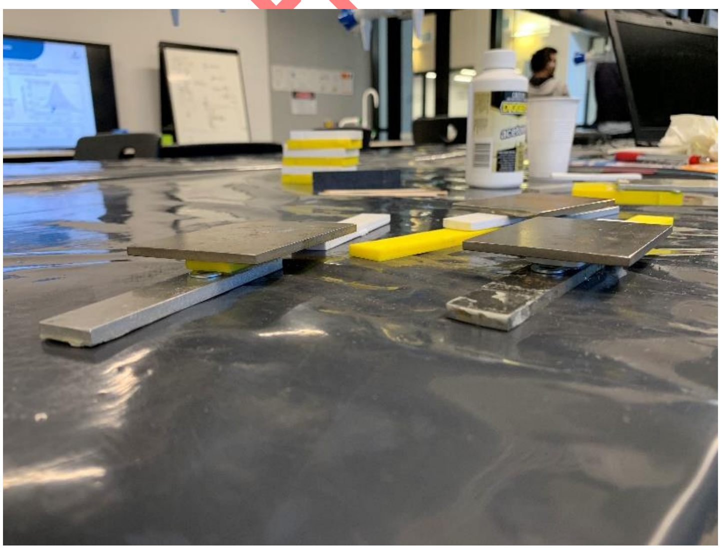
CE 1.11

I proceeded with implementation of the experimental procedure for the tensile test. I designed the PLA in the 3D CAD software fusion 360 and specified the relevant dimensions. I 3D printed the samples by making use of Intamsys Funmat HT printer by keeping the initial parameters as approximately 0.125 mm thickness with an infill percentage of 50%. I employed the AutoCad software in order to design the steel samples which consisted of length of 101 mm and breadth of 25 mm. I proceeded with the cutting of the steel samples through waterjet cutting using a steel sheet of thickness 5 mm.





I physically treated the surface of the sample of steel material by using a sandpaper of 60 grit for a duration of 1 minute in compliance with the length of 25.4 mm bond length. I made use of acetone to clean the surface and then used the adhesive onto the steel surface.



After curing of the joint I loaded the sample into the testing machine. I fixed both the sides of the samples into fixtures and ensured that the samples have been loaded in an effective manner and in a horizontal configuration to the pull direction by varying the knobs specified for fixture.

CE 1.12

I managed to implement all the designing and calculation tasks within the specified duration of the project and in compliance with the engineering specifications and standards. I collaborated with the project supervisor and formulated the methodology of the project along with the materials and dimensions that were required. I discussed the progress of the project in the project discussions and meetings and ensured that all the safety standards and specifications are complied with and implemented in the implemented processes of the project. I incorporated all the suggested modifications in a timely manner and worked on them accordingly.

d) Summary

CE 1.13

The career episode includes details regarding the optimization of the lap shear strength during bonding of those materials which are dissimilar. This project provided me an effective platform to utilize my engineering skills and knowledge in an effective way.

CAREER EPISODE 2

a) Introduction:

CE 2.1

This career episode would comprehensively elucidate the Bachelor's Degree project. The project is entitled as 'Optimization of the Friction Stir Welding Parameters of Copper (C-1000) and Aluminum (AA-6082) using grey relational analysis. I completed this project to fulfill my B.Tech degree requirement. I studied in GITAM Institute of Technology. It was started in Month/Year and completed in Month/Year. It was based in City/country.

b) Background:

CE 2.2

This project will presented the parameters optimization by considering the numerous performance characteristics of a Friction Stir Welding and this would be done by conducting grey relational analysis (GRA). For evaluating a machining effects, two types of the performance characteristics were chosen for this project which comprised of Ultimate Tensile Strength and Hardness. The project was carried out in two different stages such as, in the first stage, we studied the parameters which are correlated closely with the chosen performance characteristics i.e. Total Feed Rate, Axial Force, and Total Rotation Speed. Then, experiments were conducted first which based on the accurate LA 09. After this, the experimental results obtained from performance indicators are introduced for calculating the grades and coefficient in accordance with GRA. Further, in the second stage of the project, parameters of optimized process simultaneously leading to the higher Hardness and Ultimate Tensile Strength will be verified by conducting confirmation experiment. In the project first stage, the experimental procedure was carried out by selecting appropriate materials, specimen size, tool, FSW components, etc. and then welding was performed. Moreover, microstructural analysis was also conducted for specimen.

