

BACHELORS DEGREE ASSIGNMENT SPECIFICATION

Student name:	LACARLERE	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I declare that this assignment is all my own work and that I have acknowledged all materials used from the published or unpublished works of other people.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	19.2
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	18.3
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	18.6
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	6.5

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)		62.6 %
	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

CAN FEA REPLACE PHYSICAL TESTING?

ADVANCED STRESS ANALYSIS AND FEA

BEng Motorsport Engineering

26/04/2020

M6X00420

VIJAY SINGH KUNER LACARRERE (P150659)

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1 Question Answers

The following sections written in this paper answer the questions asked in the assignment brief:

- Why companies typically carryout FE analysis alongside physical testing.
 - Section 4: Verification and Validation.
- How a physical test may be correlated to an FE model.
 - Section 5: Correlation between FEA and physical testing
- If you think that FE analysis can (or should) ever replace physical testing.
 - Section 6: Future of FEA.

2 Introduction

Finite Element Analysis (FEA) is the simulation of any given physical phenomenon using the numerical technique called Finite Element Method (FEM). This technique is used by engineers to reduce the number of physical prototypes, as well as to optimize any kind of mechanical structure in a timely manner. It is also being used successfully in other kinds of engineering problems such as fluid dynamics, seepage flow and electric and magnetic fields. (Simscale, 2020) (Rao, 1999)

The Finite Element method (FEM) is the solution of a complicated problem by replacing it with a simpler one. This produces not an exact solution but a very close approximate one. Depending on the computing power the solution can be refined or not, the more computing power used the better the approximated result will be. (Rao, 1999)

This paper investigates the use of FEA in industry and how it is used. It focuses on the use of FEA to calculate torsional stiffness of a space frame chassis, furthermore it will investigate how correlation between real world testing and FEA analysis is of utter importance.

