

BACHELORS DEGREE ASSIGNMENT SPECIFICATION

Student name:	WILKINSON	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I declare that this assignment is all my own work and that I have acknowledged all materials used from the published or unpublished works of other people.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

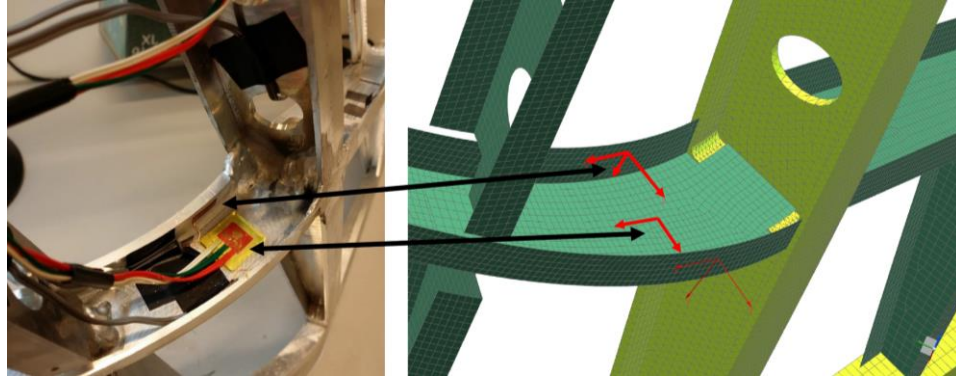
Learning Outcomes tested (from module syllabus)	Assessment Criteria To achieve each outcome a student must demonstrate the ability to:
Demonstrate an ability to analyse a range of engineering problems using advanced stress analysis principles.	

- 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	19.8
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	20.4
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	21.6
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	7

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)		68.8 %
	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			



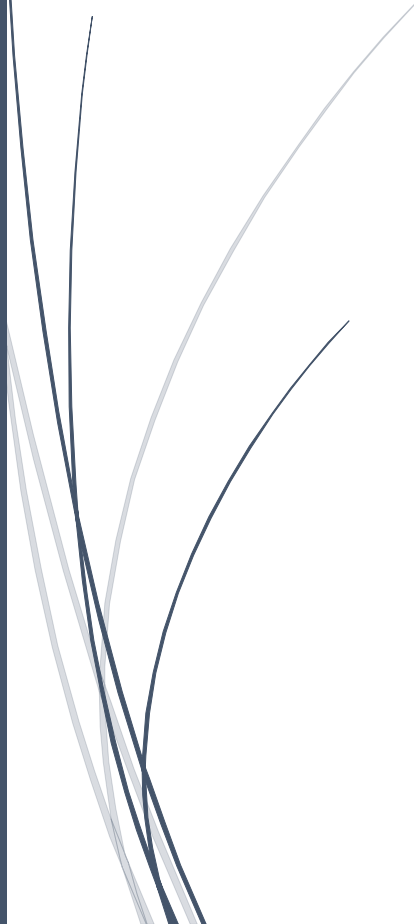
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Trinity Saint David

4/11/2020

Can FEA replace physical testing?

Advanced Stress Analysis & FEA

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Can FEA replace physical testing?

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Beng Motorsport Engineering

11/04/20

Advanced Stress Analysis & FEA

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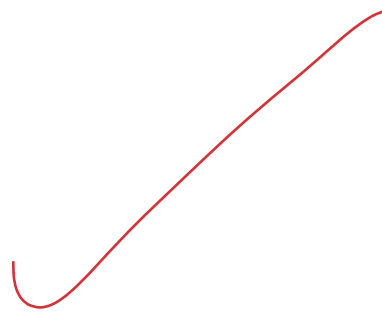
1 Introduction

With FEA becoming more and more of a necessity rather than an alternative step within a design process, this report addresses the reasons companies invest their limited resources into FEA, and the positive/ negative impacts it has on a project.

It will also compare how handwritten calculations to solve FEA studies can be advantageous but also have some disadvantages.

Further in this report, sections include FEA and CFD within a motorsport environment using the highly competitive environment of Formula 1 as an example highlighting why it's so widely used but also if should FE ever fully replace physical testing.

It will lastly touch upon the cost factors of just using FEA and/ or physical testing considering its investment costs, and the human aspect regarding training and engineering knowledge.