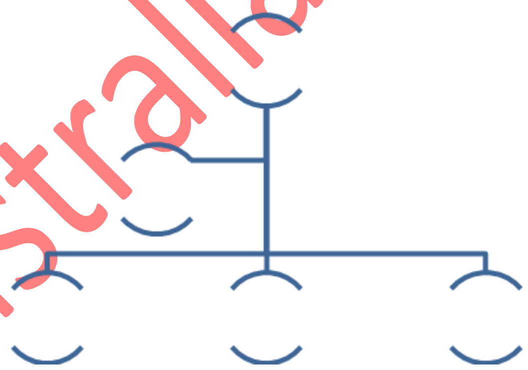
CE 2.3

The following duties were assigned to me:

- Performed literature review and studied numerous books to gather maximum knowledge before starting the project.
- Selected the adequate materials such as aluminum alloy 6082 and copper C-11000 material.
- Implemented the friction stir welding process and developed the components of the FSW equipment.
- Carried out the microstructural analysis for relevant specimens and samples.
- Performed the project tasks by obeying the international standards.
- Communicated with the supervisor daily and developed the final report.

CE 2.4

Project Hierarchy



c) Personal Engineering Activities:

CE 2.5

First of all, I attended the preliminary meeting along with other project teammates. The supervisor thoroughly explained the optimum project requirements and objectives. He divided the project into two stages so that every task can be performed accurately, within the decided time, and as per Mechanical International Standards. The supervisor also referred us to some books and research papers that would be fruitful in terms of gaining additional and maximum knowledge about the project. After the meeting, I designed the project schedule which showed tasks that had been performed in two stages, and time was allocated to every task. After getting approval from the supervisor and being a project lead, I allocated the tasks and responsibilities of the project first stage to all the members.

CE 2.6

I proceeded with the implementation of the experimental work of the project in which the first step comprised of the adequate selection of the material. On the basis of the requisites of the project as well as composition of various viable materials I selected the aluminum alloy 6082 since it consisted of medium strength along with high level of resistance against corrosion. Along with this I also selected the copper C-11000 material which is developed through the direct level conversion of the refined state cathodes that are selected. I selected this particular material due to its inherent advantages of possessing high degree of electrical and thermal conductivity as well as optimum resistance against corrosion. I then proceeded with the specification of the relevant sizes of the specimen. I took the values as 100 millimeters x 80 millimeters x 6 millimeters for both the plates of copper as well as aluminum material. The next phase was the most important part of the process development which was the tool geometry. Through the tool geometry I managed to assess the material flow as well as the transverse rate through which the FSW could be implemented. The tool that I implemented was the cylindrical tool that was comprised of HSS. I specified both the length and diameter values of the pin of the tool which were approximately 5 mm as well as 5.8 mm along with the diameter value of 16 mm for the shoulder.

CE 2.7

The next step in the project comprised of the implementation of the friction stir welding process. For this I made use of a viable force in the downward direction and commenced with inserting the specific component that had been considered to be viable for joining, in between the plates that had been fixed in a rigid manner. I developed the heat in compliance with the melting point temperature of the specific parts that had been considered for joining for the point when the probe became in direct contact with the relevant edges of the surface. Due to the heat that was produced the material got softened around the area of the probe. This softening of the material proved to be helpful as this way the probe could easily be inserted up to a certain required level of depth without making any contact with the backing plate so that no damage is incurred. I also kept moving the tool along with the specific length of the joining that had been required. I made sure that the probe that is inserted after softening the material is not short and that the phenomenon of the development of the reduction in penetration at the area of the weld root could be avoided. By making use of the friction stir welding machine I managed to butt weld the requisite specimens that were needed to be joined in a longitudinal configuration. I rotated the relevant welding tool at a very high value of speed and then fixed the welding tool into the specific joint line that had been provided between the specific plates for commencement of the butt welding operation. I tabulated the relevant process parameters in which I specified the rotation speed of the tool in revolutions per minute, feed rate of the tool as well as axial force in kN for every sample.