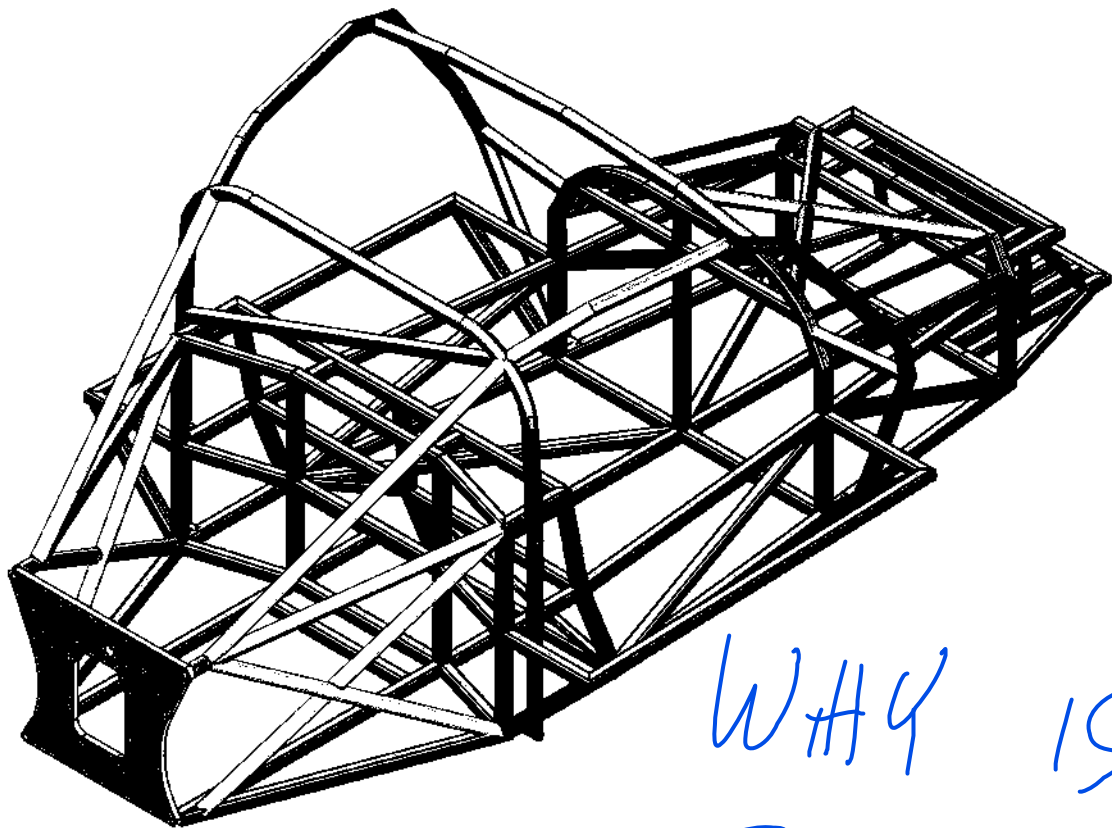


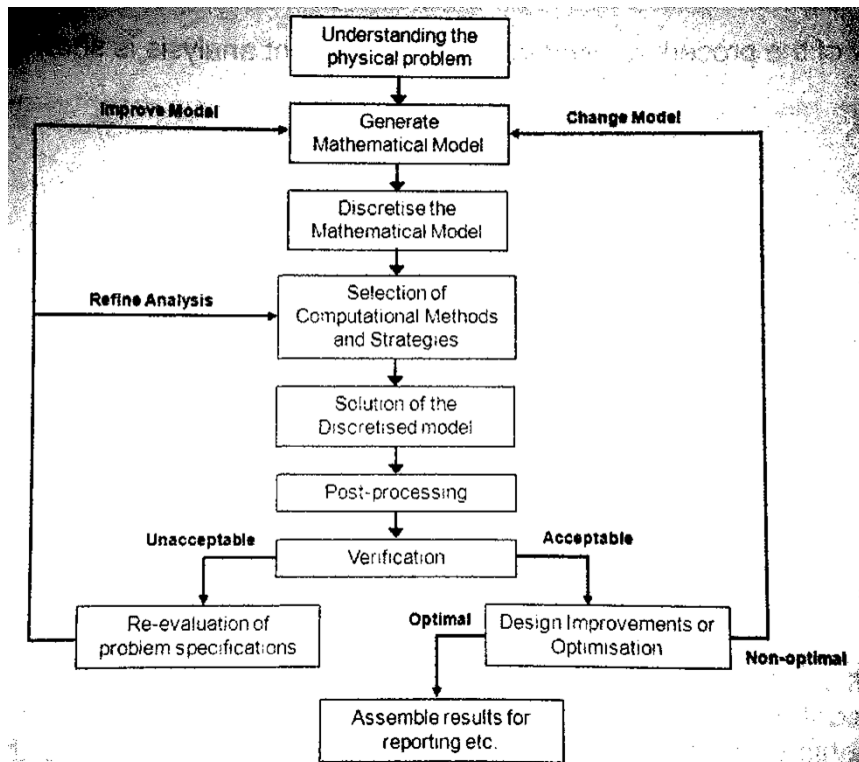
Figure 1 – UWTS Darran Chassis Design (Kuner, 2018)

WHY IS
THIS
HERE?

3 Finite Element procedure

This section will examine the FEA process and how it is undergone.

Figure 2 showcases an overview of each stage. As the design process proceeds, more knowledge is gathered and therefore optimisation of the model can be done. (Donald, 2011)



QUALITY!

Figure 2 – Stage of a FE Analysis (Donald, 2011)

3.1 Understanding the physical problem (Donald, 2011)

At this stage, the engineer would have to identify all distinctive features of the structure to be analysed, such as:

- Dimensions of the structure.
- What dimensions are important.
- Simplification of the structure into smaller less complex components.
- Simplifying the structure, getting rid of any complex geometric entities.
- If the structure is symmetric, it can be further simplified by only using half of it.
- Material it is made of.
- Loads the structure is under.
- Location of stress concentrations (holes, fillets, etc)

- Will there be yielding present in the structure, due to high loads.
- Constant or variable loads with time.
- Is the structure expected to come in contact with any other component?

