Pre-project MTP-K-2019-06

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1 Goal and Framework

1.1 Briefing

This thesis is the culmination of a life-long interest in composites. The remarkable mechanical performance and versatility of composites will very likely make them the building blocks of tomorrow. Though, due to the highly anisotropic properties of typical composites, the processes involving the design, manufacturing and validation are highly complex. A deeper insight of the possibilities and limitations of composites will undoubtedly be a valuable asset going forward.

I'm looking forward to be exploring the rather uncharted waters of the task at hand.

1.2 Topic definition

The purpose of this thesis it to develop a method for optimizing complex composite structures, considering both the topology and the parameters of the composite layup. After a converging process has been established, the results will be validated through computer simulations. A possible composite structures could be a carbon fiber bicycle frame, a carbon fiber bicycle rim or a carbon fiber alpine ski.

1.3 Performance Goals

- To have an quasi-automated process generating, from a set of boundary conditions, a structure that would outperform the same structure if it was designed the conventional way.

1.4 Effect goals

- A process one can use to generate high performing parts without an expertise in composites.

On a more personal level:

- Using genetic algorithms in an optimization process.
- Be able to link otherwise incompatible optimization processes using software.
- A deeper understanding of the optimization process itself.
- Gain experience using the "scientific method"
- Using time management to my advantage
- Making myself sought-after regarding potential future jobs or consulting work.

1.5 Framework

This thesis is hugely dependent on the access to proper CAE tools. There are complex simulations involved in several steps of the process, requiring advanced FEA and optimization software packages. These demands should be covered mostly be the Simulia package from Dassault Systems. Especially Isight Abaqus and Tosca will be used in this thesis. This software should be available at NTNU. There will be no physical model or real life validation of this project, mostly due to budget and time constraints. Time expenditure is expected to be well beyond 500 hours on this project.

2 Organization

The writing party of this thesis consists solely of Tarjei Hofset. The supervisor is Anna Olsen at NTNU.

3 Execution

3.1 Main tasks

3.1.1 Research and software acquainting

The first part of this thesis consists of gathering as much information and acquiring as much knowledge about relevant subjects as possible. Just finding the right steps and tools that will result in a reasonable pathway through the many sub-processes is a huge task.

Familiarizing with the different software is imperative to get an understanding of the possibilities and limitations of each program.

3.1.2 Fully defining the task

At this stage, there's a need of more research before the process can be fully defined. Nuances, such as weather to focus on a hollow construction or not, is yet to be determined. Thus, a certain ambiguity exists at the time of writing.

3.1.3 Choosing boundary conditions and optimization goals

When the task at hand is clear, one can start to lock down the defining constraints of the processes. An example could be deciding to constrain the amount of different ply angles, giving better manufacturability. Design space, external loads and potential fixtures will also be set at this stage.

3.1.4 Developing sub-processes

The whole process consists of several sub-processes that needs a lot of tweaking and figuring out of. Ensuring protection against non-converging results will be important here.

3.1.5 Knitting processes together

This is the part where the different steps and processes come together. input arguments of one process will most likely be a output from the task before. Variables and other values will quite possibly need conditioning between the different processes.

3.1.6 Ensuring total convergence

Debugging and making sure that the whole process converges and gives reasonable results.

3.1.7 Post-processing

The output of the optimization process will more than likely need conditioning and possibly converting to a parametric model more suitable for further testing and validation.

3.1.8 Validation

Does the results meet the criteria and do they actually preform better than their conventional counterpart? FEA of the results will provide a reasonable metric for determining the success of the process.

3.2 Milestones

15.02.2019 - Deadline pre-project
22.02.2019 - Software package installed
01.03.2019 - Fully defined task
10.04.2019 - Title
01.05.2019 - Total convergence achieved
08.05.2019 - Results validated
20.05.2019 - Thesis done.
May/June - Thesis presentation

4 Follow-up and Validation

4.1 Validation and quality assurance

- Supervisor Anna Olsen will be involved when needed.
- Friends and family with relevant knowledge and experience will be a contributing factor along the way. Formula 1 engineers, Software Architects and Carbon fiber experts are all people that may be consulted.
- "task management" software will be used extensively throughout the project, assuring that important tasks will be done on schedule.

4.2 Reports

Several status reports are scheduled through this project, ensuring that supervisor Anna Olsen is up-to-date on the progress.

5 Risk assessment

There are several potential pitfalls on this project. One concern at the time of writing is that it it simply too extensive of an undertaking. As stipulated, this project might be better suited as a master thesis. It is by no means impossible, though.
Another concern is that the processes wont converge, thus rendering the results unusable.

6 Appendix

6.1 Gantt Diagram

This is a link to a continuously updating gantt chart and below is the chart as of 14.02.2019

MTP-K-2019-06	Start Date	End Date	Status
	Today is 14/02/2019		28,57%
BACHELOR	07.01.2019	20.05.2019	Week 5 of 19
Pre-project	11.01.2019	15.02.2019	Complete
Agreement Document	07.01.2019	11.01.2019	Complete
Modular Gantt Chart development	11.01.2019	20.01.2019	Complete
Genetic algorthm research	25.01.2019	05.02.2019	Complete
Pinpoint topic	07.01.2019	10.02.2019	Complete
Pre-project research	07.01.2019	15.02.2019	Complete
Pre-project document	10.02.2019	15.02.2019	Complete
Prelimenary timeline outline	12.02.2019	15.02.2019	Complete
Main Project	15.02.2019	20.05.2019	Upcoming
Title	01.04.2019	10.04.2019	Upcoming
Research	15.02.2019	01.03.2019	Upcoming
Getting software	15.02.2019	22.02.2019	Upcoming
Defining task	15.02.2019	01.03.2019	Upcoming
Boundaries and optimization goals	25.02.2019	10.03.2019	Upcoming
Sub process development	01.03.2019	15.04.2019	Upcoming
Process knitting	10.04.2019	25.04.2019	Upcoming
Total Convergence	15.04.2019	01.05.2019	Upcoming
Post-processing	01.05.2019	05.05.2019	Upcoming
Validation	05.05.2019	08.05.2019	Upcoming
Thesis construction	01.05.2019	15.05.2019	Upcoming
Thesis revision	15.05.2019	20.05.2019	Upcoming

Timeline

Color codes

- Upcoming
- Active
- Past start / not active
- Past due / not complete
- Complete

6.2 Address list

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6.3 Agreement Document

See attached PDF