

BACHELORS DEGREE ASSIGNMENT SPECIFICATION

Student name:	SYKES	Student P number:	
Programme:	BEng Automotive and Manufacturing streams		
Module:	Advanced Stress Analysis & FEA	Module Level (4, 5, 6):	6
Module code:	M6X00420	Contribution to Overall Module Assessment (%):	50 %
Lecturer:	Kelvin Lake	Internal Verifier:	Rob Goodson
Assignment Title:	Can FEA replace physical testing?	Assignment No (x of x):	1 OF 1
Hand Out Date:	25/02/2020	Submission deadline:	29/03/2020

Referencing:	In the main body of your submission you must give credit to authors on whose research your work is based. Append to your submission a reference list that indicates the books, articles, etc. that you have read or quoted in order to complete this assignment (e.g. for books: surname of author and initials, year of publication, <u>title of book</u> , edition, publisher: place of publication).		
Disclosure:	I declare that this assignment is all my own work and that I have acknowledged all materials used from the published or unpublished works of other people. All references have been duly cited.		
Student's Signature:	Assignments will not be accepted without a signature here	Date:	
Turnitin: Lecturer to tick to indicate if an electronic version of the assignment must be submitted to Turnitin. Note: the Turnitin version is the primary submission and acts as a receipt for the student. Penalties for late submission: Up to four weeks late, maximum mark of 40%. Over four weeks late, Refer. Only Year Tutors and the Programme Director may grant an extension.			YES
			NO

Learning Outcomes tested (from module syllabus)	Assessment Criteria To achieve each outcome a student must demonstrate the ability to:
Demonstrate an ability to analyse a range of engineering problems using advanced stress analysis principles.	

- DO NOT put this form into Turnitin or it will match many similarities with other students' submissions.

TASK DESCRIPTION

This assignment explores FEA and the role that it plays in product development. It is expected that the student will research this topic (referencing any sources used, using Harvard or Vancouver).

GUIDANCE FOR STUDENTS IN THE COMPLETION OF TASKS



The above image shows a component undergoing physical testing and the corresponding FE model. Your task for this assignment is to discuss the following;

1. Why companies typically carryout FE analysis alongside physical testing.
2. How a physical test may be correlated to an FE model.
3. If you think that FE analysis can (or should) ever replace physical testing.

In order to do this, you should consider a case study and use this to discuss the above tasks.

This report should be 3000 words long and should be submitted via moodle

STRUCTURAL SECTION MARKING CRITERIA AND STUDENT FEEDBACK

This section details the assessment criteria. The *extent* to which these are demonstrated by you determines your mark. The marks available for each criterion are shown. Lecturers will use the space provided to comment on the achievement of the task(s), including those areas in which you have performed well and areas that would benefit from development/improvement.

Common Assessment Criteria Applied	Marks available	Marks awarded
1. Research-informed Literature Extent of research and/or own reading, selection of credible sources, application of appropriate referencing conventions.		
(Assessed in point 1)	30	13.5
2. Knowledge and Understanding of Subject Extent of knowledge and understanding of concepts and underlying principles associated with the discipline.		
(Assessed in point 2)	30	15
3. Analysis Analysis, evaluation and synthesis; logic, argument and judgement; analytical reflection; organisation of ideas and evidence		
(N/A)	0	
4. Practical Application and Deployment Deployment of methods, materials, tools and techniques; application of concepts; formulation of innovative and creative solutions to solve problems.		
(Assessed in point 3)	30	15.9
5. Skills for Professional Practice Attributes in professional practice: individual and collaborative working; deployment of appropriate media; presentation and organisation.		
(Assessed in report presentation and structure)	10	4

Assignment Mark Overall (Assessment marks are subject to ratification at the Exam Board. These comments and marks are to give feedback on module work and are for guidance only until they are confirmed.)	Late Submission Penalties (tick if appropriate)		48.4 %
	Up to one-week late		
	Over one week late		