3.2 Generating the mathematical model (Donald, 2011)

Once the physical features of a problem are found, these must be translated to a mathematical model. There are two major tasks which must be considered: definition of the problem domain and selection of a mathematical formulation which best represent the problem at hand. Some factors to determine what mathematical model are the following:

- The geometry of the structure.
- The type of material.
- The loads which the structure is subjected to.
- Manner the structure is supported or fixed.
- How this structure interacts with other structures and the immediate environment.
- How much computing power the user has.

An example of geometry is of a 2D Plane Stress, this kind of model assumes that the stresses acting through the structure are negligible. This kind of model is used for plates or for flat surfaces where the length and width of the structure is vastly larger than the thickness. An example of a 2D component which due to it being symmetrical can also be quartered to save on processing time is Figure 3.

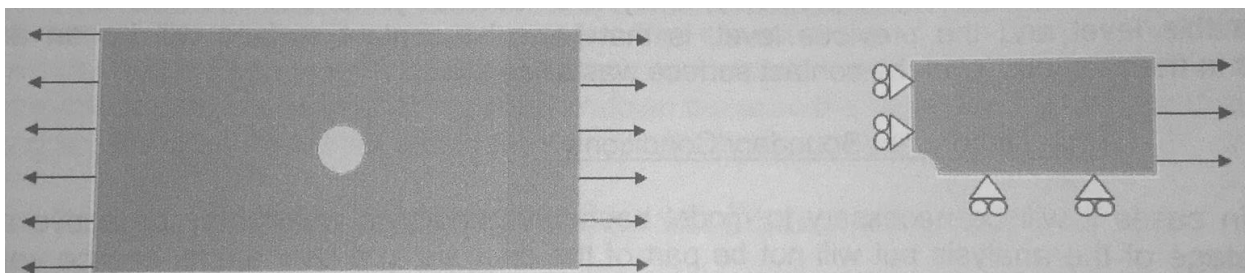


Figure 3 – 2D plane stress model (Left) quartered model (Right) (Donald, 2011)

3.3 Discretisation of the model (Donald, 2011)

Once the mathematical model is chosen discretisation of the model can be undertaken, most FEA packages these days automatically mesh the model for the user. Automatic meshing will not know where a finer mesh is necessary, this is where the user must tell the program to input a finer mesh around certain areas such as holes.

3.4 Selection of computational methods and strategies (Donald, 2011)

The basic structural computational methods are the following:

- Static analysis.
- Modal analysis.
- Harmonic analysis.
- Transient dynamic analysis.
- Explicit dynamic analysis.

3.5 Post-processing, model verification and validation (Donald, 2011)

At this stage, the user extracts information from the results given from the FEA to make design decision. The following points can be taken from post processing:

- Yield Stress of the structure.
- UTS of the material, has it been exceeded?
- Displacement of the structure under load.
- Stresses and Strains.
- Transition of stress along the structure.
- Error estimation plots.

4 Verification and Validation

The definitions of verification and validation as said by the American Society of Mechanical Engineers is as follows:

- Verification: The process of determining that a computational model accurately represents the underlying mathematical model and its solution. (Schwer, 2007)
- Validation: The process of determining the degree to which a model is an accurate representation of the real world from the perspective of the intended uses of the model. (Schwer, 2007)

Looking at Figure 4 the conceptual model splits into two branches, the mathematical model, and the physical model (experimental model). Physical testing is of utter importance in the verification and validation process, without it the mathematical experimentation cannot be validated. Close cooperation between engineers conducting the mathematical and physical testing is paramount. "Finite element and experimental analysis of the torsional stiffness of a chassis of a baja sae prototype" (Barbosa, et al., 2016), in this case study 4 mathematical cases were undertaken:

- Case 1: a minimum constraint condition, fixing the structure at two points of rear end and applying torque at the front end.
- Case 2: torque applied to front of chassis by applying equal and opposite vertical forces on the frame rails near the suspension pick up points. At the rear suspension spring mounts, the chassis is restrained in all x, y and z translations and in lateral and vertical rotations, the longitudinal rotations are free. (Thompson, Raju, & Law, 1998)
- Case 3: all degrees of freedom of both rear sides are fixed.
- Case 4: same boundary conditions as the physical model.