Sample No.	Tool rotation speed (rpm)	Tool feed rate (mm/min)	Axial Force (KN)
1	600	50	5
2	600	150	6
3	600	300	7
4	900	50	6
5	900	150	7
6	900	300	5
7	1200	50	7
8	1200	150	5
9	1200	300	6

CE 2.8

In the next step I developed the components of the FSW equipment. These components involved the work bench for clamping of the metal plates that were needed to be welded through incorporation of fixtures along with backing plates. I also incorporated spindle in order to accurately hold the tool that had been selected in its specific position followed by the rotation of the relevant tool at various levels of speed in revolutions per minute. For the specification and provision of relevant input parameters I connected the specific input devices which included a keyboard and mouse whereas for accurate display of the specific data at the output I specified a monitor as output device. After this I proceeded with the implementation of the welding procedure. I ensured to commence with the procedure in a sequential manner. I set up the tool that was required in the spindle and tightened it to the accurate level. On the work bench I set up the relevant welding plates that were needed to be welded by incorporation of the backing plates. I proceeded with moving the position of the workbench in order to ensure that the joint of the work pieces was in compliance and complete alignment with the pin of the tool. On the specific parameter screen at the input side I provided the relevant parameters that had been specified for processing in accordance with the requirement. I then started and initiated the relevant welding procedure in the automatic configuration in order to acquire the constant level of feed rate.

CE 2.9

The next process that followed was the implementation of the microstructural analysis for relevant specimens and samples. For this analysis I sectioned the welds accordingly in a longitudinal configuration as well as cross sectional configuration respectively. I acquired the samples that were to be incorporated in the microstructural analysis. I managed to prepare these sectioned configuration of samples by employing the standard procedures regarding metallography. Through the application of modified configuration of Keller's reagent, I etched the sample which was the aluminum side 6061. Whereas for the side consisting of copper material I etched with a specific solution that comprised of 100 ml quantity of water, 2 grams of potassium dichromate, approximately 5 ml of sulphuric acid followed by almost 4 ml of saturated quantity of sodium chloride. In order to accurately verify the regions that had been welded I made use of optical microscope so that the effects of FSW onto the microstructure of the alloys could be assessed and studied. I employed an Olympus BHM optical microscope that was incorporated with various magnification lenses.

CE 2.10

I commenced with the testing and measuring of the tensile strength parameter. Before the implementation of the test I placed gage marks onto the specimen and then commenced with the measurement of the initial length of the gage as well as the length of the cross section. During the duration of the test I managed to evaluate the maximum level of load and continued the implementation of the test until the fracture point was acquired. After the implementation of the relevant testing I measured the final length of the gage along with the diameter value. I made sure that the diameter value is evaluated from the neck area. I then proceeded with the implementation of the Vickers hardness test. This test methodology involved the indentation of the relevant testing material through a diamond indenter. I applied the full level of load for a duration of total 10 to 15 seconds. After this I measured the total two diagonals of the indentation that was left in the material surface after the requisite load removal which was measured through observation from a microscope followed by calculation of the average value. I also estimated the overall area of the sloping surfaces of the indentation. I estimated the quotient of Vickers hardness through dividing the load by the total area in square mm. After the estimation of the mean value of diagonal related to the indentation, I managed to estimate the Vickers hardness.

$$HV = \frac{2F\sin\frac{136^\circ}{2}}{d^2} \qquad HV = 1.854\frac{F}{d^2} \text{ approximately}$$

CE 2.11

I studied the optical micrographs that I acquired from the materials selected which were copper C11000 ETP as well as aluminum alloy AA6082. I observed that the microstructure of the alloy of aluminum comprised of grains in elongated configuration that were a result of the condition of hot rolling whereas the grains of the copper sheet on the other hand were a product of high temperature values of hot rolling. I also obtained the appearances of the surface of the samples of friction stir welding at differing parameters which included rotation speed as well as transverse speed of the tool. I observed that there were no visual defects in the welds that were acquired at the speeds of 300 as well as

900 revolutions per minute. But on the other hand, the welds that had been developed at the speed of 1200 revolutions per minute at 300 mm/min consisted of the plasticized configuration of metal that was coming out of the weld. I inferred that this was due to the high rotation of the tool as well as the feed rate that had been implemented which made the interface of the weld to be inefficient. I developed the micrographs of the welds of the interfacial region that were produced at the speed of approximately 900 revolutions per minute of the tool spindle along with a feed rate of 150 mm/min. I inferred that the joint interface of the weld structure consisted of the structure of an onion ring which were indications of an adequate flow of the material as well as appropriate mixing. I concluded from this that the specific region had been subjected to recrystallization during the friction stir welding procedure.