COMMON ASSESSMENT AND MARKING CRITERIA

	OUTRIGHT FAIL	UNSATISFACTORY	SATISFACTORY	GOOD	VERY GOOD	EXCELLENT	EXCEPTIONAL
Assessment Criteria	0-29%	30-39%*	40-49%	50-59%	60-69%	70-79%	80-100%
1. Research-informed Literature Extent of research and/or own reading, selection of credible sources, application of appropriate referencing conventions	Little or no evidence of reading. Views and findings unsupported and non-authoritative. Referencing conventions largely ignored.	Poor evidence of reading and/or of reliance on inappropriate sources, and/or indiscriminate use of sources. Referencing conventions used inconsistently.	References to a limited range of mostly relevant sources. Some omissions and minor errors. Referencing conventions evident though not always applied consistently.	Inclusion of a range of research-informed literature, including sources retrieved independently. Referencing conventions mostly consistently applied.	Inclusion of a wide range of research-informed literature, including sources retrieved independently. Selection of relevant and credible sources. Very good use of referencing conventions, consistently applied.	A comprehensive range of research informed literature embedded in the work. Excellent selection of relevant and credible sources. High-level referencing skills, consistently applied.	Outstanding knowledge of research-informed literature embedded in the work. Outstanding selection of relevant and credible sources. High-level referencing skills consistently and professionally applied.
2. Knowledge and Understanding of Subject Extent of knowledge and understanding of concepts and underlying principles associated with the discipline.	Major gaps in knowledge and understanding of material at this level. Substantial inaccuracies.	Gaps in knowledge, with only superficial understanding. Some significant inaccuracies.	Evidence of basic knowledge and understanding of the relevant concepts and underlying principles.	Knowledge is accurate with a good understanding of the field of study.	Knowledge is extensive. Exhibits understanding of the breadth and depth of established views.	Excellent knowledge and understanding of the main concepts and key theories. Clear awareness of challenges to established views and the limitations of the knowledge base.	Highly detailed knowledge and understanding of the main theories/concepts, and a critical awareness of the ambiguities and limitations of knowledge.
3. Analysis Analysis, evaluation and synthesis; logic, argument and judgement; analytical reflection; organisation of ideas and evidence	Unsubstantiated generalisations, made without use of any credible evidence. Lack of logic, leading to unsupportable/missing conclusions. Lack of any attempt to analyse, synthesise or evaluate.	Some evidence of analytical intellectual skills, but for the most part descriptive. Ideas/findings sometimes illogical and contradictory. Generalised statements made with scant evidence. Conclusions lack relevance.	Evidence of some logical, analytical thinking and some attempts to synthesise, albeit with some weaknesses. Some evidence to support findings/views, but evidence not consistently interpreted. Some relevant conclusions and recommendations, where relevant	Evidence of some logical, analytical thinking and synthesis. Can analyse new and/or abstract data and situations without guidance. An emerging awareness of different stances and ability to use evidence to support the argument. Valid conclusions and recommendations, where relevant	Sound, logical, analytical thinking; synthesis and evaluation. Ability to devise and sustain persuasive arguments, and to review the reliability, validity & significance of evidence. Ability to communicate ideas and evidence accurately and convincingly. Sound, convincing conclusions / recommendations.	Thoroughly logical work, supported by evaluated evidence. High quality analysis, developed independently or through effective collaboration. Ability to investigate contradictory information and identify reasons for contradictions. Strong, persuasive, conclusions, justifiable recommendations.	Exceptional work; judiciously selected and evaluated evidence. Very high quality analysis, developed independently or through effective collaboration. Ability to investigate contradictory information and identify reasons for contradictions. Highly persuasive conclusions
4. Practical Application and Deployment Effective deployment of appropriate methods, materials, tools and techniques; extent of skill demonstrated in the application of concepts to a variety of processes and/or contexts; formulation of innovative and creative solutions to solve problems.	Limited or no use of methods, materials, tools and/or techniques. Little or no appreciation of the context of the application.	Rudimentary application of methods, materials, tools and/or techniques but without consideration and competence. Flawed appreciation of the context of the application.	An adequate awareness and mostly appropriate application of well established methods, materials, tools and/or techniques. Basic appreciation of the context of the application.	A good and appropriate application of standard methods, materials, tools and/or techniques. Good appreciation of the context of the application, with some use of examples, where relevant.	A very good application of a range of methods, materials, tools and/or techniques. Very good consideration of the context of the application, with perceptive use of examples, where relevant. Evidence of some innovation and creativity.	An advanced application of a range of methods, materials, tools and/or techniques. The context of the application is well considered, with extensive use of relevant examples. Application and deployment extend beyond established conventions. Innovation and creativity evident throughout.	Outstanding levels of application and deployment skills. Assimilation and development of cutting edge processes and techniques.
5. Skills for Professional Practice Demonstrates attributes expected in professional practice including: individual initiative and collaborative working; deployment of appropriate media to communicate (including written and oral); clarity and effectiveness in presentation and organisation.	Communication media is inappropriate or misapplied. Little or no evidence of autonomy in the completion of tasks. Work is poorly structured and/or largely incoherent.	Media is poorly designed and/or not suitable for the audience. Poor independent or collaborative initiative. Work lacks structure, organisation, and/or coherence	Can communicate in a suitable format but with some room for improvement. Can work as part of a team, but with limited involvement in group activities. Work lacks coherence in places and could be better structured.	Can communicate effectively in a suitable format, but may have minor errors. Can work effectively as part of a team, with clear contribution to group activities. Mostly coherent work and is in a suitable structure.	Can communicate well, confidently and consistently in a suitable format. Can work very well as part of a team, with very good contribution to group activities. Work is coherent and fluent and is well structured and organised.	Can communicate professionally and, confidently in a suitable format. Can work professionally within a team, showing leadership skills as appropriate, managing conflict and meeting obligations. Work is coherent, very fluent and is presented professionally.	Can communicate with an exceptionally high level of professionalism. Can work exceptionally well and professionally within a team, showing advanced leadership skills. Work is exceptionally coherent, very fluent and is presented professionally.