Using the verification and validation model Cases 1, 2 and 3 would be not viable as there is no physical model to validate the mathematical model, on the other hand Case 4 gives the user a mathematical and a physical model for comparison. It is important that the mathematical and physical models are done separately, and results are withheld from both departments as this can influence the mathematical model by the engineer "tuning" the analysis to match the physical model. (Schwer, 2007)

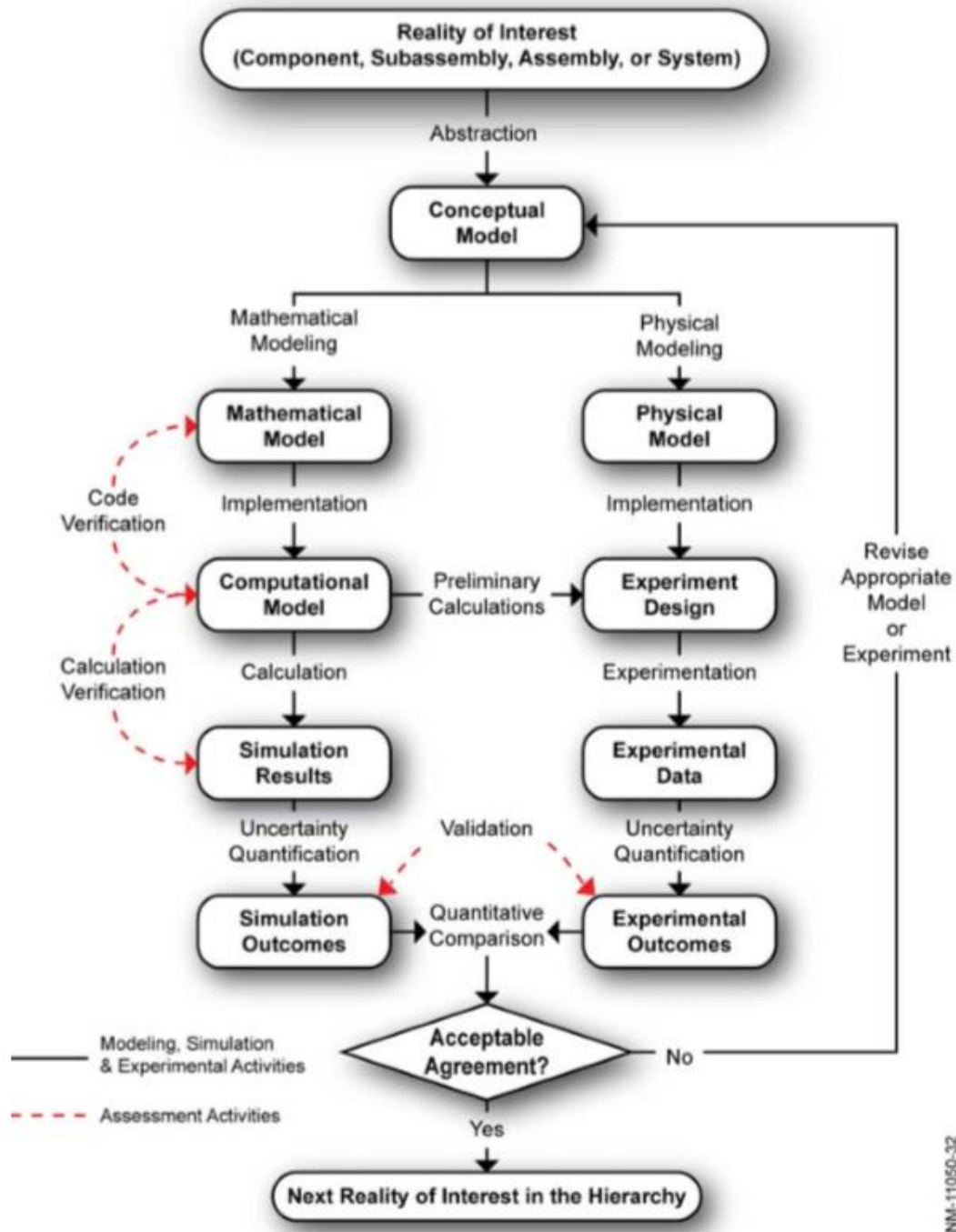


Figure 4 – Verification and Validation activities and outcomes (Schwer, 2007)