2 Why companies typically carryout FE analysis alongside physical testing.

2.1 FEA (Finite Element Analysis)

FEA allows for a greater insight into a products condition under ideal loads it is designed to be put under in a simulation environment. It can also highlight stress concentrations on a design. *IT CAN DO MUCH MORE*

With FEA the test process can begin much earlier than with physical testing and development, this is due to the nature of FEA being a computational aid to the designer. Changes to the FEA design can be made relatively quickly, and individual components redesigned before manufacturing has begun.

As FEA is a computerised simulation the operating conditions of the product can be applied to the CAD model and observed, to test if the initial design has met the design criteria and loading specifications.

A product being designed with FEA integrated into its process can be checked quickly for several different optimisations within a single design. (Design, 2020) The need for one path to be followed due to expensive prototyping can be avoided, this means targets for ideal heat, loading stress or a reduction of mass can separately be chased to find out which one is best.

2.2 Validation and verification. *WHY NOT A DESIGN TOOL?*

Companies use FEA as a verification tool of their designs, this means they can see if it has solved correctly in conjunction to their research and initial understanding of the design.

This means any small errors that has happened in the data gathering or modelling stages can lead to much larger errors with the FEA's result. (Veikos,2016)

The more complex and intricate the design the larger the potential error will be.

2.3 Design process

The design process is a step by step gates for a project to work towards and the next step should only be worked on if product confidence is achieved. (Shahin,2003)

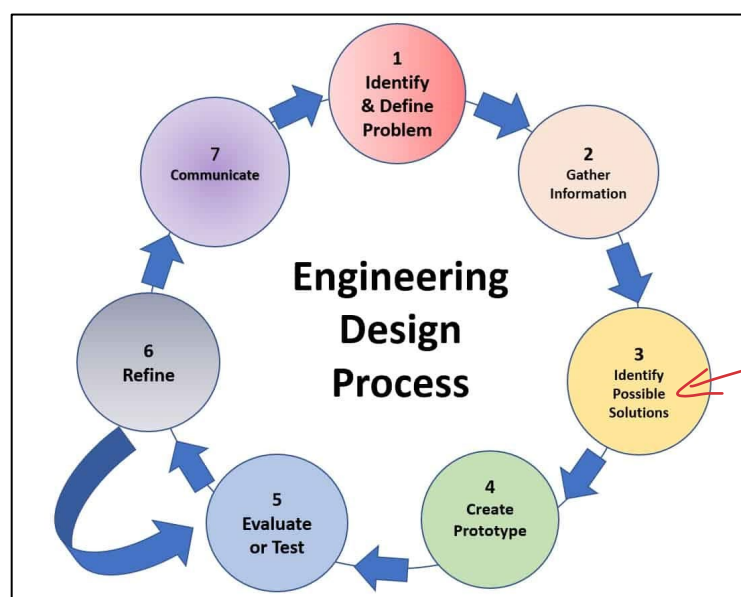


Figure 1: Engineering design process.

2.3.1 Design loop

When FEA and CAD are introduced into the process a feedback loop can be created (Steps 5-6).

This allows for any design flaws to be quickly rectified and tested on the software often with the same design engineer. It also allows for stakeholders to visually see progress of their project instead of a massive influx of progress nearer the end of the project. (Design, 2020)

2.3.2 Ultimate costs.

When FEA is integrated as a part of the design stage. The overall costs are reduced at the validation stage, this is because there is less need for constant redesign and manufacture of prototypes.

The overall lead time and scale of the project is reduced, further saving costs in the form of human working hours and running costs of the infrastructure. More projects can be started or completed at the same time; this increases profitability. (Belhe, 2014)

The initial costs of using FEA software and the training it requires will lead to huge investment costs in a project early on, however these are offset by the reduction in manufacture of prototypes and often its more profitable than “Traditional methods”.