Student Self Evaluation Form

Student name:		Student P number:	
Programme:		Year of programme	
Assignment Title:			

This section repeats in brief the common assessment criteria detailed on previous pages. The *extent* to which these are demonstrated by you determines your mark. Using these criteria, tick the box that best indicates the level of achievement you feel you have achieved with regard to each of them.

Common Assessment Criteria Applied	Level of Achievement						
	REFER		3 rd	2:2	2:1	1 st	1 st
	OUTRIGHT FAIL	UNSATISFACTORY	SATISFACTORY	GOOD	VERY GOOD	EXCELLENT	EXCEPTIONAL
1. Research-informed Literature	0-29% ☐	30-39% ☐	40-49% ☐	50-59% ☐	60-69% ☐	70-79% ☐	80-100% ☐
2. Knowledge and Understanding of Subject	0-29% ☐	30-39% ☐	40-49% ☐	50-59% ☐	60-69% ☐	70-79% ☐	80-100% ☐
3. Analysis	0-29% ☐	30-39% ☐	40-49% ☐	50-59% ☐	60-69% ☐	70-79% ☐	80-100% ☐
4. Practical Application and Deployment	0-29% ☐	30-39% ☐	40-49% ☐	50-59% ☐	60-69% ☐	70-79% ☐	80-100% ☐
5. Skills for Professional Practice	0-29% ☐	30-39% ☐	40-49% ☐	50-59% ☐	60-69% ☐	70-79% ☐	80-100% ☐

PLEASE COMMENT ON AREAS IN WHICH YOU FEEL THAT YOU HAVE PERFORMED WELL	PLEASE COMMENT ON AREAS YOU FEEL THAT YOU NEED TO DEVELOP

Student's Name		Date	
Student's Signature			



Prifysgol Cymru
Y Drindod Dewi Sant
University of Wales
Trinity Saint David



ADVANCED STRESS ANALYSIS & FEA

[Document subtitle]



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1. Introduction

This assignment asks that the author research finite element analysis (FEA) with the aim of determining and outlining the role FEA plays in product development in industry today, in order to do this the author must consider a case study of FEA testing alongside physical testing.

The study asks that this task be completed in 3 sections firstly why company's use FEA analysis alongside physical testing, how physical testing can be correlated to an FE model and finally it asked if the author would determine that FE analysis can or should replace physical testing.

1.2. What is FEA

Finite element analysis is a method of analysing how parts and assemblies interact together and how they will perform under predicted conditions across its lifetime, FEA is a simulation method which takes calculates detailed interactions between elements within a part or assembly and the material it is made from. FEA looks at several detrimental conditions commonly found in a range of products such as stress, Strain, Vibration, buckling, fatigue, heat and several more conditions all to determine the structural integrity and safety of a part of product. (Caliber Design) Before computational FEA was put into common use designs where FEA wasn't used components would likely be over engineered which doesn't lead to the best possible design performance and usually adding more mass through material than is necessarily needed.

2. Task 1

Task 1 asks that the author determine why companies carry FEA alongside physical testing.

In today's industry FEA is widely used in the development of components alongside Physical testing this is largely due to the cost reduction and time reduction of using FEA simulations before manufacturing. FEA simulations are largely computational methods that allow for virtual construction and design of parts and allows for testing under known or predicted conditions prior to

FONT?