Figure 4 can be used as a basis to a Verification and Validation plan, V & V plan, there are three key elements:

- System Response Features: the features of interest to be compared and how they are to be compared (Schwer, 2007)
- Validation Testing: physical testing done to demonstrates the predictive capability of the mathematical model to be true. (Schwer, 2007)
- Accuracy Requirements: requirements done by the engineer beforehand to be met. (Schwer, 2007)

This plan is of paramount importance, it is the document given to management for evaluation and decision-making process. If this kind of plan is not done management would never let a project, go ahead and take the chassis into production.

4.1 Verification

Verification must always precede Validation. A badly done code, will lead to a false conclusion.

Verification can be split into different paths as seen in Table 1:

- Code Verification: through the collection of evidence, showcase that the mathematical model is working in a correct manner. (Schwer, 2007)
- Calculation Verification: through the collection of evidence, show that the discrete solution of the mathematical model is accurate. (Schwer, 2007)

Table 1 – Verification assessment classification and descriptions. (Thacker, et al., 2004)

Classification		Focus	Responsibility	Methods
Code Verification	Software Quality Assurance	Reliability and robustness of the software	Code developer & Model developer	Configuration management, static & dynamic testing, etc.
	Numerical Algorithm Verification	Correctness of the numerical algorithms in the code	Model developer	Analytical solutions, benchmark problems, manufactured solutions, etc.
Calculation Verification	Numerical Error Estimation	Estimation of the numerical accuracy of a given solution to the governing equations	Model developer	Grid convergence, time convergence, etc

4.2 Validation

When it is said that a model is validated, not only the computational model is validated, but also its mathematical and conceptual models, from which the computational model was built. (Schwer, 2007)

Figure 5 showcases two model variables X_1 and X_2 . Model calculations and validation experiments are done and verified at values X_1 and X_2 . The uncertainties within the model create the contours shown, the darker the area within the contour the more accuracy. In short, higher confidence will be associated with predictions closer to the validation points.