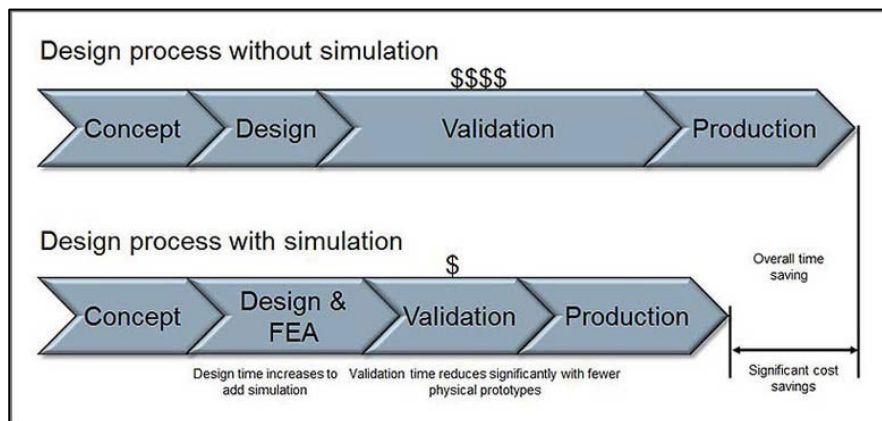


Figure 2: Cost savings using FEA.

REF ?



2.4 Alternative process

If the product being designed is not very complex and the process does not require a full FEA simulation. Then this can be carried out using hand calculations to achieve the answer very similar or the same as an FEA packaged.

2.4.1 Benefits.

- It is much faster to do some relatively simple calculations with a pen, paper and calculator than set up an entire FEA model.
- Its inexpensive and there is no need to purchase software.
- It's much easier to teach a team member how to answer hand calculation problems than teach an entire FEA package.
- It's a great way to validate or gain first-hand knowledge of how your material or design may behave before setting up a complex FEA study.

2.4.2 Disadvantages

- Matrices used to calculate the problems can quickly become too large to answer in a reasonable amount of time.
- The "mesh size" is very large and is not very accurate if detail is desired.
- It will leave potentially a small percentage error if compared answers to a full FEA study.

3 How a physical test may be correlated to an FE model.

3.1 Formula 1 and FEA development.

In any sport in which development of a team or equipment plays a part then anytime wasted spent attempting to improve performance will have a massive negative impact if that be in investment lost or social impacts from fan engagement. In Motorsport this is just as applicable, an example of this is in Formula 1 and its development in the winter months prior to the start of a championship season.

3.1.1 At base development.

3.1.1.1 Computational fluid dynamics (CFD)

Within an F1 team, FEA is used to drive the development and advancement of aerodynamic package across the car.

All the teams that complete heavily use and put their engineering judgement in CFD to validate results. Example of this is Renault F1 in which they constructed a purpose-built centre specifically for FEA testing. (solutions, 2016)

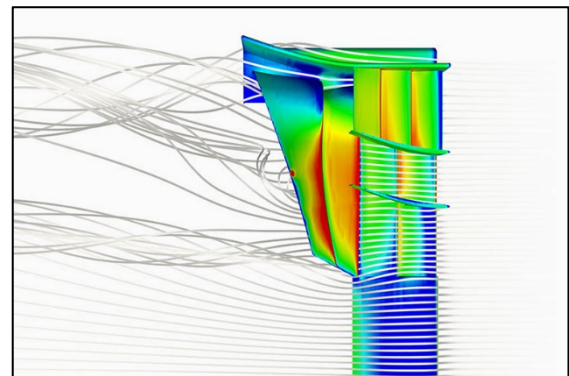


Figure 3: FEA of a front wing.

A CAD design is continually altered, and small refinements are made which are rigorously re-tested to achieve the maximum amount of downforce to aid performance whilst still being able to be within the tightly scrutinised championship regulations.

Teams can use physical testing to verify an FEA model and test their designs in a semi real environment by using Wind tunnel testing.

This uses a scale model of the car or components at around 60% size of the real thing. This creates an individual feedback loop before any true scale manufacturing has been undertaken.

At this point in development this also means the car has undergone a huge amount of simulation and physical testing ahead of manufacturing and actual circuit testing.

Using a wind tunnel allows for correlation to the FEA data by seeing how the simulated data compares to actual air flowing over the car. Any design issues can be rectified and retested in a short lead time as the whole process is usually in one self-contained factory.

(Vyssion,2018)



Figure 4: F1 Wind tunnel

3.1.2 On circuit development

Once the design of the car has been tested, signed off and manufactured further on track testing can begin using high visibility 'flow paint' as the vehicle travels at speed flows across the surface of the vehicle being manipulated by the airflow around it. This is photographed and cross referenced with the wind tunnel/FEA data to check if the pattern created matches the testing done previously and if any design errors have been made.