Problem Sources	Planning	Execution
Software Incompatibility	x	
Hardware Inadequacy	x	
Computer Down	x	x
CAD Incompetence	x	x
FEA Incompetence	x	x
Miscommunication		x
Lack of Communication		x
Lack of Data	x	
Database Support	x	x
Lack of FEA Guideline		x
Lack of Technical Support		x
Lack of Management Support		x

Table 1 Issues in FEA product development (S. Shih, 1998)

prototyping, this process considerably reduces the time it takes to test and redesign a part if necessary. Without this process of FEA company's would have to make initial designs and calculations to estimate the result under loading conditions before waiting for a component to be manufactured creating a cost and

likely relying on a second department increasing cost further and time taken before testing is possible, once the part is manufactured it would be sent for testing likely requiring a 3rd department before results are gathered, at this point if the design fails in testing then the design team must try redesign by hand and the process is repeated until a final product is developed, (see Figure 1 Old design Process without FEA

Figure 1 Old design Process without FEA) FEA reduces the amount of departments needed to develop a final design by allowing the design engineer simulate any failures before prototyping and testing decreasing design time and cost while increasing the likely hood of manufacturing a component that withstands testing after minimal design attempts and prototypes.

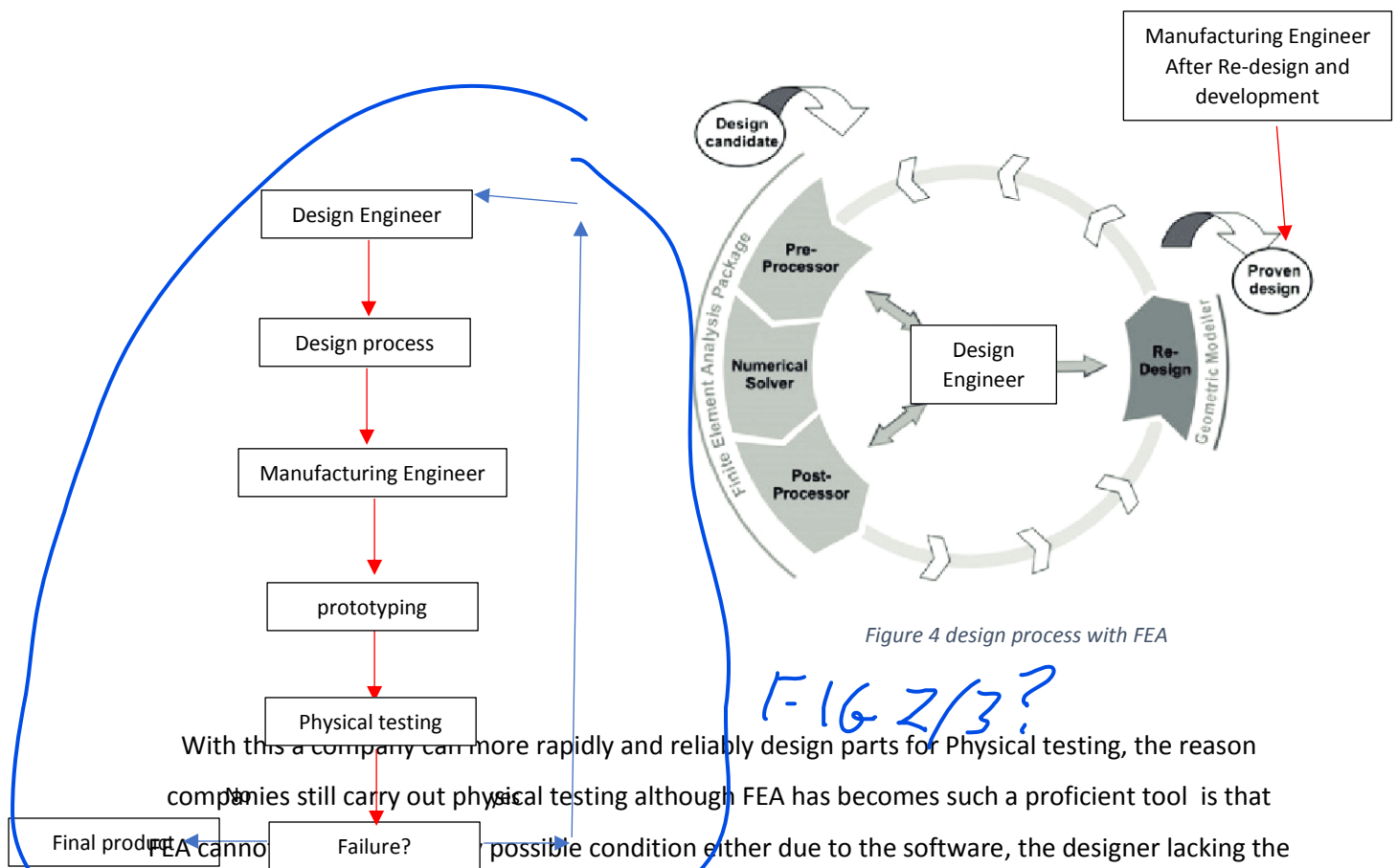


Figure 1 Old design Process without FEA

Figure 4 design process with FEA

error was made in the design or manufacturing, (see Table 1 Issues in FEA product development) this is where physical testing becomes necessary for example in connecting rod designs the fatigue life can be calculated however validation needs to be made.