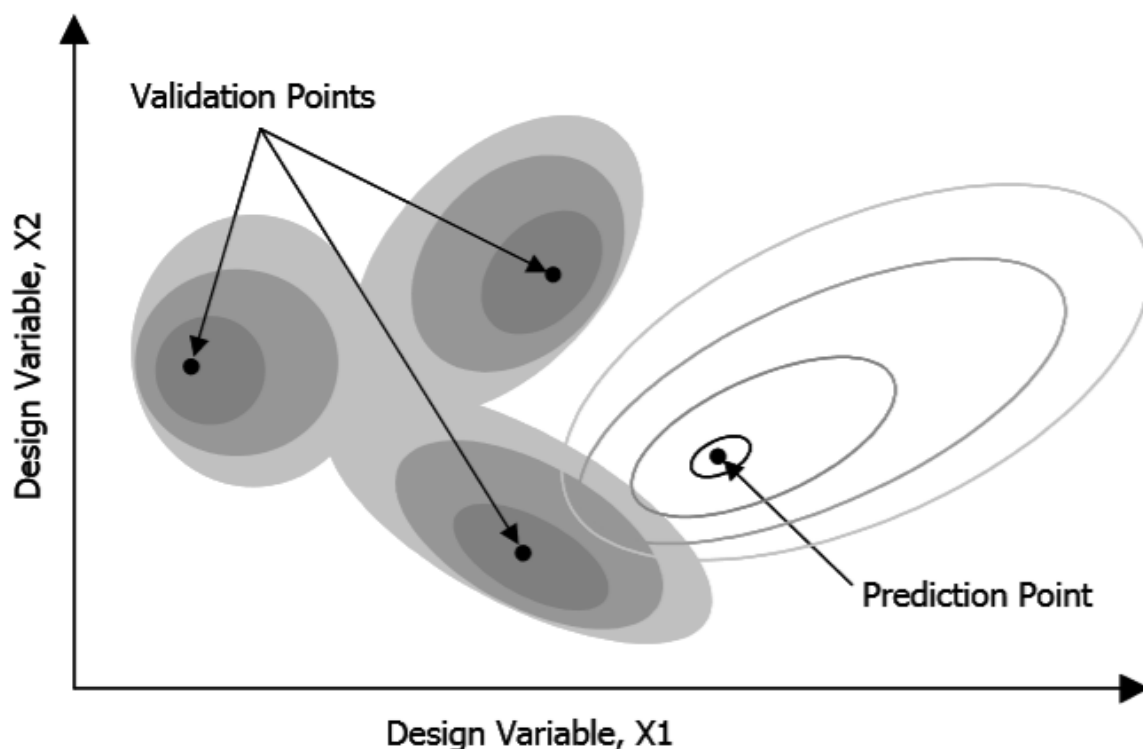


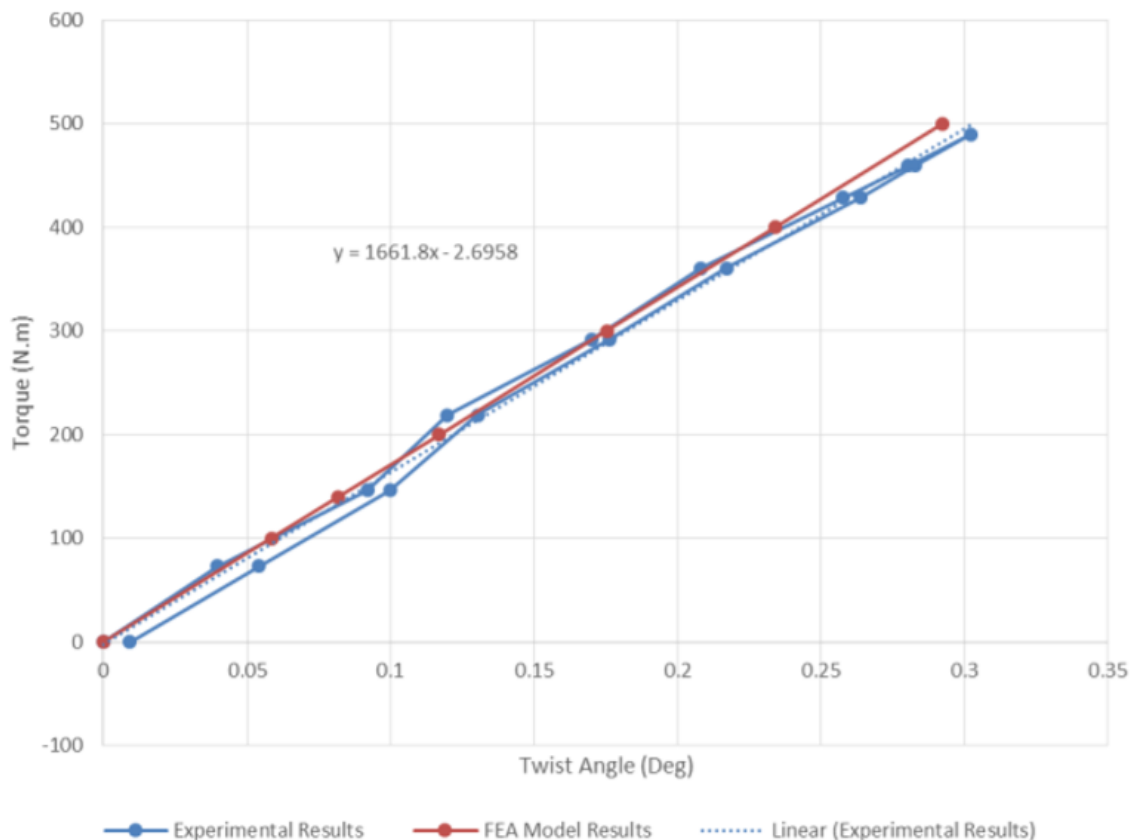
Figure 5 – Validation and application domain for two design variables (Thacker, et al., 2004)

It is emphasized, that adjusting model parameters or basic equations to improve agreement between validation and prediction points is not valid and will give “tuned” results. Calibration of the model is a valid activity; however, this is part of the model building process and not the validation process. (Thacker, et al., 2004)

5 Correlation between FEA and physical testing

The following section will explain the procedure undertaken for calculating the torsional stiffness within an FEA program and how it correlates with the physical test.