CE 2.12

For the implementation of the Taguchi methodology I assessed the overall performance as well as the optimization of quality. Through this I managed to reduce the number of experiments to 9. I also evaluated the degree of freedom so that the accurate orthogonal array could then be selected easily. I inferred that the degree of freedom for the array was needed to be higher or equivalent to the parameters of the process. On the basis of this I selected the L9 orthogonal array which consisted of a degree of freedom that was equivalent to 8. Then, I continued with an implementation of the Grey Relation analysis. This firstly involved the identification of the relevant performance characteristics as well as the parameters of the process that were needed to be estimated. I determined the total number of levels that were requisite for the parameters of the process. I then selected the specific OA and proceeded with the conduction of relevant experimentation in compliance with the specified OA. I brought about a normalization in the experimental results obtained from the parameters of the rotational speed of tool, feed rate of the tool as well as the axial force.

Experimental No.	Tool Rotation Speed(N) in (RPM)	Feed Rate (S) in mm/min	Axial Force (F) In KN	Hardness (Joules)	Tensile Strength (K) N/mm^2
1	600	50	5	100.6	73
2	600	150	6	98.3	113.333
3	600	300	7	104.7	63.333
4	900	50	6	60.4	108.333
5	900	150	7	130.4	120
6	900	300	5	53.5	70
7	1200	50	7	59.5	71.667
8	1200	150	5	62.4	116.667
9	1200	300	6	54.7	60

CE 2.13

I followedASTM-E8M-11 standards while testing and measuring tensile strength parameters. Furthermore, I obeyed international mechanical engineering standards to conduct the project for all tasks in order to get the best optimum experimental results. Moreover, in this project, the FSW process is carried out instead of conventional welding because it avoided numerous safety and environmental issues that are associated with the traditional welding methods. Also, I kept in mind the safety guidelines and standards and avoided all the procedures which pose serious threats to the safety of team members.

CE 2.14

Before starting the project, I conducted a literature review with the purpose to collect maximum knowledge and to perform a gap analysis. I studied the background history of friction stir welding, advantages and disadvantages of the FSW process, working of FSW, and then finally, I reviewed multiple research papers such as use of 6082 aluminum alloy and 11000 copper alloy for analyzing microstructural and mechanical properties through FSP (Friction Stir Processing). I developed the table which showed the findings of all researchers and flaws in their research. Then, I did a gap analysis to reveal the unexplored topic or findings of the previous researchers.

d) Summary:

CE 2.15

The project first phase was completed in the decided period and I made the document for representing experimental procedures and microstructural analysis results and after getting approval from my supervisor, I proceeded towards the second phase of the project. In this first phase, I daily communicated with the team members and we worked closely to avoid errors in the results and conflicts.

CAREER EPISODE 3

a) Introduction:

CE 3.1

The aforesaid career episode develops to illustrate eloquently the details of my assignment project. The project is entitled as Displacement and Vibration Analysis on a Wire under Various Conditions. The time assigned to complete the project was Month/Year. I started working on the project in Month/Year and finished it Month/Year.

b) Background:

CE 3.2

From the past few years, multiple different techniques and strategies have been developing to study the structures as well as the sheer effects of several parameters on these structures. By using the developed methods and techniques, we can measure precisely all those factors which are affecting significantly the structures. Thus, this project was developed to analyze accurately the vibrational frequency and displacement of a wire piece. The project's main aim was to determine the piece wire's Young's Modulus by fixing its one end as a cantilever. Then, the wire will allow bending in a random shape and its one side was clamped again as a cantilever beam. This experimental set-up was created to observe the defection produced in the piece of wire and also frequency was examined at the first model of vibration with free and with applying some load at the wire-free end.