A study found by (Suresh Kumar Kandreegula, 2016) highlights the use of a strain gauged jig set up on a connecting rod tested under VE commercial vehicles Ltd regulations who are a components design and manufacturing engineering company which claim to operate under the highest standard of quality control. (see Table 1 Issues in FEA product development in the Appendix) (Eicher, 2020)

The author of the case study uses data calculated from combustion forces (gas force & inertia force) to simulate the effect operational loads on a fracture split rod where the big end cap is split from the rod when forged as one component, to test the integrity of the design in key areas of stress under these loading conditions. this data was used to generate a static FEA simulation using ANSYS software where the connecting rod was analysed under operational loads to generate results of the induced stresses.

With the static FEA study results a fatigue solver (FEMFAT) was used to determine the fatigue life a Rod is manufactured and tested using the test jig mentioned, the same calculated forces over a cycle were applied to the test jig over 10million test cycles to ensure durability this is repeated with several samples with increasing safety factors (cover factors) to ensure no failures under unexpected conditions such as pre ignition or knock, each sample passed the fatigue tests without any failures, cracks or deformation validating the FEA tests and allowing for further tests in a real engine.

This demonstrates that the use of FEA and physical testing together saves production time and material costs when manufacturing, the use of both tests together demonstrate that under the simulated conditions the component will last 10million cycles which is the industry design target for infinite life which is a requirement in most commercial ICE engines.



Figure 7 test jig for Fatigue life evaluation

(Suresh Kumar Kandreegula, 2016)

Sample No.	Cover Factor	Test Loading (KN)		Target no. of Cycles	Completed test cycles (million)
		Stress (Mpa)	Stress (Mpa)		
1	1.4	180.6	21	5 million/Specimen	10
2	1.6	206.4	24		10
3	1.6/1.9	206.4	28.5		10
4	1.82/0	235	0		10
5	1.82/0	235	0		10

Figure 9 Sample tests of Fatigue life

FIG 8?

An added benefit to the use of FEA and physical testing is the ability to refine a component to far higher standard than without the use of FEA, this is due to massive prototyping not being cost effective when attempting to refine aa product without FEA commonly leading to a over engineered component that suits the need. other considerations why industry does not rely only on FEA simulation before use of a component to save additional time and cost are that the simulation rlys on correct input to provide correct results for example incorrectly mesh sizing on your component would lead to inaccuracy's where as physical testing excludes these issues due to the nature of physical testing.

3. Task 2

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Task 2 asks that the author to determine how physical testing of a component correlates to FE modelling and testing the purpose of this is that no FEA study can validate its own results without a second method of testing for reliable and validated results, this is where correlating results from different forms of study's is crucial and this can only be done through accurate and correct methods of modelling and simulation otherwise the results will be inaccurate of the physical tests which will near allows give consistent real results.

Several aspects of FEA simulations are crucial to use correct condition as per the area of study for example, quality of meshing leads to inaccurate results if not fine enough leading to uncreating data for example it will say the structure will fail whereas if the correct mesh is used to increase the detail of analysis the it may no longer fail. The accuracy and correlatability is also dependant on the type of solver used in simulation for example 1D, 2D or 3D solvers will yield significantly different results in material behaviour under load.

For example, 1D simulations are generally used for long members where cross sectional area is minimal in comparison, this is used largely in determining the cause of fractures due to bending where as 2D solvers are used largely for large cross sectional area sheets or components with a thickness this allows for calculation of shear deformation as well as bending deformation. 1D and 2D FEA is largely combined used for simple FEA on simple components however 3D element solvers (known as solid elements) which are used is used in most FEA packages due to the most accurate results from FEA due to most products that require complex FEA are 3D components, 3D elements are commonly simulated using computational methods due to the complexity. (Cyprien, 2015)

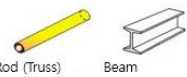
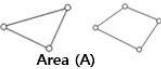
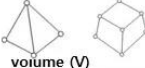
Type	Actual Models	Finite Element Expressions (Geometric Properties Defined by Nodes)	Additional Requirements (Actual Volume Calculation)
1D	 Rod (Truss) Beam	 Length (L)	Area (A, cross-sectional shape) $\rightarrow V = L \times A$
2D	 Shell, Plane Stress, Plane Strain, Axisymmetric, etc.	 Area (A)	Thickness (t) $\rightarrow V = A \times t$
3D	 Solid	 volume (V)	None (volume calculation possible)
Misc.	Spring, Mass, Rigid Link, etc.	-	-

Figure 12 1D, 2D & 3D Application situations

Fig 10/11 ?