Figure 5: Flow paint

Another form of correlation testing that Formula 1 teams use is 'Aero rakes' these are a grid of sensors behind each of the front wheels. These log and record the velocity of the air which is disturbed by the car's wake.

Teams use these to correlate their simulation data with an actual on circuit physical test. If the data that this test is generating is within a desired percentage of the CFD data, then it's agreed the engineers can trust it. (Smedley, 2019)

Trusting simulation data is crucial for a team as availability to be on circuit testing is limited, developing using FEA is a cheaper and more efficient way of developing then manufacturing numerous aerodynamic iterations.



Figure 6: Aero Rakes.

3.1.3 F1 and design process

The development of an F1 car throughout a season follows the same design process as any other engineering problem, however small individual development loops are created in different stages of the products inception to the racing circuit.

Once an interaction has been developed and prototypes tested it is then fed back into the process and its findings used to create an updated package for the next round of the championship.

The design process has now gone back to stage 1 and identifying the problems that have occurred, this means a constant loop of continuous progress will now happen.

The benefits of a team using physical testing and real world testing means their designs are tested in the environment they are intended and the ability to correlate real data with simulation improves accuracy and keeps the project on the correct path, speeding up development.

3.1.4 Managing development time.

The FIA that governs Formula 1 has put in place numerous restrictions to limit the amount of time teams can utilise FEA software to develop their performance on-circuit.

They have restricted the number of hours a team at base can be operating an FEA package and wind tunnel use to 30hrs per week. As it is monitored through a combination of the two, priorities and strategic planning prior to any simulation testing must be carefully done. (FIA, 2019)

This has been put in place to make the teams more efficient in energy consumptions that the teams are using during the winter break.

Before the restriction it was not unheard-of teams using as much as 250hrs of CFD and the wind tunnels operating 24/7 (Scarborough, 2017) This has huge investment costs for running these FEA studies and its aim to balance the teams that have the largest annual budgets to teams with less available money to spend on testing.

4 If you think that FE analysis can (or should) ever replace physical testing.

Finite element analysis is a fantastic tool for engineers and designers to use alongside physical testing. However, FEA's biggest downfall is the users experience of the software, another point that also harms FEA is the users general lack of an engineering justification. This could mean a designer understands the setup and technical aspects of the software but not what the colours indicating stress concentrations are referring to or if they are potentially unsafe to the operation of the product.

To use FEA to its full potential and positively support the design process of a products development, it is essential that the user is firstly instructed by an expert in the software prior to independent operation. This is because it is very easy to get lost within an FEA package and start getting results which look very accurate but are in fact incorrect due to an error in the pre-processing stage, for example setting up the mesh or element sizes.

FEA requires constant refinement of skills and some prior engineering knowledge to make decisive yet accurate decisions to the results.

The final convergence of the analysis compared to the real-life problem will take a large degree of engineering judgement if the computational power available is not at a level where some margin of error is seen.

So long as the people who are carrying out the FEA have sufficient time to understand the system/software and some background engineering knowledge then this will allow less chance for errors within the results.

However, when a designer who does not have this knowledge uses FEA this could potentially cause mistakes within the data, this can include an incorrect element size when meshing the design or applying the incorrect boundary conditions which can lead to the end results being unsuitable.

FEA requires continuous refinement of skills to be able to keep on top with the latest developments and techniques to further increase user proficiency.

FEA is good because it can analysis complex designs quickly, and you will be able to edit and refine them without too much trouble.

On the other hand, a negative of FEA is its large cost/knowledge needed to be put into it. This leads to think that FEA is only worth a company investing its resources to it if its properly researched and profits are clearly gained by its expenditure and not elsewhere in the project.

FEA should be used in conjunction with physical data collections or tests because it gives a clearer overall picture of the design's behaviour.

The initial stages of FEA design should be hand calculations and then the use of FEA software's should be introduced. This would then focus the design on data that's been drawn on the area needed instead of having a too broad subject initially.

4.1 Within FEA Motorsport

For the Motorsport industry physical testing should never be completely replaced by FEA as software becomes more advanced and computational power becomes larger, this should only enhance and ultimately strengthen the development process.

As the Motorsport is every increasing to become an all year-round sporting fixture the time in which a team developing their own aerodynamic package for example is shortened. This means projects need to now be carefully planned and time managed to fit this shortening window.