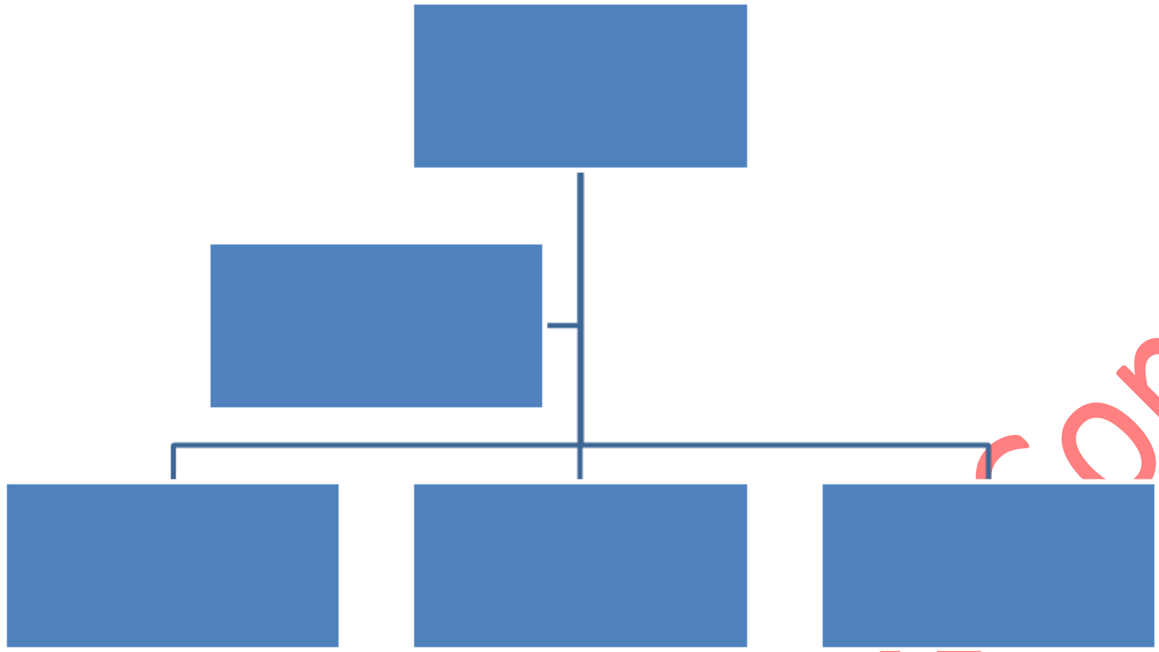
CE 3.3

The below-mentioned tasks were assigned to me:

- Researched developing more understanding of vibrational and displacement analysis.
- Examined the vibration and displacement in the wire by applying three methods such as Analytical, Experimental, and by using Abaqus software.
- Determined Young's modulus of the given wire by performing calculations and making few assumptions.
- Developed the model of bent wire in the Abaqua software and determined the bent wire's displacement and vibrational frequency.
- I explained the results to the supervisor and made the final report.
- Ensured all the project activities were conducted according to the Internal Standards.

CE 3.4

Project hierarchy:



c) Personal Engineering Activities:

CE 3.5

The first essential task was to plan every step of this project and to collect maximum knowledge from useful resources. To accomplish the first task, I researched previous research papers which explain thoroughly the techniques for measuring vibrational frequencies and displacement. Also, the project supervisor helped me in gaining maximum information and data on my project by suggestinga few books and the latest articles. Next, afteridentifying all the activities and the requirement, I broke down the project activities into different tasks to schedule my project. Hereafter, I explained the project schedule to my supervisor and after getting his approval, I started the experimental work.

CE 3.6

To carry out the experimental task, I choose a 225mm wire with a diameter of 1.25 millimeters. Now, to determine the modulus of rigidity, I clamped the one end of a given wire (before bending the wire) and then this was bent in a random shape in such a way that it makes seven bents. From here, my task was to calculate the displacement and frequency at first mode of vibration by using three methods such as analytical method, experimental method, and lastly by using Abaqus software.

Before applying the experimental method, I had to find out the wire's Young's modulus. For this, I clamped one end of the wire and then applied loadon its other end. To calculate the deflection, I applied the following formula:

$\delta l = WL^3/3El.$

Where L = wire length, W is the load, δl is the deflection, I = moment of inertia, and E is the Young' modulus.

At the free end of wire, I applied load by placing coins of 1$, 20 cents, and then 50 cents with a weight of 9g, 11.3g, and 15.55g respectively. By using wire length as $2.5x10^{-1}$, I found out the deflection generated due to every weight. Now, by using the above-mentioned equation, I determined the young's modulus for each weight, for instance, I determined the moment of inertia ($\pi d^4/64$) = 0.12 mm^4, now, for coin 1: to get the entire weight of the coin, I multiplied 1 dollar coin with its weight i.e. = $9x10^{-3}$ x 9.81. Then, I assumed δ_l to be 11mm, so, E1 was obtained as 2067 Gpa. Similarly, for coin 2: I again multiplied the 20 cents coin with its weight and I supposed δ_2 to be 14.5 mm, so, E_2 = 196.3 Gpa. After calculating E_3 of 212 Gpa, I took the average of all the obtained results. Therefore, the wire's average young's modulus was obtained to be $204.6x10^3$ Mpa. While calculating Young's modulus, I made the few assumptions i.e. I assumed load to be point load at the wire's free end, wire's material must be isotropic and homogenous, curvature's radius must be large than that of cross-section dimension, a wire must be straight enough before the application of load, and wire have a constant cross-section.