Buckling or failure tests in connecting rods are directly related to yield stress where yield is commonly tested as 90% of the Ultimate Tensile strength (UTS) in the automotive industry when using steel for to provide a safety net for unpredicted additional forces. tests can be simulated under load for example, simulating tensile loads in computational FEA to yield to see buckling effects under load, this can also be done on a jig using the same forces and if the deformation occurs at the same point in the study then the results should show correlation in turn validating the FEA. (Yukioka, 2012)

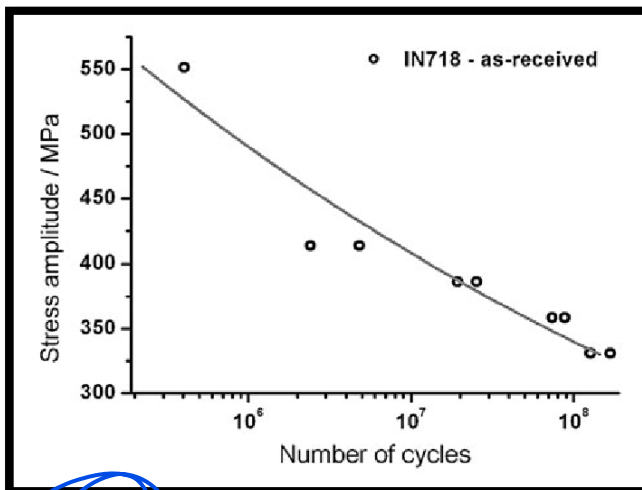


Figure 18 Fatigue S-N curve for inconela alloy (Belan, 2015)

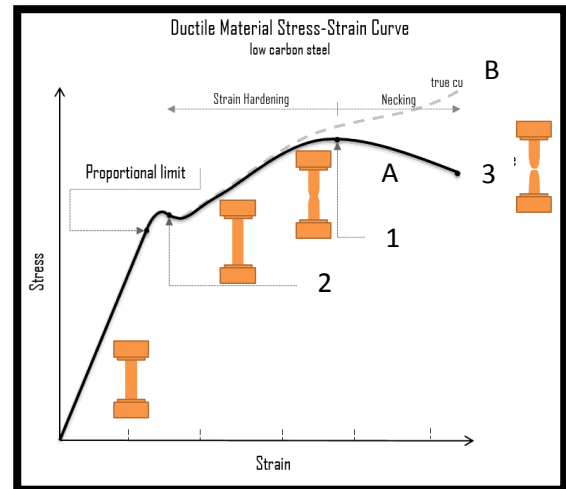


Figure 16 stress Vs strain in ductile material

figure 5 represents a typical representation of the behaviour of a ductile material found in a using a tensile test jig for physical testing where line B (dotted) represents the climb of stress on the component and line A (Black) is the actual stress acting on the component under deformation measured through strain gauge and deformation sensors.

Figure 6 stress Vs strain in ductile material

Figure 6 stress Vs strain in ductile material:

- 1 = UTS
- 2 = Yield strength (yield point)
- 3 = component Failure

Figure 7 Fatigue S-N curve for inconela alloy

Figure 9 ANSYS Bumper crash test Figure 7 Fatigue S-N curve for inconela alloy demonstrates a typical representation of a fatigue duty cycle where test were conducted on an Inconel alloy under different loads to determine maximum stress the material can be repeatedly subjected to archive $\times 10^8$ cycles this test can be conducted though physical tests on prototype material to validate FE calculations.

A case study found on the development of a car bumper which due to new regulations had to be able to withstand repeated impact forces at 5Mpa impact speed without failure or visual signs of cracks to ensure a fatigue life cycle of $\times 10^8$ cycles, this is an industry standard for some automotive components in the manufacturing industry to ensure infinite life. The author was able to obtain some original bumper for the test vehicle in question which were reinforce and physically tested to the specified crash conditions until visual damage was seen in each re-enforced bumper, with a number of sensors the was able to obtain data such as maximum allowable crash speed before damage, damage location, impact energy and the number of impacts before failure.

These tests provided data for virtual prototyping correlation, as the author now knows the real results for a crash test the virtual simulations can be developed to correlate to the crash tests for further development as reinforced bumpers failed the strength and fatigue testing.

to cost and time efficiently develop the new bumper a simplified FEA model was conducted using ANSYS to aid in the time taken of the simulation, to simulate the reinforced bumper to obtain the same results as the physical testing the author used the data gathered such as vehicle impact load at a specific velocity and energy exerted on and absorbed by the bumper as a target for the model to achieve as seen in figures 7 & 8 where the FEA analysis shows that deformation was highest in the second highest are of stress which due to the impact direction is to be expected due to bending moments from corner impacts.