The easiest way of correlation in this case is to do a static analysis of a simulation of the chassis within a FEA program and physical testing using a purpose-built rig. The FEA model is to be identical to the physical model, once the FEA model is complete it is run and the torsional stiffness of the chassis is calculated from the FEA data, as well as from the physical test data. These two pieces of information are compared to each other in the form of a graph as seen in Graph 1.



Graph 1 – Validation between experimental results and FEA model results (Youssef & Elhaddad, 2015)

In the paper “Finite Element Modelling and Analysis of Vehicle Space Frame with Experimental Validation” by Eng. Abdelrahman M. M. Youssef it was found that for their chassis, the torsional stiffness was 1661.8 Nm/deg. While the FEA model gives a torsional stiffness of 1710.593 Nm/deg. These two pieces of information are then compared giving the model an error of 2.936% (Youssef & Elhaddad, 2015)

1

Once this error is calculated and it is acceptable, the engineer can do further work by doing many different FEA iterations with the safety of knowing that there is good correlation between the virtual model and the physical model.

5.1 Other form of validation

As well as the physical testing validation, within the FEA model some other points can be verified:

- Sensitivity: this is the responsiveness of a model to changing conditions. For example, if the boundary conditions of the model are changed slightly, the engineer can see if that change affects the model in a large manner or in a small way. Depending on the outcome an informed decision can be taken on the trustworthiness of a model, there should always be a section regarding model sensitivity in any engineering report. (Thornton, 2010)

6 Future of FEA

Due to the high complexity of simulations it is not enough to validate these models using only simple engineering judgement and hand calculations. The physical tests are critical for obtaining credible results. (Thornton, 2010)

A quote by Jack Thornton in their paper “The question of credibility” says: “FEA does not eliminate the need for prototypes, but it can shorten the process. Often only one or two prototypes need to be built and tested before anything new goes into production.” (Thornton, 2010). The verification and validation process in which a simulation model is validated by conducting physical testing is not going to disappear anytime soon, engineers will always be in need to validate their work to showcase to their managers and to move the project ahead. At this moment in time FEA is not powerful enough or “clever” enough, to detect when an engineer is inputting wrong information into the program. Consequently, the software will give the engineer a set of wrong results, which if not validated with another form of testing, such as physical testing, the engineer can use wrong information when designing the component, putting in danger the user of such a component.

Governments have put into law that validation for certain high-risk products must be undertaken. For example, the United States Food and Drug administration states that for a product to achieve approval from the administration it must achieve a 95 per cent reliability of the device and a 99 per cent confidence level. That usually means 400 million test cycles, focused on fatigue life for the worst-case loading condition. (Thornton, 2010) Laws like these will not be overturned easily even if it is proven in

the future that FEA is intelligent enough to not need validation by means of physical testing, because there will always be that 'what if' in the back of any superior's head.

6.1 New FEA technology, Meshless FEA.

Traditional FEA relies on solving complete components by breaking it down into simpler regions (elements). The displacement of these regions is defined by internal shape functions. The functions are controlled by the nodal displacement responses at each degree of freedom at the node. (Abbey, 2019)

Meshless technology delivers results where the accuracy level can be quantified, and the meshing burden is removed. Consequently, it should in theory lower analysis time.

There are different types of meshless FEA, these will be talked about in the following sections.