CE 3.7

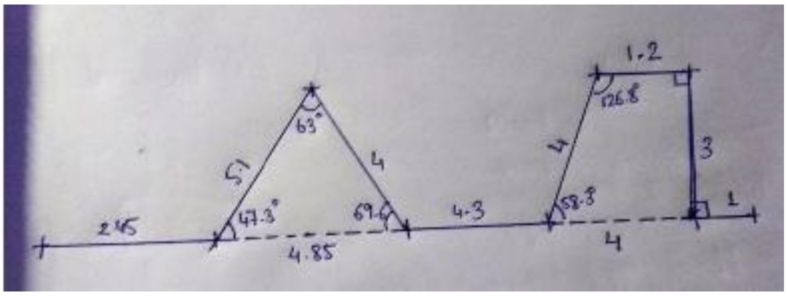
My next task was to perform the experimental method. For this, I first measured the overall axial length of the bent wire which was found out as 165mm. Now, I clamped one end of the wire as a cantilever beam and I carried out further experiments to determine both the displacement and frequency without and with the load. First of all, I calculated the bent wire's displacement by applying load on the free end by using a coin of 1 Dollar with weight 9g which is also equal to 0.008N. So, by using a ruler, the displacement was obtained as 11mm. Next, I determined the frequency without applying any load. I measured the natural frequency by clamping bent wire as a cantilever beam, while, its other end was free. Now, on the free end, I applied an impulse through fingers and then recorded the slow-motion movement of the wire with a camera. I kept the frame rate at 120 frames/sec. I observed the total number of oscillations using frames and time. I used the following formula to calculate the frequency of the vibration.

frequency = 1/total time taken in completing one oscillation

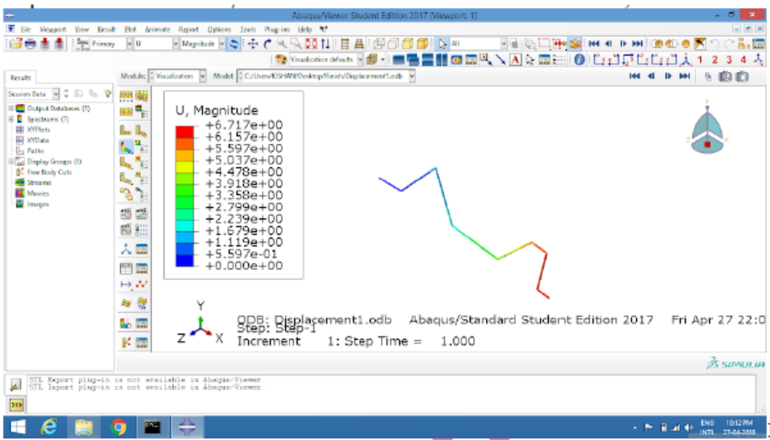
Through the above-mentioned equation, I found out the wire's frequency as 17.6Hz. Similarly, to determine the frequency with load the load was applied by placing 1 dollar coin. So, because of coin weight, the oscillations were produced and impulse was applied with the finger. In this case, the frequency was obtained as 5.2Hz.