(Neely, 2011)

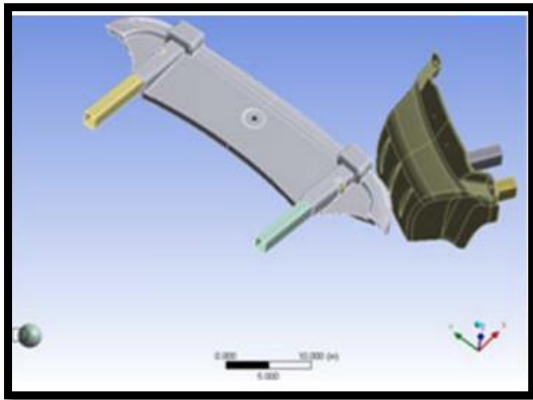


Figure 23 ANSYS Bumper crash test (Neely, 2011)

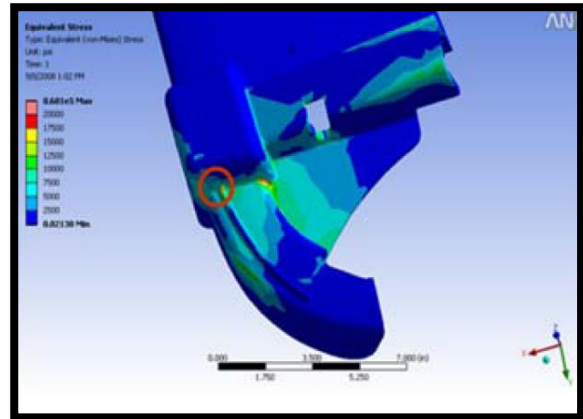


Figure 24 ANSYS FEA of Crash test (Neely, 2011)

The method of ensuring accuracy of the FEA model is through correlating the results of crash testing in analysing the areas of failure in both real and simulated crash test as well as the impact energy recorded under the same speed and loading conditions, one of the main aspects of using a physical test for results first is that when meshing of the component stress and energy results if inaccurate then the likely hood is that mesh size needs to be refined which increases solver time however is necessary to determine if the FEA results are accurate or there are modelling issues.

For example, on a simple beam of 30mm by 30mm by 200mm with a fixed and 8kN on the other (see Figure 10 meshed simple beam

Table 2 Solidworks 3D solver results with different element sizesFigure 10 meshed simple beam) was simulated in Solidworks to determine the results with decreasing element size (see Table 2 Solidworks 3D solver results with different element sizes

Figure 11Bumper Design processTable 2 Solidworks 3D solver results with different element sizes).

The Solidworks tests were conducted after real world hand calculations were sued to determine the deflection and stress where:

- $Y_{\max}$ (deflection) = 1.5mm
- $\sigma_{\max}$ = 355.5mpa



The closest that Solidworks predicted was with a 2mm element size where the larger element sizes gave increasing inaccuracy, these settings obviously vary with the complexity and geometry showing that to ensure that the simulation is accurate there must be initial studies real world done to obtain correlative results.

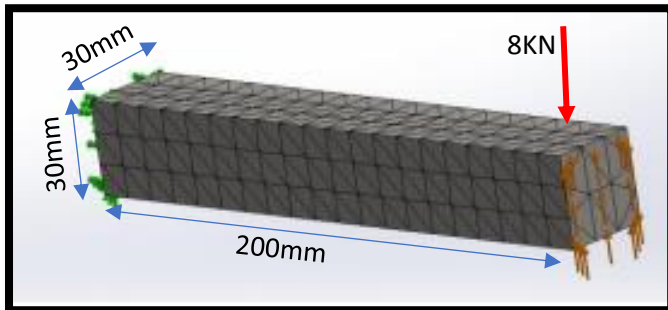


Figure 28 meshed simple beam

Element Size (mm)	Maximum Stress (MPa)	Maximum Deflection (mm)
1	393	1.52
2	357	1.51
5	299	1.43
10	236	1.2
20	162	0.6
30	70	0.4

Table 3 Solidworks 3D solver results with different element sizes

Going back to the bumper crash testing once the author of the case study had virtually crash simulated the modelled reinforced bumper with correct boundary conditions and meshing the areas of deformation and fracture were found in the same location as in the real world crash testing, due to slight changes made in the crash scenario due to ANSYS simulation limitations for example the bumper in the virtual scenario was the moving object and the impacting vehicle was stationary to optimise the test to suite in lab testing later for further validation. (shashi, 2016)