6.2 Element Free Galerkin Method (EFG)

In this method, the geometry is filled by randomly distributed points. Each point becomes the centre of a local region of influence. Other points are found within the region of influence, creating the basis for a set of shape functions to be created. (Abbey, 2019)

The geometry is filled with regions of influence. The regions can overlap, as well as be discontinuous. (Abbey, 2019)

The internal displacement field is the unknown. However, in traditional FEA the boundary conditions are set at 0 displacement at boundary nodes, while in EFG method, initially they are not zero. An iteration of solutions will be undertaken till there is convergence towards a condition where boundary displacements approach zero, and these reaction forces converge. (Abbey, 2019)

This method is attractive to design engineers because of the non-requirement to prepare a mesh. At the current state it is at, this method is not as accurate as traditional FEA, but if progress is made in this field, considerable computing power can be saved by getting rid of the mesh altogether and thus easing the use of FEA for design engineers. (Abbey, 2019)

6.3 SIMSOLID

This is a meshless software which is used mainly in the early stages of design work, it is not as accurate as traditional mesh FEA, but due to its meshless format it can run a lot of different iterations of your design in a very low timeframe. On the company website they have a case where they could run 10 different iterations of a product in a time slot of 25mins. (Altair, 2020)

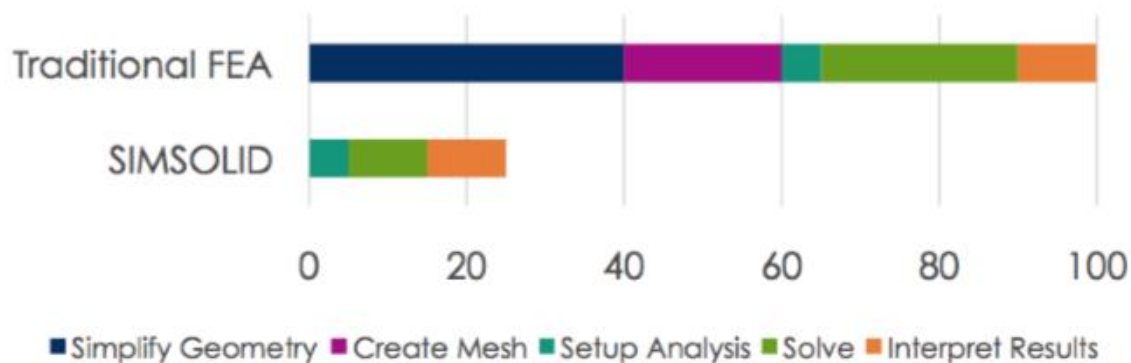


Figure 6 – Traditional FEA vs SIMSOLID timeframe (Altair, 2020)

This kind of software is capable of analysing large assemblies and complex parts, without the need of simplifying or “model clean-up” of any kind, like in traditional FEA. This is a key advantage of meshless FEA. Design engineers when they are modelling a product in CAD can use this kind of meshless FEA, to have a base understanding of what could happen to the product. Consequently, a better product is designed early in the process, which in turn, increases time efficiency. Also, when the model is put into a traditional FEA package to get more accurate results it should theoretically, put out results more in line with what it is looking for. (Altair, 2020)

This kind of FEA could have been implemented into the earlier stages of chassis design to have an approximate torsional rigidity of many different iterations and an informed decision of various different iterations can be chosen to be moved forward for more in depth analysis using traditional FEA methods.



7 Conclusion

Verification and Validation is of utmost importance when modelling a component, the validation by physical testing of the component is not going away any time soon. Head of departments and customers will always want to have that physical testing done to validate that the engineer has not made any mistakes in their virtual model, even if such model is theoretically perfect. What happens in the real world can change due to many factors which simply cannot be modelled into the program.

Meshless FEA is a very interesting concept which is still in its infancy, but if it keeps getting developed as much as current traditional FEA packages are it can definitely be a game changer in the way analysis of components are done, in terms of time and complexity.

SECTION 3 JUST APPEARS TO BE A REPRODUCTION OF DONALD'S WORK,
(1 4 " " " MOSTLY A " " SCHWERS "

EACH OF YOUR SECTIONS JUST APPEARS TO BE REPEATING THE VIEWS OF 1 OR 2
AUTHORS. YOUR REPORT SHOULD PUT TOGETHER AN ARGUMENT FROM MANY AUTHORS.

8 References

- Abbey, T. (2019, January 01). *Meshless FEA Opportunities*. Retrieved from Digital Engineering 247: <https://www.digitalengineering247.com/article/meshless-fea-opportunities/simulate>
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