CE 3.8

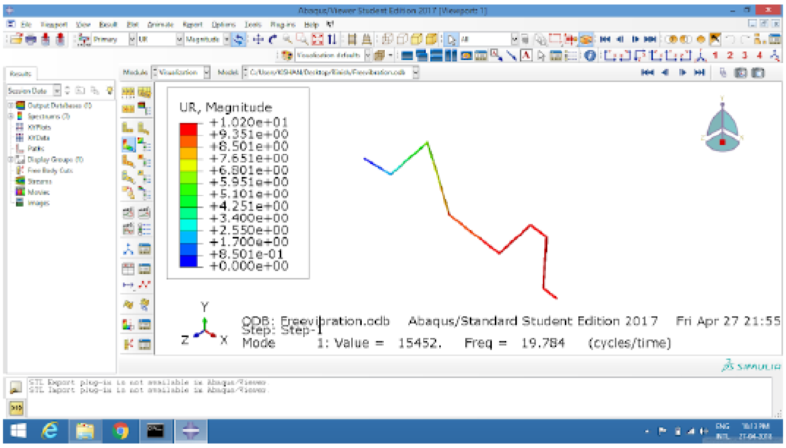
Next, I performed the calculations by using Abaqus software. Before this, I traced the wire shape on the paper and I extended the curved edges to make them sharp. Now, I determined the coordinates of each node by using geometric methods, instruments, and formula. A total of seven bents were produced on the wire in such a way that there were eight nodes present and then I sketched the same pattern on the Abaqua software by using nodal coordinates.



The bent wire was modeled in the software to determine the bent wire's displacement. After modeling, I assigned properties to the beam according to the wore specifications. I considered a cubic formulation beam such as b33 and to perform analysis, I selected static general analysis. Then, I applied boundary conditions and fixed the beam's one end, while on its other end, I applied a point load of 0.088N through 1$ coin. Next, I assigned the value of young's modulus as 204.6 Mpa and considered a cross-section of the beam as a circle with 1.25mm diameter and I assumed poison's ratio as 0.3. Finally, after completing the above steps, I submitted the final model for analysis. The resulted displacement displayed by the Abaqus software was 6.7mm.



In my next step, I did vibration analysis both without and with the load. I used the same above-mentioned steps, however, I selected analytical type for vibrational analysis without load as 'frequency' in linear perturbation menu. I set the eigenvalues by using Lancoz solver which was set to 6 eigenvalues. Now, for constraining both rotational and translational movement, I fixed the beam from one point, while, considered its other end free. To perform this analysis, I determined the density by dividing mass with volume. I input the wire's volume and mass values in the density formula. It was computed as 7.4×10^3 Kg/m^3. Lastly, I submitted the model for frequency analysis and it was obtained as 19.7 Hz.



Then, in the end, I performed a vibrational analysis with the load by using the same process of frequency determination without load. However, at the free end, I applied a load of 9grams. I also applied the same boundary conditions for the model and frequency was obtained as 5.18 Hz.

CE 3.9

Now, I used an analytical method to determine the displacement and frequency. First, I did displacement calculations. I determined the displacement of the cantilever beam from the equation: u = $WL^3/3El$. This equation is limited to straight elements. As thee were 8 nodes and 7 bends in the wire, therefore, I calculated the displacement at every node and then took the average. I applied the following displacement equation at every node:

$$u_n = \frac{Wx_n^2}{6EI}(3l - x_n)$$

Where W is the load at the wire-free end, u_n is the displacement at the nth node, Xn is the node distance from the fixed end, E is the young's modulus, and L is the length. I geometrically calculated length 'l' and distance 'x' from the wire sketch. After summing up the displacements at each node the displacement at the unclamped end was determined as 11.6mm.

Afterward, I calculated the vibration without load. I used the following equation to calculate the cantilever beam's frequency:

$$\omega = (1.875)^2 = \sqrt{\frac{El}{mL^4}}$$

Where M is the beam mass and L is the wire length. I calculated by frequency from the equation:

$$F = \frac{\omega}{2\pi}$$

Now, by putting all the values, I obtained vibration as 12.55 Hz. Similarly, I also determined the vibration with the load.

CE 3.10

After obtaining the results from all the three methods i.e. experimental, software, and analytical, I compared them and found out that from all the methods the displacement values were 11mm, 6.7 mm, and 11.6 mm respectively. I observed that there was a difference in displacement in every method. Moreover, the frequency from these methods without load was 17.6, 19.7, and 12.55 Hz and with load was 5.2, 5.1, and 6.49 Hz. I discussed all the results with my supervisor in the meeting and explained each step of all three methods. After getting his approval, I made the assignment report using MS-Word software. I mentioned the step-by-step procedure of all three methods and also attached the software results.

d) Summary:

CE 3.11

I performed the analysis by using three different methods to get accurate results and then I also compared all the results. From the comparisons of the results, I have seen variations in the results because of the assumptions made during the experiments and the calculations errors. But, I also observed that Abaqus software helped me to determine the exact results and also save time and complications.