The final stage in the case study of correlating results was to do in house quasi-static tests on an impact jig as seen in Figure 12 Quasi-static Rear bumper testing

Figure 13 VE commercial Vehicles automotive Certifications
Figure 12 Quasi-static Rear bumper testing under the same conditions velocity and forces as the ANSYS study. FEA results from ANSYS for a 3.5 Mph crash were predicted at a maximum impact load of 3.1Klbf (13.78949 KN) this was used as a base of the scale during the quasi-static testing, the final results for failure of the reinforced bumper amounted to determining that the bumper withstood loads under the 13KN impact load however

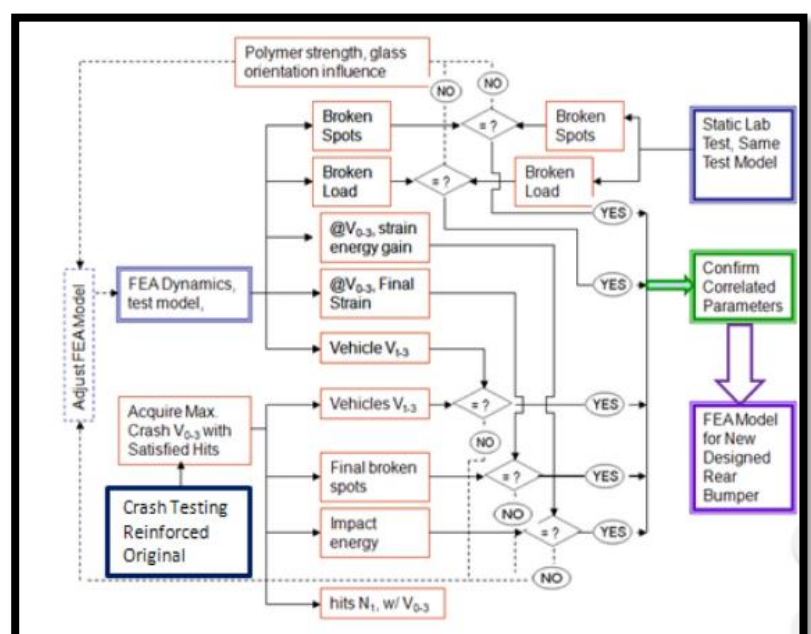


Figure 30 Bumper Design process

in a range between 3.1Klbf and 3.92Klbf (13.8 KN & 17.4 KN) the bumper failed leading to a mean impact stress of failure at 3.53Klbf (15.7KN) which gave a 90% accuracy of correlation between the FEA study and the physical anastatic testing.



Figure 33 Quasi-static Rear bumper testing

Through the final physical tests being conducted and correlated to within 90% accuracy according to the study the author then went on to use the FEA and physical data to redesign the bumper to withstand derided impact speeds over an infinite life through the use of FEA with a degree of certainty that the results produced will be withing an acceptable accuracy of what real rests will show this is how correlation of physical or multiple test types allow for efficient and accurate use of FEA simulations.

4. Task 3/conclusion

Task 3 poises that the author speculate if FE analysis can or should ever replace physical testing. FEA is currently an exceptional tool Widley used to benefit almost all areas of product development in several industry's by reducing cost and development time however currently the complexity and accuracy of these systems rely on user proficiency such as meshing experience & proficiency mentioned as well as accurate validated data where as physical testing is as true to what real life situations as can be achieved and usually needs to be conducted first to obtain reliable data for FEA simulation.

in industry such as the automotive industry components such as the case studied components mentioned (Rear crash Bumper & connecting rod) often if failure occurs after being sold to a

consumer can lead to injury or worse, because of this many companies will extensively physically test components due to the potential for error in FE analysis and simulation. Physical testing in industry has been refined for decades where as FEA solvers are still being refined most companies have adopted FEA as a method of cost and time saving however cannot simulate complex materials and compound behaviour as easily as the real world. Many issues with a product or components can develop in the manufacturing phase which and FEA solver will be programmed to simulate under ideal material properties and manufacturing, this is where physical testing of multiple samples are conducted after FEA to ensure manufacturing quality as well as design quality it is for these reasons in the authors opinion FEA should not replace Physical testing, that being said the day may arrive that solvers and programs will be advanced to perform and correlate to physical tests accurately every time however for certainty of product safety and reliability physical testing should always be conducted on the final product.

In conclusion due to the potential for user error and the need for correlation to validate FEA at its current sophistication means that FEA simulations should never currently replace physical testing due to the reasons aforementioned such as potential risk to consumer as one of the largest.

WHILST YOUR REPORT CONTAINS
SOME GOOD INFORMATION, THE
WAY IT HAS BEEN WRITTEN
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