With this knowledge, FEA has positive impacts as it speeds up the data process gathering time; however, some data will always be more accurate in physical testing.

FEA should always be used to back up a physical test and validate it from the simulation that was carried out creating a path of results from hand calculation to FEA models then onto an actual prototype test, this means if done correctly and with care the results will be very similar.

Conducting a physical test validates that the design process has been positively driven and in the case of (Australia, 2014) brings to light the percentage error of FEA to an actual test during a torsional experiment on a race car chassis.

The physical test provided higher results between 5-7% from the FEA results and this would have gone unnoticed if just an FEA study was undertaken.

By highlighting this the engineer can retrace their steps along the process to find out if errors have been human created or it's a convergence gap between real and simulation.

4.2 Hand calc vs FEA.

Not all FEA studies need complex and expensive software to get valid and reliable results. If there is an engineering problem on a simple structure or beam it is suitable to use basic hand calculations to reach a satisfying answer without impairing safety on the project. Often this will be as accurate as within a few percentage differences of the real answer because you are using the same parameters such as material properties and geometries that the FEA software would calculate.

If the problem requires complex geometry's, then an FEA study should be considered as it is more accurate and cost efficient than spending vast amounts of time in calculating it.

4.3 Physical testing.

Physical testing is constrained by the conditions on which the test occurred on. It is expensive to keep retesting under different conditions that are desired for example, a Formula 1 team will need to thoroughly test their aerodynamic packages and if the conditions are not right on the intended test then the results could be misaligned to what it should be.

By using FEA before this test they can first investigate different air pressures or loading onto the wings before any physical testing has occurred and it can also be simulated in the idea “perfect conditions”

FEA can help identify to teams any potential design flaws which would otherwise ruin the planned test day making the limited track time available more cost efficient.

(Pounds /second/lap)

4.4 Cost factors

4.4.1 Software

A complete FEA software package or licence to use the program can be a very costly investment for any small/ medium business. A single licence of Solidworks can cost in the region of several thousands. If an entire team of designers needs access to FEA or a CAD package the cost can considerably skyrocket.

For a company investing large resources into FEA, huge amounts of servers are needed to store the data from the studies, this escalates the costs.



Figure 7: Server room at Renault F1 CFD facility.

On the other hand, FEA analysis packages has decreased in costs with the ability for CAD packages including multiple programs within it, so no need to purchase multiple different programs.

The continual development of computational power has allowed FEA to become more technological and complex but also meant it has become easier to have more calculations on smaller devices. (Ari, 2013) This is also because the use of cloud computing has become more widely used, this means designers can achieve more larger projects with more finer mesh sizes thanks to the use of remote servers with multiple cores. (Cyprien, 2019)

4.4.2 Engineers and Training.

The time and availability to educate engineers in an FEA package can also be a large investment to a business, this will require constant review and refinement as new techniques and updates are developed.

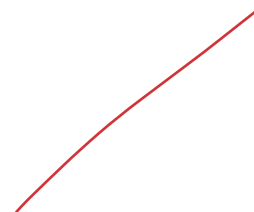
FEA packages are expensive to obtain licences. Designers and companies need to consider if the project is appropriate for FEA use or can it be done by just hand calculations. They also need to consider if the answers obtained reliable enough and doing so mean the project is still maintaining a satisfactory level of safety.

4.4.3 Engineering Knowledge

Having engineers who have knowledge of the different types of FEA studies available to them before they start the process is crucial as this will jeopardy the results. If the error is not found it can impact further stages of development.

- Static or dynamic?
- Linear or nonlinear.

This is important to correctly apply these as research into the type of loading conditions the real product will encounter as this will lead to a more accurate simulation. If these are not correct it renders the FEA study pointless and the user/ project has wasted valuable time and resources into it.



5 Conclusion

In the modern world technology advances at an ever-increasing pace and with business's always needing to be at the fore front of the consumer focal point they need to embrace the use of more technological tools at there disposal.

FEA is a fantastic way to be used alongside physical testing to validate and reassure engineers of choices they need to make. This makes product manufactured more accurate or complex and most importantly increases the safety to the user.

Physical testing for this reason should not be the only way to test a design when FEA can aid this process. FEA however should be only used when the design process is applicable to need it and only proficiently skilled users should attempt a study otherwise misinterpreted results can easily lead the project into costly errors.

6 Bibliography

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