PROFESSIONAL ENGINEER

Summary Statement

Competency Element	A brief summary of how you have applied the element	Paragraph in the career episode(s) where the element is addressed
PE1 KNOWLEDGE AND SKILL BASE		

PE1.1 Comprehensive, theory-based understanding of the underpinning natural and physical sciences and the engineering fundamentals applicable to the engineering discipline	I implemented the knowledge and fundamentals of Engineering to achieve the goals of the projects	CE 1.6, CE 1.7, CE 1.8, CE 1.9, CE 1.10, CE 1.11, CE 2.6, CE 2.7, CE 2.8, CE 2.9, CE 2.10, CE 2.11, CE 2.12
PE1.2 Conceptual understanding of the mathematics, numerical analysis, statistics and computer and information sciences which underpin the engineering discipline	Experimental results obtained from performance indicators are introduced for calculating the grades and coefficient in accordance with GRA	CE 2.10
PE1.3 In-depth understanding of specialist bodies of knowledge within the engineering discipline	Chose the CAD software to design the three-dimensional plastic design. Also used BlueHill software and AutoCad software to design the steel samples	CE 1.6, CE 1.9, CE 1.11
PE1.4 Discernment of knowledge development and research directions within the engineering discipline	Studied some literature work &background study to get enough understanding	CE 2.5, CE 2.14
PE1.5 Knowledge of contextual factors impacting the engineering discipline	Conducted all the project tasks as per engineering specifications and standards. Also obeyed ASTM-E8M-11 codes while testing and measuring tensile parameters	CE 1.12, CE 2.5, CE 2.13

PE1.6 Understanding of the scope, principles, norms, accountabilities and bounds of contemporary engineering practice in the specific discipline	My designs incorporated both, primal and latest methods and I was able to abide by various codes of practice According to engineering specifications and standards, I performed all the project tasks. I ensured that each step is in compliance with the safety standards	CE 1.6, CE 1.7, CE 1.8, CE 1.9, CE 1.10, CE 1.11, CE 2.6, CE 2.7, CE 2.8, CE 2.9, CE 2.10, CE 2.11, CE 2.12 CE 1.12, CE 2.5, CE 2.13 CE 1.12, CE 2.13
PE2 ENGINEERING APPLICATION ABILITY		
PE2.1 Application of established engineering methods to complex engineering problem solving	I identified and targeted salient issues that arose in the project and pulled them out by root to save costs and time of the project	
PE2.2 Fluent application of engineering techniques, tools and resources	Used multiple softwares while optimizing the lap shear strength	CE 1.6, CE 1.9, CE 1.11

PE2.3 Application of systematic engineering synthesis and design processes	The projects were crafted by following the International Engineering Standards and by implementing the latest knowledge and strategies	CE 1.6, CE 1.7, CE 1.8, CE 1.9, CE 1.10, CE 1.11, CE 2.6, CE 2.7, CE 2.8, CE 2.9, CE 2.10, CE 2.11, CE 2.12
PE2.4 Application of systematic approaches to the conduct and management of engineering projects	I coordinated with the project team and supervisor to seek their suggestions and did modification as per their recommendations Managed all the project tasks by formulating the methodology of the project along with the materials and dimensions	CE 1.12 CE 1.6, CE 1.12, CE 2.5
PE3 PROFESSIONAL AND PERSONAL ATTRIBUTES		
PE3.1 Ethical conduct and professional accountability	I upheld engineering norms and professional code of ethics to devise my designs I performed all the work by keeping in mind safety guidelines and standards	CE 1.12, CE 2.5, CE 2.13 CE 1.12, CE 2.13
PE3.2 Effective oral and written communication in professional and lay domains	Organized meetings to discuss the project progress with the supervisor	CE 1.12, CE 2.5
, PE3.3 Creative innovative and proactive demeanour	I undergone extensive research and browsed numerous websites to gather data and knowledge	CE 2.5, CE 2.14
PE3.4 Professional use and management of information	I followed ethical rules and professor guidelines to develop the project final report by using MS-WORD Software	

,PE3.5 Orderly management of self, and professional conduct	I managed to carry out all the specified tasks by monitoring the project progress and updating the supervisor I implemented all the project work accurately by studying background history of friction stir welding, advantages and disadvantages of the FSW proces	CE 1.12, CE 2.5 CE 2.14
PE3.6 Effective team membership and team leadership	Coordinated with project supervisor and team to discuss the project details	CE 1.12